UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 2, 1993

Docket No. 50-390

APPLICANT: Tennessee Valley Authority (TVA)

FACILITY: Watts Bar Nuclear Plant, Units 1 and 2

SUBJECT: MEETING SUMMARY - OCTOBER 13, 1993 MANAGEMENT MEETING ON USE OF U-BOLTS AS PIPE CLAMPS (TAC M79718)

REFERENCE: Meeting Notice by P. S. Tam, September 21, 1993

TVA requested this meeting to discuss with NRR senior managers the use of U-bolts as pipe clamps at Watts Bar Unit 1. Based on the review of pertinent TVA submittals, the staff, on September 13, 1993, issued a safety evaluation which states that "... the staff finds that TVA has not provided sufficient justification to demonstrate that the U-bolt pipe clamps as used at Watts Bar are acceptable. Further, the staff considers the U-bolt pipe clamp a poor design that is not recommended by the industry standard on pipe support design, WRC Bulletin 353."

Enclosure 1 lists the meeting participants and observers. Enclosures 2 and 3 are handout materials used by TVA.

TVA participants stated that their survey finds that a number of nuclear plants have employed U-bolts as pipe clamps (e.g., Clinton, Diablo Canyon, Fermi, Limerick, Vogtle, Shearon Harris, Susquehanna), and that they could not find any specific safety evaluation written by the staff on such. In this context, TVA did not state whether or not these utilities employ the U-bolt supports in configurations or applications in the same manner as TVA. They further stated that while WRC Bulletin 353 says that U-bolts are not recommended, it nevertheless described ways to use them acceptably. Pages 6 through 12 of Enclosure 2 summarize TVA's rebuttal of the staff's September 13, 1993 safety evaluation. In addition, TVA participants claimed that the chairman of the industry group that wrote WRC Bulletin 353 agreed with their interpretation.

The staff asked what the estimated cost would be if all U-bolts were replaced with standard pipe clamps. TVA stated that about 380 U-bolts would have to be replaced at an estimated cost of five million dollars, and would not likely result in a significant impact on Watts Bar's completion schedule.

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The staff requested TVA to submit detailed information on the matters discussed in the meeting, including specific details on the methods and calculations used to support its position. The staff would then review this information to determine if its decision on this issue needs to be revisited.

Original signed by

Peter S. Tam, Sr. Project Manager
Project Directorate II-4
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
1. Participant List
2. TVA Handout Material
3. TVA Slides (not originally intended as handout)

cc w/enclosures:
See next page

OFFICE	PDII-4/LA	PDII-4/PM	EMEB/BC	DE/D	PDII-4/D
NAME	BClayton	PTam	JNorberg	JWiggins	FHebdon
DATE	10/28/93	10/28/93	10/1/93	10/1/93	10/2/93

DOCUMENT NAME: UBOLTMTG

cc:
Mr. Craven Crowell, Chairman
Tennessee Valley Authority
ET 12A
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. W. H. Kennoy, Director
Tennessee Valley Authority
ET 12A
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. Johnny H. Hayes, Director
Tennessee Valley Authority
ET 12A
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. D. E. Nunn, Vice President
Tennessee Valley Authority
3B Lookout Place
1101 Market Street
Chattanooga 37402-2801

Mr. W. J. Museler, Vice President
Watts Bar Nuclear Plant
Tennessee Valley Authority
Route 2, P.O. Box 800
Spring City, TN 37381

Mr. B. S. Schofield, Manager
Nuclear Licensing and Regulatory Affairs
Tennessee Valley Authority
4G Blue Ridge
1101 Market Street
Chattanooga, TN 37402-2801

Mr. G. L. Pannell
Site Licensing Manager
Watts Bar Nuclear Plant
Tennnessee Valley Authority
Route 2, P.O. Box 800
Spring City, TN 37381

TVA Representative
Tennessee Valley Authority
11921 Rockville Pike
Suite 402
Rockville, MD 20852

General Counsel
Tennessee Valley Authority
ET 11H
400 West Summit Hill Drive
Knoxville, TN 37902

The Honorable Robert Aikman
County Executive
Rhea County Courthouse
Dayton, TN 37321

The Honorable Garland Lanksford
County Executive
Meigs County Courthouse
Decatur, TN 37322

Mr. Michael H. Mobley, Director
Division of Radiological Health
3rd Floor, L and C Annex
401 Church Street
Nashville, TN 37243-1532

Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW., Suite 2900
Atlanta, GA 30323

Senior Resident Inspector
Watts Bar Nuclear Plant
U.S. Nuclear Regulatory Commission
Route 2, Box 700
Spring City, TN 37381

Ms. Danielle Droitsch
Energy Project
The Foundation for
Global Sustainability
P.O. Box 1101
Knoxville, TN 37901

Mr. Bill Harris
Route 1, Box 26
Ten Mile, TN 37880

Distribution
Enclosure 1

T. Murley/ F. Miraglia	12-G-18
J. Callan	12-G-18
W. Russell	
J. Wiggins	
S. Varga	
G. Lainas	
F. Hebdon	
P. Tam	
B. Clayton	
OGC	15-B-18
E. Jordan	MNBB-3701
L. Callan	12-G-18
T. Chan	7-E-23
J. Norberg	7-E-23
ACRS (10)	
L. Plisco	17-G-21
E. Merschoff	RII

Enclosures 1, 2 and 3

Docket File
NRC & Local PDRs
WBN Rdg. File
P. Tam/C. Jackson
E. Merschoff

ENCLOSURE 1

LIST OF PARTICIPANTS AND OBSERVERS

MANAGEMENT MEETING ON USE OF U-BOLTS AT WATTS BAR

October 13, 1993

Name	Affiliation
L. Joseph Callan	NRC/NRR/Acting Asso. Dir. for Projects
Terence L. Chan	NRC/NRR/Mechanical Engineering Branch
R. L. Cloud	TVA contractor, RLC Associates
Walt Elliot	TVA/Watts Bar Engineering
Frederick Hebdon	NRC/NRR/Project Directorate II-4
Gus Lainas	NRC/NRR/Div. of Reactor Projects
Mark Medford	TVA/VP for Technical Support
William Museler	TVA/Watts Bar Site VP
Jim Norberg	NRC/NRR/Mechanical Engineering Branch
George Pannell	TVA/Watts Bar Site Licensing
James G. Partlow	NRC/NRR/Associate Director for Projects
William T. Russell	NRC/NRR/Associate Director for Inspection and Technical Assessment
Peter Tam	NRC/NRR/Project Directorate II-4
S. A. Varga	NRC/NRR/Div. of Reactor Projects
Jim Wiggins	NRC/NRR/Director, Division of Engineering
H. Lee Williams	TVA/Chief Civil Engineer
Richard Zuercher	Reporter, Inside NRC

Enclosure

WATTS BAR NUCLEAR PLANT

NRC/TVA MEETING

U-BOLTS

ROCKVILLE, MD

OCTOBER 13, 1993

NRC MEETING
U-BOLTS
WATTS BAR NUCLEAR PLANT

• OPENING REMARKS	MEDFORD
• ISSUE DEFINITION	MUSELER
• BACKGROUND	WILLIAMS
• DISCUSSION OF KEY TECHNICAL ISSUES	WILLIAMS
• SUMMARY AND CONCLUSIONS	ELLIOTT

ISSUE DEFINITION

U-Bolt Issue

NRC believes that WBN U-bolt pipe supports in combination with struts and snubbers are not acceptable.

NRC position based on:

- Precedent - U-Bolts not used at Comanche Peak
- Compliance with WRC Bulletin 353
- Applicability of U-Bolt Testing
- Pipe and Pipe Support Deflections
- Local Pipe Stresses

Precedent Issue

U-Bolts not approved at Comanche Peak.

TVA Response

- U-Bolt designs changed by Texas Utilities as a Mgmt./Schedule decision.
- U-Bolt designs similar or identical to WBN designs exist at eight plants (11 units) licensed since issue raised at Comanche Peak.
- WBN U-Bolt designs meet Regulatory and Code requirements.
- Based on the above, TVA considers the NRC position to be a ratchet under 10CFR50.109

WRC Bulletin 353 Issue

WBN U-Bolt designs do not comply with WRC Bulletin 353.

TVA Response

- WRC Bulletin is not a Regulatory requirement.
- Bulletin discusses and provides guidance for U-Bolt use specific to two design types involving trapeze hangers.

  WBN complies with the use of the two specific types.
- WBN U-Bolt designs address the criteria of WRC 353, including specified "do's and don'ts".
- NRC has not identified any non-compliance with the ASME Code or WRC 353.

BACKGROUND/TECHNICAL DISCUSSION

ISSUE BACKGROUND

1984

- COMANCHE PEAK U-BOLT CINCHING ISSUE
  - TU DECISION TO ELIMINATE ALL U-BOLTS AT COMANCHE PEAK

1985

- PIR WRITTEN AT WBN ON U-BOLT APPLICATIONS ON TRAPEZE SUPPORTS
  - FOLLOW-UP TVA CALC ENDORSED G-53 SPECIFICATION TORQUE

1987

- WBN - HAAUP PROGRAM IDENTIFIED
  - U-BOLT W/TRAPEZE SUPPORT STABILITY WAS IDENTIFIED
  - DUKE POWER/CLOUD CALCS INDEPENDENTLY CONCLUDED G-53 SPECIFICATION VALUES ACCEPTABLE FOR STABILITY

1989 & 1990

- WBN - ENGINEERING REVERIFICATION OF ALL LARGE BORE SUPPORTS
  - FOR SOME SUPPORTS, RECALCULATED MIN. TORQUE VALUES LOWER THAN SPEC G-53 VALUES

1990

- WRC BULLETIN 353 ISSUED

1992

- WBN - IDI INSPECTIONS
  - U-BOLTS TRAPEZE ROTATED UNDER PERSONNEL WEIGHT
  - 1990 CALCULATION ESTABLISHING TORQUE FOUND TO BE IN ERROR
  - CORRECT TORQUE WOULD HAVE PREVENTED ROTATION (DEMONSTRATED BY FIELD TEST DURING IDI)

1993

- FOUR INFORMATION SUBMITTALS FORWARDED IN RESPONSE TO NRC QUESTIONS
  - TWO TECHNICAL MEETINGS

KEY TECHNICAL ISSUES

NRC SAFETY EVALUATION ON USE OF U-BOLTS

- WATTS BAR U-BOLT DESIGNS DO NOT PROVIDE REASONABLE ASSURANCE THAT THE SUPPORTS WILL FUNCTION UNDER ALL ANTICIPATED LOADING CONDITIONS BASED ON THE FOLLOWING:
  - COMANCHE PEAK PRECEDENCE
  - WRC BULLETIN 353
  - APPLICABILITY OF TESTING
  - PIPING/SUPPORT DEFLECTION
  - LOCAL PIPE STRESS

WBN RESPONSE

- PROPERLY ENGINEERED U-BOLT CONFIGURATIONS MEET APPLICABLE ASME CODES AND CRITERIA, ARE STABLE AND WILL PERFORM THEIR INTENDED FUNCTION.

COMANCHE PEAK PRECEDENCE

SER CONCERN

BECAUSE OF TECHNICAL CONCERNS . . . THE APPLICANT (TU) DECIDED TO REPLACE ALL OF THESE DESIGNS AT COMANCHE PEAK.

WBN RESPONSE

TOTAL TU PROGRAM NOT COMPLETED NOR SUBMITTED FOR REVIEW BY STAFF.

WESTINGHOUSE PROGRAM CONCLUDED THAT PROPERLY ENGINEERED U-BOLTS CAN PERFORM DESIGN FUNCTIONS.

TVA HAS REVIEWED W PROGRAM AND FOUND IT TO BE TECHNICALLY DEFENSIBLE AND APPLICABLE TO WBN.

WATTS BAR HAS SUPPLEMENTED AND ENHANCED PROGRAM BEGUN BY TU/WESTINGHOUSE/RLCA.

EIGHT PLANTS (11 UNITS) WITH SIMILAR CONFIGURATIONS HAVE BEEN LICENSED SINCE COMANCHE PEAK ISSUE RAISED.

WRC BULLETIN 353

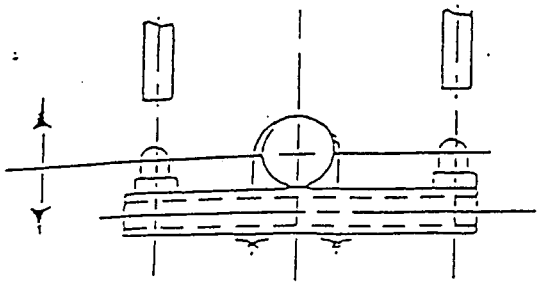
SER CONCERN

SECTION 2.4.5.3 TRAPEZE ASSEMBLIES "TIGHT-FIT U-BOLTS ARE OFTEN USED IN SUPPORT ASSEMBLIES TO PROVIDE SUPPORT IN ONE DIRECTION FOR ROD HANGERS AND TWO DIRECTIONS FOR STRUTS AND SNUBBERS. THE LATTER DESIGN IS NOT RECOMMENDED (REFER TO SECTION 2.4.1) FOR STABILITY REASONS."

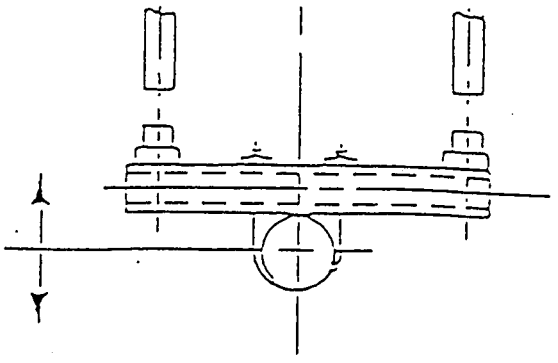
WBN RESPONSE

- CLARIFICATION OF WBN SUPPORTS
  - ROD HANGERS ON SAFETY PIPING USED IN ONE DIRECTION ONLY.
  - U-BOLTS WITH STRUTS OR SNUBBERS USED IN VERTICAL OR LATERAL DIRECTION ONLY.
  - WRC 353, SECTION 2.4.5.3 CONTINUES WITH:

    "IN THESE TYPE OF APPLICATIONS, THE U-BOLT IS PRIMARILY IN TENSION. THIS TYPE OF SUPPORT CAN BE USED FOR ALL SIZES OF PIPE. SEE FIGURES 6 AND 9."
- WBN PERFORMED INSITU TESTING TO VERIFY STABILITY
- WRC 353 PROVIDES SPECIFIC GUIDANCE FOR USE OF U-BOLTS
  - WBN COMPLIES WITH DO'S AND DON'TS

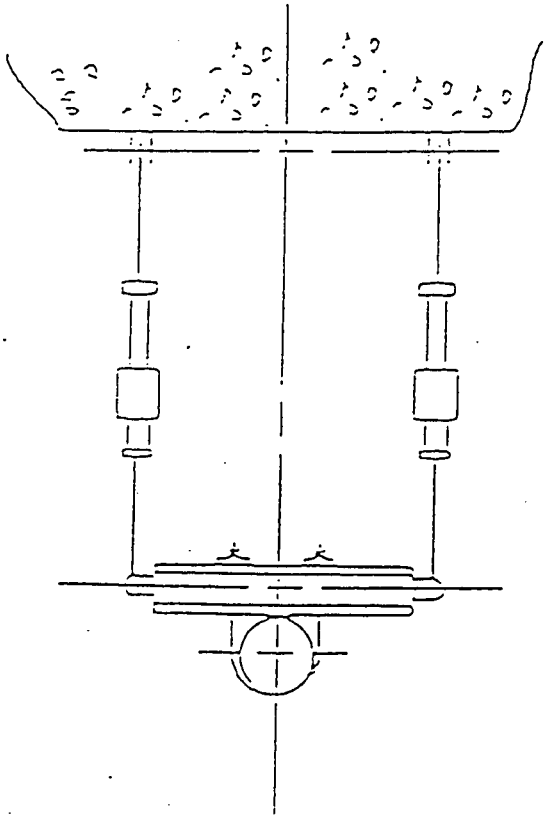


USE OF U-BOLT IN A RESTRAINT-TYPE TRAPEZE HANGER

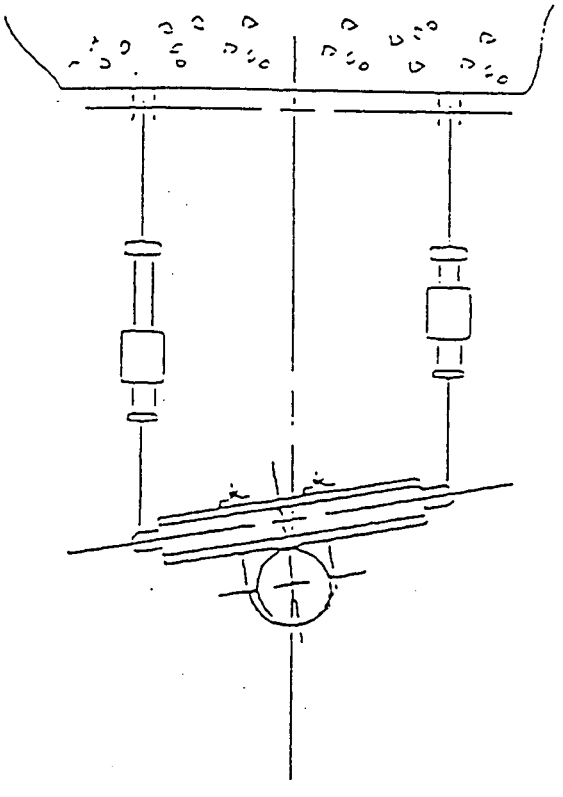


ALTERNATE USE OF U-BOLT IN A RESTRAINT-TYPE TRAPEZE HANGER

FIG. 6 - TIGHT FIT



U-BOLT PROPERLY TORQUED
STABLE



U-BOLT NOT PROPERLY TORQUED
UNSTABLE

FIG. 9 - TIGHT FIT U-BOLTS IN TRAPEZE ASSEMBLIES

APPLICABILITY OF TESTING

SER CONCERN	WBN RESPONSE
ONE SEISMIC TEST PERFORMED BY WESTINGHOUSE	•TEST WAS WORST CASE BASED ON 10" SS PIPE HAVING HIGHEST STRESSES BY EVALUATION •SEISMIC ONLY ONE ASPECT OF SIGNIFICANT TESTING PROGRAM
U-BOLT SLID AXIALLY DURING W SEISMIC TEST	• U-BOLT MOVED AXIALLY BY 1/2" MOVEMENT. INSIGNIFICANT COMPARED TO OFFSET ALLOWABLES •10 TIMES DURATION AND TWO TIMES LOAD • RESTRAINT REMAINED STABLE
GLOBAL PIPE BENDING STRESS LEVEL IN W TEST NOT DISCUSSED	EFFECT ON BENDING STRESSES ARE ADDRESSED IN QUALIFICATION METHODS TO ASME CODE
W TEST NOT DIRECTLY APPLICABLE TO WBN DESIGNS	TESTING CONDUCTED ON POINT CONTACT BETWEEN PIPE/CROSS-MEMBER. SPECIFIC SUPPORT CONFIGURATIONS EVALUATED CASE BY CASE
DIFFERENCES BETWEEN W TEST RESULTS AND FINITE ELEMENT ANALYSIS CAUSES THE TESTS TO BE OF LIMITED USE	W REPORT RESULTS ARE CONSISTENT WITH TYPICAL COMPARISON BETWEEN TESTING AND ANALYSIS
W TEST PERFORMED WITHOUT BELLEVILLE WASHER ASSEMBLIES	NO EFFECT - LOADS CARRIED BY COLLARS IN AXIAL COMPRESSION

- IN CONJUNCTION WITH THE WBN U-BOLT PROGRAM ELEMENTS, WESTINGHOUSE TESTING PROVIDES REASONABLE ASSURANCE THAT THE WBN DESIGNS WILL FUNCTION UNDER ALL ANTICIPATED LOADING CONDITIONS

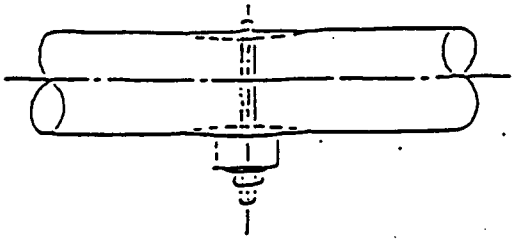
PIPING/SUPPORT DEFLECTION

SER CONCERN

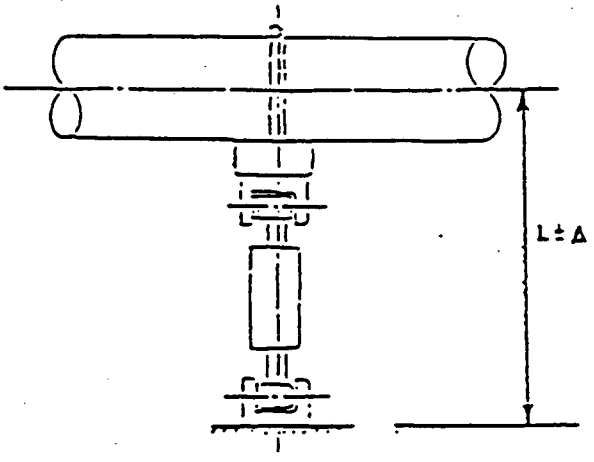
STAFF QUESTIONED WHETHER DEFLECTION EXPERIENCED DURING THE LOCAL PIPE STRESS EVALUATION AND/OR FLEXIBILITY OF WBN DESIGN EXCEEDED THE ALLOWABLE GLOBAL DEFLECTION LIMITS SPECIFIED IN THE FSAR.

WBN RESPONSE

- WBN FSAR CRITERIA LIMITS TO 1/8" GLOBAL SUPPORT DEFLECTION
- LOCAL PIPE DEFLECTION INDEPENDENT OF GLOBAL DEFLECTION
  - INDUSTRY PRACTICE
  - MEETS ASME CODE



LOCAL PIPE DEFLECTION
ASME CRITERIA



GLOBAL SUPPORT SYSTEM DEFLECTION
FSAR REQUIREMENTS

LOCAL PIPE STRESSES

SER CONCERN

- TECHNICAL BASIS NOT PROVIDED TO DETERMINE ACCEPTABLE LOCAL BEARING LOAD ON PIPE.

WBN RESPONSE

- MEETS REQUIREMENTS OF ASME CODE
  - NC-1100 PROVIDES FOR USE OF ALTERNATE METHODS WHERE COMPLETE DETAILS ARE NOT PROVIDED
  - LOCAL U-BOLT BEARING LOAD EVALUATED UNDER NB-3228.1
- TO PROVIDE ASSURANCE OF LOCAL PIPE ACCEPTABILITY, THE FOLLOWING WERE PERFORMED:
  - DETERMINE ALLOWABLE BEARING LOAD ON PIPE
  - DEMONSTRATE APPLIED LOADING < ALLOWABLE LOCAL BEARING LOAD
  - SUPPORTS WHICH EXCEEDED ALLOWABLE LOCAL BEARING LOAD WERE MODIFIED

CONCLUSION: LOCAL PIPE BEARING LOAD EVALUATION MEETS ASME CODE REQUIREMENTS, INCLUDES APPLICATIONS TO ALL CONFIGURATIONS AND IS CONSERVATIVE.

SUMMARY AND CONCLUSION

SUMMARY OF WBN APPROACH FOR U-BOLT UTILIZATION

AS A RESULT OF NRC ISSUES RAISED, WBN HAS INITIATED:

COMPLETE ENGINEERING PROGRAM

- CONSISTING OF TESTING, ANALYSIS, APPROPRIATE ACCEPTANCE CRITERIA, DETAILED INSTALLATION PROCEDURE, INDIVIDUALLY ANALYZED SUPPORTS

- TWELVE STATIC EQUIVALENT TESTS CONFIRMED TORQUE REQUIREMENTS AND INSTALLATION PROCEDURE

SUPPORT DESIGN IMPROVEMENTS

- ENGINEERED BELLEVILLE SPRING STACKS

- MODIFICATION OF SUPPORTS THAT DID NOT MEET DESIGN REQUIREMENTS

OVERALL CONCLUSIONS

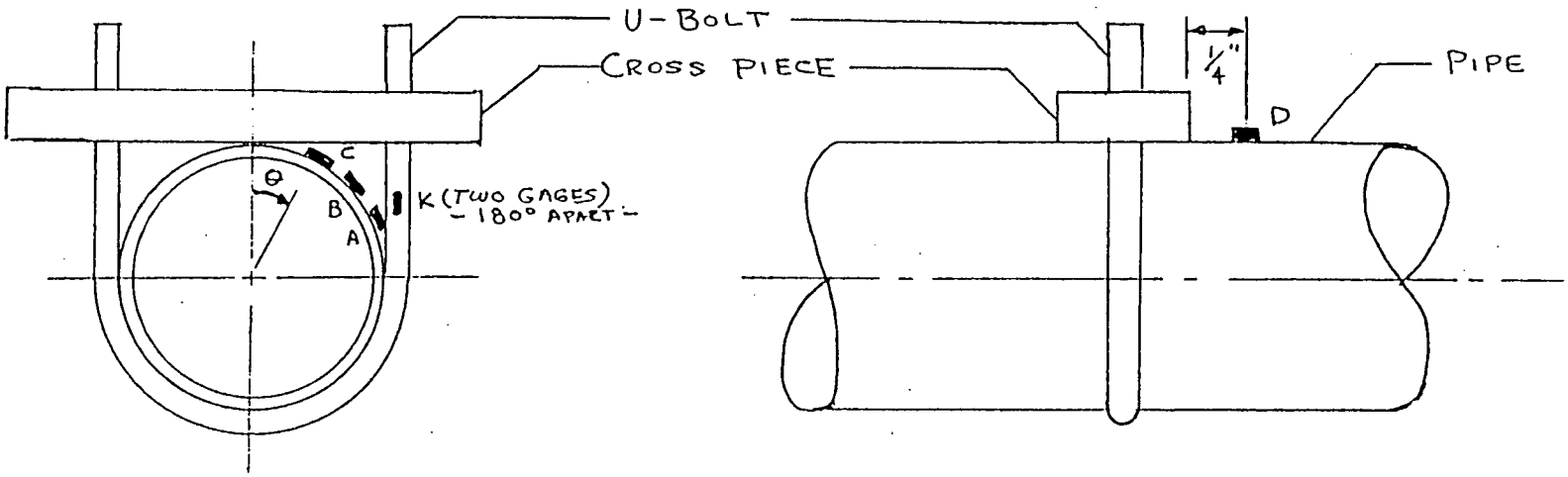
- U-BOLT PIPE SUPPORTS HAVE BEEN PROPERLY ENGINEERED AND ARE CONSISTENT WITH INDUSTRY PRACTICE.

- WBN DESIGN METHODOLOGY FOR USE OF U-BOLTS MEETS CODE AND ENGINEERING REQUIREMENTS.

- WBN PROGRAM FOR U-BOLTS ENSURES PIPING INTEGRITY.

TABLE 1
COMPARISONS OF W ANALYSIS/TEST RESULTS
(WCAP-1067 AND WCAP-10620)

GAGE	LOCATION DESCRIPTION/ ORIENTATION	STRESSES AT MAXIMUM PRELOAD (P_{MAX})											
		4" SCH 80 PIPE P_{MAX} = 60 FT-LBS			10" SCH 40 PIPE P_{MAX} = 100 FT-LBS			10" SCH 80 PIPE P_{MAX} = 100 FT-LBS			32" (t=1.45") PIPE P_{MAX} = 240 FT-LBS		
		θ	Test	Analysis	θ	Test	Analysis	θ	Test	Analysis	θ	Test	Analysis
C	PIPE/HOOP	20	-7140	-12137*	15	-15708	-20040	15	-8092	-14170	7	-1568	-4859
B	PIPE/HOOP	45	2408	3413	45	13608	11536	45	5660	6261	45	420	789
A	PIPE/HOOP	70	4424	*9520	75	11900	13568	75	5964	8910	83	0	1113
D	PIPE/LONGIT.	-	-2996	-3787	-	-7560	-20561	-	-672	-8291	-	-308	-493
K	U-BOLT/AXIAL	-	26628	27544	-	12838	12726	-	17164	17008	-	644	1018



* AVERAGE FOR TWO FEA ELEMENTS

Enclosure 2

TABLE 1: BOUNDING EQN 9 AND 10 INTENSIFIED MOMENTS

Support No.	Support Type	Pipe Dia.	Fitting Type	*i* (SIF)	ASME Eq. 10 Mom (ft-kips)	ASME Eq. 9 Mom (ft-kips)	i * (Eq. 10 M) + 0.75 i * (Eq. 9 M)	Mom @ Pc (1) (ft-kips)	Ratio
631SISR161	STRUT	14	TEE	2.32	17.393	18.466	72.5	87	0.83
631SISR109	SNUB	24	---	1.0	8.578	140.958	149.5	188	0.80
103A453	SNUB	6	---	1.0	5.653	14.492	20.1	27	0.75
631SISR137	STRUT	14	TEE	2.32	3.877	28.853	59.2	87	0.68
671ERCWR365	SNUB	8	ELB	1.84	12.733	2.234	26.5	39	0.68
631SISR138	STRUT	14	ELB	2.94	2.137	23.623	58.4	87	0.67
103A482	SNUB	6	---	1.0	4.726	12.609	17.3	27	0.64
47A42705023	STRUT	6	---	1.0	2.581	14.691	17.3	27	0.64
03B1AFWR209	SNUB	4	---	1.0	8.578	1.160	9.7	17	0.57
103A280	SNUB	16	---	1.0	14.812	41.756	56.6	107	0.53
03B1AFWR175	STRUT	4	ELB	1.5	4.083	2.197	8.6	17	0.51
103A487	SNUB	6	---	1.0	2.809	10.643	13.5	27	0.50
47A46501066	SNUB	4	ELB	1.95	1.927	1.454	5.9	17	0.35
03B1AFWR147	STRUT	4	ELB	1.5	3.173	0.413	5.2	17	0.31
47A40006118	SNUB	4	ELB	1.0	4.842	0.218	5.1	17	0.30
47A49606009	SNUB	4	---	1.0	3.730	1.144	4.9	17	0.29
47A46503048	SNUB	3	ELB	1.8	1.495	0.606	3.5	12	0.29
103A320	SNUB	16	---	1.0	10.755	18.222	29.0	107	0.27
47A40108001	SNUB	6	---	1.0	3.396	2.720	6.1	27	0.23
103A582	SNUB	2	---	1.0	0.017	1.050	1.1	7.5	0.14
162A466	SNUB	3/4	---	2.1	0.054	0.080	0.2	3	0.08
47A46508092	STRUT	1	---	2.1	0.038	0.103	0.2	4	0.06
162A406	SNUB	3/4	---	2.1	0.060	0.030	0.2	3	0.06
162A431	SNUB	1	---	2.1	0.008	0.070	0.1	4	0.03
47A40610018	SNUB	1	---	1.0	0.009	0.054	0.1	4	0.02

NOTES:

1. If the quantity 0.75 * i is less than 1.0, use 1.0; otherwise use 0.75 * i.

WBN TYPICAL TRAPEZE ARRANGEMENT

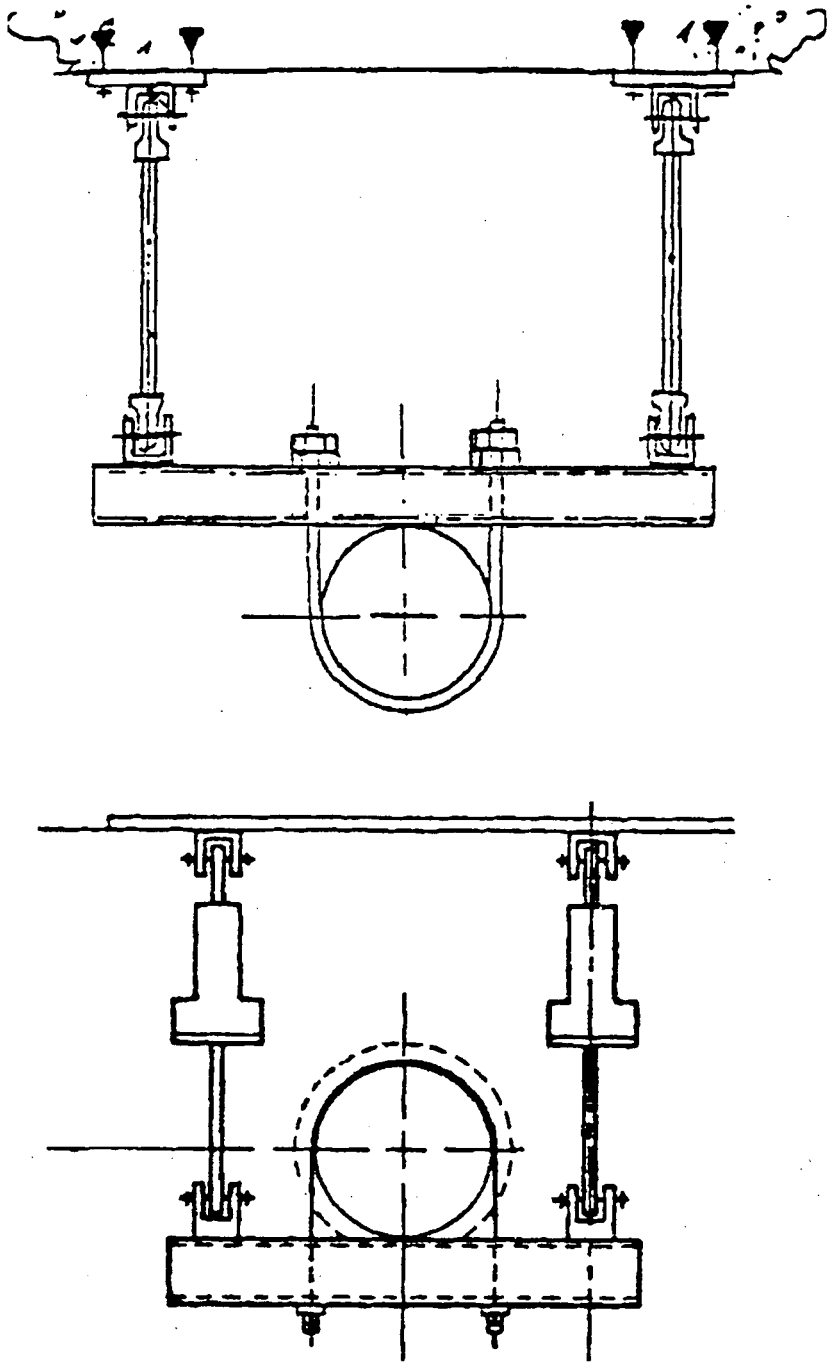


TABLE 2: BOUNDING AMPLIFIED FORCES

1	2	3	4	5	6	7	7A	8	9
Support No.	Support Type	Pipe Dia.	Fitting Type	*i* (SIF)	(1) Critical Comp.	(2) F p (kips)	(3) Fp (amp) (kips)	P c (kips)	Ratio Fp(amp) / Pc col.7A / col.8
631SISR138	STRUT	14	ELB	2.94	P	14.78	22.81	24.15	0.94
631SISR161	STRUT	14	TEE	2.32	P	15.29	21.62	24.15	0.90
631SISR137	STRUT	14	TEE	2.32	P	15.53	20.00	24.15	0.83
47A46501066	SNUB	4	ELB	1.95	P	3.88	4.52	6.79	0.66
47A40610018	SNUB	1	---	1.0	P	3.72	3.72	6.51	0.57
162A466	SNUB	3/4	---	2.1	P	4.67	4.71	8.46	0.56
103A482	SNUB	6	---	1.0	X	17.40	17.40	31.32	0.56
103A280	SNUB	16	---	1.0	P	53.41	53.41	96.49	0.55
03B1AFWR147	STRUT	4	ELB	1.5	P	8.28	8.46	15.30	0.55
631SISR109	SNUB	24	---	1.0	P	18.56	18.56	34.37	0.54
103A487	SNUB	6	---	1.0	U	13.15	13.15	24.88	0.53
103A320	SNUB	16	---	1.0	U	53.01	53.01	105.19	0.50
103A582	SNUB	2	---	1.0	P	3.10	3.10	6.63	0.47
47A42705023	STRUT	6	---	1.0	U	14.90	14.90	32.75	0.45
47A46503048	SNUB	3	ELB	1.8	P	2.03	2.30	5.06	0.45
47A40108001	SNUB	6	---	1.0	P	9.62	9.62	23.22	0.41
162A406	SNUB	3/4	---	2.1	P	1.01	1.03	3.06	0.34
47A49606009	SNUB	4	---	1.0	P	3.92	3.92	12.17	0.32
47A40006118	SNUB	4	ELB	1.0	X	2.99	2.99	10.09	0.30
03B1AFWR175	STRUT	4	ELB	1.5	U	3.17	3.34	14.27	0.23
162A431	SNUB	1	---	2.1	U	1.77	1.83	8.46	0.22
47A46508092	STRUT	1	---	2.1	U	0.78	0.88	5.39	0.16
03B1AFWR209	SNUB	4	---	1.0	U	2.69	2.69	17.15	0.16
103A453	SNUB	6	---	1.0	U	14.64	14.64	102.58	0.14
671ERCWR365	SNUB	8	ELB	1.84	X	3.58	3.88	35.04	0.11

NOTES:

1. P = Pipe; U = U-Bolt; X = Cross Piece
2. Value of Fp obtained from TVA Calculations TEACEBEMG72, Rev. 2, TEACEBEMG74, Rev. 2, and
3. Fp(amp) = 2 (Ui + Ut + Up + 0.75i * P/2 * [1 / (alpha * (Kp / Kcl + 1)])