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SCHWENCER,A. Licensing Branch 2

SUBJECT: Forwards sweepolet stress calculation per SER,NUREG-0892, Confirmatory Issue 6 & 820930 telcon.

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December 8, 1982
GO2-82-968
SS-L-02-PLP-82-086

Docket No. 50-397

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Schwencer:

Subject: NUCLEAR PROJECT NO. 2
SWEEPOLET STRESS CALCULATION (ATTACHED)

As committed to in a phone conversation (September 30, 1982) between Mr. R. Auluck (NRC), Ms. R. Li (NRC), Mr. J. Prevost (ETEC), Mr. J. Thompson (GE), and Mr. P.L. Powell (SS), the attached stress report prepared by General Electric for WNP-2 is forwarded.

This report is provided to aid in evaluation of Confirmatory Issue (6) of the WNP-2 Safety Evaluation Report, NUREG-0892. Should you have any questions, please contact Mr. R.M. Nelson, Manager, WNP-2 Licensing.

Very truly yours,

GD Bouchey

G. D. Bouchey
Manager, Nuclear Safety and Regulatory Programs

PLP/jca
Attachment

cc: R Auluck - NRC
WS Chin - BPA
R Feil - NRC Site
R Li - NRC
J Prevost- ETEC
J Thompson-GE

B001

DESIGN MEMO 170-54

SUBJECT: HANFORD 2 SWEEPOLET STRESS CALCULATION

PREPARED BY: H. L. Hwang Oct. 28, 82
H. L. Hwang

REVIEWED BY: D. L. Thompson
D. L. Thompson

October 28, 1982

PURPOSE

This design memo presents the justification for the method of calculating stresses in sweepolets used in the Hanford-2 Main Steam Piping analysis.

DISCUSSION

Three basic questions concerning the method of calculating safety relief valve Sweepolet stresses have been raised by reviewers: (1) the technical basis for using Sweepolet stress indices updated from those provided by Bonney Forge; (2) the applicability of 1980 Code analysis rules to piping designed to 1971 Code rules; (3) and the rationale for calculating branch pipe moments at the run pipe wall. These questions are addressed as follows.

STRESS INDICES

The Bonney Forge sweepolet stress indices issued in January 1971 were based on photoelastic tests and the recommendations of E.C. Rodabough of Battelle Laboratories. Subsequent work by Rodabough resulted in the adoption of branch pipe connection indices in the Summer of 1979 Addenda of the Code. Since the later work by Rodabough was applicable to Sweepolets under the rules of NB-3681, the Sweepolet indices were modified by General Electric Piping Analysis to be consistent with Rodabough's later work. These modifications were incorporated into General Electric's proprietary computer program ANSI7 in 1980. Table I presents a detailed comparison of tee, branch connections per NB-3643, and Sweepolet stress indices before and after the Summer of 1979 Code Addenda. The notes and verification calculation elucidate the rationale for the indice changes.

TABLE I. COMPARISON OF STRESS INDICES

Stress Indices	Before Summer 1979			After Summer 1979			Hanford Value (14)	Remark
	Table NB-3681		Bonney Forge Sweepolet Equations	Table NB-3681		(13) Sweepolet		
	Tee	Branch		Tee	Branch			
B1	1.0	1.0	1.0	0.5	0.5	0.5	0.5	(11)
C1	1.5	2.0	(9)	1.5	1.5	(15)	2.0 Ref. Verification Pg. 4	
K1	4.0	1.7	$1.45/2.4^{(10)}$	4.0	1.7	$1.7/2.4^{(10)}$	1.7	
B2b	$0.75C_{2b}$	$0.75C_{2b}$	$0.75C_{2b}$	$0.60C_{2b}$	$0.5C_{2b}$	$0.5C_{2b}^{(12)}$	1.0 Ref. Verification Pg. 4	(6)
C_{2b}	(1)	(2)	(3)	(1)	(2)	(3)	2.0 Ref. Verification Pg. 4	
B_{2r}	$0.75C_{2r}$	$0.75C_{2r}$	$0.75C_{2r}$	$0.75C_{2r}$	$0.75C_{2r}$	$0.75C_{2r}$	1.0 Ref. Verification Pg. 4	(5)
C_{2r}	(1)	(4)	(7)	(1)	(4)	(7)	1.26 Ref. Verification Pg. 4	
K_{2b}	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
C_3	1.0	1.8	$1.8^{(8)}$	1.0	1.8	$1.8^{(8)}$	$1.8^{(8)}$	
K_3	1.0	1.7	$1.7^{(8)}$	1.0	1.7	$1.7^{(8)}$	$1.7^{(8)}$	

NOTES:

1) $C_{2b} = C_{2r} = 0.67\ (Rm/Tr)^{0.67}$, but not less than 2.0

2) $C_{2b} = 3(Rm/Tr)^{2/3}\ (rm/Rm)^{\frac{1}{2}}\ (Tb/Tr)\ (\dot{rm}/rp)$, but not less than 1.5

3) $C_{2b} = 0.9(R/T)^{2/3}\ (r/R)^{\frac{1}{2}}\ (t/T)\ (Fs)$, $Fs = 1 + 0.05\ (r - 3)$, but not less than 1.5

4) $C_{2r} = 0.8\ (Rm/Tr)^{2/3}\ (\dot{rm}/Rm)$, but not less than 1.0

5) All B_{2r} should not be less than 1.0

6) All B_{2b} should not be less than 1.0

7) $C_{2r} = 0.8\ (R/T)^{2/3}$ Fs, but not less than 1.5 if $r/R > 0.5$

$C_{2r} = 0.8\ (R/T)^{2/3}\ (r/R)$ Fs, but not less than 1.0 if $r/R < 0.5$

8) This is not in Bonney Forge stress indices equations. Use the same value as it is for branch.

9) $C_1 = 1.0\ \{(r/R)\ (2R/T)^{\frac{1}{2}}\}^{\frac{1}{2}}$ Fs, for $r/R \leq 0.5$, but not less than 2.0, $C_1K_1 \geq 3.4$

10) Upper number is for flush weld joint.
Lower number is for As weld joint.

11) B_1 for branch connections per NB-3643 and for butt welding tee per ANSI B16.9 was reduced from 1.0 to 0.5 in Summer 79 Addenda. Since sweepolet meets the requirements of B16.9, B_1 stress indices should be the same as tee and branches.

12) $B_2b = 0.75C_2b$ was used for branch connection per NB-3643 before Summer '79 Addenda and $B_2b = 0.5C_2b$ is used after the addenda. $B_2b = 0.75C_2b$ was used for tee before Summer '79 Addenda and $B_2b = 0.4$ $(Rm/Tr)^{0.667} = 0.6\ C_2b$ after the addenda. Since sweepolet geometry is closer to branch and provided with smooth transition, the equation to be used to calculate C_2b is the same form as the branch stress indice equation, therefore, the change of the stress indice for branch connection should be used for sweepolet.

13) This column is the stress indices established by GE based on the intent of the Code for branch connection.

14) This column is the stress indices used for Hanford Main Steam line sweepolet as issued in the stress report 22A6537.

15) C_1 for branch connections per NB-3643 was reduced from 2.0 to 1.5 in the Summer Addenda of 79. C_1 for welding tee per B16.9 before and after Summer 79 Addenda remain the same as 1.5. Since sweepolet meets the requirement of B16.9 and its transition is much smoother than branch, C_1 is the same as 9) except the value not less than 1.5.

Numerical Verifications:

$C_{2b} = 0.9\ (R/T)^{2/3}\ (r/R)^{\frac{1}{2}}\ (t/T)\ (Fs)$

For Hanford

R = (26.00-1.158)/2 = 12.421
r = (8.625-0.910)/2 = 3.8575
T = 1.158
t = 0.910
Fs = 1+0.05(r-3)
= 1+0.05(3.857-3)
= 1.0428

$$C_{2b} = 0.9\ \left(\frac{12.421}{1.158}\right)^{0.6667}\ \left(\frac{3.8575}{12.421}\right)^{\frac{1}{2}}\ \left(\frac{0.910}{1.158}\right)\ (1.0428)$$

$= 0.9 \times 4.864 \times 0.5573 \times 0.78583 \times 1.0428$

$= 1.999193$

$= 2.00$ ok checked

$B_{2b} = 0.5C_{2b} = 1.0$ checked

$C_{2r} = 0.8\ (R/T)^{2/3}\ (r/R)\ Fs$

$= 0.8 \times 4.864 \times (3.8575/12.421) \times 1.0428$

$= 1.26018 > 1.0$ checked

$B_{2r} = 0.75 \times 1.26 = 0.945$ use 1.0 checked

$C_1 = 1.10\ \{(r/R)\ (2R/T)^{0.5}\}^{0.5}\ Fs$

$= 1.10\ \{3.8575/12.421)\ (2 \times 12.421/1.158)^{0.5}\}^{0.5} \times 1.0428$

$= 1.10\ \{0.31056 \times 4.6316\}^{0.5} \times 1.0428$

$= 1.3757$

$C_1K_1 = 3.4$, $K1 = 1.7$

therefore, $C_1 = 3.4/1.7 = 2.0$

$1.3757 < 2.0$, use $C_1 = 2.0$ checked.

APPLICABILITY OF CODE EDITION TO ANALYSIS

The issue of, 'What version of the Code should be used for analysis?', has been discussed by the Code Committee on numerous occasions. A letter summarizing the conclusion of the committe is attached. It is clear that, it is the intent of the Code Committee that any edition of the Code is acceptable for analysis provided the dimensional requirements of the pipe fittings meet the requirements of that Code edition.

BRANCH PIPE MOMENTS

The Summer of 1980 Addenda of the Code revised note 5(c) of NB-3681(9)-1 to read: "where r'm/Rm$\leq$ 0.5,Mb (i.e. branch pipe moments for run to branch pipe radius ratios of one half or less) may be computed at the outside surface of the pipe run." Prior to the Summer of 1980 Addenda, GE Piping Analysis was calculating moments at the pipe surface based on rational engineering logic, which was confirmed by Rodabough, the indice developer, in response to an inquiry by GE. It is clear that no moment exists at the mathematical intersection of the run and branch pipe centerlines. The load path for the moment must be in the run pipe wall. Logic demands that branch pipe fitting moments be applied to the run pipe wall surface provided the restriction on branch to run size are met.

NUCLEAR POWER SYSTEMS ENGINEERING DEPARTMENT MEMO

RECEIVED
OCT 6 1982
E.C. WOOD

TO: E. C. Wood
M/C 392

DATE: Oct. 4, 1982

FROM: E. O. Swain

REQUIRED RESPONSE DATE:

SUBJECT: Use of Latest Code Editions for Piping Stress Analysis

FOR: ACTION ☐
DECISION ☐
INFORMATION ☐

The ASME-III rules for stress analysis of Class 1 piping are contained in Article NB-3600. The group responsible for the preparation, maintenance, and alteration of these stress rules is the Working Group on Piping. This is a very active working group and the rules are undergoing constant change and improvement. Code Addendas are issued twice each year.

All engineering organizations performing the stress analysis of ASME-Class 1 piping use a computer program. The large number of calculations required make manual calculations impractical. The computer code that GE uses to solve the NB-3600 equations is ANSI-7. It is our policy to keep the computer program up-to-date to the latest addenda of ASME-III. It is also our normal practice to use the latest version of our ANSI-7 computer program for each of our stress reports. It is not practical to maintain an approved (Level 2) version of ANSI-7 for each addenda of the Code. Further it is not necessary to do so.

It is the position of the Working Group on Piping that any edition of NB-3600 is acceptable for use, and for this reason many engineering organizations keep their computer codes updated to the latest code revisions and perform their analyses to the latest revisions.

I have been a member of the Working Group on Piping ever since it was first formed. Over the years there have been many discussions concerning this question. After you again raised this question, I again discussed the subject with the chairman of the Working Group on Piping and the chairman of the Sub-Group on Design. On the basis of these discussions, I conclude our position has been reaffirmed. Both chairmen agreed that use of the latest code rules in NB-3600 are acceptable for use. It is important, however, that there be no incompatibilities between the rules for stress analysis and the rules for design, manufacture, fabrication and installation. For example, the stress indices used for a joint or fitting must be applicable to the joint or fitting actually used in fabrication. The code is clear on the dimensional requirements for fittings such as taper transitions and branch connections and the stress index for the fitting. We, of course, make sure that there are no incompatibilities between our stress analysis and the piping system actually fabricated and installed. Our QA systems are aimed at this and a Professional Registered Engineer certifies the design report.

/dej

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cc. UR Sinha, W. Schultheis

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