PDR/CF

E. C. Rodabaugh Associates, Inc.

50-424

4625 CEMETERY ROAD • HILLIARD, OHIO 43026
614/876-5719

January 31, 1985

Mr. S. E. Moore
Oak Ridge National Laboratory
P.O. Box Y
Oak Ridge, TN 37830

Subject: Vogtle, Design Documents Audit, Meeting at Bechtel Offices, Norwalk, CA, January 9 & 10, 1985

Dear Sam:

I have organized this letter under the headings:

(1) Documents Requested/Furnished

(2) Stress Report on ASME Code Class 1 Valves

(3) Responses (by Bechtel) to Questions from 11/8,9/84 Meeting

(4) Vogtle Action Items from 1/9,10/85 Meeting

(5) Bechtel Pump Spec. X4AF03 (ECR No. 19) and
Seismic Analysis of AFW Pump (ECR No. 22)

(6) Agenda for February '85 Meeting with Westinghouse

(1) Documents Requested/Furnished

My letter to you dated November 10, 1984 listed documents which we requested, at our meeting on November 8, 9, 1984, be furnished to us. Documents were received from Westinghouse with a letter from Rahe to Denton, dated 12/10/84. Documents were received from Bechtel with a letter from Malcom to Denton, dated 12/5/84. These documents are essentially those corresponding to the 35 documents requested; with the 5 exceptions shown on Enclosure 1.

ECR Nos. 2 and 3 were reviewed by me during our Jan. '85 meeting and I found them to be acceptable. ECR Nos. 10 and 18 will be reviewed during our planned visit to Westinghouse, Feb. 7, 1985. The status of ECR No. 22 is discussed in Par. (5) of this letter.

(2) Stress Report on ASME Code Class 1 Valves

This Stress Report, ECR No. 8, Westinghouse Engineering Memorandum No. 5405, as furnished was incomplete in at least two aspects:

(a) Table of Contents was not included.

(b) There was no evidence that the Report had been reviewed and accepted by the Owner (or his authorized agent) as required by the ASME Code.

(c) The Report includes about 300 pages that are not numbered. There is no way to tell if the furnished Report is complete.

At the Jan. '85 meeting, the missing Table of Contents was supplied and a form sheet was supplied which is purported to indicate that Georgia Power (or agent) has reviewed and certified the document. However, the name Georgia Power does not appear on the form sheet furnished. Copies of these two sheets are included herewith as Enclosure 2. I intend to discuss this Stress Report further at our Feb. '85 meeting with Westinghouse.

(3) Responses (by Bechtel) to Questions from Nov. '84 Meeting

Bechtel's letter (Malcom to Denton, 12/5/84) included five questions and responses as shown in Enclosure 3. These questions/responses were discussed at the Jan. '85 meeting.

(i) Minimum Wall Thickness Control

The response, in conjunction with definitions of "minimum wall thickness" in Spec. X4AQ01, 10.11.1B., was accepted.

(ii) Value of f-factor

The response was accepted.

(iii) Purchase Order for an Elbow and Tee

The response was deemed not acceptable. A purchase order was examined at the Jan. '85 meeting and is to be furnished; see Vogtle Action Items, Par. (4) herein.

(iv) Pressure Design of Branch Connections

A copy of branch connection calculations for the 4x28 AFW pump turbine steam line connection to the main steam line is to be furnished; see Vogtle Action Items, Par. (4) herein.

(v) Values of i-factors

Bechtel prepared (while we were at the Jan. '85 meeting) a list of moments and calculated stresses at the 4x24 branch connection between the 4 NPS line to the AFW pump turbine and the ~28" O.D. main steam line. This is Node 138 on the main steam line; Node 1 (Data Pt) in the 4 NPS line. The three sheets prepared by Bechtel are included herewith as Enclosure 4.

With the data in Enclosure 4, the i-factor used can be ehcked and I have done so as indicated on Enclosure 4.

For the branch, Node 1, the i-factor used is 1.00. This is not the i-factor given on p. 4A of 15, Calc. X4CP-7075A furnished us; there the i-factor is 1.551. The i = 1.551 is stated to be calculated "using Bonney Forge and Foundry Equation". Bechtel, after preparing Enclosure (3), stated that p. 4A of 15 was incorrect because the branch connection is not fabricated with a Weldolet. Rather, Bechtel now states, the branch connection is an extruded outlet. Bechtel indicated they used Bonney Forge's Sweepolet i-factors; see Enclosure 5. As you know, the Code does not give i-factors for extruded outlets and (with the exception of a Report I prepared for General Electric on a few extruded outlets with well-defined dimensions), I am not aware of any published paper or report that gives i-factors for extruded outlets. Bechtel's assumption that Sweepolet i-factors can be used for extruded outlets is indicative of a generic problem in the casual and sometimes questionable use of i-factors in nuclear power plant piping evaluations.

However, with respect to the specific 4x28 branch connection in our audit, the Code equations for "Branch Connections" (which I deem appropriate for extruded outlets with $d/D < 0.5$) give i-factors less than unity for both run and branch and would be controlled by the specified lower bounds of 1.0 for branch, 1.5 for run. Hence, Bechtel's use of i = 1.0 for the branch; 1.5 for the run is deemed appropriate. I do not believe the generic problem should be continued as part of our Vogtle audit. Accordingly, I consider this Vogtle response as acceptable.

(4) Vogtle Action Items from 1/9, 10/85 Meeting

The following is my understanding of documentation which Vogtle (Jan.'85 meeting) agreed to furnish us.

(a) Wall thickness verification measurement record sheet for Valve HV-106.

(b) Copy of purchase order for fittings (see Par. (3), question iii).

(c) Copy of drawing of 4x28 extruded outlet and calculations showing conformance with pressure design requirements of the Code (see Par. (3), question iv).

(d) Miscellaneous steel calculations for anchor at Point 125, Calc. X4CP-7075A (This request is related to the statement on p. 4D of 15 of the Calc: "Anchor at 125 will be based on upstream and downstream loads.)

(e) Revised sheets in calculation package X4CP-7075A

1. Sheet 4A: correct i-factor calculation, Data Pt 1 (See Par. (3), question v).
2. Sheet 7B: correct discrepancy between stress of 13877 on sheet 7B versus 23054 on p. 9.
3. Sheet 13E: cite proper reference that shows that Valve No. 051 has a moment load capacity equal to that of the attached pipe.
4. Sheet 4: Add note on appropriate page to indicate that maximum temperature range has been covered by analysis. (Problem is that portions of the piping may have temperatures as low as 17°F per sheet 4.)

(f) Update of Status of Hot Functional Test Program.

This request arose in connection with a general discussion of binding of sliding supports because of either:

1. radial thermal expansion of large size, hot (e.g. main steam) pipe that would close the gaps, or
2. Lack of parallelism between support shoe and support such that as the pipe moves axially due to thermal expansion, the gaps might close.

While the Specs. indicate 1/8" gaps on hot piping restraints, which should be sufficient, it appeared that Bechtel agreed that potential binding (along with other things) would have to be checked during hot functional testing.

While several of the above documents were shown to us at the Jan. '85 meeting, we did not keep them; the Vogtle commitment was to formally submit them. So far, I have not received anything. It would be desirable to transmit Par.(4) to Georgie Power to make sure we are in agreement as to what is to be furnished.

(5) Bechtel Pump Spec. X4AF03 (ECR No. 19) and
Seismic Analysis of AFW Pump (ECR No. 22)

The copy of Spec. X4AF03 furnished to me with Bechtel's 12/5/84 letter was incomplete; about half of the pages were missing. Accordingly, I could not review Spec. X4AF03 before the January '85 meeting. I requested and received at the meeting a purportedly complete copy of Spec. X4AF03. I have reviewed Spec. X4AF03 subsequent to the January '85 meeting and find it acceptable with two exceptions:

(1) Attachment 3 (Steam Turbine Loading Diagram) states that:

"Resultant piping loads are shown in Table IV of the design specification."

There is no Table IV in Spec. X4AF03, although it is mentioned on p. 12 of the Spec. Also, we received (ECR No. 23) a document X4AF03-2-0, Turbine Allowable Nozzle Loads; however there is no indication as to what relationship, if any, this document has to Table IV of Spec. X4AF03.

(2) The bidder's (Ingersall-Rand) proposal includes a Section 9.0, "Deviations" (presumably deviations from Spec. X4AF03). Under 9.2, "Technical Provisions or Design Specifications" the bidder has apparently stated "See comments attached". There are no attached comments. Accordingly, it appears that the bidder may have deviated from Spec. X4AF03, but there is no description of what these deviations might be.

Related to these exceptions is ECR No. 22, "Seismic Analysis of AFW Pump". As indicated by Enclosure 1, this document has not been furnished. In view of questions about Spec. X4AF03, I think we should ask for it again. According to the Code, Design Specifications are required to provide the basis for evaluations of the adequacy of the component and, as part of our Vogtle audit, we should see if this Code requirement has been met for the AFW pumps.

Perhaps the most expeditious way to accomplish this would be to send Par.(5) of this letter to Georgia Power Co. for Bechtel's response.

(6) Agenda for February '85 Meeting with Westinghouse

(a) Stress Report on Pressurizer Surge Line (ECR No. 18)

(b) Wording for valve operability qualification as applicable to Vogtle (ECR No. 10)

(c) Westinghouse Engineering Memorandum No. 5, "Stress Report for Class, 6-inch and Larger Gate Valves (ECR No. 8).

Yours very truly,

Everett

E. C. Rodabaugh

ECR/mr

Enclosures:

(1) Requested but Not Received Documents
(2) Table of Contents and Certification Sheet, Valve Stress Report
(3) Responses (by Bechtel) to 11/8, 9/84 Meeting Questions
(4) Bechtel Data to Check i-factors
(5) Bonney Forge Sweepolet i-factors

cc: Dave Terao
Melanie Miller

Vogtle

Enclosure 1
ECR to SEM, 1/30/85

Documents Requested (ECR to SEM, 11/10/84)
but
Not received as of 12/31/84

ECR No.	Source	Item	Document
2	Westinghouse	RHR Pump	ME-174, "Structural Integrity and Operability Analysis of RHR Pumps"
3	"	"	M 010201, Rev. 1, 3/26/84, "Seismic Analysis Report for GAE/GBE-DCP/DBP RHR Pump Motor"
10	"	RHR Pump, 12" Suction Valve	Wording for valve operability qualification (as it will becomes applicable to Vogtle)
18	"	Piping, Pressurizer Surge Line	Calculation Package for Pressurizer Surge Line Piping System
22	Bechtel	AFW Pump	Seismic Analysis, AFW Pump (by Vendor, Preliminary)

Notes:

(1) ECR Nos. 2 and 3 reviewed at Jan. '85 meeting and deemed to be acceptable.

(2) ECR Nos. 10 and 18 to be reviewed at Feb. '85 meeting with Westinghouse.

(3) ECR No. 19, Bechtel Pump Spec. X4AF03, was incomplete as furnished. A complete copy of the Spec. was furnished at the Jan. '85 meeting. See Item (5) of this letter with respect to ECR Nos. 19 and 22.

(4) ECR No. 8, Stress Report on ASME Code Class 1 Valves, was furnished without the Table of Contents with many unidentified pages. A Table of Contents was furnished at the Jan. '85 meeting. See Item (2) of this letter.

→ TO: S. CEREGHINO / T. MATTY, ω - B43F5

Encl. 2, ECR to SEM, 1/30/85
2 pages
Provided at Meeting in Norwalk, CA,
1/10/85
Westinghouse
Stress Report on Valves

TABLE OF CONTENTS

VOLUME I

OCUMENT SUBMITTAL FORM
(WESTINGHOUSE FORM 54956E)

PAR

C- 0495

FROM
WESTINGHOUSE ELECTRIC CORPORATION
NUCLEAR ENERGY SYSTEMS
BOX 355
PITTSBURGH, PENNSYLVANIA 15230
ATTN: E. D. Webster

TO
WEMD
CHESWICK, PA. 15024
W. H. Black WB-0-151

PAR NO. 40 PAGE 1 OF 1
ISSUE DATE 6-3-80
ENG. LTR. NO. AE-VE-2078
P.O. SEE BELOW
G.O.
SUPPLIER ORDER NO.

COMPONENT: Auxiliary Valves
SPIN NO./I.D.: GAE/GBF
SUPPLIER SERIAL NO.

SUPPLIER ACTION(S) REQUIRED BY THIS ... MUST BE COMPLETE

SUBMITTAL CODE
A = FOR APPROVAL
I = FOR INFORMATION
(Use Proper Code)

SEQUENCE CODE (Use proper Code)
O = ORIGINAL SUBMITTAL
R = RESUBMITTAL DUE TO W COMMENTS
V = RESUBMITTAL DUE TO SUPPLIER CHANGES
M = RESUBMITTAL DUE TO DOCUMENT QUALITY

APPROVAL STATUS CODE
A = APPROVED
C = APPROVED W/COMMENT RESUBMITTAL REQUIRED
D = DISAPPROVED
I = RECEIVED FOR INFORMATION
(Use Proper Code)

ITEM NO.	P.O. ITEM NO.		DRAWING NO./SPEC. NO. PROCEDURE NO.	REVISION		DESCRIPTION/TITLE		ENGINEERING COMMENTS
1		A	EM-5161	1	0	Stress Report 6"+ Check Valves	A	
2		A	EM-5405	1	0	" " 6"+ Gate Valves		

Also for G.O. & P.O. below - PAR#

G.O. AT-68563-ARG-AR1	P.O. 546-NCJ-191614-BN	44
G.O. AT-68561-ARG-AR1	P.O. 546-NCJ-191604-BN	40
G.O. AT-68512	P.O. 546-NCJ-191613-BN	46
G.O. AT-68510	P.O. 546-NCJ-191603-BN	40

ADDITIONAL ENGINEERING COMMENTS
THIS CERTIFIES THAT STRESS REPORTS EM #5161-1 AND EM #5405-1 HAVE BEEN REVIEWED PER REQUIREMENTS OF SECTION III, DIV. 1, OF THE ASME BOILER AND PRESSURE VESSEL CODE, PARA's NA-3350 AND NB-3500 AND SATISFIES THE DESIGN AND OPERATING CONDITIONS STATED IN EQUIPMENT SPECIFICATIONS G-678852-2 AND G-678853-2.

DISTRIBUTION
QC RECORDS-2 EA — P.C. BLDG. 2
PURCH. SYSTEMS — M. BONFIGLIO
PAR ORIGINATOR — K. DELUSE
PAR APPROVER — R. DELISSIO
BUYER — D. CAVADA
PROJECT MGR(S) — AEE FILE:
DPC — 220/68572/1.2
220/68510/1.2

PAR WRITTEN BY & DATE: M. BONFIGLIO 5/28/80
PAR APPROVED BY & DATE: K. DELUSE 5/28/80

PURCHASING AUTHORIZATION
If information contained herein does involve a change in price, delivery or terms and conditions, you are not to proceed in accordance with PAR but pursue the scope as currently defined by the order and immediately notify the buyer.
This PAR confirms ☐ WIRE ☐ Verbal to ______ Date
Please acknowledge receipt and acceptance of this PAR by signing and returning one copy to Westinghouse Electric Corporation at the above address, within 15 days from date of this PAR.
MARK for attention of E.D. Webster 6/3/80
SIGNATURE

ACKNOWLEDGMENT
(RETURN IMMEDIATELY)
ACKNOWLEDGED AND ACCEPTED BY
SIGNED BY SUPPLIER DATE

Bechtel, 12/5/84 Submitted on Vogtle

Encl. 3 ECR to SEN, 1/30/85 2 pages

Request for additional information by NRC at the MEB meeting on November 8 and 9, 1984 at the VEGP jobsite.

QUESTION i

Demonstrate the means by which the specification dictates the minimum wall thickness for the steam line to the turbine-driven auxiliary feedwater pump.

RESPONSE

Piping wall schedules as called out in the material classification sheets are based on the minimum wall calculations for the indicated pressure temperature design conditions.

The piping fabricator is required by specification (X4AQ01, Paragraph 13.2.3.3) to measure the wall thickness on all pipe and fittings and determine acceptability based on the minimum wall thickness as specified in appendix D, "Butt Weld End Preparations and Transitions". A copy of X4AQ01, Paragraph 13.2.3.3 is attached.

QUESTION ii

What value was assigned to the adjustment factor f in stress calculations and justify the use of the value?

RESPONSE

A stress adjustment factor, f of 1.0 was considered in the stress calculation for the transient from cold startup to hot standby. The number of cycles for this occurrence is significantly less than 7000. This condition envelopes all other conditions.

For example, table 3.9.N.1-1 in the VEGP-FSAR-3 (attached) defines the number of loading and unloading operations between 15 and 100 percent of full power as 13,200. The f factor for this cyclic condition is 0.9. In consideration of the small temperature range (554°F-545°F per W letter GP-2932), the expansion stresses are significantly lower than 90 percent of the stress allowable.

QUESTION iii

Provide a copy of purchase orders for an elbow and a tee fitting in the steam line to the auxiliary feedwater turbine-driven pump.

RESPONSE

A copy of the purchase order is not available for these items since these are purchased by the piping fabricator and not by Bechtel.

QUESTION iv

What checks are performed to ensure pressure design requirements are satisfied for the 4 inch branch connection to the main steam line.

RESPONSE

Bechtel reviews and verifies the vendor branch connection calculations in accordance with paragraph 9.1.2F of specification X4AQ01 (copy attached).

QUESTION v

What is value of the factor i utilized in the stress calculations? Provide sufficient information to allow reviewer to verify value of i.

RESPONSE

Stress intensification factors for the steam line between the main steam line and the turbine-driven pump are shown in the Assumptions, Section IV, of the stress calculation folders.

Stress intensification factors for standard fittings such as elbows, tees, and reducers are calculated and applied by the ME-101 computer program (Linear Elastic Analysis of Piping Systems). The SIF are calculated in accordance with ASME Section III, Division I - subsection NC, Fig. NC-3673.2 (b)-1.

) Encl: 4 (3 pages)

CALCULATION SHEET

ECR to SCM 1/30/85

SIGNATURE J. Hol DATE 1-9-85 CHECKED DATE CALC. NO.
PROJECT VOGTLE JOB NO. 9510-001
SUBJECT JUNCTION PT. @ 1301-009-4" SHEET 1 OF 1 SHEETS

@ NODE 138. ISO: SK--1K5-1301-001-01

FT-LB

	MA	MB	MC	STRESS (A in X Dir. B in Y Dir.)	M/Z	i
DW	1599	-14	-24467	372	270.7	1.374
THERMAL	0	285	-30	5	3.163	~1.58
SEIS (SSE)	34857	19704	13135	522	465.2	1.122
SEIS (OBE)	33409	17298	10340	483	430.8	1.121
SAM (SSE)	0	286520	38996	4776	3192	1.496
SAM (OBE)	0	200581	27297	3344	2235	1.496

$M = (M_A^2 + M_B^2 + M_C^2)^{1/2}$

ECR

FOR MAIN HEADER

ECR

Z for Main Header (Run Pipe)
Bechtel apparently used a mean radius of "14",
wall thickness of 1.875"

Then O.D. = 28 + 1.875 = 29.875
I.D. = 28 - 1.875 = 26.125

$\therefore Z = \frac{\pi}{32} \frac{(D_o^4 - D_i^4)}{D_o} = 1086.93 \text{ in}^3$

M/Z_2	i
270.7	1.374
3.164	1.580
465	1.122
430.8	1.121
3192	1.496
2235	1.496

FOR BRANCH

MOMENTS AT DATA PT 1.

	M_x	M_y	M_z	$\bar{M} = (M_x^2 + M_y^2 + M_z^2)^{1/2}$
WEIGHT	880 -	27 -	13 -	880.51
SAMSS	2295 -	6938 -	849 -	7356.87
THRM1	-99	-680	132	699.73
THRM2	5	30	-7	31.21
THRMBS	-6040	-152	344	6051.7
SEISSS	1087 -	5451 -	649 -	5596.1
SEISOB	819	4027	481	4137.49

CCR

- JUNCTION PT @ D.P. 1 (LINE 1301-009-4")
- REF. SK-1K3-1301-010-02 (STRESS ISO)
- ORIENTATION AS SHOWN ON REF. SKETCH (ISO).

LAO 0513 B

CALCULATION SHEET

CALC. NO.

SIGNATURE ______ DATE ______ CHECKED ______ DATE ______

PROJECT ______ JOB NO. ______

SUBJECT ______ SHEET ______ OF ______ SHEETS

DATA PT #1 STRESSES

ISO # 1K3-1301-010-02

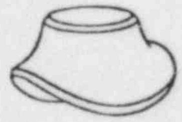
	PSI	M/Z	i
SAMSS	19245	19246	1.00
DW	2302	2303	1.00
THRM 1	1629	1830	1.00
THRM 2	81	81.6	1.00
SEIS SS	14641	14640	1.00
SEIS OB	10824	10824	1.00
THRM BS	15831	15832	1.00
PRESS	3091	—	—

—ECR

Z for 4" Sch. 80 Branch Pipe

$$Z = \pi r^2 t = \pi\left(\frac{4.5-.337}{2}\right)^2 \times .337 = 4.587 \text{ in}^3$$

Encl. 5
ECR to SEM, 1/30/85
2 pages



STRESS INTENSIFICATION FACTORS FOR SWEEPOLETS

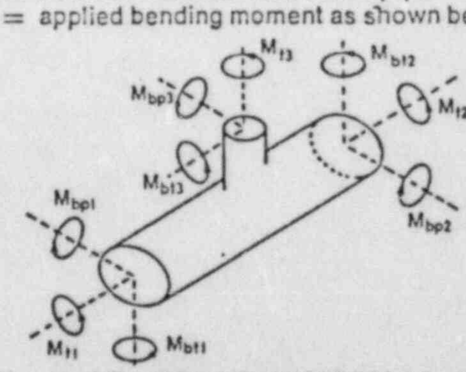
RECOMMENDED USE:

The values in Table 1 are intended to be used in making piping system stress analyses in accordance with all ANSI Piping Codes and other Codes which use stress intensification factors.

NOMENCLATURE:

b = branch

r = mean radius of branch pipe
R = mean radius of run pipe
t = nominal wall thickness of branch pipe
T = nominal wall thickness of run pipe
M = applied bending moment as shown below:



(A copy of Fig. 119.6.4(b) of USAS B31.1.0—1967)

i = stress intensification factor. Subscripts indicate the applicable moment, for example, i_{bp3} means the stress intensification factor for an in-plane bending moment applied to the branch.

Insert weld = the weld which joins the Sweepolet and run pipe.

Flush weld = a buttweld in which both the inside and outside surface of the weld are ground essentially flush with the parent metal and any offset resulting from misalignment is smoothly blended out. The weld and adjacent areas shall be capable of meeting the inspection requirements of the particular code.

Dressed weld = a buttweld in which all irregularities are ground smooth and the edges of the weld reinforcement are (where necessary) ground so that the angle between weld reinforcement and pipe surface is not over 14°. The weld and adjacent areas shall be capable of meeting the inspection requirements of the particular code.

As-welded weld = buttwelds with no special requirements except that they meet the requirements of the particular code.

F_1, F_2 = correction factors for the condition of the insert weld.

F_s = a size correction factor.

TABLE 1 — STRESS INTENSIFICATION FACTORS FOR SWEEPOLETS[1]

M[2]	Equation for Stress Intensification Factor i[3]	i_{min}[4] F or D	i_{min}[4] A-W
M_{bt3}	$0.45\,(R/T)^{2/3}\,(r/R)^{1/2}\,(t/T)\,(F_1)\,(F_s)$	0.85	1.0
M_{bp3}	(a) For $r/R \lesssim 0.5$ Lesser of: $0.45\,(R/T)^{2/3}\,(r/R)^{1/2}\,(t/T)\,(F_1)\,(F_s)$ and $[0.17\,(R/T)^{2/3} + 0.25]\,(t/T)\,(F_1)\,(F_s)$ (b) For $r/R > 0.5$ Interpolate between: $r/R = 0.5,\ i = [0.17\,(R/T)^{2/3} + 0.25]\,(t/T)\,(F_1)\,(F_s)$ $r/R = 1.0,\ i = 0.45\,(R/T)^{2/3}\,(t/T)\,(F_1)\,(F_s)$	0.85 0.85	1.0 1.0
M_{t3}	1.0	1.0	1.0
M_{bt1}, M_{bp1} M_{bt2}, M_{bp2}	$0.40\,(R/T)^{2/3}\,(F_2)\,(F_s)$	—	—
M_{t1}, M_{t2}	1.0	—	—
M_{t1}, M_{bt1}, M_{bp1} M_{t2}, M_{bt2}, M_{bp2}	or, for $r/R \lesssim 0.5$, $0.8\,(R/T)^{2/3}\,(r/R)\,(F_s)$ but not less than 1.5	—	—

(1) These factors are to be used in accordance with USAS B31.1.0—1967, Par. 119.6.4 except that for "Branch (Leg 3)"

$$S_b = \frac{\sqrt{(i_{bt3}\,M_{bt3})^2 + (i_{bp3}\,M_{bp3})^2}}{\pi r^2 t}$$

and similarly for the other Codes based on the stress intensification factor concept.

(2) See nomenclature sketch for definition of subscripts.

(3) $F_1 = F_2 = 1.0$, for flush or dressed insert welds.
$F_1 = 1.6$, for as-welded insert walds
$F_2 = (0.5 + r/R)$ but not less than 1.0, for as-welded insert welds.
$F_s = 1 + 0.05\,(r-3)$, but not less than 1.0.

(4) The minimum values of i depend upon the type of girth butt weld between Sweepolet and branch pipe. F or D stands for flush or dressed; A-W stands for as-welded.

EXAMPLE #1

Calculate the stress intensification factor for an out-of-plane bending moment applied to the branch of a 12" x 6", standard weight, carbon steel Sweepolet header. The insert weld and the girth weld between Sweepolet and branch pipe are dressed.

$r = (6.625-0.280)/2 = 3.172"$
$R = (12.75-0.375)/2 = 6.187"$
$t = 0.280"$
$T = 0.375"$
$F_s = 1 + 0.05\,(3.172-3) = 1.0086$

From Table 1, the stress intensification factor for an out-of-plane moment on the branch (M_{bt3}) is:

$i_{bt3} = 0.45\,(R/T)^{2/3}\,(r/R)^{1/2}\,(t/T)\,(F_1)\,(F_s)$
$i_{bt3} = 0.45\,(6.187/0.375)^{2/3}\,(3.172/6.187)^{1/2}\,(0.280/0.375)\,(1.0)\,(1.009)$
$i_{bt3} = 1.57$

EXAMPLE #2

Calculate the stress intensification factor for an in-plane moment on the branch of the header described in Example #1.

$r/R = 0.5,\ i = [0.17\,(R/T)^{2/3} + 0.25]\,(t/T)\,(F_1)\,(F_s)$
$i = [0.17\,(6.187/0.375)^{2/3} + 0.25]\,(0.280/0.375)\,(1.0)\,(1.009)$
$i = 1.018$
$r/R = 1.0,\ i = 0.45\,(R/T)^{2/3}\,(t/T)\,(F_1)\,(F_s)$
$i = 0.45\,(6.187/0.375)^{2/3}\,(0.280/0.375)\,(1.0)\,(1.009)$
$i = 2.196$

Interpolating for $r/R = 3.172/6.187 = 0.513$ yields

$i_{bp3} = 1.048$.

The research program conducted by Bonney included the fatigue testing of a number of 12" x 6", standard weight, carbon steel headers with welds dressed. The average value of i determined experimentally for an out-of-plane bending moment on the branch was (i_{bt3}) avg. = 1.22.

While the degree of conservatism in Tables 1, 2 and 3 is variable, for Example #1

(i_{bt3}) calculated = 1.57 vs. (i_{bt3}) experimental = 1.22.

In the case of Example #2, (i_{bp3}) calculated = 1.05 vs. (i_{bp3}) experimental = 0.85. Therefore, for the examples cited, the stress intensification factors calculated by the appropriate equations in the above table are about 25% higher than the average experimentally determined values.