Entergy

Entergy Nuclear Northeast
Indian Point Energy Center
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Robert Walpole
Licensing Manager
Tel (914) 734-6710

October 3, 2007

Re: Indian Point Unit 3
Docket 50-286

NL-07-120

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: **Response to Request for Additional Information Regarding <u>Relief Request 3-43 for Temporary Repair to Service Water Pipe</u>**

Reference: 1. Entergy letter NL-07-118 dated September 27, 2007 regarding Relief Request 3-43 for Temporary Repair to Service Water Pipe

Dear Sir or Madam:

Entergy Nuclear Operations, Inc (Entergy) requested relief (Reference 1) in accordance with 10 CFR 50.55a(a)(3)(i) for a temporary non-code repair to an ASME Code Class 3 piping elbow in the Indian Point 3 (IP3) Service Water System. During a conference call with NRC staff on October 1, 2007, Entergy agreed to provide additional information regarding this request as summarized in Attachment 1. Based on this additional information, Entergy is providing Revision 1 of the Relief Request 3-43 in Attachment 2. Other information being provided to support NRC review of this Relief Request is:

- Attachment 3, Flaw Evaluation based on ASME Code Case N-513-1
- Attachment 4, Ultrasonic Test results for current flaw and historical data
- Attachment 5, Structural calculation for proposed repair

There are no new commitments being made in this submittal. If you have any questions or require additional information, please contact Mr. Robert Walpole, Manager, Licensing at (914) 734-6710.

Sincerely,

Robert Walpole
Licensing Manager
Indian Point Energy Center

A047

cc: Mr. John P. Boska, Senior Project Manager, NRC NRR DORL
Mr. Samuel J. Collins, Regional Administrator, NRC Region 1
NRC Resident Inspector, IP3
Mr. Paul D. Tonko, President NYSERDA
Mr. Paul Eddy, New York State Dept. of Public Service

ATTACHMENT 1 TO NL-07-120

REPLY TO REQUEST FOR ADDITIONAL INFORMATION REGARDING INDIAN POINT 3 RELIEF REQUEST 3-43 FOR TEMPORARY NON-CODE REPAIR TO SERVICE WATER PIPING

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NO. 3
DOCKET NO. 50-286

SUMMARY OF ADDITIONAL INFORMATION

The following summarizes the additional information being provided in this transmittal regarding IP3 Relief Request 3-43, based on a conference call with NRC staff on October 1, 2007. The revised relief request is provided in Attachment 2. The contents of Attachments 3, 4, and 5 are as described in the following summary.

A. Flaw Characterization and Evaluation

- The flaw evaluation performed per ASME Code Case N-513-1 is provided in Attachment 3.

- Two ultrasonic examination test (UT) reports for the affected area are provided in Attachment 4. One is for the recent examination performed in September 2007 for the current flaw and one is for the examination performed in March 2007 for a repair performed prior to startup from the last refueling outage (3R14). A UT examination in 3R13 was not required and therefore no report for that timeframe is available. Radiography of the area prior to 3R13 identified an area of concern on the opposite side of the pipe which was investigated and repaired in March 2005. The Relief Request has been revised to include these previous inspections and repairs.

- The typical unprotected metal corrosion rate for service water crevice corrosion observed at Indian point is 0.024 inches per two year cycle (0.012 inches per year). This is based on the wear rates observed and calculated for the evaluation of previous service water piping degradations.

B. Repair Design and Installation

- Additional description of the proposed repair has been added to the revised Relief Request, including dimensions and weld detail provided in Figure A. The reinforcing plate will be fabricated to match the contour of the repair area to the extent practical and the perimeter gap will be maintained within the limits of the procedure for this type of weld.

- The design calculation, including the applied stress allowables and safety factors, is provided in Attachment 5.

- The welding of the reinforcing plate will be in accordance with applicable requirements of ASME Section XI, with qualified welders using a welding procedure qualified per ASME Section IX.

C. Repair Examination and Inservice Monitoring

- The relief request has been revised to provide additional information regarding the NDE to be performed as part of the repair, for inservice monitoring, and for extent-of-condition augmented inspections.

- During the repair, Entergy will perform surface examinations prior to starting the welding, after the root pass weld, and after the final pass weld.

- Inservice examinations will use straight line UT. Initial baseline exam after repair installation will be followed by monthly exam for the first quarter, and then quarterly for the balance of the Relief Request duration, unless maintaining a more frequent exam is warranted based on UT results.

- Selection of the 5 locations for augmented inspections will be per ASME Code Case N-513-1.

- NPO visual check walkdowns will be performed at a frequency of at least once per day.

ATTACHMENT 2 TO NL-07-120

INDIAN POINT 3 RELIEF REQUEST 3-43, REVISION 1 REGARDING

TEMPORARY NON-CODE REPAIR TO SERVICE WATER PIPING

(Supersedes Revision 0 from Entergy letter NL-07-118 dated September 27, 2007)

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NO. 3
DOCKET NO. 50-286

INDIAN POINT UNIT 3
RELIEF REQUEST 3-43, REVISION 1

Proposed Alternative in accordance with 10 CFR 50.55a (a)(3)(i)

Alternative Provides Acceptable Level of Quality and Safety

A. ASME Code Component Affected

18" Service Water supply line number 408 to the Containment Fan Cooler Units (FCU). This line is one of two lines which supplies Hudson River water to the FCUs which are used to remove containment heat during normal plant operation and following a design basis accident.

B. Applicable Code Edition and Addenda

The applicable Code of Record for the current 10 year inservice inspection interval is the ASME Section XI Code, 1989 Edition with no Addenda. However, for Repair and Replacement activities, Entergy has requested and the NRC has approved (Reference 1) the use of subsection IWA-4000 of the ASME Section XI, 2001 Edition through the 2003 Addenda.

The affected portion of the service water piping was designed and constructed in accordance with the requirements of the USAS B31.1.0, 1967 Edition of the Power Piping Code.

C. Applicable Code Requirement

IWA-4422.1 requires that defects be removed or reduced to an acceptable size prior to implementing a repair or replacement in accordance with the requirements of IWA-4000. Since the current through-wall defects are beyond the acceptance criteria of IWD-3000 and removal is not practical without system depressurization, the proposed repair method would not be consistent with IWA-4422.1.

D. Reason for Request

On September 18, 2007 a Nuclear Plant Operator conducting a routine plant walkdown noted minor leakage of approximately 5 drops per minute in one of the two cement-lined 18" diameter, 0.375" nominal thickness service water supply lines for the containment fan cooler units. As a result of this leak a volumetric examination of the surrounding area was performed and the results were evaluated (IP-CALC-07-00083) against the requirements of ASME Code Case N-513-1. Although this evaluation confirmed that the affected piping remains within the requirements of Code Case N-513-1, the calculated corrosion rate does not support continued structural integrity through the remainder of the current operating cycle.

A weld repair/replacement fully compliant with the requirements of IWA-4000 is not practical. The affected piping section would need to be removed from service which would result in 3 FCUs inoperable. Indian Point 3 Technical Specification 3.6.6 does not have a Condition Statement for that configuration.

Entergy has evaluated alternative options for repairing this degraded area including weld overlay using ASME Code Case N-661 or an approach using a welded reinforcing plate. The weld overlay based on Code Case N-661 does not have a high probability of success due to the risk of "burn-through" in small areas where the remaining pipe thickness is insufficient to deposit weld metal. To protect against "burn-through" as shown in EPRI testing, a modified approach for weld overlay may be possible by placing a small intermediate plate over the localized area subject to "burn-through" and then the weld overlay could be applied over that plate. Both the reinforcing plate option and the overlay-with-intermediate-plate option could be designed to adequately restore the required structural margin for the remainder of the current operating cycle. The welded reinforcing plate is the preferred option because less welding will result in lower residual shrinkage stresses. Therefore the balance of the discussion provided in this relief request is directed at describing the welded reinforcing plate approach.

E. Proposed Alternative and Basis for Use

As discussed above, IWA-4422.1 requires that a defect be removed prior to implementing an IWA-4000 repair. However, this is not practical for the reason described in Section D regarding Technical Specification 3.6.6 for the FCUs. The preferred alternative proposed under this relief request would install a reinforcing plate over the degraded area to allow the attachment welding (Figure A) to be located in an area with minimal degradation therefore ensuring a structurally sound load path while minimizing the risk of "burn-through" and increased leakage.

The design will also ensure that the configuration of the repair will allow continued monitoring of the region by volumetric examination to ensure that future degradation will not adversely impact the structural capability of the repaired section.

1. Materials and Installation

   The material of the component to be repaired is concrete lined Carbon Steel, A-234, Grade WPB. The proposed reinforcing material to be installed is ASTM A-234, Grade WPB/A-106 or equivalent carbon steel material with an ASME Code stress allowable of 15,000 psi. The welding process to be used in this repair is SMAW with a Carbon Steel, 7018 weld wire. The reinforcing material would either be plate stock rolled to fit the contour of the affected repair area or a section from pipe will be used to fit the contour. The gap between the repair area and the reinforcing material will be controlled by procedure.

   The welding will be performed per the requirements of ASME Section XI using qualified welders and the weld procedure will be qualified in accordance with ASME Section IX. The weld procedure specifies 50 ^{O}F pre-heat for welds less than ¾ inch thickness and no post weld heat treatment required for P-1 materials less than ¾ inch thick.

2. Design Parameters

   The welded plate/weld repair option will be designed and installed consistent with the original USAS B31.1.0, 1967 Edition of the Power Piping Code requirements for a reinforcing plate (paragraph 104.3). A structural evaluation (IP-CALC-07-00209) has been performed to ensure that the resulting stresses in the piping, the plate and the attaching welds do not exceed the allowable stresses of the USAS B31.1.0 Code, 1967 Edition. The repair material will be carbon steel or pipe equivalent to the existing pipe material with allowable stress of S = 15,000 psi. The Code Case N-513-1 evaluation used the required factors of safety of 2.77 for the normal / upset condition and 1.39 for the emergency / faulted condition.

For purposes of this repair design and monitoring, Entergy will assume that the cement lining is no longer present in the area of the planned repair so that the corrosion rate for unprotected carbon steel will be applied.

3. Non Destructive Examinations

The area to be repaired has been characterized by performing straight beam UT mapping (Report IP3-UT-07-110) of the region to bound the degraded area and to ensure that the welds for repair are located in areas of sound base metal. At least ½ inch of the weld for attaching the reinforcing plate to the elbow will be performed in an area of average wall thickness exceeding 0.18 inches to ensure a structurally sound load path around the perimeter of the repair area.

NDE of this area was also performed in March 2007 (Report IP3-UT-07-049) when a through-wall flaw was discovered during startup from refueling outage 3R14. Plant conditions at that time allowed for a weld repair consistent with ASME IWA-4422.1, so that a relief request was not needed. Four areas with thickness readings less than 0.110 inches were excavated and weld repaired in accordance with the requirements of ASME Section XI. Corrective action at that time also included developing plans for replacing this elbow at the next refueling outage (3R15, Spring 2009).

The pipe wall was repaired to a minimum wall thickness needed to support operation until the next refueling outage, based on nominal corrosion rate assumptions. The typical unprotected metal corrosion rate for service water crevice corrosion observed at Indian point is 0.024 inches per two year cycle (0.012 inches per year). This is based on the wear rates observed and calculated for the evaluation of previous service water piping degradations. However, corrosion rates could be higher in localized areas.

The location of the March 2007 repair with respect to the current area of interest is adjacent to grid location H6 as shown on the UT map in IP3-UT-07-110. A final assessment of why a new through-wall leak developed near the area of the prior repair has not been completed at this time. Further characterization of the degradation in this elbow will be accomplished when the component is replaced.

Prior to shutdown for 3R13 (March 2005) radiography of this elbow as part of the Generic Letter 89-13 Corrosion Monitoring Program identified an area of interest on the opposite side of the elbow from the current flaw. Localized UT performed during 3R13 identified a 0.25-inch diameter area in the weld with a thickness less than 0.135 inches. An ASME Section XI repair was implemented prior to startup from that outage. There is no historical UT data resulting from the March 2005 repair for the current area of interest.

NDE inspections for the extent-of-condition review will also be performed as stated in section E.5. NDE related to the repair and inservice monitoring is discussed in Section E.4.

4. Repair Monitoring

   During installation of the reinforcing plate, welds will be examined, consistent with the requirements described in Code Case N-661. This includes performing a surface examination of the area to be welded, a surface examination (dye penetrant or magnetic particle) after the first weld pass and a final surface examination of the completed weld.

   Inservice monitoring of the repair will be accomplished by applying a 1-inch by 1-inch grid over the area which will cover the reinforcing plate and the flat portion of the attaching weld (refer to Figure A). The intersection points in the grid will be inspected using straight beam UT. An initial baseline UT will be performed after installing the repair. Subsequent UTs will then be performed to verify that the structural requirements of the original construction code are maintained through the remainder of the current operating cycle. The UTs will be performed monthly for the first quarter and if no unexpected degradation is identified, UTs will then be performed quarterly for the balance of the duration of this relief request.

   Also, routine walkdowns will be performed by Nuclear Plant Operators at least daily. This piping is not insulated and is accessible for visual inspection.

5. Degradation mechanism

   Based on the location of the defect and based on the UT inspections of the degraded area, Entergy concludes that this was likely caused by degradation of the protective concrete lining directly under the degraded area which allowed brackish water from the Hudson River to contact the unprotected carbon steel piping resulting in localized corrosion. The degradation of the concrete lining was likely caused by the high flow velocities and turbulence from the valve located just upstream of the degraded area. Further evaluation of the degradation mechanism will be performed during the next outage as stated in Section F, when the elbow can be removed and replaced.

   Entergy will perform augmented inspections, as required by Code Case N-513-1, for the extent-of-condition evaluation. The inspections will be at 5 locations selected as most susceptible to the degradation mechanism suspected at this time. Parameters to be considered for selection of the augmented inspection locations will include system operating conditions, proximity of upstream valves, and years of service.

6. Applicable Loads

   The repair will be designed to accommodate all appropriate deadweight, pressure, and seismic loads. Since the system is a moderate energy system which operates at a low temperature, differential thermal expansion between the repair plate and the repaired component is not a concern.

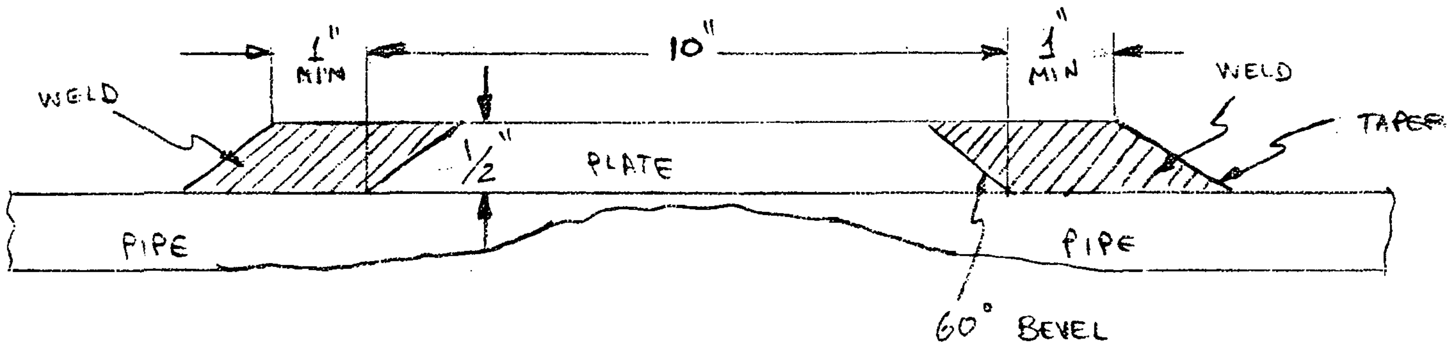
F. Duration of Proposed Alternative

The duration of the temporary repair is limited until the next scheduled outage exceeding 30 days, but no later than the next refueling outage currently scheduled for the Spring of 2009.

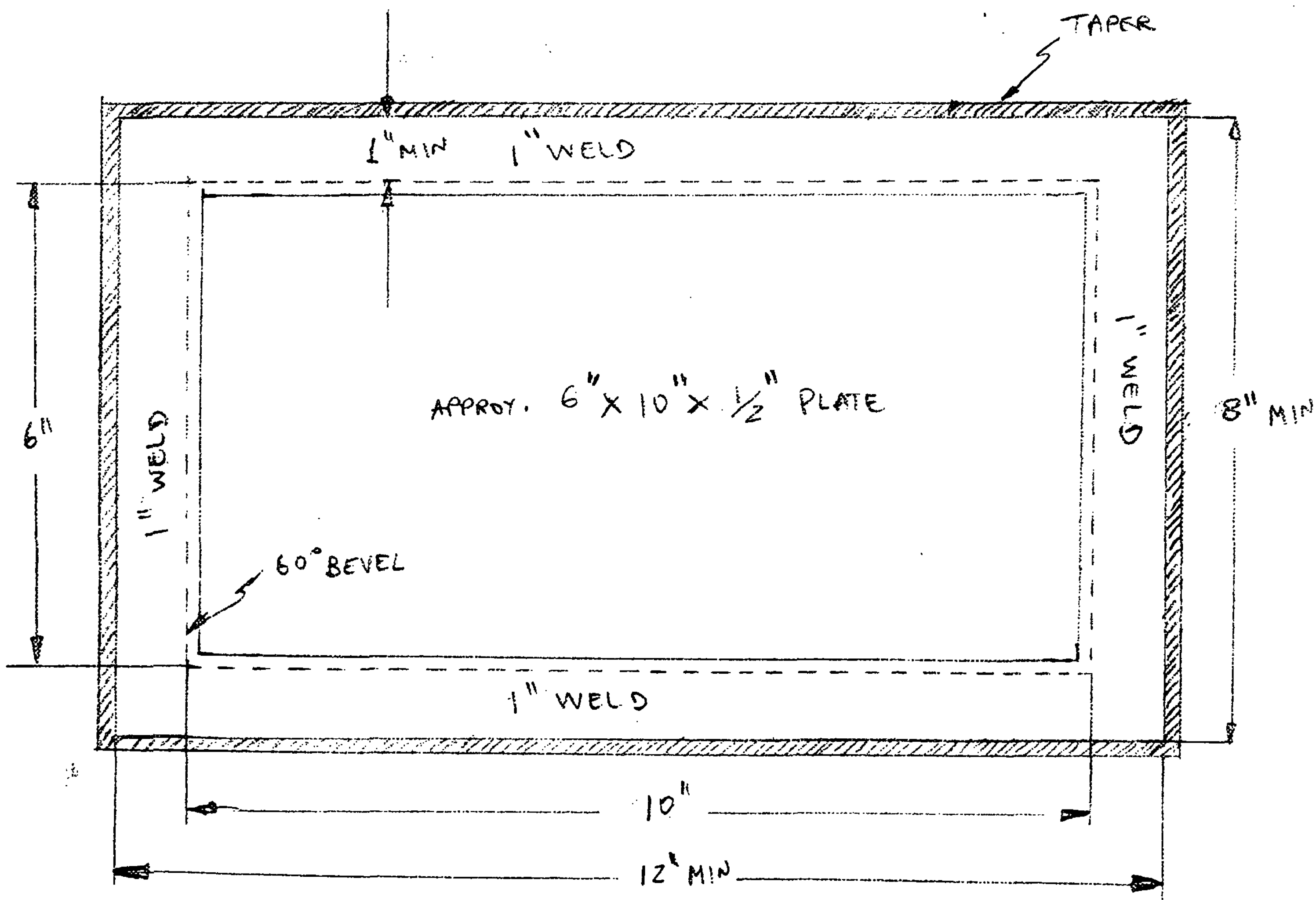
G. References

1. NRC Safety Evaluation dated April 24, 2007 for Relief Request 3-42 (ML070880358).

INDIAN POINT UNIT 3
RELIEF REQUEST 3-43, REVISION 1
PAGE 6 OF 6
FIGURE A



SIDE VIEW



PLAN VIEW

☐ ANO-1	☐ ANO-2	☐ GGNS	☐ IP-2	☒ IP-3
☐ JAF	☐ PNPS	☐ RBS	☐ VY	☐ W3

CALCULATION COVER PAGE

(1) EC # 3047

(2) Page 1 of 12

(3) Design Basis Calc. ☐ YES ☒ NO

(4) ☐ CALCULATION ☒ EC Markup

(5) **Calculation No: IP-CALC-07-00083 EC 3047**

(6) **Revision: 0**

(7) **Title: Evaluation OF Through Wall Flaw at leak downstream of SWN-38**

(8) **System(s): SWS**

(9) **Review Org (Department): Civil / Structural Design Engineering**

(10) Safety Class:	(11) Component/Equipment/Structure Type/Number:	
☒ Safety / Quality Related ☐ Augmented Quality Program ☐ Non-Safety Related	SWN-38	
	Line 408	
(12) Document Type: CALC		
(13) Keywords (Description/Topical Codes):		

REVIEWS

(14) Name/Signature/Date	(15) Name/Signature/Date	(16) Name/Signature/Date
Kai Lo 9-19-07 Klo	GOPAL BHALLA Gopal Bhalla 9/19/07	R. Drake [signature] 9/19/07
Responsible Engineer	☒ **Design Verifier** ☒ **Reviewer** ☐ Comments Attached	**Supervisor/Approval** ☐ Comments Attached

CALCULATION REFERENCE SHEET	CALCULATION NO: IP-CALC-07-00083, REV. 0 Page 2 of 12

I. EC Markups Incorporated: NONE

1,
2.
3.
4.
5.

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1.			☐	☐		
2.			☐	☐		
3.			☐	☐		
4.			☐	☐		
5.			☐	☐		

III. CROSS REFERENCES:

1. See page 6
2.
3.
4.
5.

IV. SOFTWARE USED: NONE

Title:__________________ Version/Release:_________ Disk/CD No.______

V. DISK/CDS INCLUDED: NONE

Title:__________________ Version/Release_________ Disk/CD No.______

VI. OTHER CHANGES: NONE

Revision	Record of Revision
0	Initial issue of Calculation IP-CALC-07-00083

LIST OF EFFECTIVE PAGES

Page 4 of 12

Calculation Number: IP-CALC-07-00083 Revision Number: 0

PAGE	REV.	PAGE	REV.	PAGE	REV.
All	0				

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6.0 Calculation Section

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6.1 Background

Two through wall leaks were found on an elbow downstream of SWN-38. This line is for the Service Water supply line. This weld was weld repaired at end of 3R14.

6.2 Purpose

The leak is at downstream of SWN-38 and is ISI class 3, seismic class I. It is necessary to evaluate the structural integrity of the through wall leak for operability and extent of weld repair.

6.3 Method of analysis

1. Based on the reference, "Companion Guide to the ASME BPVC", page 555, the SIF at an elbow is maximum at the 45 degrees location. Since the leak and thinned area is approximately 3" from the elbow weld, an SIF of 1.0 for a straight pipe is used, i.e. 0.75i = 1.0.
2. Instead of using an uniform thinning approach to determine the minimum required wall thickness t'min, the exact method was used by using average UT readings at locations of leakage and wall thinning.
3. Determine the minimum required wall thickness to satisfy the 1967 B31.1 code limit.
4. ASME CC-N513 is used to determine the acceptable flaw length for normal/upset and emergency/faulted loading condition.

6.4 Assumption

1. The wall thickness of locations beyond the 1"x1" grids (A1 through K6) are assumed to be the same as the average wall thickness of section 1,2 & 3 for the 2" grids at the weld section UT.
2. The wall thickness used for the CC N-513 evaluation is an average value of the thickness around the thinned area.

6.5 Design Input

1. This leak location is the same as inspection ID PAB-90 in 3R13.
2. IP3 Pipe specification MS-TS-027
3. Flow diagram 9321-F-27223
4. Drawing 9321-F-53533
5. IP3 Line List
6. IP-CALC-07-00083 Rev. 0
7. UT Report IP3-UT-07-110

6.6 Reference

1. ENN-CS-S-008, "Pipe Wall Thinning Structural Evaluation"
2. EN-DC-185, "Through-Wall Leaks in ASME XI Class 3 Moderate Energy Piping Systems"
3. ASME 1995 B & PV Code, Section XI, Appendix H, Article H-4000
4. ASME B & PV Nuclear Code Case N-513, Rev. 1.
5. USAS B31.1, Power Piping Code, 1967.
6. "Companion Guide to the ASME BPVC", volume 1

6.7 Calculation

For pipe stress corresponding to 0.75i = 1.0

P = design pressure =	150	psi
D = outside diameter =	18	in
t = pipe wall thickness =	0.375	in for std size pipe
0.75i = SIF at pipe section =	1.00	
0.75i' = SIF used in stress run = .75*3.5 =	2.625	at 45 degrees portion of elbow [Ref. 6]
f'_{nor} = normal stress from stress run =	3120	psi, from PAB-90 inpsection point
f'_{dw+obe} = DW+OBE stress from stress run =	5490	psi
f'_{dw+dbe} = DW+DBE stress from stress run =	6680	psi

Based on 0.75i = 1.0

f_p = longitudinal stress due to pressure = PD/(4t) =	1800	psi
f'_{dw} = dead weight stress w/out pressure = f'_{nor} - f'_p =	1320	psi
f_{dw} = dead weight stress = $f'_{dw}(i/i')$ =	503	psi
f_{nor} = normal stress = f_p + f_{dw} =	2303	psi
f'_{dw+obe} = obe pipe stress w/out pressure = f'_{dw+obe} - f_p =	2370	psi
f_{obe} = obe pipe stress = $f'_{obe}(i/i')$ =	903	psi
f_{ups} = DW+OBE stress = f_p + f_{obe} =	2703	psi
f'_{dbe} = dbe pipe stress w/out pressure = f'_{dw+dbe} - f_p =	4880	psi
f_{dbe} = dbe pipe stress = $f'_{dbe}(i/i')$ =	1859	psi
f_{emg} = DW+DBE stress = f_p + f_{dbe} =	3659	psi

6.7 Calculation

Determine Minimum Wall for Operability based on Axial Stress Calculation for Actual Thinned Section

1. Actual Section Modulus Calculation:
(See Ref. 2.7)

(Boxed values are input.)

D_o : Pipe OD, (in)	18
R_o : Pipe outside radius, = D/2, (in)	9
t_{nom} : Pipe nominal wall thickness, (in)	0.375
Y' : Total service years up to latest inspection, (yr)	30
Y : Service years between latest inspection and next inspection, (yr)	1.5
N : Total no. of thickness measurements (equal grid) in circumferential direction	20
$\Delta\theta = 2\pi/N$, angle of each grid, (rad) (where π = 3.142)	0.314

Section 4 UT reading was used:

n	$(t_{meas})_n$	$(t_p)_n$	R_{in}	θ_n	A_{in}	A_{mn}	B_{iyn}	B_{ixn}	I_{xn}	I_{yn}	I_{xyn}	
		(in.)	(in.)	(rad)	(in^2)	(in^2)	(in^3)	(in^3)	(in^4)	(in^4)	(in^4)	
1	0.229	0.221	8.78	0.00	12.1	0.62	70.9	0.0	48.8	0.0	0.0	
2	0.152	0.140	8.86	0.31	12.3	0.39	69.3	22.5	28.3	3.0	9.2	note 1
3	0.090	0.074	8.93	0.63	12.5	0.21	60.2	43.8	11.0	5.8	8.0	
4	0.186	0.175	8.82	0.94	12.2	0.49	42.3	58.2	13.5	25.5	18.5	
5	0.255	0.248	8.75	1.26	12.0	0.69	21.7	66.8	5.2	49.4	16.0	note 2
6	0.255	0.248	8.75	1.57	12.0	0.69	0.0	70.2	0.0	54.6	0.0	
7	0.255	0.248	8.75	1.88	12.0	0.69	-21.7	66.8	5.2	49.4	-16.0	
8	0.255	0.248	8.75	2.20	12.0	0.69	-41.3	56.8	18.9	35.7	-26.0	
9	0.255	0.248	8.75	2.51	12.0	0.69	-56.8	41.3	35.7	18.9	-26.0	
10	0.255	0.248	8.75	2.83	12.0	0.69	-66.8	21.7	49.4	5.2	-16.0	
11	0.255	0.248	8.75	3.14	12.0	0.69	-70.2	0.0	54.6	0.0	0.0	
12	0.255	0.248	8.75	3.46	12.0	0.69	-66.8	-21.7	49.4	5.2	16.0	
13	0.255	0.248	8.75	3.77	12.0	0.69	-56.8	-41.3	35.7	18.9	26.0	
14	0.255	0.248	8.75	4.08	12.0	0.69	-41.3	-56.8	18.9	35.7	26.0	
15	0.255	0.248	8.75	4.40	12.0	0.69	-21.7	-66.8	5.2	49.4	16.0	
16	0.255	0.248	8.75	4.71	12.0	0.69	0.0	-70.2	0.0	54.6	0.0	
17	0.255	0.248	8.75	5.03	12.0	0.69	21.7	-66.8	5.2	49.4	-16.0	
18	0.255	0.248	8.75	5.34	12.0	0.69	41.3	-56.8	18.9	35.7	-26.0	
19	0.255	0.248	8.75	5.65	12.0	0.69	56.8	-41.3	35.7	18.9	-26.0	
20	0.255	0.248	8.75	5.97	12.0	0.69	66.8	-21.7	49.4	5.2	-16.0	
Min.	0.09	0.074		Σ_n =	A_i	A_m	B_{iy}	B_{ix}	I_x	I_y	I_{xy}	
aver	0.23683				241.7	12.8	7.7	4.8	488.8	520.3	-32.2	

Where n : ID of measurement grid

$(t_{meas})_n$: Min. thickness measured in nth grid

$(t_p)_n$: Min. predicted thickness of nth grid at next inspection, $= (t_{meas})_n - Y^*[1.1(t_{nom} - (t_{meas})_n)/Y']$

R_{in} : Inside thinned radius = $R_o - (t_{meas})_n$ of nth grid

θ_n : Circumferential angle clockwise of nth grid (from vertical axis of pipe section)

$A_{mn} = (R_o^2 - R_{in}^2)*(\Delta\theta)/2$, $A_{in} = R_{in}^2*(\Delta\theta)/2$

$B_{iyn} = R_{in}^3*\cos(\theta_n)*(\Delta\theta)/3$, $B_{iXn} = R_{in}^3*\sin(\theta_n)*(\Delta\theta)/4$

$I_{xn} = (R_o^4 - R_{in}^4)*\cos^2(\theta_n)*(\Delta\theta)/4$, $I_{yn} = (R_o^4 - R_{in}^4)*\sin^2(\theta_n)*(\Delta\theta)/4$, $I_{xyn} = (R_o^4 - R_{in}^4)*\sin(\theta_n)*\cos(\theta_n)*(\Delta\theta)/4$,

$A_m = \Sigma^N_{n=1} A_{mn}$, similar for A_i, B_{iy}, B_{ix}, I_x, I_y, and I_{xy} (The origin of x-y coordinates is at the center of pipe section.)

Gravity center of pressure area : $Y_p = B_{iy}/A_i$; $X_p = B_{ix}/A_i$; (in)	0.032	0.020	
Gravity center of metal area : $X_m = -A_i/A_m*X_p$; $Y_m = -A_i/A_m*Y_p$; (in)	-0.373	-0.600	
Moment inertias at G.C. of metal area : $I_{x'} = I_x - A_m*X_m^2$, $I_{y'} = I_y - A_m*Y_m^2$, & $I_{x'y'} = Ixy - A_m*X_m*Y_m$;(in^3)	487.0	515.7	-35.09
Actual thinned Section: $I_{min} = \{I_{x'} + I_{y'} - [(I_{x'} - I_{y'})^2 + 4*I_{x'y'}^2]^{0.5}\}/2$, $R_{max} = R_o + (X_m^2 + Y_m^2)^{0.5}$, $Z_{min} = I_{min}/R_{max}$	463.4	9.71	47.7
Nominal section: I_{nom}, R_o, Z_{nom} (for t_{nom}= 0.375 in.); (in^3, in, in^2)	806.6	9.00	89.6
Uniformly thinned section: I, R_o, Z (for $(t_{meas})_{min}$ = 0.074 in.); (in^3, in, in^2)	168.1	9.00	18.7

2. Axial Stress for Actual Thinned Section

P : Design pressure, (psi)		150		
$S_p = P^*A_i/A_m$ /1000, (ksi)		2.83		
$\delta = (X_m^2+Y_m^2)^{0.5}$, Eccentricity of thinned section, (in)		0.71		
$M_p = (\pi^*R_o^2)^*P^*\delta/1000$, Bending moment due to eccentricity of pressure force, (k-in)		27.0		

Operating Condition		Normal	Upset	Emerg.
S : Code axial stress, (ksi)	Ref. Inspection ID. PAB-90 in3R13	3.12	5.49	6.68
$M_b = (S - P^*D_o/4t_{nom}/1000)^*Z_{nom}$: Bending moment due code loadings, (k-in)		118	331	437
$M' = M_b + M_p$: Total bending moment for thinned section, (k-in)		145	358	464
$S' = S_p + M'/Z_{min}$: Actual stress due to thinning, (ksi)		5.88	10.33	12.56
new (0.75x sif) :	use 1.0	1.00	1.00	1.00
original (0.75xsif) used in stress calc		2.625	2.625	2.625
[(new 0.75xsif) / (old 0.75xsif)](S') : Stress adjusted for new sif from wall thinning		2.2	3.9	4.8
S_{allow} : Allowable stress, (ksi)		15.0	18.0	27.0
Acceptable if $S_{allow} \geq S'$		Yes	Yes	Yes

Note: Due to accessibility, the wall thickness beyond the 10" region is an average of all the 2" grid UT readings

Note 1: $t_{min} = PD/[2(S_h + .4P)] =$ 0.090 inch for hoop stress

Note 2: average wall thicknes = 0.255

ID No. Through wall leak and flaw at

A. Pipe Parameters

D_o = Pipe OD (in)		18
t = Pipe wall thickness (in)	(.179+.185+.231+.156+.131+.159+.149)/7.231)/7 =	0.170
t_{nom} = nominal pipe wall thickness (in)		0.375
P' = Operational Pressure (psi)		70
P = Design Pressure (psi)		150
T = Design Temperature (°F)		160
R = pipe mean radius (in) = (D_o - t)/2		8.915
E = elastic modulus at T (ksi)		27800
J_{1c} = material toughness (lb/in)		45
K_{1c} = material critical stress intensity factor =J_{1c}*E/1000)$^{0.5}$ (ksi(in)$^{0.5}$)		35.37

B. Evaluation of Axial Flaw

c = ℓ/2 = Half axial flaw length (in)	, try "c" to make K_{Ic} - K_I > 0.0	1.31	1.23
$\lambda = c/(tR)^{0.5}$		1.07	1.00
$F = 1 + A\lambda + B\lambda^2 + C\lambda^3 + D\lambda^4 + E\lambda^5$		1.58	1.52
Where A= 0.0724 B= 0.6486 C= -0.2327 D= 0.0382		E= -0.0023	
Operating Conditions		Nor/Ups	Eme/Fau
P' = Pressure (psi)	, use P' for Nor/Ups & P for Eme/Fau condition	70	150
σ_h = P'"*R/t/1000 = Hoop Stress (ksi)		3.67	7.87
SF : Safety Factor		3.00	1.50
K_{Ic} - K_I = K_{Ic} - (SF)*(P'*R/t)*(π*c)$^{0.5}$*F $\geq$ 0.0		0.0	0.0
Flaw length (2c) =		2.63	2.46

C. Evaluation of Circumferential Flaw

c : Half circumferential flaw length	, try "c" to make K_{Ic} - K_I > 0.0					1.46	1.98
$\alpha = c/\pi R$						0.052	0.071
r = R/t						52.4	52.4
	i=	0	1	2	3		
$A_m = A_{m0} + A_{m1}{}^*r + A_{m2}{}^*r^2 + A_{m3}{}^*r^3$	A_{mi}	-2.0292	1.6776	-0.0799	0.0018	120.1	120.1
$B_m = B_{m0} + B_{m1}{}^*r + B_{m2}{}^*r^2 + B_{m3}{}^*r^3$	B_{mi}	7.0999	-4.4239	0.2104	-0.0046	-314.1	-314.1
$C_m = C_{m0} + C_{m1}{}^*r + C_{m2}{}^*r^2 + C_{m3}{}^*r^3$	C_{mi}	7.7966	5.1668	-0.2458	0.0054	383.1	383.1
$A_b = A_{b0} + A_{b1}{}^*r + A_{b2}{}^*r^2 + A_{b3}{}^*r^3$	A_{bi}	-3.2654	1.5278	-0.0727	0.0016	107.8	107.8
$B_b = B_{b0} + B_{b1}{}^*r + B_{b2}{}^*r^2 + B_{b3}{}^*r^3$	B_{bi}	11.363	-3.9141	0.1862	-0.0041	-273.0	-273.0
$C_b = C_{b0} + C_{b1}{}^*r + C_{b2}{}^*r^2 + C_{b3}{}^*r^3$	C_{bi}	-3.1861	3.8476	-0.1830	0.0040	276.4	276.4
Operating Conditions						Nor/Ups	Eme/Fau
$F_m = 1 + A_m{}^*\alpha^{1.5} + B_m{}^*\alpha^{2.5} + C_m{}^*\alpha^{3.5}$						2.25	2.88
$F_b = 1 + A_b{}^*\alpha^{1.5} + B_b{}^*\alpha^{2.5} + C_b{}^*\alpha^{3.5}$						2.12	2.69
P_m = P*D/4t_{nom} : Axial stress due to design pressure (ksi)						1.80	1.80
S = P_m + P_b: Piping Axial Stress						$\boxed{2.70}$	$\boxed{3.66}$
P_b = S - P_m						0.90	1.86
SF : Safety Factor						2.77	1.39
K_{Ic} =						35.4	35.4
K_{Ic} - K_I = K_{Ic} - (SF)*(π*c)$^{0.5}$ * (P_m*F_m + P_b*F_b) $\geq$ 0.0						0.0	0.0
Flaw length (2*c) =						2.92	3.97

The acceptable circumferential flaw length for normal/upset loading condition is 2.9", less than the combined (1" + 0.5" + 1.875") = 3.375", the flaw must be repaired and can not delayed until 3R15. Since the acceptable circumferential flaw length for emergency/upset loading condition is 3.9", greater than the 3.375" flaw, the flaw is structural acceptable and operable for the past and present. The wall thinning area and the leak need to be repaired by weld overlay.

Provide minimum weld overlay from 1.5" beyond section 1 to 1.5" beyond section K in the circumferential direction and 1.5" beyond section 1 to 1.5" beyond section 6 in the axial direction. The minimum overlay area is 9" axial by 14" circumferential.

After weld overlay, the SIF needs to be 2.1 for even a straight pipe. Since the pipe stress is low, the new stress after using the SIF mutiplier of 2.1 will still be below code limit.

New UT Results show flaw is less than 2.92" therefore acceptable per N-513.

6.8 Conclusion

The acceptable circumferential flaw length for normal/upset loading condition is 2.9", less than the combined (1" + 0.5" + 1.875") = 3.375", the flaw must be repaired and can not delayed until 3R15. Since the acceptable circumferential flaw length for emergency/upset loading condition is 3.9", greater than the 3.375" flaw, the flaw is structural acceptable and operable for the past and present. The wall thinning area and the leak need to be repaired by weld overlay.

ATTACHMENT 9.4 — OPERABILITY EVALUATION/FUNCTIONALITY FORM

Sheet 1 of 1

Operability/Functionality Evaluation — **Page 1 of 1**

1. Condition Report No./Operability Evaluation No. CR-IP3-2007-03630

2. Summary of Operability Evaluation:

A thru wall leak was observed on the base metal of the elbow just above the weld of the 18" diameter SW FCU supply line downstream of SWN-38 on line #408.

The leak is a downstream of SWN-38 on a ISI class 3, Seismic class I line. The flaw was measured and characterized by UT Report IP3-UT-07-110 as three flaws (two leaking). The flaws were evaluated one flaw .75" circumferential by 1.75" axial and another combined flaw of 3.375" circumferentially by 1.75" axial. These flaws were evaluated by using the ASME Code Case N-513 and acceptable at this time since they are less than the allowable flaw length of 3.97" circumferential and 2.46" axial. (See attached calculation).

The flaws are acceptable but will not last until the next outage.
The pipe needs to be repaired as soon as possible, Within the month, so an proper repair can be made and to prevent the flaw from growing beyond the acceptable length.

3. Basis for Operability Evaluation attached. ☒ IP-CALC-07-00083 mark up attached.

4. Are there any other affected SSCs? ☐ **No** ☒ **Yes Service Water supply header to the FCUs**

5. **Recommendation:** ☒ **Operable;** ☐ **Operable – COMP;** ☐ **Inoperable**
☐ **Functional;** ☐ **Non-functional**

6. **Identify any Limitations, Long Term Actions and/or Compensatory Measures to maintain Operability:** ☐ **N/A** ☒ **Yes (List WO, CA, tracking no., etc.) The pipe is operable at this time in accordance with ASME Code Case N-513 "Evaluation Criteria for Temporary Acceptance of Flaws in Class 3 Piping". The pipe needs to be repaired as soon as possible, within the month, so an effective repair can be made and to prevent the flaw from growing beyond the acceptable length. ECR#2532 (EC 00003047).**

50.59 Process Completed for Compensatory Actions Required to Maintain Operability: ☐ **Yes** ☐ **N/A** ☒ **N/A**

Approvals:
Prepared By (Name/Date): Richard Drake Richard D Drake 9/19/07
Additional Reviews (Assign thru CA Process) By (Name/Date): KAI La 6 [illegible] 9-19 CA No.
Additional Reviews (Assign thru CA Process) By (Name/Date) CA No.
Engineering Manager Approval By (Complete only if not entered in PCRS) (Print/Sign/Date) Tom McCaffrey By Telecon
Shift Manager (Complete only if not entered in PCRS) (Print/Sign/Date)
OE Closed: Date: Shift Manager:

Send a copy of the Operability Evaluation to the System Engineer for use in the System Health Report.

(Attach additional pages as necessary)

ATTACHMENT 4 TO NL-07-120

REPLY TO REQUEST FOR ADDITIONAL INFORMATION REGARDING

INDIAN POINT 3 RELIEF REQUEST 3-43

Ultrasonic Test Results for Area of Interest Downstream of SWN-38

IP3-UT-07-110, September 2007

IP3-UT-07-049, March 2007

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NO. 3
DOCKET NO. 50-286

UT Erosion/Corrosion Examination

Entergy

Site/Unit:	IP3 / 3	Procedure:	ENN-NDE-9.05	Outage No.:	N/A
Summary No.:	18" Line # 408	Procedure Rev.:	1	Report No.:	IP3-UT-07-110
Workscope:	BOP	Work Order No.:	00123409-02	Page:	1 of 5

Code: ANSI B31.1 1967 Ed. Thru 1969 Add. Cat./Item: N/A Location: PAB / Minim Containment

Drawing No.: 9321-F-27223 Description: Characterize thru wall pipe leak

System ID: Service Water

Component ID: 18" Line # 408 D/S of valve SWN-38 Size/Length: 18" Sch STD Thickness/Diameter: 0.375"

Limitations: Partially painted Component File No.: SWN-38 Start Time: 0800 Finish Time: 1630

Calibration Information

Calibration Thickness (In)		Calibration Times / Initials		
.040"	.500"	Start:	0945	REA
.100"	N/A	Verify:	1025	REA
.200"	N/A	Verify:	1120	REA
.300"	N/A	Verify:	1410	REA
.400"	N/A	Final:	1445	REA

Partitioning Information

Component	Begin/Col/Row	Ending/Col/Row
M. UPST Ext.	N/A	
Main UPST.	N/A	
Main	A1	AC3
Main DNST.	A1	K6
M. DNST Ext.	N/A	
Branch	N/A	
Branch Ext.	N/A	

Component Information

Component Geometry:	90 Deg. Elbow		
Outside Diameter:	18"	Grid Size:	1" X 2"
Max. Thickness:	.369"	Min. Thickness:	.077"
Nominal Thickness:	.375"	Tmin.:	.090"
Min. Thickness Location:	Micro grid I4		
Max. Thickness Location:	Weld grid Q1		

Instrument:
Manufacturer: Panametrics
Model: 37DL+
Serial No.: 031110106
Gain: 60
Range: 1.0"

Transducer:
Manufacturer: Panametrics
Serial No.: 1003013
Size: .312 Freq.: 5 MHZ
Model: D7906
# of Elements: Dual

Reference/Simulator Block:
Serial No.: A23867
Type: C/S .04"-.5"
Ref./Simulator Block Temp.: 91.2 °F
Material/Component Temp.: 85.6 °F

Temp. Tool:
Manufacturer: Control Co., Inc
Serial No.: QS-78
Couplant:
Type: Ultragel
Batch No.: 05325

Comments/Obstructions: Thru coat mode used for micro & weld grids. D798 probe (S/N 532905) use for area sizing data.

REA 9/20/07

Results: Accept ☐ Reject ☑ Info ☐ Tmin = .090" per IP-CACL-07-00083. REFERENCE CR-IP3-2007-03630

Examiner	Level	Signature	Date	Reviewer	Signature	Date
Allen II, Robert E.	III-PDI	[signature]	9/19/2007	N/A		
Examiner N/A	N/A			Site Review: MICHAEL A. TERPENING	[signature]	9/19/07
Other N/A	N/A			ANII Review: N/A		

Entergy

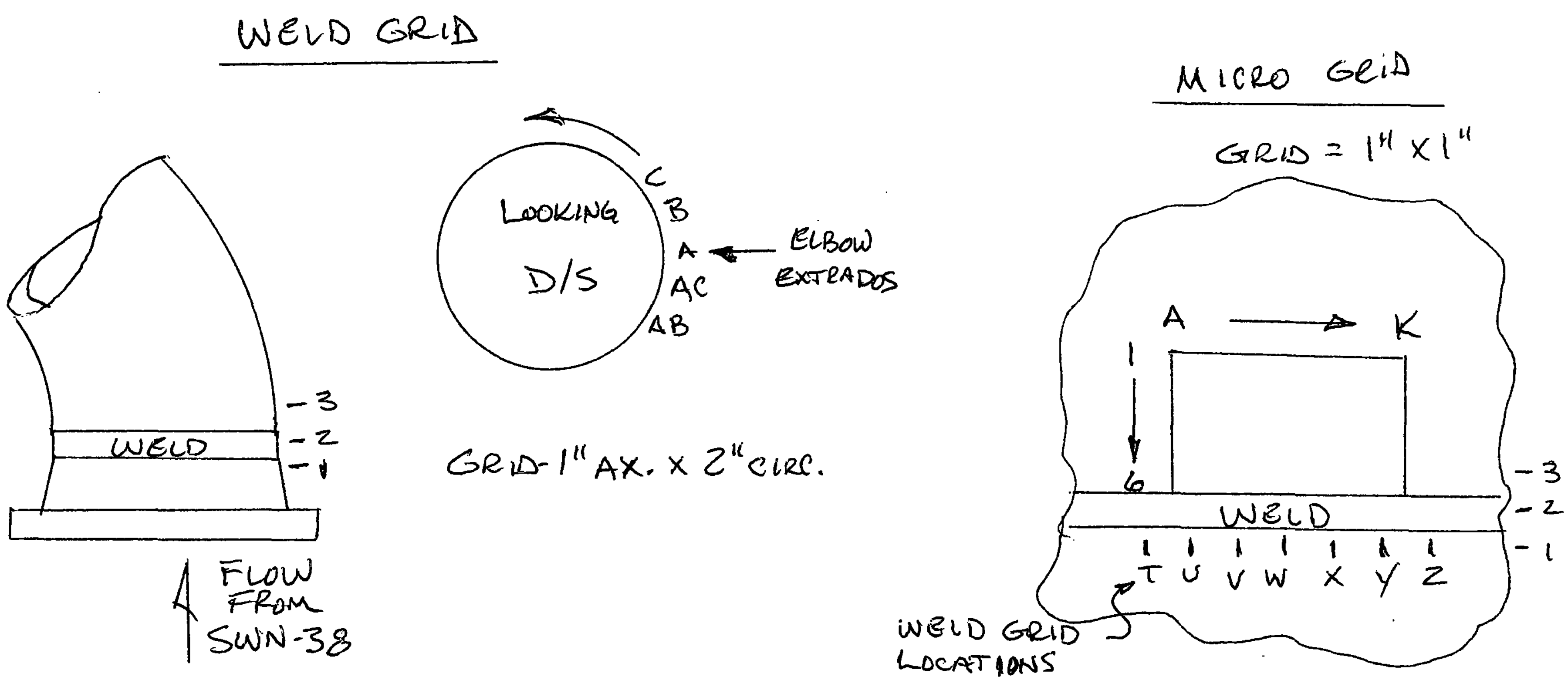
Supplemental Report

Report No.: IP3-UT-07-110

Summary No.:	18" Line # 408						
Examiner:	Allen II, Robert E.	Level:	III-PDI	Reviewer:	N/A	Date:	
Examiner:	N/A	Level:	N/A	Site Review:	Michael A. Terpening	Date:	9/19/07
Other:	N/A	Level:	N/A	ANII Review:	N/A	Date:	

Comments: **Sketch of weld & micro grid layouts. Weld grid locations U3, V3, W3, X3 and Y3 correspond with micro grid locations B6, D6, F6, H6, and J6 and are only shown in th micro grid data printouts.**

Sketch or Photo:



Win37DLPlus Data Grid

18" Line # 408 D/S of [illegible]-38 - Weld Grid

File Name :	SWN-38	Survey Date :	9/19/2007
File Type :	2D Grid	Minimum thickness:	.152" @ O2
File Description :	E/C	Maximum thickness:	.369" @ Q1
Location Note :	IP3	Report No.:	IP3-UT-07-110
Inspector ID :			Page 3 of 5
Robert Allen			
Obstructions:	F1-H3, need scaffold to reach		
	U3-Y3, locations on micro grid	Reviwer:	MICHAEL A. TERPENING

0.000	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	0.259	0.297	0.325	0.364	0.257	0.000	0.000	0.000	0.346	0.329	0.247	0.345	0.258	0.281	0.343	0.277
2	0.302	0.298	0.276	0.263	0.292	0.000	0.000	0.000	0.306	0.250	0.190	0.242	0.286	0.359	0.152	0.179
3	0.319	0.249	0.278	0.289	0.283	0.000	0.000	0.000	0.304	0.290	0.225	0.232	0.230	0.246	0.250	0.264
Min	0.259	0.249	0.276	0.263	0.257				0.304	0.250	0.190	0.232	0.230	0.246	0.152	0.179
Max	0.319	0.298	0.325	0.364	0.292				0.346	0.329	0.247	0.345	0.286	0.359	0.343	0.277
Avg	0.293	0.281	0.293	0.305	0.277				0.319	0.290	0.221	0.273	0.258	0.295	0.248	0.240
TMin	0.152															
TMax	0.369															
TAvg	0.276															

0.000	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	Min	Max	Avg
1	0.369	0.311	0.302	0.319	0.320	0.334	0.294	0.196	0.312	0.335	0.272	0.249	0.319	0.196	0.369	0.302
2	0.265	0.221	0.203	0.276	0.300	0.267	0.238	0.237	0.278	0.192	0.253	0.213	0.289	0.152	0.359	0.255
3	0.273	0.300	0.282	0.270	0.000	0.000	0.000	0.000	0.000	0.207	0.280	0.274	0.287	0.207	0.319	0.268
Min	0.265	0.221	0.203	0.270	0.300	0.267	0.238	0.196	0.278	0.192	0.253	0.213	0.287			
Max	0.369	0.311	0.302	0.319	0.320	0.334	0.294	0.237	0.312	0.335	0.280	0.274	0.319			
Avg	0.302	0.277	0.262	0.288	0.310	0.301	0.266	0.217	0.295	0.245	0.268	0.245	0.298			
TMin																
TMax																
TAvg																

Color Legend

Over Range	
Not Used	
Not Used	
Not Used	0.421
0.328 - 0.421	0.328
0.262 - 0.328	0.262
0.090 - 0.262	0.090
0.000 - 0.090	0.000
Under Range	

Report Date: 9/19/2007

Win37DLPlus Data Grid

18" Line # 408 D/S of SWN-__ - Micro Grid on elbow

File Name :	SWN-38M	Survey Date :	9/19/2007
File Type :	2D Grid	Minimum thickness:	.077" @ I4
File Description :	E/C	Maximum thickness:	.328" @ K1
Location Note :	IP3	Report No.:	IP2-UT-07-110
Inspector ID :			Page 4 of 5
Robert Allen			
Obstructions:	A2-C2, valve hand wheel		
		Reviwer:	MICHAEL A. TERPENING

0.000	A	B	C	D	E	F	G	H	I	J	K	Min	Max	Avg
1	0.306	0.287	0.231	0.176	0.201	0.203	0.177	0.167	0.210	0.254	0.328	0.167	0.328	0.231
2	0.000	0.000	0.000	0.143	0.175	0.171	0.182	0.184	0.194	0.222	0.276	0.143	0.276	0.193
3	0.271	0.150	0.146	0.149	0.153	0.187	0.212	0.179	0.185	0.225	0.248	0.146	0.271	0.191
4	0.309	0.123	0.175	0.160	0.121	0.159	0.149	0.084	0.077	0.231	0.249	0.077	0.309	0.167
5	0.294	0.191	0.121	0.197	0.139	0.209	0.159	0.131	0.156	0.207	0.230	0.121	0.294	0.185
6	0.300	0.258	0.194	0.190	0.213	0.170	0.199	0.191	0.167	0.278	0.220	0.167	0.300	0.216
Min	0.271	0.123	0.121	0.143	0.121	0.159	0.149	0.084	0.077	0.207	0.220			
Max	0.309	0.287	0.231	0.197	0.213	0.209	0.212	0.191	0.210	0.278	0.328			
Avg	0.296	0.202	0.173	0.169	0.167	0.183	0.180	0.156	0.165	0.236	0.259			
TMin	0.077													
TMax	0.328													
TAvg	0.198													

Color Legend

Over Range	
Not Used	
Not Used	
Not Used	0.421
0.328 - 0.421	0.328
0.262 - 0.328	0.262
0.112 - 0.262	0.112
0.000 - 0.112	0.000
Under Range	

Report Date: 9/19/2007

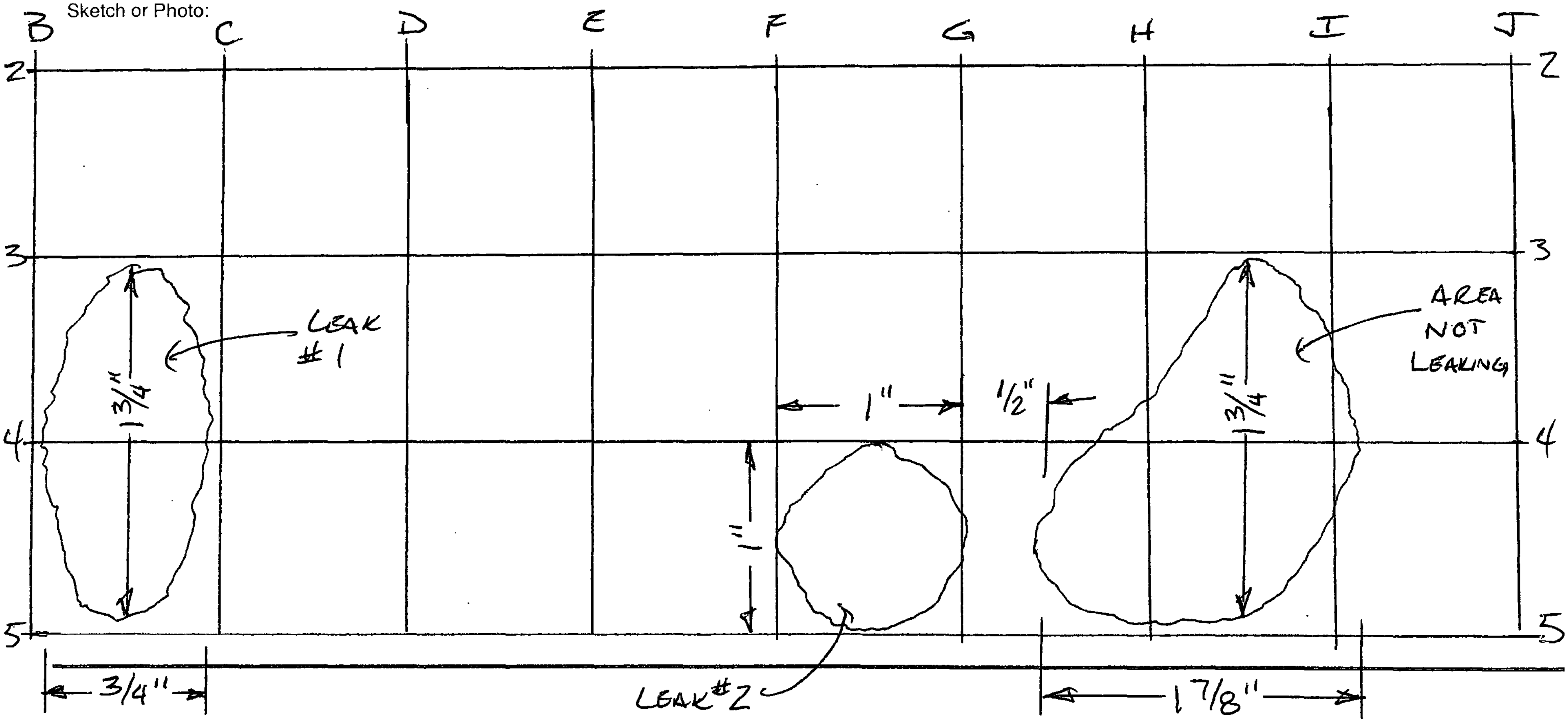
Entergy

Supplemental Report

Summary No.:	18" Line # 408						
Examiner:	Allen II, Robert E.	Level:	III-PDI	Reviewer:	N/A	Date:	
Examiner:	N/A	Level:	N/A	Site Review:	Michael A Jerpening	Date:	9/19/07
Other:	N/A	Level:	N/A	ANII Review:	N/A	Date:	

Comments: Scan of the elbow micro grid showing the areas that are less than .109" thick. These areas are around both through wall leaks and the grid locations H4 and I4. Leak #1 is contained in grid B3-B4-C3-C4, and leak #2 is contained in grid F4-F5-G4-G5.

Sketch or Photo:



Entergy

UT Erosion/Co sion Examination

Site/Unit:	IPEC / 3	Procedure:	ENN-NDE-9.05	Outage No.:	N/A
Summary No.:	N/A	Procedure Rev.:	0	Report No.:	IP3-UT-07-049
Workscope:	BOP	Work Order No.:	IP3-07-17850	Page:	1 of 3

Code: ANSI B31.1, 1967 Ed. thru 1969 Add. Cat./Item: N/A Location: 32' PAB SW Chase

Drawing No.: 9321F27223 Description: Pipe and weld down stream of SWN-38

System ID: Service Water

Component ID: SWN-38 Size/Length: 18" Sch Std. Thickness/Diameter: .375"

Limitations: Painted surface Component File No.: N/A Start Time: 0830 Finish Time: 1045

Calibration Information

Calibration Thickness (In)		Calibration Times / Initials		
.040"	N/A	Start:	0830	RDH
.100"	N/A	Verify:	0920	RDH
.200"	N/A	Verify:	N/A	N/A
.300"	N/A	Verify:	N/A	N/A
.400"	N/A	Final:	1045	RDH

Partitioning Information

Component	Begin/Col/Row	Ending/Col/Row
M. UPST Ext.	N/A	N/A
Main UPST.	N/A	N/A
Main	N/A	N/A
Main DNST.	N/A	N/A
M. DNST Ext.	N/A	N/A
Branch	N/A	N/A
Branch Ext.	N/A	N/A

Component Information

Component Geometry: Pipe & weld

Outside Diameter: 18" Grid Size: 1"

Max. Thickness: .340" Min. Thickness: .033"

Nominal Thickness: .375" Tmin.: .110"

Min. Thickness Location: H6

Max. Thickness Location: A4

Instrument:

Manufacturer: Panametrics

Model: 37DL+

Serial No.: 031110106

Gain: 59db

Range: 2"

Transducer:

Manufacturer: Panametrics

Serial No.: 576062

Size: .312" Freq.: 5 MHZ

Model: D7906

\# of Elements: Dual

Reference/Simulator Block:

Serial No.: 99-7437

Type: C/S .04"-.5"

Ref./Simulator Block Temp.: 71.7 °F

Material/Component Temp.: 46 °F

Temp. Tool:

Manufacturer: Control Co., Inc

Serial No.: QS-75

Couplant:

Type: Ultragel

Batch No.: 05325

Comments/Obstructions: The grid range was from A1 to K6. No readings were taken at A1, A2, A6, B1, K1, K2 or K6.

Results: Accept [ ] Reject [✓] Info [ ] Gage operated in thru-coat mode.

Examiner Herrmann, Robert D.	Level III	Signature Robert Herrmann	Date 3/27/2007	Reviewer N/A	Signature	Date
Examiner N/A	Level	Signature	Date	Site Review	Signature	Date 3/24/07
Other N/A	Level	Signature	Date	ANII Review N/A	Signature	Date

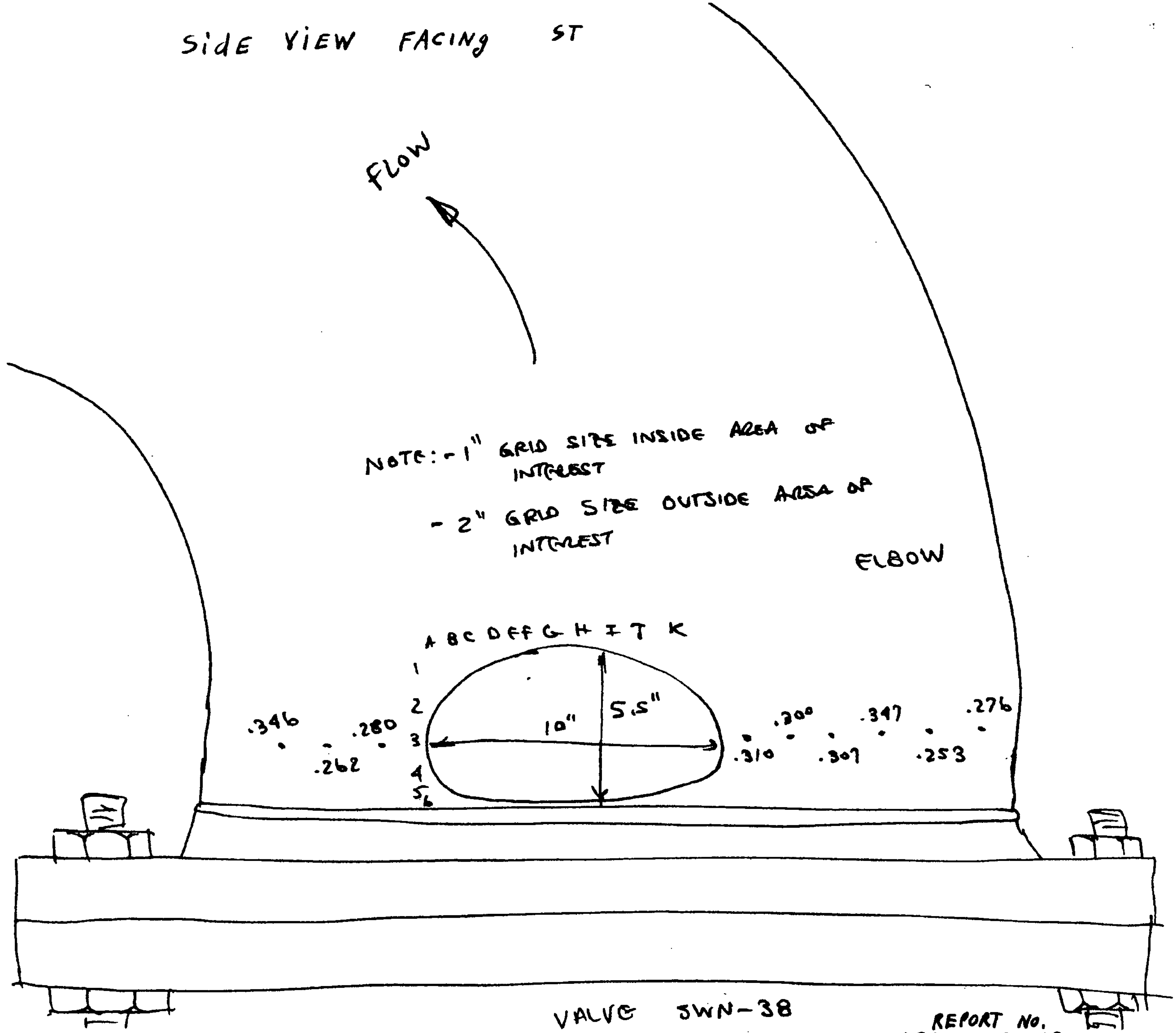
ALL THICKNESSES OUTSIDE OF THE LINE ARE > 0.210.
AREA OF INTEREST IS 10" x 5.5"

	A	B	C	D	E	F	G	H	I	J	K
1			0.275	0.228	0.250	0.207	0.135	0.202	0.191	0.224	
2		0.220	0.275	0.144	0.207	0.181	0.143	0.197	0.190	0.224	
3	.330	0.182	0.128	0.139	0.162	0.189	0.235	0.181	0.169	0.256	0.250
4	.340	0.163	0.126	0.100	0.128	0.155	0.206	0.133	0.124	0.230	0.258
5	.291	0.233	0.185	0.167	0.142	0.055	0.109	0.185	0.221	0.236	0.301
6		0.231	0.208	0.282	0.185	0.215	0.230	0.033	0.206	0.301	

0.403 0.398
0.367 0.327 0.340

REPORT No. 1P3-UT-07-

SIDE VIEW FACING ST



REPORT NO.
1P3-UT-07-049

ATTACHMENT 5 TO NL-07-120

REPLY TO REQUEST FOR ADDITIONAL INFORMATION REGARDING

INDIAN POINT 3 RELIEF REQUEST 3-43

Entergy Calculation IP-CALC-07-00209, Revision 0
Design Reinforcement Plate for Through Wall Leak Repair D/S SWN-38

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT NO. 3
DOCKET NO. 50-286

klo

☐ ANO-1	☐ ANO-2	☐ GGNS	☒ IP-2	☒ IP-3
☐ JAF	☐ PNPS	☐ RBS	☐ VY	☐ W3

CALCULATION COVER PAGE	(1) **EC #** 3176	(2) **Page 1 of** 8
(3) Design Basis Calc. ☐ YES ☒ NO	(4) ☒ CALCULATION ☐ EC Markup	
(5) **Calculation No: IP-CALC-07-00209**	(6) **Revision: 0**	

(7) **Title: Design Reinforcement Plate for Through Wall Leak Repair D/S SWN-38**

(8) **System(s): SWS**	(9) **Review Org (Department): Civil / Structural Design Engineering**
(10) **Safety Class:** ☒ **Safety / Quality Related** ☐ **Augmented Quality Program** ☐ **Non-Safety Related**	(11) **Component/Equipment/Structure Type/Number:** **SWN-38**
(12) **Document Type: CALC**	
(13) **Keywords (Description/Topical Codes):**	

REVIEWS

(14) Name/Signature/Date	(15) Name/Signature/Date	(16) Name/Signature/Date
Kai Lo 9-25-07	P. Bowe 9-26-07	R. Drake 9-26-07 9/27/07
Responsible Engineer	☒ **Design Verifier** ☐ **Reviewer** ☐ Comments Attached	**Supervisor/Approval** ☐ Comments Attached

CALCULATION REFERENCE SHEET	CALCULATION NO: IP-CALC-07-00209, REV. 0 Page 2 of 8

I. EC Markups Incorporated: NONE

1,
2.
3.
4.
5.

II. Relationships:	Sht	Rev	Input Doc	Output Doc	Impact Y/N	Tracking No.
1.			☐	☐		
2.			☐	☐		
3.			☐	☐		
4.			☐	☐		
5.			☐	☐		

III. CROSS REFERENCES:

1.
2.
3.
4.
5.

IV. SOFTWARE USED: NONE

Title:__________________ Version/Release:_________Disk/CD No.______

V. DISK/CDS INCLUDED: NONE

Title:__________________ Version/Release_________Disk/CD No.______

VI. OTHER CHANGES: NONE

Revision	Record of Revision
0	Initial issue of Calculation IP-CALC-07-00209.

LIST OF EFFECTIVE PAGES

Page 4 of 8

Calculation Number: IP-CALC-07-00209 Revision Number: 0

PAGE	REV.	PAGE	REV.	PAGE	REV.
All	0				

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6.0 Calculation Section

Page 6 of 8

6.1 Background

Two through wall leaks and a below minimum wall thickness area were found down-stream of the valve SWN-36 at the region next to the weld toe on Line 408.

6.2 Purpose

A temporary repair is needed to repair the elbow at two leaks and below minimum wall thickness area. It is necessary to design a plate and weld it over the leaked/thinned area.

6.3 Method of analysis

1. Based on a four side simple support regular plate with a uniform design pressure of 150 psi acting on it, determine plate thickness required to stay below the allowable stress for the plate material.
2. Based on item1, reaction at the simple supported edge can be obtained for the weld stress.
3. Determine the transverse shear to be carried by the weld (in the longitudinal direction) in order for the elbow and curved plate to act as one integral piece to resist flexural bending.
4. Determine the torsion shear taken by weld along the circumferential direction.
5. SRSS the weld stresses to obtain the resultant weld stress and determine the fillet size to ensure the weld stress is below the allowable weld stress.
6. Evaluate the pipe stress of a section of uniform wall thickness of 0.2" (minimum pipe thickness outside of the reinforced plate) for design loadings.

6.4 Assumption

1. Allowable stress of 15000 psi is based on either a curved section of a 20" elbow of A53 Gr. B seamless material, or A106 Gr B or C, or a rolled plate from A442, A515 or A516 Gr. 60 material.
2. Three times the larger reaction from the two adjacent pipe supports is used to design for the transverse shear carried by the weld for the reinforcement plate.

6.5 Design Input

1. IP3 Pipe specification TS-MS-027
2. Drawing 9321-F-53533
3. USAS B31.1, Power Piping Code, 1967.
4. Pipe support calculation for SWN-R-524-R & SWN-H&R-525-U

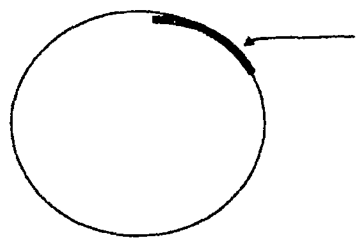
6.6 Reference

1. IP3 Pipe specification TS-MS-027
2. Drawing 9321-F-53533
3. "Formula of Stress and Strain", Roark and Young, 5th edition
4. USAS B31.1, Power Piping Code, 1967.
5. Pipe support calculation for SWN-R-524-R & SWN-H&R-525-U

6.7 Calculation

Determine reinforcement plate thickness and fillet weld size

Pipe thickness beyond the reinforcement plate is greater than 0.25".



t = plate thickness =	0.5	in			
a = plate length in the circumferential direction =	10	in, line from A to J plus 1.5" on each side			
b = plate length in the axial direction =	7	in, from line 1 to 6 plus 1.5" from line 1			
q = design pressure of piping =	150	psi			
w = filet weld size =	0.5	in			
Use plate material A442, A515, or A516 Gr. 60, S_h =	15000	psi	(or cut from a pipe elbow)		
Design plate for uniform pressure:					
Assume 4 sides simple support			[Ref 3, table 26, case 1a]		
a/b =	1.429				
β =	0.463				
γ =	0.48				
σ = plate normal stress = $\beta q b^2/t^2$ =	13612	psi < S_h =		15000	psi
max R = $\gamma q b$ =	504	lb per inch			
f_{w1} = weld stress for pressure = R/(0.707w) =	1426	psi			
Design plate for bending:					

Plate and exist pipe must act together as a composite, integral section
with the weld taking the transverse shear.

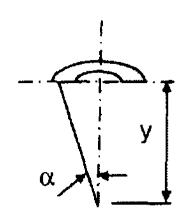
f = transverse shear at weld = VAy/(In)

For a continuous beam, the resisting shear will be smaller than the reaction at the support

To design for shear, consider the adjacent support reaction.

Reaction at adjacent support SWN-R-524-R =	2411	lb [Ref. 5]
Design for 3 times the reaction, V = shear =	7233	lb

Determine the distance from the c.g. of new plate to pipe cenetrline for new plate:



t = nominal thickness of new plate =	0.5	in	
R = mean radius to plate =	9.25	in	
L_c = length of new plate =	10.0	in	
$\alpha = 0.5\left[\frac{L_c}{2\pi R}(360)\right]$ =	30.97	degrees	
$\alpha(radian)$ =	0.5405		
t/R =	0.0541		
A = area = $\alpha t(2R-t)$ =	4.86	in^2	[Ref 3, table 1, case 19]
$y_n = R\left[1-\frac{2\sin\alpha}{3\alpha}\left(1-\frac{t}{R}+\frac{1}{2-t/R}\right)\right]$ =	0.680	in	

y = distance from c.g. of segment to pipe center = R - y_{1a} =	8.570	in
D = outside diameter =	18	in
For moment of inertia calculation, use t =	0.200	in
d = inside diameter = D - 2t =	17.600	in
I = moment of inertia of the pipe = $0.0491[D^4 - d^4]$ =	443.1	in^4
n = number of welds to carry the transverse shear =	2	
f = transverse shear at weld = VAy/(In) =	340	#/in note: in the longitudinal of the pipe
f_{w2} = f/(.707w) =	963	psi
Design weld for torsional shear		
T = torsion at pipe, conservatively use	437248	in-lb, see $0.75i(M_a + M_b)$ for value (see below)
R = outside radius = D/2 =	9.0	in
R_i = inside radius = (R-t) =	8.80	in
$\tau = 2TR/[\pi(R^4-R_i^4)]$ =	4442	psi
$f_{w3} = \tau(t/w)/(.707)$ =	2513	psi
$f_w = \{f_{w1}^2 + f_{w2}^2+f_{w3}^2\}^{0.5}$ =	3045	psi
e = efficiency factor for weld =	0.8	
Allowable weld stress is governed by base metal = eS_h =	12000	psi > f_w = 3045 psi, o.k.

Verify the repaired condition meeet original design loading requirement.

For original pipe stress analysis

P = design pressure =	150	psi
D = outside diameter =	18	in
t' = nominal pipe wall thickness =	0.375	in
S' = section modulus =	89.60	in^3
0.75i' = SIF used in stress run = .75*3.5 =	2.625	at 45 degrees portion of elbow
f'_{nor} = normal stress from stress run =	3120	psi, from PAB-90 inpsection point
f'_{dw+obe} = DW+OBE stress from stress run =	5490	psi
f'_{dw+dbe} = DW+DBE stress from stress run =	6680	psi
f_p = PD/(4t') =	1800	psi
f'_{dw} = dead weight stress w/out pressure = $f'_{nor} - f'_p$ =	1320	psi
$0.75iM_a$ = moment due to DW loading = $f_{dw}S'$ =	118272	in-lb
Based on wall thinning pipe wall, t =	0.20	in
S based on t =	61	in^3
$PD/(4t) + 0.75iM_a/S$ =	5314	psi < S_h = 15000 psi
f'_{dw+obe} = obe pipe stress w/out pressure = $f'_{dw+obe} - f_p$ =	3690	psi
$0.75i(M_a+M_b)$ = moment due to DW+OBE loading = $f'_{dw+obe}S'$ =	330624	in-lb
$PD/(4t) + 0.75i(M_a+M_b)/S$ =	8795	psi < $1.2S_h$ = 18000 psi
f'_{dbe} = dbe pipe stress w/out pressure = $f'_{dw+dbe} - f_p$ =	4880	psi
$0.75i(M_a+M_b)$ = moment due to DW+DBE loading = $f'_{dw+dbe}S'$ =	437248	in-lb
$PD/(4t) + 0.75i(M_a+M_b)/S$ =	10543	psi < $1.8S_h$ = 27000 psi

6.8 Conclusion

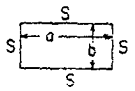
The new reinforcement plate stress, new fillet weld, and pipe section with reinforcement plate are structurally adequate per B31.1 code and criteria.

ILE 26 *Formulas for flat plates with straight boundaries and constant thickness*

TATION: The notation for Table 24 applies with the following modifications: a and b refer to plate dimensions, and when used as subscripts for stress, y refer to the stresses in directions parallel to the sides a and b, respectively. σ is a bending stress which is positive when tensile on the bottom and npressive on the top if loadings are considered vertically downward. R is the reaction force normal to the plate surface exerted by the boundary support the edge of the plate (pounds per inch). r_o' is the equivalent radius of contact for a load concentrated on a very small area and is given by $r_o' = \sqrt{1.6r_o^2 + t^2} - 0.675t$ if $r_o < 0.5t$ and $r_o' = r_o$ if $r_o > 0.5t$

Case no., shape, and supports	Case no., loading	Formulas and tabulated specific values

Rectangular plate; all edges simply supported



1a. Uniform over entire plate

(At center) $\text{Max } \sigma = \sigma_b = \dfrac{\beta q b^2}{t^2}$ and $\max y = \dfrac{-\alpha q b^4}{E t^3}$

(At center of long sides) $\text{Max } R = \gamma q b$

a/b	1.0	1.2	1.4	1.6	1.8	2.0	3.0	4.0	5.0	∞
β	0.2874	0.3762	0.4530	0.5172	0.5688	0.6102	0.7134	0.7410	0.7476	0.7500
α	0.0444	0.0616	0.0770	0.0906	0.1017	0.1110	0.1335	0.1400	0.1417	0.1421
γ	0.420	0.455	0.478	0.491	0.499	0.503	0.505	0.502	0.501	0.500

(Ref. 21 for $\nu = 0.3$)

1b. Uniform over small concentric circle of radius r_o (note definition of r_o')

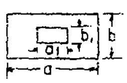
(At center) $\text{Max } \sigma = \dfrac{3W}{2\pi t^2}\left[(1+\nu)\ln\dfrac{2b}{\pi r_o'} + \beta\right]$

$\text{Max } y = \dfrac{-\alpha W b^2}{E t^3}$

a/b	1.0	1.2	1.4	1.6	1.8	2.0	∞
β	0.435	0.650	0.789	0.875	0.927	0.958	1.000
α	0.1267	0.1478	0.1621	0.1715	0.1770	0.1805	0.1851

(Ref. 21 for $\nu = 0.3$)

1c. Uniform over central rectangular area

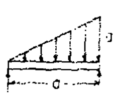


(At center) $\text{Max } \sigma = \sigma_b = \dfrac{\beta W}{t^2}$ where $W = q a_1 b_1$

b_1/b \ a_1/b	$a = b$: 0	0.2	0.4	0.6	0.8	1.0	$a = 1.4b$: 0	0.2	0.4	0.8	1.2	1.4	$a = 2b$: 0	0.4	0.8	1.2	1.6	2.0
0		1.82	1.38	1.12	0.93	0.76		2.0	1.55	1.12	0.84	0.75		1.64	1.20	0.97	0.78	0.64
0.2	1.82	1.28	1.08	0.90	0.76	0.63	1.78	1.43	1.23	0.95	0.74	0.64	1.73	1.31	1.03	0.84	0.68	0.57
0.4	1.39	1.07	0.84	0.72	0.62	0.52	1.39	1.13	1.00	0.80	0.62	0.55	1.32	1.08	0.88	0.74	0.60	0.50
0.6	1.12	0.90	0.72	0.60	0.52	0.43	1.10	0.91	0.82	0.68	0.53	0.47	1.04	0.90	0.76	0.64	0.54	0.44
0.8	0.92	0.76	0.62	0.51	0.42	0.36	0.90	0.76	0.68	0.57	0.45	0.40	0.87	0.76	0.63	0.54	0.44	0.38
1.0	0.76	0.63	0.52	0.42	0.35	0.30	0.75	0.62	0.57	0.47	0.38	0.33	0.71	0.61	0.53	0.45	0.38	0.30

(Values from charts of Ref. 8; $\nu = 0.3$.)

1d. Uniformly increasing along length

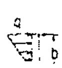


$\text{Max } \sigma = \dfrac{\beta q b^2}{t^2}$ and $\max y = \dfrac{-\alpha q b^4}{E t^3}$

a/b	1	1.5	2.0	2.5	3.0	3.5	4.0
β	0.16	0.26	0.34	0.38	0.43	0.47	0.49
α	0.022	0.043	0.060	0.070	0.078	0.086	0.091

(Values from charts of Ref. 8; $\nu = 0.3$.)

1e. Uniformly increasing along width

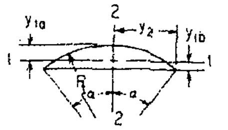
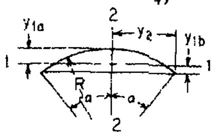
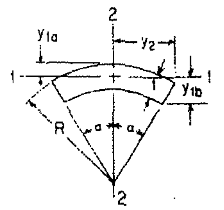
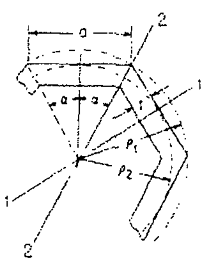


$\text{Max } \sigma = \dfrac{\beta q b^2}{t^2}$ and $\max y = \dfrac{-\alpha q b^4}{E t^3}$

a/b	1	1.5	2.0	2.5	3.0	3.5	4.0
β	0.16	0.26	0.32	0.35	0.37	0.38	0.38
	[illegible]	[illegible]	0.056	0.063	0.067	0.069	0.070

ATT. 1, p. 2 of 2

TABLE 1 ***Properties of sections (Cont.)***

Form of section	Area and distances from centroid to extremities	Moments and products of inertia about central axes	Radii of gyration about central axes
17. Segment of solid circle (*Note:* If $\alpha < \frac{\pi}{4}$, use expressions from case 18) 	$A = R^2(\alpha - \sin\alpha\cos\alpha)$ $y_{1a} = R\left[1 - \frac{2\sin^3\alpha}{3(\alpha - \sin\alpha\cos\alpha)}\right]$ $y_{1b} = R\left[\frac{2\sin^3\alpha}{3(\alpha - \sin\alpha\cos\alpha)} - \cos\alpha\right]$ $y_2 = R\sin\alpha$	$I_1 = \frac{R^4}{4}\left[\alpha - \sin\alpha\cos\alpha + 2\sin^3\alpha\cos\alpha - \frac{16\sin^6\alpha}{9(\alpha - \sin\alpha\cos\alpha)}\right]$ $I_2 = \frac{R^4}{12}(3\alpha - 3\sin\alpha\cos\alpha - 2\sin^3\alpha\cos\alpha)$	$r_1 = \frac{R}{2}\sqrt{1 + \frac{2\sin^3\alpha\cos\alpha}{\alpha - \sin\alpha\cos\alpha} - \frac{16\sin^6\alpha}{9(\alpha - \sin\alpha\cos\alpha)^2}}$ $r_2 = \frac{R}{2}\sqrt{1 - \frac{2\sin^3\alpha\cos\alpha}{3(\alpha - \sin\alpha\cos\alpha)}}$
18. Segment of solid circle (*Note:* Do not use if $\alpha > \frac{\pi}{4}$) 	$A = \frac{2}{3}R^2\alpha^3(1 - 0.2\alpha^2 + 0.019\alpha^4)$ $y_{1a} = 0.3R\alpha^2(1 - 0.0976\alpha^2 + 0.0028\alpha^4)$ $y_{1b} = 0.2R\alpha^2(1 - 0.0619\alpha^2 + 0.0027\alpha^4)$ $y_2 = R\alpha(1 - 0.1667\alpha^2 + 0.0083\alpha^4)$	$I_1 = 0.01143R^4\alpha^7(1 - 0.3491\alpha^2 + 0.0450\alpha^4)$ $I_2 = 0.1333R^4\alpha^5(1 - 0.4762\alpha^2 + 0.1111\alpha^4)$	$r_1 = 0.1309R\alpha^2(1 - 0.0745\alpha^2)$ $r_2 = 0.4472R\alpha(1 - 0.1381\alpha^2 + 0.0184\alpha^4)$
19. Sector of hollow circle (*Note:* If t/R is small, α can exceed π to form an overlapped annulus) 	$A = \alpha t(2R - t)$ $y_{1a} = R\left[1 - \frac{2\sin\alpha}{3\alpha}\left(1 - \frac{t}{R} + \frac{1}{2 - t/R}\right)\right]$ $y_{1b} = R\left[\frac{2\sin\alpha}{3\alpha(2 - t/R)} + \left(1 - \frac{t}{R}\right)\frac{2\sin\alpha - 3\alpha\cos\alpha}{3\alpha}\right]$ $y_2 = R\sin\alpha$	$I_1 = R^3t\left[\left(1 - \frac{3t}{2R} + \frac{t^2}{R^2} - \frac{t^3}{4R^3}\right) \times \left(\alpha + \sin\alpha\cos\alpha - \frac{2\sin^2\alpha}{\alpha}\right) + \frac{t^2\sin^2\alpha}{3R^2\alpha(2 - t/R)}\left(1 - \frac{t}{R} + \frac{t^2}{6R^2}\right)\right]$ $I_2 = R^3t\left(1 - \frac{3t}{2R} + \frac{t^2}{R^2} - \frac{t^3}{4R^3}\right) \times (\alpha - \sin\alpha\cos\alpha)$	$r_1 = \sqrt{\frac{I_1}{A}}$ $r_2 = \sqrt{\frac{I_2}{A}}$
		Note: If α is small: $\frac{\sin\alpha}{\alpha} = 1 - \frac{\alpha^2}{6} + \frac{\alpha^4}{120}$ $\quad \alpha - \sin\alpha\cos\alpha = \frac{2}{3}\alpha^3\left(1 - \frac{\alpha^2}{5} + \frac{2\alpha^4}{105}\right)$ $\cos\alpha = 1 - \frac{\alpha^2}{2} + \frac{\alpha^4}{24}$ $\quad \alpha + \sin\alpha\cos\alpha - \frac{2\sin^2\alpha}{\alpha} = \frac{2\alpha^5}{45}\left(1 - \frac{\alpha^2}{7} + \frac{\alpha^4}{105}\right)$ $\frac{\sin^2\alpha}{\alpha} = \alpha\left(1 - \frac{\alpha^2}{3} + \frac{2\alpha^4}{45}\right)$	
20. Hollow regular polygon with n sides 	$A = nat\left(1 - \frac{t\tan\alpha}{a}\right)$ $\rho_1 = \frac{a}{2\sin\alpha}$ $\rho_2 = \frac{a}{2\tan\alpha}$ If n is odd: $y_1 = y_2 = \rho_1\cos\left(\alpha\frac{n+1}{2} - \frac{\pi}{2}\right)$ If $n/2$ is odd: $y_1 = \rho_1 \quad y_2 = \rho_2$ If $n/2$ is even: $y_1 = \rho_2 \quad y_2 = \rho_1$	$I_1 = I_2 = \frac{na^3t}{8}\left(\frac{1}{3} + \frac{1}{\tan^2\alpha}\right) \times \left[1 - 3\frac{t\tan\alpha}{a} + 4\left(\frac{t\tan\alpha}{a}\right)^2 - 2\left(\frac{t\tan\alpha}{a}\right)^3\right]$	$r_1 = r_2 = \frac{a}{\sqrt{8}} \times \sqrt{\left(\frac{1}{3}\right) + \frac{1}{\tan^2\alpha}\left[1 - 2\frac{t\tan\alpha}{a} + 2\left(\frac{t\tan\alpha}{a}\right)^2\right]}$