ATTACHMENT 4

TO ENTERGY LETTER 2.14.032

PILGRIM RELIEF REQUEST PRR-25, Rev 1

Calculation Cover Page EC # 49514

Flaw Evaluation of SSW Discharge Piping Leaking Elbow

Structural Integrity Associates Calculation No. 1400287.302, Rev. 0

(20 Pages)

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

CALCULATION COVER PAGE

(1) EC # 49514 (2) Page 1 of 20

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Structural Integrity Assoc.	John A. Tucker JAT 3-3-14	See IAS
Responsible Engineer	☐ **Design Verifier** ☒ **Reviewer** ☐ Comments Attached	**Supervisor/Approval** ☐ Comments Attached

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2.
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4.
5.

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3.			☐	☐		
4.			☐	☐		
5.			☐	☐		

III. CROSS REFERENCES:

1. ASME B&PV Code , Section XI, App C, 2001 Edition w/ Add through 2003
2. ASME B31.1, Power Piping, 1967 Edition
3. ASME Code Case N-513-3
4. Flow of Fluids Through valves, Fittings and Pipe, Crane Co,., Technical Paper No. 410

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Flaw Evaluation of SSW Discharge Piping Leaking Elbow

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1.0 INTRODUCTION

A weeping flaw, shown on Figure 1, was discovered near the extrados of a 90 degree elbow in the Salt Service Water (SSW) piping at Pilgrim Nuclear Power Station (Pilgrim). The leak is located on the JF29-8-4 pipe spool of the SSW system [1]. Ultrasonic testing has been conducted in order to characterize the flaw [1]. Allowable through-wall flaw lengths are determined using methods consistent with an upcoming revision of Code Case N-513-3 [2] as described below.

2.0 TECHNICAL APPROACH

The flaw evaluation herein is based on the criteria prescribed in an upcoming revision of ASME Code Case N-513-3. This Code Case allows for the temporary acceptance of through-wall flaws in moderate energy Class 2 or Class 3 piping. N-513-3 has been conditionally accepted by the NRC with the stipulation that, "The repair or replacement activity temporarily deferred under the provisions of this Code Case shall be performed during the next scheduled outage," and is published in the latest revision of Regulatory Guide 1.147 [3]. N-513-3 allows non-planar, through-wall flaws to be characterized and evaluated as planar (i.e., crack-like), through-wall flaws in the axial and circumferential directions.

The evaluation criteria provided in N-513-3 are only for straight pipe since the technical approach relies on ASME Section XI, Appendix C [4] methods. A new revision of the Code Case (N-513-4) includes rules for the evaluation of piping components such as elbows, branch tees and reducers. Flaws in these components may be evaluated as if in straight pipe provided the stresses used in the evaluation are adjusted to account for geometric differences. For elbows, hoop stress is adjusted by considering flaw location and primary stress due to elbow ovalization from axial loads. For axial stresses, the stress scaling follows the same approach given in ASME Section III, ND-3600 [5] design by rule using stress indices and stress intensification factors for the adjustment. Details are provided in N-513-4 for determining these adjusted stresses.

N-513-4 has not been approved by the ASME or reviewed by the NRC; however, it is recognized in ASME committee that the technical approach is very conservative. Simple treatment of piping component flaw evaluation using hand calculations was an important objective in the development of the approach recognizing the trade-off being conservative results. N-513-4 allows for more sophisticated analysis by the user.

As stated above, Code Case N-513-3 evaluation criteria rely on the methods given in ASME Section XI, Appendix C. Linear Elastic Fracture Mechanics (LEFM) criteria are conservatively employed as described in Article C-7000. Since a through-wall flaw is being evaluated, through-wall shape factors F_m, F_b and F are used which are given in Appendix I of the Code Case. Allowable flaw lengths are determined through iteration comparing calculated stress intensity factors to a critical fracture toughness defined in C-7200 of Section XI, Appendix C.

This evaluation utilizes finite element methods (FEM) to calculate the primary membrane stress in the hoop direction due to ovalization from axial loads. Section 3.3 of the Code Case's new revision states

that "Alternative methods may be used to calculate the stresses used in evaluation," which justifies the use of FEM techniques.

Details of the Code Case N-513-4 evaluation procedure for elbows are given in Appendix A.

3.0 DESIGN INPUTS / ASSUMPTIONS

The SSW Code of Construction is ANSI B31.1 1967 Edition [6].

Based on information provided by Entergy, the 18 inch elbow is located on SSW spool JF29-8-4 [1]. The 90 degree elbow located on JF29-8-4 is a schedule 20, long radius elbow [7]. The design pressure and temperature are 10 psig and 100°F, respectively [8].

The elbow material is ASTM A-234 WPB [7] carbon steel. For the analysis, A106 Gr. B carbon steel is judged to have equivalent material properties. The nominal composition of the two materials is essentially the same and the minimum yield and tensile strengths are the same for both materials. In addition, the longitudinal and transverse elongations are similar between these materials.

The applied moment loadings are obtained from the ME-101 output listings in Reference [9]. Based on information provided by Entergy, the location of interest is node 22. The moments for each load case are provided in three dimensions (MA, MB, and MC), which are combined by square-root-of-the-sum-of-the-squares (SRSS). The resulting SRSS moments at each location along the elbow (beginning, middle, and end) are compared for each loading, and the bounding moment is used in this analysis.

Determination of the fracture toughness, J_{IC}, used in the evaluation is based on Section XI, Appendix C, C-8320 [4], which specifies that 'reasonable lower bound fracture toughness data' may be used to determine the allowable stress intensity factor, K_{IC}. The NRC's Pipe Fracture Encyclopedia [10] contains numerous CVN test results for A106 Gr. B carbon steel at low temperature, which are reproduced in Table 1. The minimum reported value of 293 in-lb/in^2 is used in the analysis for both axial and circumferential flaws.

Finite element methods are used to determine the primary membrane stress in the hoop direction due to ovalization from axial loads in Reference [11]. A unit moment of 10,000 in-lbs is applied to the FEM and linearized stresses are extracted at paths in the axial direction from the flaw. A stress of 100 psi conservatively bounds the tensile hoop stress reported in Reference [11]. This bounding stress is factored based on the ratio of the applied moment for the applicable service level to the unit moment of 10,000 in-lbs. The factored stress is used as described in Section 4.1.1 below.

The following design inputs are used in this calculation:

1. Long radius 90° elbow OD = 18 inches [7]
2. Nominal elbow thickness = 0.312 inch (based on Schedule 20 piping [7])
3. Design pressure = 10 psig [8]

4. Design temperature = 100°F [8]
5. Young's modulus = 27,900 ksi [6, Table C-1]
6. Allowable stress = 15 ksi [6, Table A-2]
7. Enveloped SRSS Deadweight Moment = 43,973 in-lbs [9]
8. Enveloped SRSS OBE Moment = 38,820 in-lbs [9]
9. Enveloped SRSS SSE Moment = 72,789 in-lbs [9]
10. Enveloped SRSS Thermal Moment = 22,047 in-lbs [9]
11. Stress intensification factor, i = 3.98 [6]
12. J_{IC} for axial flaws = 293 in-lb/in^2 [4, 10]
13. J_{IC} for circumferential flaws = 293 in-lb/in^2 [4, 10]
14. Bounding primary membrane stress in the hoop direction due to unit moment load = 100 psi [11]

Note that the wall thickness surrounding the flaw is greater than the elbow nominal thickness [1]. Therefore, the use of the 0.312 inch surrounding wall thickness is considered conservative.

The following assumptions are used in this calculation:

1. Poisson's ratio is assumed to be 0.3.
2. Due to the flaw remoteness from a weld, residual stress effects are assumed negligible.
3. A corrosion allowance is not considered (the ongoing inspection requirements in Code Case N-513-3 address the possibility of flaw growth during the temporary acceptance period).

4.0 CALCULATIONS

4.1 Applied Loads

4.1.1 Hoop Stress

For the allowable axial flaw length, the hoop stress, σ_h, due to internal pressure and elbow ovalization from the axial moments may be determined from Equation 9 of N-513-4 (see Appendix A):

$$\sigma_h = \left(\frac{pD_o}{2t}\right)\left[\frac{2R_{bend} + R_o \sin\phi}{2(R_{bend} + R_o \sin\phi)}\right] + \left(\frac{1.95}{h^{2/3}}\right)\frac{R_o M_b}{I} \quad (1)$$

where:

p = internal pressure, psig
D_o = outside diameter, in
t = wall thickness, in
R_{bend} = elbow bend radius (27 inches)
R_o = outside radius, in
ϕ = circumferential angle from elbow flank (see Figure 7 in Appendix A)

h = flexibility characteristic = $t^*R_{bend}/(R_{mean})^2$ [6]
R_{mean} = elbow mean radius, in
M_b = primary bending moment, in-lbs
I = moment of inertia, in^4.

Note that the first term of Equation 1 accounts for the hoop stress due to internal pressure and includes a scaling factor to account for the circumferential location of the flaw (assuming uniform thickness, pressure based hoop stress is a maximum at the elbow intrados, while a minimum at the elbow extrados). At the flank, the pressure based hoop stress is equal to that of straight pipe. For the analysis herein, it is conservative to set $\phi = 0$ since the flaw is between the flank and extrados as shown on Figure 2.

The second term of Equation 1 accounts for the hoop stress resulting from the axial moments acting to ovalize the elbow. This term is replaced with the scaled primary membrane stress in the hoop direction as discussed in the previous section.

Finally, N-513-4 limits the use of Equation 1 for $h \geq 0.1$. For this elbow, $h \approx 0.11$.

4.1.2 Axial Stresses

For the allowable circumferential flaw length, the axial stress due to pressure, deadweight, seismic, and thermal loading is presented below. For axial membrane stress due to pressure, σ_m, Equation 10 of N-513-4 is used:

$$\sigma_m = B_1\left(\frac{pD_o}{2t}\right) \quad (2)$$

where B_1 is an ASME Section III primary stress index for internal pressure. N-513-4 sets this value to 0.5.

For axial bending stress, σ_b, due to deadweight and seismic moments, Equation 11 of N-513-4 may be used:

$$\sigma_b = B_2\left(\frac{R_o M_b}{I}\right) \quad (3)$$

where B_2 is an ASME Section III primary stress index for moment loading. From Figure ND-3673.2(b)-1 of Reference [5], $B_2 = 1.30/h^{2/3}$. For this elbow, $B_2 = 5.74$.

For axial bending stress due to thermal moments, σ_e, Equation 12 of N-513-4 may be used:

$$\sigma_e = i\left(\frac{R_o M_e}{I}\right) \quad (4)$$

where i is the stress intensification factor. From [6, Appendix D], i = 3.98.

4.2 Stress Intensity Factor Calculations

For LEFM analysis, the stress intensity factor, K_I, for an axial flaw is taken from Article C-7000 [4] as prescribed by N-513-3 and is given below:

$$K_I = K_{Im} + K_{Ir} \qquad (5)$$

where:

$K_{Im} = (SF_m)F\sigma_h(\pi a/Q)^{0.5}$

SF_m = structural factor for membrane stress (see Table 2)

F = through-wall shape factor for an axial flaw under hoop stress (given in Appendix I of N-513-3)

σ_h = hoop stress, ksi

a = flaw depth (half flaw length for through-wall flaw), in

Q = flaw shape parameter (unity per Appendix I of N-513-3)

K_{Ir} = K_I from residual stresses at flaw location (assumed negligible).

Only the hoop stress influences the allowable axial flaw length which is a function of pressure and primary bending stress.

For LEFM analysis, the stress intensity factor, K_I, for a circumferential flaw is taken from Article C-7000 [4] as prescribed by N-513-3 and is given below:

$$K_I = K_{Im} + K_{Ib} + K_{Ir} \qquad (6)$$

where:

$K_{Im} = (SF_m)F_m\sigma_m(\pi a)^{0.5}$

F_m = through-wall shape factor for a circumferential flaw under membrane stress (given in Appendix I of N-513-3)

σ_m = membrane stress, ksi

$K_{Ib} = [(SF_b)\sigma_b + \sigma_e]F_b(\pi a)^{0.5}$

SF_b = structural factor for bending stress (see Table 2)

σ_b = bending stress, ksi

σ_e = thermal stress, ksi

F_b = through-wall shape factor for a circumferential flaw under bending stress (given in Appendix I of N-513-3).

Note that the through-wall flaw shape factors are a function of flaw length.

Table 3 shows the specific load combinations considered herein for the allowable circumferential flaw calculations. Since the load combination for Service Level C and D are equivalent, the more limiting flaw length associated with the Service Level C structural factors are presented.

4.3 Critical Fracture Toughness Determination

For LEFM analysis, the static fracture toughness for crack initiation under plane strain conditions, K_{Ic}, is taken from Article C-7000 [4] as prescribed by N-513-3 and is given below:

$$K_{Ic} = \sqrt{\frac{J_{Ic}E'}{1000}} \tag{7}$$

where:

J_{Ic} = material toughness, in-lb/in^2
$E' = E/(1-v^2)$
E = Young's modulus, ksi
v = Poisson's ratio.

Based on the design input listed previously, K_{Ic} is 94.7 ksi-in$^{0.5}$ for both axial and circumferential flaws. The allowable flaw lengths are determined iteratively by increasing flaw length until the stress intensity factor is equal to the static fracture toughness.

5.0 RESULTS

Table 4 shows the allowable through-wall flaw lengths resulting from the analysis based on a surrounding nominal wall thickness. The most limiting flaw length is 8 inches in the circumferential direction. The UT results for the leaking elbow are shown in Figure 3 [1]. The leak is easily bounded in the axial and circumferential directions by 8 inches. Thus, the acceptance criteria of Code Case N-513-4 are met.

Finally, Paragraph 3.2(d) requires that N-513-3 Equation 9 be satisfied (i.e., the remaining ligament average thickness over the degraded area bounded by the limiting flaw size will resist pressure blowout). The average remaining wall thickness requirement covering the degraded area from Equation 9 is 0.07 inch (using a d_{adj} = 8 inches). From the inspection data given in Figure 3, only the grids nearest to the leak are less than this value. Thus, this Code Case requirement is met.

6.0 CONCLUSIONS

The flaw evaluation of the weeping flaw in a 18-inch elbow of the SSW piping at Pilgrim has been evaluated using the methods of a pending revision to Code Case N-513-3 (designated N-513-4) currently in the ASME approval process (N-513-3 does not provide evaluation criteria for flaws in elbows, while N-513-4 does). N-513-4 has not been approved by the ASME or reviewed by the NRC; however, it is recognized in ASME committee that the technical approach is very conservative. Table 4 shows the axial and circumferential allowable flaw lengths based on a surrounding nominal wall thickness of 0.312 inch. The most limiting flaw size is 8 inches in the circumferential direction. The leak is easily bounded

in the axial and circumferential directions by 8 inches (as shown in Figure 3). Thus, the acceptance criteria of Code Case N-513-4 are met.

7.0 REFERENCES

1. Pilgrim NDE Inspection Report, File Name "JF29 4 8 0.dmsdr," February 25, 2014, SI File Number 1400287.201.
2. ASME Code Case N-513-3, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping Section XI, Division 1," Cases of ASME Boiler and Pressure Vessel Code, January 26, 2009.
3. Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," Revision 16, Nuclear Regulatory Commission, October, 2010.
4. ASME Boiler and Pressure Vessel Code, Section XI, Appendix C, 2001 Edition with addenda through 2003.
5. ASME Boiler and Pressure Vessel Code, Section III, Subsection ND, 2004 Edition.
6. ANSI B31.1, Power Piping, 1967 Edition.
7. Entergy Drawing Number M100-7250, Revision E5, "Service Water System E209B SSW Backwash Drain Piping," SI File Number 1400287.201.
8. Pilgrim Nuclear Power Station Specification Number M300, System 29 Service Water, SI File Number 1400287.201.
9. Pilgrim Nuclear Power Station Pipe Stress Calculation 638, SI File Number 1400057.201.
10. Pipe Fracture Encyclopedia, US Nuclear Regulatory Commission, Volume 1, 1997.
11. SI Calculation Number 1400287.301, Revision 0, "Pilgrim Salt Service Water Discharge Piping Elbow (JF29-8-4 Spool) Wall Thinning Stress Analysis."

Table 1: J_{IC} Values for A106 Gr. B Carbon Steel from NRC's Pipe Fracture Database [10]

A106 Grade B					
Database Reference	Temperature (°C)	Temperature (°F)	JIC (kJ/m^2)	JIC (lb$_f$-in/in^2)	KIC (ksi-in$^{0.5}$)
2	24	75	97	552	133
2	24	75	336	1919	249
16	25	77	81	464	122
16	25	77	418	2386	277
16	25	77	270	1542	223
16	25	77	193	1104	189
22	24	75	224	1278	203
22	20	68	112	641	144
22	20	68	117	668	147
22	23	73	214	1223	199
22	20	68	167	954	175
22	20	68	223	1271	202
22	20	68	108	617	141
23	52	126	116	663	146
23	23	73	103	590	138
23	23	73	105	600	139
23	23	73	93	528	131
24	23	73	76	431	118
24	23	73	82	469	123
24	57	135	51	293	97
25	23	73	77	439	119
25	23	73	70	400	114
25	57	135	62	356	107
90	20	68	235	1342	208
90	20	68	219	1251	201
90	20	68	255	1456	217
90	20	68	281	1605	228
90	20	68	281	1605	228
90	20	68	335	1913	248
90	20	68	421	2404	279
90	20	68	385	2198	266
90	20	68	175	999	180
90	20	68	172	982	178
90	20	68	178	1016	181
90	20	68	214	1222	199
90	20	68	275	1570	225
90	20	68	133	759	157
90	20	68	140	799	161
90	20	68	174	994	179
90	20	68	111	634	143
90	20	68	190	1085	187
90	20	68	71	405	114
90	20	68	110	628	142
90	20	68	104	594	138
90	20	68	104	594	138
90	20	68	97	554	134
90	20	68	89	508	128
90	20	68	88	502	127
90	20	68	267	1525	222

Table 2: Axial and Circumferential Structural Factors [4]

Service Level	Membrane Stress, SF_m	Bending Stress, SF_b
A	2.7	2.3
B	2.4	2.0
C	1.8	1.6
D	1.3	1.4

Table 3: Load Combinations for Circumferential Flaw Analyses

Load Combination	Service Level
P+DW+TH	A
P+DW+OBE+TH	B
P+DW+SSE+TH	C/D

Table 4: Allowable Through-Wall Flaw Lengths (based on t = 0.312")

Service Level	Allowable Axial Flaw Length (in)	Allowable Circumferential Flaw Length (in)
A	16.0	13.2
B	16.0	8.8
C/D	16.0	8.0

Figure 1. Pinhole Leak in Service Water Piping, 18-inch Elbow

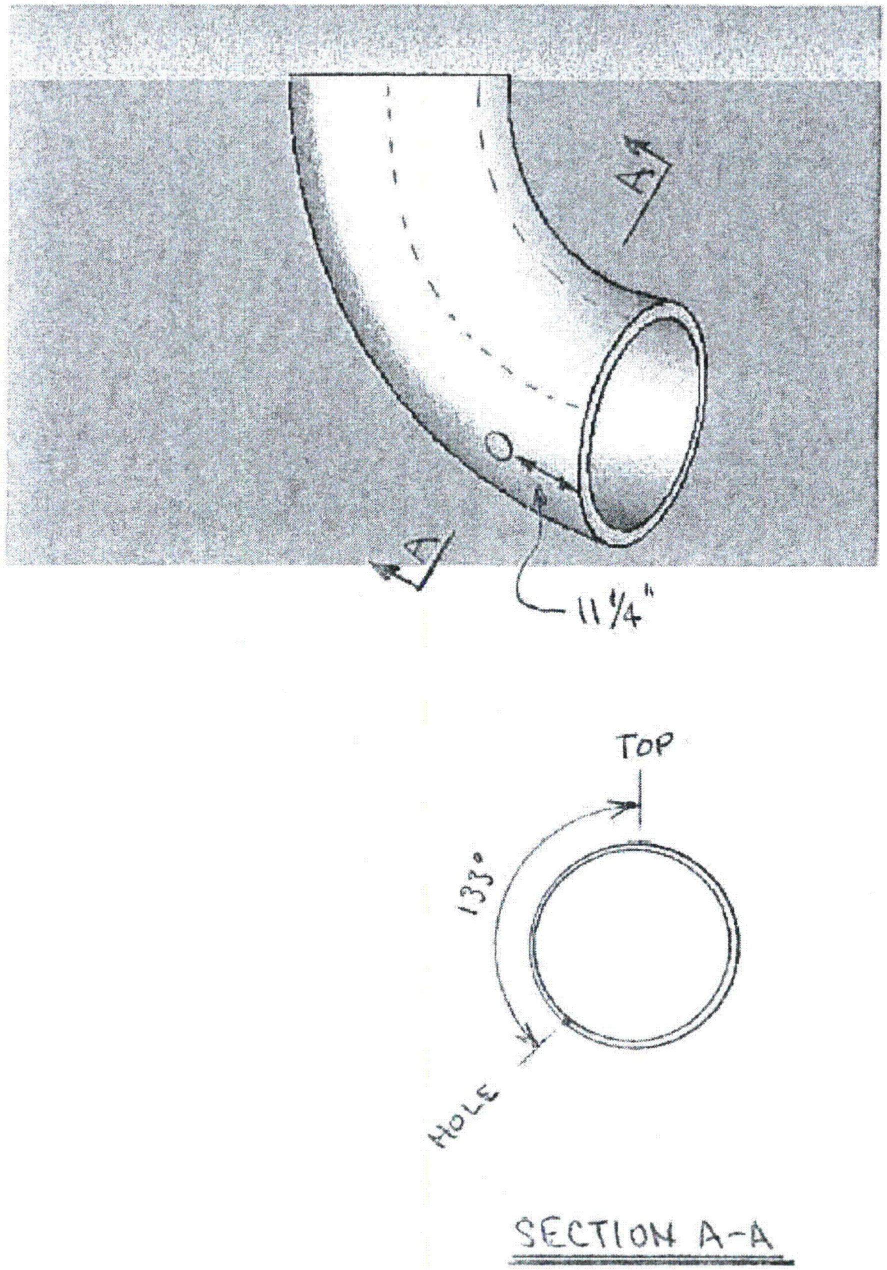


Figure 2. Sketch of Leak Location in Service Water Piping, 18-inch Elbow

LOCATION	AJ:	AK:	AL:	AM:	AN:	AO:	AP:	AQ:	AR:	AS:	AT:	AU:	AV:
1	0.396	0.397	0.397	0.380	0.369	0.352	0.348	0.344	0.342	0.335	0.328	0.315	0.328
2	0.398	0.396	0.393	0.371	0.334	0.353	0.347	0.343	0.345	0.341	0.337	0.311	0.325
3	0.393	0.390	0.393	0.369	0.309	0.361	0.347	0.338	0.343	0.335	0.327	0.308	0.326
4	0.387	0.389	0.389	0.383	0.150	0.051	0.109	0.336	0.299	0.336	0.327	0.308	0.318
5	0.386	0.390	0.394	0.192	0.087	0.064	0.083	0.334	0.313	0.328	0.328	0.315	0.320
6	0.389	0.388	0.392	0.108	0.352	0.362	0.332	0.333	0.334	0.298	0.292	0.317	0.323
7	0.390	0.390	0.393	0.390	0.380	0.343	0.342	0.339	0.341	0.296	0.337	0.321	0.323
8	0.385	0.388	0.392	0.388	0.386	0.366	0.360	0.356	0.349	0.349	0.348	0.327	0.326

Figure 3. UT Data (3/4 Inch Grid) for Service Water Piping, 18-inch Elbow

Appendix A

DRAFT CODE CASE N-513-4 PROCEDURES FOR ELBOW FLAW EVALUATION

3.3 Through-wall Flaws in Elbows and Bent Pipe

Through-wall flaws in elbows and bent pipe may be evaluated using the straight pipe procedures given in 3.1 or 3.2(d) provided the stresses used in the evaluation are adjusted as described below to account for the geometry differences. Alternate methods may be used to calculate the stresses used in evaluation.

The hoop stress, σ_h, for elbow and bent pipe evaluation shall be:

$$\sigma_h^c = \left(\frac{pD_o}{2t}\right)\left[\frac{2R_{bend} + R_o \sin\phi}{2(R_{bend} + R_o \sin\phi)}\right] + \left(\frac{1.95}{h^{2/3}}\right)\frac{R_o M_b}{I} \quad (9)$$

where

R_{bend}	= elbow or bent pipe bend radius
ϕ	= circumferential angle defined in Figure 7
h	= flexibility characteristic
M_b	= resultant primary bending moment
I	= moment of inertia based on evaluation wall thickness, t

Equation 9 is only applicable for elbows and bent pipe where $h \geq 0.1$.

The axial membrane pressure stress, σ_m, for elbow and bent pipe evaluation shall be:

$$\sigma_m = B_1\left(\frac{pD_o}{2t}\right) \quad (10)$$

where B_1 is a primary stress index as defined in ASME Section III for the piping item. B_1 shall be equal to 0.5 for elbows and bent pipe.

The axial bending stress, σ_b, for elbow and bent pipe evaluation shall be:

$$\sigma_b = B_2\left(\frac{R_o M_b}{I}\right) \quad (11)$$

where B_2 is a primary stress index as defined in ASME Section III for the piping item.

The thermal expansion stress, σ_e, for elbow and bent pipe evaluation shall be:

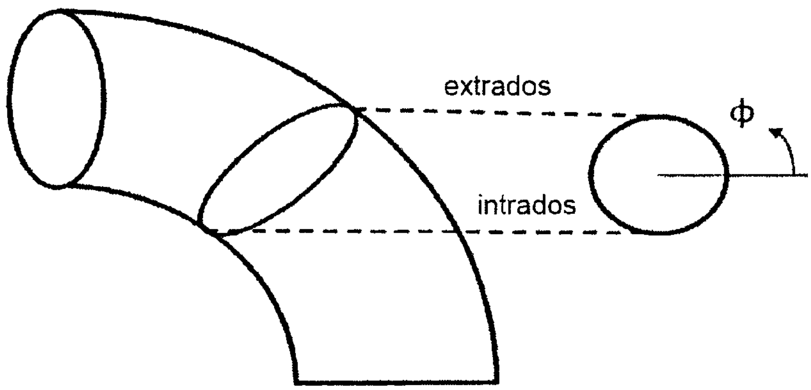
$$\sigma_e = i\left(\frac{R_o M_e}{I}\right) \quad (12)$$

where

i	= stress intensification factor as defined in the Code of Record for the piping item
M_e	= resultant thermal expansion moment

Figure 7 from N-513-4:

FIG. 7 CIRCUMFERENTIAL ANGLE DEFINED



ATTACHMENT 5

TO ENTERGY LETTER 2.14.032

PILGRIM RELIEF REQUEST PRR-25, Rev 1

SSW Spool JF 29-8-4 NDE Data Sheet

(4 pages)

UT Erosion/Corrosion Examination

Entergy

Site/Unit:	PNPS / 1	Procedure:	CEP-NDE-0505	Outage No.:	N/A
Summary No.	SSW Pipe Spool	Procedure Rev.:	004	Report No.:	BOP-UT-14-001
Workscope:	BOP	Work Order No.:	375247-04	Page:	1 of 24

Code: ASME Sec-XI, 2001-2003 Ada. Cat./Item: C-H/C7.10 Location: "B" Aux Bay

Drawing No.: M100-7250 Description: 18" Elbow

System ID: Service Water System (29)

Component ID: Pipe Spool JF29-8-4 Size/Length: 18" / 6"-12" Thickness/Diameter: Sch.-20/18"

Limitations: N/A Component File No.: N/A Start Time: 9:45 Finish Time: 14:10

Calibration Information

Calibration Thickness (In) Actual	Measured	Calibration Times / Initials		
0.100	0.100	Start:	9:40	RDA
0.200	0.199	Verify:	12:00	RDA
0.300	0.299	Verify:	N/A	N/A
0.400	0.400	Verify:	N/A	N/A
0.500	0.500	Final:	14:15	RDA

Partitioning Information

Component	Begin/Col/Row	Ending/Col/Row
M. UPST Ext.	N/A	N/A
Main UPST.	N/A	N/A
Main	1 A	8 BI
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 Elbow		
Outside Diameter:	18"	Grid Size:	3/4"
Max. Thickness:	0.457	Min. Thickness:	0.051
Nominal Thickness:	0.312	Tmin.:	0.270
Min. Thickness Location:	4 AO		
Max. Thickness Location:	8 Z		
Surface Condition:	SMOOTH		

Instrument:
- Manufacturer: GE
- Model: USM-GO
- Serial No.: USMGO12915119
- Gain: 66
- Range: 0.500

Transducer:
- Manufacturer: KBA
- Serial No.: 01550W
- Size: 0.375" Freq.: 5.0 MHz
- Model: 113-550-001
- # of Elements: 2

Reference/Simulator Block:
- Serial No.: 94-5570
- Type: 0.1"-0.5"
- **Ref./Simulator Block Temp.:** 70 °F
- **Material/Component Temp.:** 73 °F

Temp. Tool:
- Manufacturer: Elcometer
- Serial No.: PNPTEM-288

Couplant:
- Type: Ultragel II
- Batch No.: 05125

Comments/Obstructions: UT performed do to a through wall hole. See CR-PNP-2014-00815. This is not a Code required exam.

Results: Accept ☐ Reject ☐ Eval ☑

Examiner	Level	Signature	Date	Reviewer	Signature	Date
Avery, Richard D. (Rick)	III	R. D. Avery	2/25/2014	D.B. King	UT Level III	2/27/14
Examiner N/A	N/A			Site Review N/A		
Other N/A	N/A			ANII Review N/A		

Entergy

Supplemental Report

Summary No. SSW Pipe Spool

File Name Spool JF29-8-4
Description 18" Elbow
Creation Date: 2/25/2014
Probe See UT Report
Cal Comment See report
Inspector R. AVERY Company : Entergy
Instrument Type : DMS Go Instrument S.N : USMGO12015119

Units INCH Velocity(in/us) : 0.2360

Number of Readings : 488 Number of Empties es; 0
Number of Obstructs . 0 Number of Attachments : 0
Range : 0.406 Points Below MinAlarm : 0
Mean 0.368 Standard Deviation : 0.047
Minimum Value 0.051
Minimum Value Loc. : 4:AO:1
Maximum Value . 0.457
Maximum Value Loc. : 8:Z:1

100% GRID SCANS, LOWEST READING RECORDED

LOCATION	A:	B:	C:	D:	E:	F:	G:	H:	I:	J:	K:	L:	M:	N:
1	0.344	0.348	0.365	0.372	0.374	0.375	0.377	0.373	0.372	0.364	0.361	0.364	0.358	0.359
2	0.346	0.356	0.365	0.370	0.372	0.376	0.373	0.377	0.375	0.370	0.367	0.367	0.364	0.365
3	0.348	0.358	0.363	0.366	0.373	0.376	0.375	0.377	0.376	0.374	0.369	0.367	0.366	0.366
4	0.354	0.352	0.365	0.369	0.375	0.379	0.381	0.380	0.380	0.380	0.372	0.367	0.366	0.368
5	0.349	0.354	0.366	0.368	0.375	0.378	0.378	0.382	0.382	0.380	0.377	0.372	0.369	0.372
6	0.353	0.357	0.364	0.367	0.378	0.378	0.381	0.382	0.366	0.381	0.375	0.372	0.373	0.372
7	0.354	0.357	0.365	0.374	0.375	0.380	0.381	0.385	0.381	0.379	0.379	0.371	0.372	0.371
8	0.360	0.359	0.363	0.374	0.373	0.363	0.369	0.382	0.380	0.378	0.377	0.377	0.374	0.372

TOP C/L of PIPE

Direction of Flow ↑

2/27/14

Summary No. SSW Pipe Spool

	O:	P:	Q:	R:	S:	T:	U:	V:	W:	X:	Y:	Z:	AA:	AB:	AC:	AD:	AE:
1	0.367	0.371	0.380	0.386	0.398	0.400	0.373	0.413	0.419	0.425	0.427	0.421	0.417	0.415	0.417	0.413	0.404
2	0.372	0.378	0.385	0.392	0.398	0.401	0.409	0.411	0.419	0.431	0.428	0.428	0.421	0.422	0.417	0.414	0.405
3	0.373	0.380	0.383	0.394	0.400	0.405	0.410	0.415	0.420	0.429	0.437	0.428	0.422	0.417	0.418	0.410	0.404
4	0.374	0.382	0.383	0.396	0.400	0.405	0.409	0.413	0.423	0.427	0.429	0.423	0.421	0.418	0.419	0.415	0.403
5	0.378	0.384	0.385	0.400	0.403	0.407	0.412	0.416	0.426	0.428	0.429	0.431	0.427	0.423	0.423	0.421	0.409
6	0.380	0.389	0.393	0.404	0.407	0.414	0.421	0.419	0.429	0.437	0.433	0.430	0.428	0.425	0.422	0.426	0.408
7	0.380	0.387	0.390	0.400	0.406	0.412	0.416	0.419	0.430	0.433	0.430	0.430	0.427	0.425	0.423	0.426	0.414
8	0.383	0.389	0.395	0.401	0.407	0.412	0.418	0.422	0.426	0.428	0.427	0.457	0.421	0.419	0.422	0.421	0.406

	AF:	AG:	AH:	AI:	AJ:	AK:	AL:	AM:	AN:	AO:	AP:	AQ:	AR:	AS:	AT:	AU:	AV:
1	0.400	0.395	0.391	0.396	0.396	0.397	0.397	0.380	0.369	0.352	0.348	0.344	0.342	0.335	0.328	0.315	0.328
2	0.393	0.394	0.389	0.397	0.398	0.396	0.393	0.371	0.334	0.353	0.347	0.343	0.345	0.341	0.337	0.311	0.325
3	0.394	0.390	0.388	0.389	0.393	0.390	0.393	0.369	0.309	0.361	0.347	0.338	0.343	0.335	0.327	0.308	0.326
4	0.391	0.385	0.383	0.383	0.387	0.389	0.389	0.383	0.150	0.051	0.100	0.336	0.299	0.336	0.327	0.308	0.318
5	0.378	0.388	0.380	0.380	0.386	0.390	0.394	0.182	0.087	0.064	0.083	0.334	0.313	0.328	0.328	0.315	0.320
6	0.390	0.380	0.382	0.383	0.389	0.388	0.392	0.108	0.352	0.362	0.332	0.333	0.334	0.298	0.292	0.317	0.323
7	0.398	0.385	0.385	0.380	0.390	0.390	0.393	0.390	0.380	0.343	0.342	0.339	0.341	0.296	0.337	0.321	0.323
8	0.401	0.392	0.388	0.381	0.385	0.388	0.392	0.388	0.386	0.366	0.360	0.356	0.349	0.349	0.348	0.327	0.326

Areas that are below 0.300. Area of hole

	AW:	AX:	AY:	AZ:	BA:	BB:	BC:	BD:	BE:	BF:	BG:	BH:	BI:
1	0.336	0.345	0.346	0.340	0.339	0.339	0.335	0.338	0.333	0.332	0.338	0.341	0.338
2	0.337	0.341	0.344	0.345	0.341	0.337	0.332	0.328	0.331	0.330	0.336	0.339	0.343
3	0.332	0.336	0.343	0.346	0.339	0.337	0.327	0.335	0.334	0.336	0.336	0.339	0.344
4	0.326	0.338	0.344	0.343	0.339	0.331	0.336	0.336	0.334	0.336	0.336	0.340	0.349
5	0.331	0.337	0.343	0.345	0.341	0.339	0.333	0.339	0.335	0.335	0.330	0.346	0.343
6	0.336	0.341	0.347	0.348	0.349	0.346	0.339	0.335	0.338	0.343	0.345	0.339	0.345
7	0.337	0.347	0.350	0.380	0.348	0.347	0.339	0.335	0.344	0.340	0.339	0.341	0.377
8	0.332	0.343	0.351	0.356	0.351	0.348	0.338	0.343	0.343	0.341	0.339	0.343	0.351

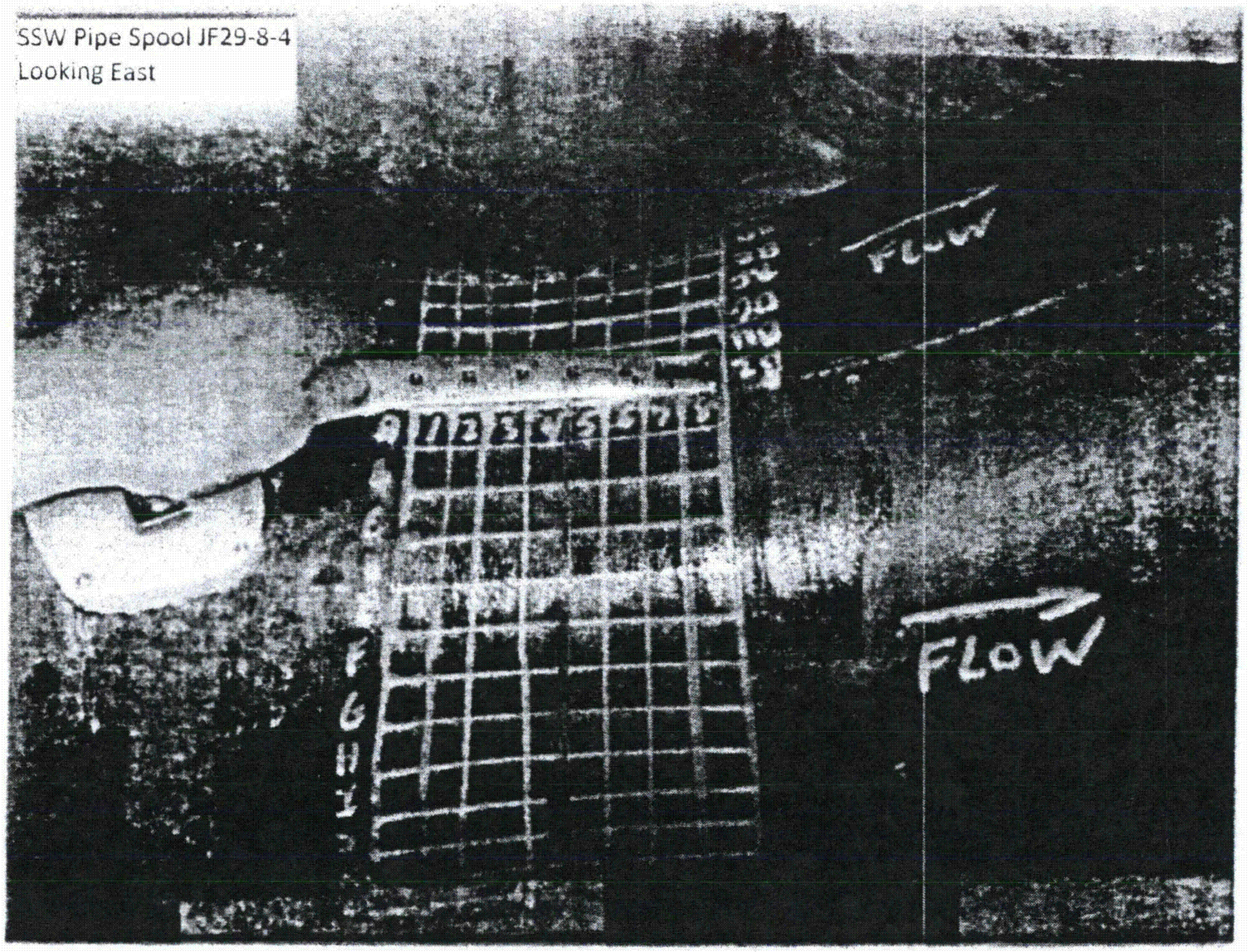
2/27/14

Entergy

Supplemental Report

Report No.: BOP-UT-14-001

Summary No.: SSW Pipe Spool



SSW Pipe Spool JF29-8-4
Looking East

2/27/14

<u>ATTACHMENT 6</u>

TO ENTERGY LETTER 2.14.032

PILGRIM RELIEF REQUEST PRR-25, Rev 1

Mechanical Clamp Information

(2 Pages)

Mechanical Clamp Information

Structural / Seismic Loading:

Approximate total weight of clamp assembly is:

U-Bolt = 13.5 lb (1" Rod stock per Piping Technology & Products Catalog, Feb 1995)

L3x3x1/4 Strong back = (4.9 lb/ft)* (2 ft) = 10 lb (AISC Steel Manual 8th Edition)

Contoured bearing plate, gasket and misc. = 6.5 lb (conservative estimate by inspection)

Total = 30 lb

Maximum seismic acceleration = 2.51g conservatively using Reactor Building El. 23' spectra and 1% damping (Ref. Spec C114ERQE1 Sheet A-6). Maximum combined deadweight and seismic force in any direction is therefore approximately (2.51 + 1)* 30 lb = 105 lb.

This is a very small force with respect to the strength of the steel clamp assembly. The clamp becoming completely detached from the piping/elbow is therefore not credible. Consider the possibility the of clamp slipping along the elbow. This would be resisted by the friction force due to the clamping action.

Clamp Force

$$F_{seismic} = \mu N = 105 \div 2\ (two\ points\ of\ contact)$$

$$\mu = 0.25 \quad N = 210\ lb_f$$

$$\frac{N}{2} = 105\ lb_f\ per\ leg$$

$$T = FKD = 105\ lb_f \cdot 0.2 \cdot 1\ in$$

$$T = 21\ in \cdot lb_f\ min.\ per\ nut$$

Suggested Torque = 5 ft-lb

$$T = 5\ ft \cdot lb \rightarrow 60\ in \cdot lb$$

$$F = \frac{T}{KD} \quad F = 300\ lb_f\ per\ nut$$

$$F_{Total} = F \times 2 = 600\ lb_f$$

Mechanical Clamp Information (Cont.)

Strong Back

$$M = \frac{600\ lb_f \cdot 20\ in}{4} = 3000\ in \cdot lb$$

$$\sigma = \frac{3000\ in \cdot lb}{0.577\ in^3} = 5200\ psi$$

Pressure on Pipe

$$A = 4\ in \times 4\ in = 16\ in^2$$

$$F = 600\ lb_f$$

$P = \frac{F}{A} = 37.5\ psi$ Based on Suggested Torque of 5 ft-lb

ATTACHMENT 7

TO ENTERGY LETTER 2.14.032

PILGRIM RELIEF REQUEST PRR-25, Rev 1

SSW Spool JF29-8-4 NDE Data Sheets

(10 Pages)

SSW Spool JF29-8-4

UT Exam-1) 2/25/2014

1. Gridded 18" elbow, grid was approx. 6" wide at top of pipe and 10" wide on bottom of elbow, 360 digress around pipe. Performed 100% UT scan of each grid block and recorded low reading for each location.
2. Only readings found to violate the elbow T-min. dimension of 0.212 (ref. specification M591) where in the vicinity of the through wall hole.

UT Exam-2) 3/04/2014

1. Performed another UT exam on the east lower side of the elbow. A compression was made to the UT readings obtained on 2/25/2014.
2. Most areas remained the same, however; several areas had a slight change in wall thickness (See attached for actual readings obtained.

UT Exams 3 & 4) 3/06/2014, 3/11/2014

1. Only changes in wall thickness were in the area of the hole

UT Exam 5) 3/19/2014

1. Again slight changes in thickness around the location of the hole.

Notes:

- Areas that were marked “same” had reading within +/- 0.005 of previous readings
- These exams were a best effort UT’s for the following reasons
    1. West lower side of the pipe (side with hole) is very restricted do to other pipes in this location.
    2. Water was flowing from the hole, during several exams.
    3. Portions of existing grid gets washed away from water
    4. Official UT reports to be issued and reviewed by another individual with UT certifications.

R. Avery *R. Avery* 3/25/2014, UT Level-II

1st UT.
360° AROUND ELBOW

PERFORMED ON 2/26/2014
PG 1 of 3

------------------------------- File Header -------------------------------

File Name : JF29 ~~4 8~~ -3-4 0.dmsdr
Description : NOV
Creation Date : 2014-02-25 10:23:02
Probe :
Cal Comment :
Inspector : R. AVERY Company :
Units : INCH Velocity(in/us) : 0.2360

---------------------------- File statistics ----------------------------

Number of Readings : 488 Number of Empties : 800
Number of Obstructs : 0 Number of Attachments : 0
Range : 0.406 Points Below MinAlarm : 0
Mean : 0.368 Standard Deviation : 0.047
Minimum Value : 0.051
Minimum Value Loc. : 4:AO:1
Maximum Value : 0.457
Maximum Value Loc. : 8:Z:1

LOCATION	A:	B:	C:	D:	E:	F:	G:	H:	I:	J:	K:	L:	M:	N:	O:	P:	Q:	R:	S:	T:
1	0.344	0.348	0.365	0.372	0.374	0.375	0.377	0.373	0.372	0.364	0.361	0.364	0.358	0.359	0.367	0.371	0.380	0.386	0.398	0.400
2	0.346	0.356	0.365	0.370	0.372	0.376	0.373	0.377	0.375	0.370	0.367	0.367	0.364	0.365	0.372	0.378	0.385	0.392	0.398	0.401
3	0.348	0.358	0.363	0.366	0.373	0.376	0.375	0.377	0.376	0.374	0.369	0.367	0.366	0.366	0.373	0.380	0.383	0.394	0.400	0.405
4	0.354	0.352	0.365	0.369	0.375	0.379	0.381	0.380	0.380	0.380	0.372	0.367	0.366	0.368	0.374	0.382	0.383	0.396	0.400	0.405
5	0.349	0.354	0.366	0.368	0.375	0.378	0.378	0.382	0.382	0.380	0.377	0.372	0.369	0.372	0.378	0.384	0.385	0.400	0.403	0.407
6	0.353	0.357	0.364	0.367	0.378	0.378	0.381	0.382	0.366	0.381	0.375	0.372	0.373	0.372	0.380	0.389	0.393	0.404	0.407	0.414
7	0.354	0.357	0.365	0.374	0.375	0.380	0.381	0.385	0.381	0.379	0.379	0.371	0.372	0.371	0.380	0.387	0.390	0.400	0.406	0.412
8	0.360	0.359	0.363	0.374	0.373	0.363	0.369	0.382	0.380	0.378	0.377	0.377	0.374	0.372	0.383	0.389	0.395	0.401	0.407	0.412

TOP C/L of PIPE

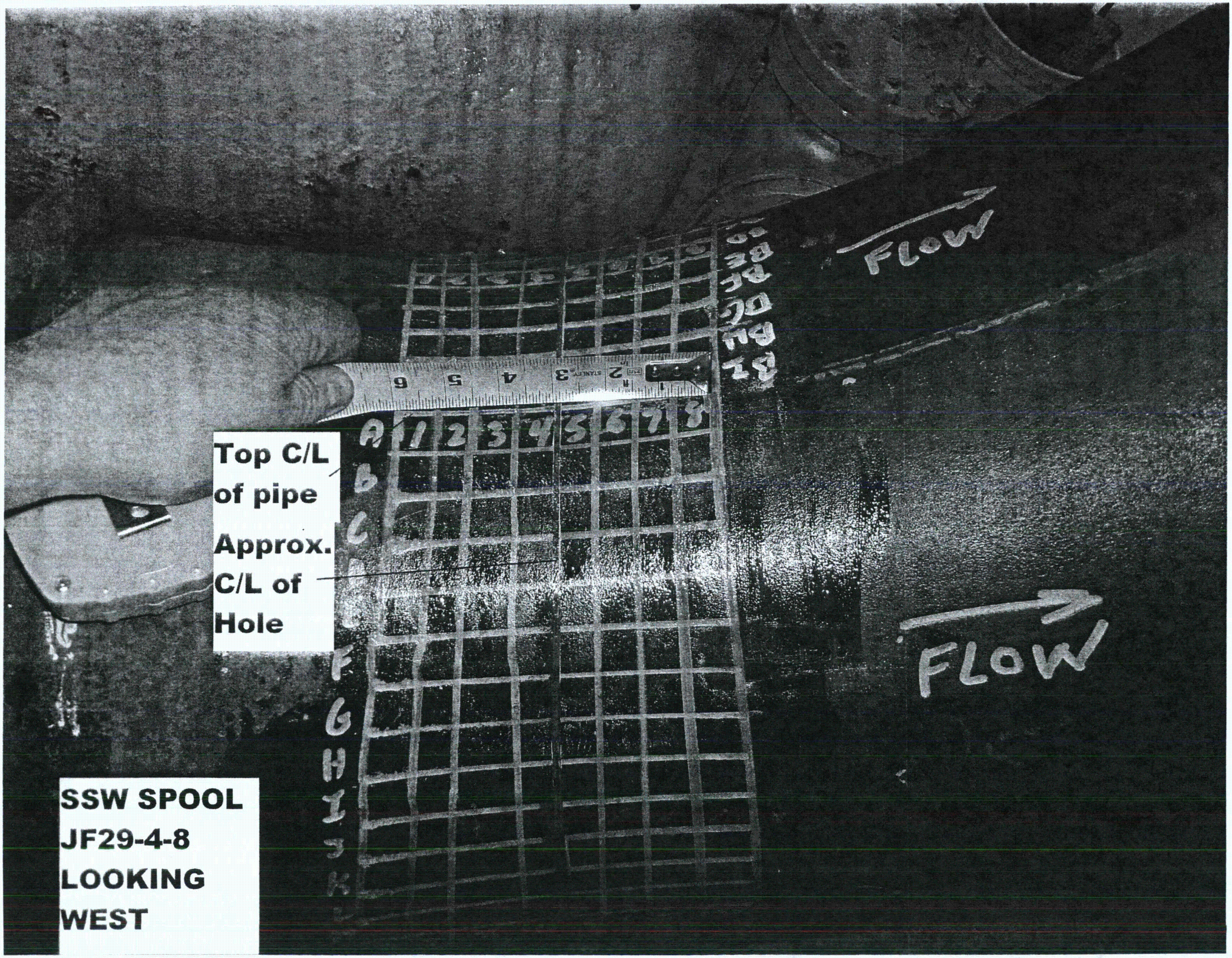
Direction of Flow ↑

Pg 2 of 3

U:	V:	W:	X:	Y:	Z:	AA:	AB:	AC:	AD:	AE:	AF:	AG:	AH:	AI:	AJ:	AK:	AL:	AM:	AN:	AO:
0.373	0.413	0.419	0.425	0.427	0.421	0.417	0.415	0.417	0.413	0.404	0.400	0.395	0.391	0.396	0.396	0.397	0.397	0.380	0.369	0.352
0.409	0.411	0.419	0.431	0.428	0.428	0.421	0.422	0.417	0.414	0.405	0.393	0.394	0.389	0.397	0.398	0.396	0.393	0.371	0.334	0.353
0.410	0.415	0.420	0.429	0.437	0.428	0.422	0.417	0.418	0.410	0.404	0.394	0.390	0.388	0.389	0.393	0.390	0.393	0.369	0.309	0.361
0.409	0.413	0.423	0.427	0.429	0.423	0.421	0.418	0.419	0.415	0.403	0.391	0.385	0.383	0.383	0.387	0.389	0.389	0.383	0.150	0.051
0.412	0.416	0.426	0.428	0.429	0.431	0.427	0.423	0.423	0.421	0.409	0.378	0.388	0.380	0.380	0.386	0.390	0.394	0.192	0.087	0.064
0.421	0.419	0.429	0.437	0.433	0.430	0.428	0.425	0.422	0.426	0.408	0.390	0.380	0.382	0.383	0.389	0.388	0.392	0.108	0.352	0.362
0.416	0.419	0.430	0.433	0.430	0.430	0.427	0.425	0.423	0.426	0.414	0.398	0.385	0.385	0.380	0.390	0.390	0.393	0.390	0.380	0.343
0.418	0.422	0.426	0.428	0.427	0.457	0.421	0.419	0.422	0.421	0.406	0.401	0.392	0.388	0.381	0.385	0.388	0.392	0.388	0.386	0.366

Yellow are the areas that are below 0.300. Area of hole

AP:	AQ:	AR:	AS:	AT:	AU:	AV:	AW:	AX:	AY:	AZ:	BA:	BB:	BC:	BD:	BE:	BF:	BG:	BH:	BI:
0.348	0.344	0.342	0.335	0.328	0.315	0.328	0.336	0.345	0.346	0.340	0.339	0.339	0.335	0.338	0.333	0.332	0.338	0.341	0.338
0.347	0.343	0.345	0.341	0.337	0.311	0.325	0.337	0.341	0.344	0.345	0.341	0.337	0.332	0.328	0.331	0.330	0.336	0.339	0.343
0.347	0.338	0.343	0.335	0.327	0.308	0.326	0.332	0.336	0.343	0.346	0.339	0.337	0.327	0.335	0.334	0.336	0.336	0.339	0.344
0.109	0.336	0.299	0.336	0.327	0.308	0.318	0.326	0.338	0.344	0.343	0.339	0.331	0.336	0.336	0.334	0.336	0.336	0.340	0.349
0.083	0.334	0.313	0.328	0.328	0.315	0.320	0.331	0.337	0.343	0.345	0.341	0.339	0.333	0.339	0.335	0.335	0.330	0.346	0.343
0.332	0.333	0.334	0.298	0.292	0.317	0.323	0.336	0.341	0.347	0.348	0.349	0.346	0.339	0.335	0.338	0.343	0.345	0.339	0.345
0.342	0.339	0.341	0.296	0.337	0.321	0.323	0.337	0.347	0.350	0.380	0.348	0.347	0.339	0.335	0.344	0.340	0.339	0.341	0.377
0.360	0.356	0.349	0.349	0.348	0.327	0.326	0.332	0.343	0.351	0.356	0.351	0.348	0.338	0.343	0.343	0.341	0.339	0.343	0.351


FLOW
FLOW
Top C/L of pipe
Approx. C/L of Hole
SSW SPOOL JF29-4-8 LOOKING WEST

2ND EXAM ON 3/04/2014

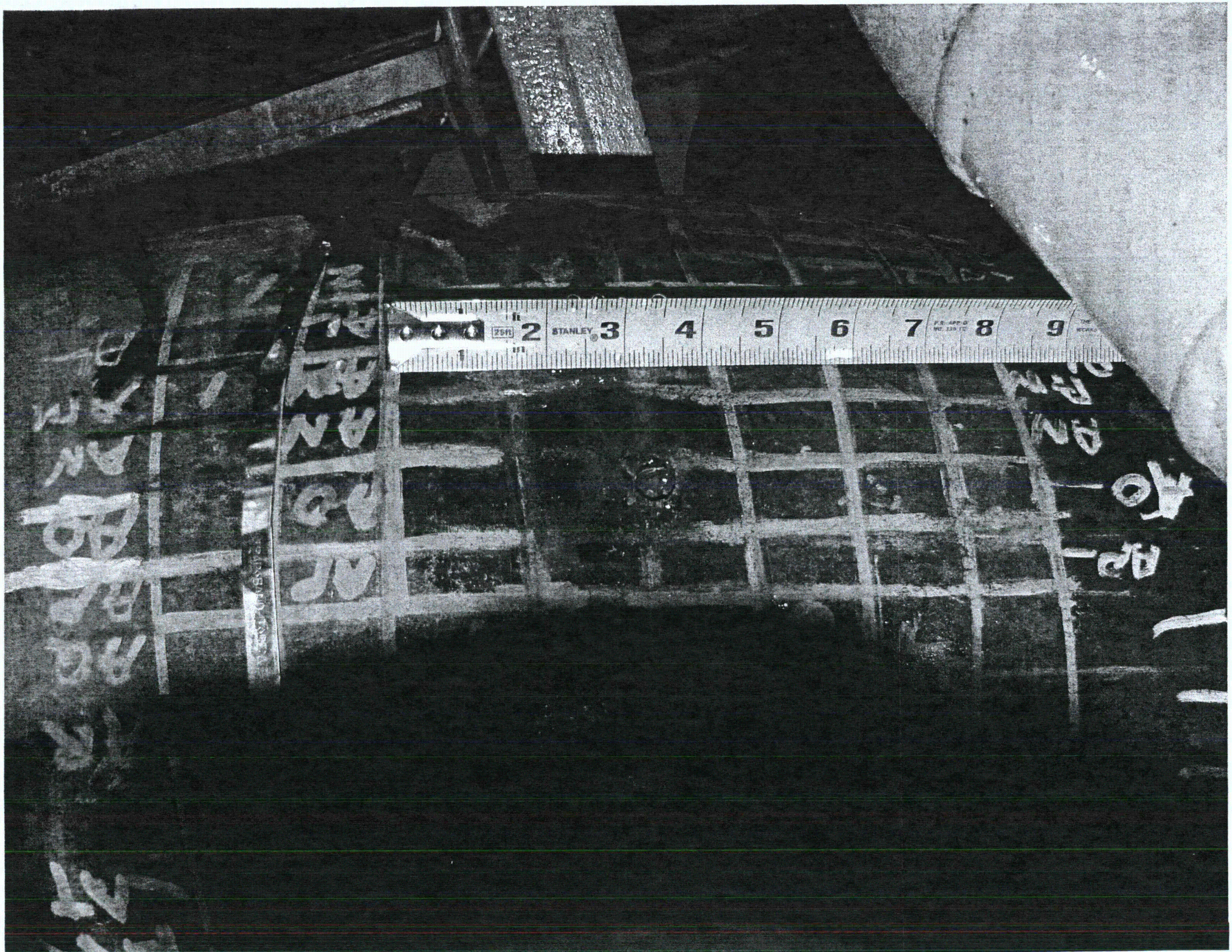
	8	7	6	5	4	3	DATE
AU	0.327 same	0.321 same	0.317 same	0.315 same	0.308 same	0.308 same	2/25/2014 ← 1ST EXAM 3/04/2014 ← 2ND EXAM
AT	0.348 same	0.337 same	0.292 0.333	0.328 same	0.327 0.319	0.327 0.321	2/25/2014 3/04/2014
AS	0.349 same	0.296 same	0.298 0.292	0.328 same	0.336 0.322	0.335 same	2/25/2014 3/04/2014
AR	0.349 same	0.341 same	0.334 same	0.313 same	0.299 0.292	0.343 same	2/25/2014 3/04/2014
AQ	0.356 0.344	0.339 same	0.333 0.328	0.334 same	0.336 same	0.338 same	2/25/2014 3/04/2014
AP	0.360 same	0.342 same	0.332 same	0.083 same	0.109 0.104 0.090	0.347 same	2/25/2014 3/04/2014 3/06/2014 ← 3RD EXAM
AO	0.366 same	0.343 same	0.362 0.349	0.064 same	0.051 same	0.361 same	2/25/2014 3/04/2014
AN	0.386 0.378	0.380 0.374	0.352 same	0.087 same 0.056	0.150 same	0.309 same	2/25/2014 3/04/2014 3/06/2014
AM	0.388 same	0.390 same	0.108 0.096	0.192 0.065	0.383 same	0.369 same	2/25/2014 3/04/2014
AL	0.392 0.386	0.393 same	0.392 same	0.394 same	0.389 same	0.393 same	2/25/2014 3/04/2014

[Type text]

Looking West

See next sheet for notes

3RD EXAM 3/06/2014 ONLY CHANGES TWO AREAS, AP4 & AN5.


STANLEY
2 3 4 5 6 7 8 9

	8	7	6	5	4	3	
AP	0.360 same same	0.342 same same	0.332 same same	0.083 same same	0.109 0.104 0.090 same	0.347 same same	2/25/2014 3/04/2014 3/06/2014 3/11/2014
AO	0.366 same same	0.343 same same	0.362 0.349 same	0.064 same same	0.051 same same	0.361 same 0.311	2/25/2014 3/04/2014 3/11/2014
AN	0.386 0.378 same	0.380 0.374 same	0.352 same 0.120	0.087 same 0.056 0.048	0.150 same same	0.309 same same	2/25/2014 3/04/2014 3/06/2014 3/11/2014
AM	0.388 same same	0.390 Same same	0.108 0.096 same	0.192 0.065 same	0.383 same same	0.369 same same	2/25/2014 3/04/2014 3/11/2014
AL	0.392 0.386 same	0.393 same same	0.392 same same	0.394 same same	0.389 same same	0.393 same same	2/25/2014 3/04/2014 3/11/2014

4TH EXAM

★ Hole, Green = only changes identified on 3/06/2014,

Changes identified on 3/11/2014

3/11/14 R. Avery

UT Exam on 3/~~12~~ 19 MAY /2014, READING'S IN AU 8 - AU 3 TO AL 8 - AL 3 UNCHANGED

5TH 9' FINAL U.T. EXAM

WO-52547248-01

	6	5	4
AP	0.332 SAME	OVER 0.300; 0.083	0.090; OVER 0.300
AO	0.349 SAME	OVER 0.300; 0.064	0.051; ★ HOLE; OVER 0.300
AN	0.352 SAME; 0.120	0.048; COULD NOT GET GOOD READING'S IN THESE TWO CELLS DUE TO AMOUNT OF WATER	0.150
AM	0.096 *0.081; OVER 0.300	0.065 *0.062; OVER 0.300	0.383 same

*LOWER READING'S

3/19/14 R. Avery