April 5, 2013
GO2-13-055

10 CFR 50.55a

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

Subject: **COLUMBIA GENERATING STATION, DOCKET NO. 50-397 PROPOSED
RELIEF REQUEST 3ISI-13 FOR TEMPORARY NON-CODE REPAIR OF
REACTOR WATER CLEANUP SYSTEM PIPING**

Dear Sir or Madam:

Columbia Generating Station (Columbia) is requesting approval for the use of a
temporary non-code repair of ASME Class 3 piping to prevent a reactor shutdown until
the startup of the next scheduled outage R21, starting on May 11, 2013 in accordance
with Generic Letter 90-05. Approval of the repair would avoid the hardship of having to
do a permanent repair while in Mode 1 and in high dose conditions and approaching
limiting reactor water chemistry conditions.

Energy Northwest makes the commitment to perform an ASME Section XI Code IWA-
4420 repair during refueling outage R21. This commitment and others are identified in
Attachment 3. If you have any questions or require additional information regarding this
matter, please contact Ms. LL Williams, Licensing Supervisor, at (509) 377-8148.

Respectfully,

A.L. Javorik
Vice President, Engineering

Attachment 1:   Relief Request 3ISI-13 for Temporary Non-Code Repair of Reactor Water
                Cleanup System Piping
Attachment 2:   ME-02-13-09, RWCU Regenerative Heat Exchanger Piping Repair
                Patch Analysis
Attachment 3: Additional Information
Attachment 4: List of Commitments

A047
NRR

cc: NRC RIV Regional Administrator
NRC NRR Project Manager
NRC Senior Resident Inspector/988C
AJ Rapacz – BPA/1399
WA Horin – Winston & Strawn

Columbia Generating Station
Relief Request Number 3ISI-13 for
Temporary Non-Code Repair of Reactor Water Cleanup Piping

Component(s) Affected

ASTM A 106 Grade B 4" Schedule 80 pipe (4.5" outer diameter x 0.337" wall)

System:

Reactor Water Cleanup (RWCU)

ASME Code Class

The portion of the RWCU piping containing the affected piping is treated as ASME Section III Class 3.

Function:

The affected portion of piping is on the RWCU regenerative heat exchanger piping between RWCU-HX-1A and RWCU-HX-1B and is physically located in the RWCU heat exchanger room. This section of the RWCU system is downstream of the reactor coolant pressure boundary (RCPB) portion of the system and has no safety function.

Applicable Code Edition and Addenda

A leak in the piping was detected by Operations personnel during a shift walk down. To perform a repair/replacement activity, IWA-4412 of the 2001 Edition of ASME Section XI with Addenda through 2003 requires that "defect removal shall be accomplished in accordance with the requirements of IWA-4420". A code repair cannot be performed during plant operations since the RWCU system needs to be placed back in service prior to reactor water chemistry parameters exceeding limits that would necessitate a plant shutdown. Specifically, it is estimated that the code repair could not be completed prior to reaching limiting reactor water chemistry conditions. Therefore, a modification is proposed which is considered a "temporary non-code repair," necessitating the need for this alternative. See the Proposed Temporary Non-Code Repair section of this alternative for more details.

Alternative Requirement

In lieu of performing an ASME Code compliant repair, Energy Northwest is requesting approval of a temporary non-code repair until startup from the next refueling outage. The refueling outage will begin on May 11, 2013 with a scheduled duration of 40 days. Compliance with the specified requirements of the ASME Code would result in hardship without a compensating increase in the level of quality and safety; therefore, approval of this alternative per 10 CFR 50.55a(a)(3)(ii) should be granted.

Positive Flaw Detection during Plant Operation

On April 1, 2013, a through-wall leak was discovered in the RWCU system. The initial leakage is documented in Columbia Generating Station (Columbia) Condition Report 281780.

Hardship of Repair

The RWCU system is depicted in Columbia Final Safety Analysis Report (FSAR) Figures 5.4-22 and 5.4-23. The system continuously purifies reactor water during all modes of reactor operation. The system takes suction from the inlet of each reactor main recirculation pump and from the reactor pressure vessel bottom head. Processed water is returned to the reactor pressure vessel. Major equipment of the RWCU system includes the RWCU pumps, the regenerative and non-regenerative heat exchangers, filter-demineralizers, and associated valves and piping. Performing an ASME Code repair would require continued isolation of the RWCU system from the reactor coolant system. Currently, trending of reactor coolant system chemistry parameters indicate a reactor shutdown will be necessitated on or around April 8, 2013. The RWCU system needs to be placed back into service to restore or ensure chemistry parameters remain within limits. Shutting the plant down to perform a code repair versus using the proposed temporary non-code repair is considered by Energy Northwest to be a hardship without a compensating increase in the level of quality and safety.

Specific Consideration

Since the RWCU system is a high energy system, the following considerations were addressed to ensure public health and safety is maintained. Once the proposed temporary non-code repair is made any potential adverse effects due to leakage will be mitigated.

- Leakage: Since the RWCU system is connected to the RCPB, it is equipped with a leakage detection system capable of isolating the system from the RCPB. The isolation instrumentation is subject to Columbia Technical Specification (TS) 3.3.6.1 and includes those functions specified in TS Table 3.3.6.1-1 Functions 4.a through 4.k. Abnormal conditions within the RWCU system will be detected and the instrumentation will automatically isolate the system from the RCPB. The RWCU system does not perform a safety function and is not an Engineered Safety Function (ESF) system.

- Flooding: The flooding analysis for the RWCU heat exchanger room postulates a crack in the 16" residual heat removal (RHR) pipe in the room and does not credit the existing floor drain. The maximum flow rate through the crack is postulated to be approximately 740 gpm. The maximum flood height is determined by the height of a weir. There are no safety related components in the room below the maximum calculated flood height. This flooding analysis bounds leakage from the 4" RWCU line that is being repaired, which carries a nominal flow of approximately 265 gpm.

- Spraying Water: RWCU is a high-energy system which has been analyzed for pipe-breaks within the RWCU heat exchanger room. The scope of the analyses addresses pipe whip, jet impingement and flooding in the room. The locations of pipe breaks are postulated based upon criteria of Branch Technical Position (BTP) ASB 3-1, Rev. 1, 1981. That criteria defines that pipe breaks be considered at high-stress locations and at terminal ends. The

location of the RWCU leak and repair is immediately adjacent to the nozzle of RWCU-HX-1A, a terminal end. Thus, the effects of any leakage at the repaired area have been bounded by pipe break existing analyses.

Flaw Evaluation and Proposed Temporary Non-Code Repair

- Degradation Mechanism: The leak is postulated to be caused by localized flow accelerated corrosion (FAC) due to a weld discontinuity developed from multiple repairs during initial fabrication. Based on the localized nature of the wall thinning and proximity to the weld, the failure was most likely caused by localized FAC resulting from a flow disturbance with the weld. The flow disturbance is postulated to be the result of an irregularity in the weld root surface, such as excessive weld root reinforcement or inner diameter (ID) mismatch or a combination of both.

- Flaw Sizing: The ultrasonic testing (UT) scan characterized the ID wall loss as a thinned area with dimensions of approximately 1" by 3" parallel to and immediately downstream from the edge of the elbow to pipe weld.

  The leak location is at the one o'clock position when looking into the elbow from horizontal, on the intrados of the elbow. The diameter of the hole is 0.15" and is located at the elbow side weld edge. The minimum wall thickness value of 0.285" was used as the bounding edge of the damaged area. The damaged area can be bounded by a rectangle that is 3" long (along weld edge) and 1" wide (into the elbow). The rectangle boundary extends 1" toward top dead center from the leak and 2" past the leak toward three o'clock. It then extends into the elbow base material for a distance of 1". The remaining thickness is lowest along the weld edge. The thickness of the horizontal pipe is 0.304"-0.310" along the weld edge opposite the damaged area. The thickness of the elbow outer diameter was spot checked in four locations and all were between 0.397" to 0.403".

- Proposed Repair: The repair is a fillet welded patch. The patch is fabricated from ASTM A234 GR WPB. The pad is sized to be a 3.5" x 5.25" x 0.5" thick patch. The work instructions require that the maximum gap between the pipe and patch be less than or equal to 3/32". The post-modification testing consists of a VT-2 examination with the RWCU system piping at normal operating pressure and temperature to verify the absence of leakage. Additionally, a camera in the RWCU heat exchanger room will be installed to provide leak monitoring until the outage.

- Stress Analysis: The analysis in Attachment 2 provides an evaluation of a proposed patch repair for the leaking RWCU pipe. The repair analyzed is a fillet welded patch, in accordance with ASME PCC-2 Article 2.12. The pad is sized to be 3.5" x 5.25" x 0.5" thick patch. The repair consists of a fitted patch that overlaps the leak and surrounding degraded material. The analysis of the repair takes no credit for the 1" x 3" section of degraded material, assuming the material is gone, and the installed patch provides all structural and pressure-retention functions.

Augmented Inspection

The piping containing the leak is high energy piping located in a section of the RWCU system that normally experiences flow while the system is in service. In accordance with the guidance in GL 90-05, Energy Northwest will perform an augmented inspection via UT or RT to assess the overall degradation of the affected system. The inspection of at least 10 susceptible (and accessible) locations for high energy lines will be performed. The locations will be examined within 15 days of the discovery of the leak as specified by GL 90-05. Flaws detected in the augmented inspection will be characterized and evaluated. As required by GL 90-05, if any flaw is detected having a minimum measured wall thickness less than the code-required minimum wall thickness, inspection of an additional 10 samples will be performed.

Additional Information

Following a review of the analysis in Attachment 2, it was decided to provide additional information relative to thermal expansion, thermal bending, and seismic stresses. This discussion is included in Attachment 3.

ME-02-13-09 Revision 1

RWCU Regenerative Heat Exchanger Piping Repair Patch Analysis

The RWCU piping between the heat exchangers is 4 inch schedule 80 carbon steel. The piping connects heat exchanger nozzles and is provided with a short thermal expansion loop as it connects the heat exchangers. The heat exchangers are stacked vertically and the piping loops vary in length from less than two feet to less than four feet horizontally. The piping loop is free to thermally expand since it is supported from the vessel nozzles with no intermediate supports. The total length of the unsupported 4" diameter piping for each loop is less than 10 feet. This is far less than the pipe span spacing table recommendation of 14 feet for 4" pipe as noted in Table 121.5 of the B31.1 Code. The sustained load bending stress for a 14 ft spacing is 2300 psi. This is the basis for determining the patch does not impact sustained load bending stress. To confirm this assessment the ANSYS model evaluated in Attachment 2 was extended to include the full piping expansion loop. (See Figure 1 below.)

Figure 2 shows the calculated hoop stress at 1450 psig design pressure. Figure 3 removes pressure to show the sustained bending stresses. The results show a maximum bending stress intensity of 668 psi. This result confirms the assessment in the previous analysis that bending stresses due to weight are insignificant. A summary of the modal analysis of the ANSYS model resulted in a first mode frequency of 42.6 Hz. Since the 1st fundamental frequency of the piping system is greater than 33Hz, the seismic loadings are evaluated for the piping system by conservatively using the maximum zpa seismic SSE horizontal (0.424) and SSE vertical (0.6062) values multiplied by 1.5 in this analysis. The piping system is evaluated using equivalent static analysis technique. The vertical loading is 1.0g (DW) + 0.9093g (Seismic Vertical) and 0.636g in both horizontal directions simultaneously. Figure 4 through 8 show the stress intensity plots for the piping and patch. Table 1 documents the resulting stresses versus allowables.

Appendix A of this attachment contains the updated weld evaluation with includes sustained + seismic loading.
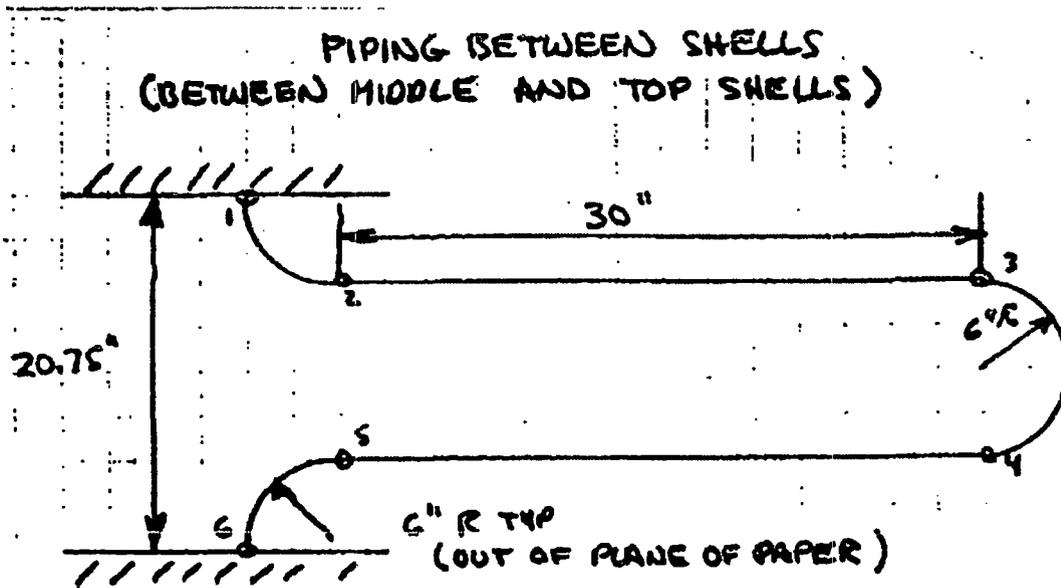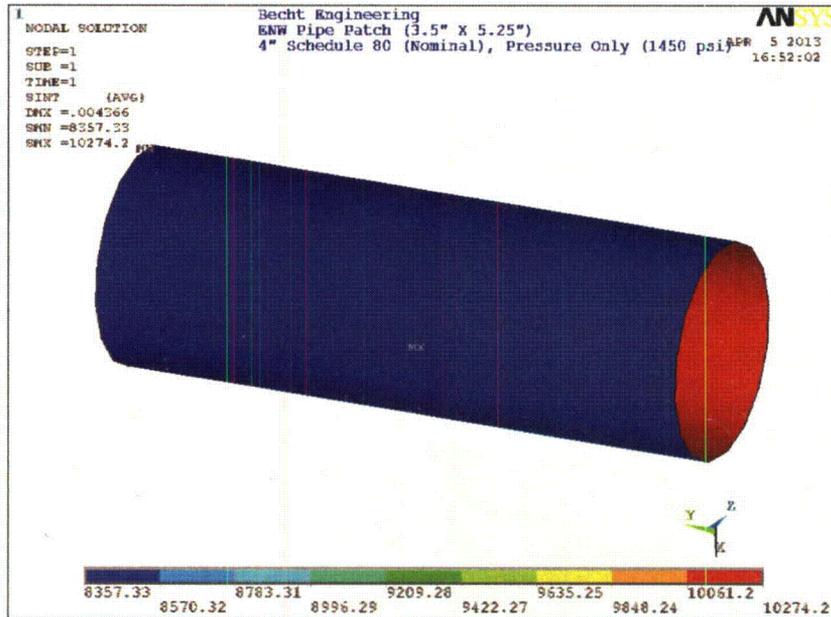

Figure 1 – Piping Schematic

Figure 2 – Hoop Stress for Design Pressure Only
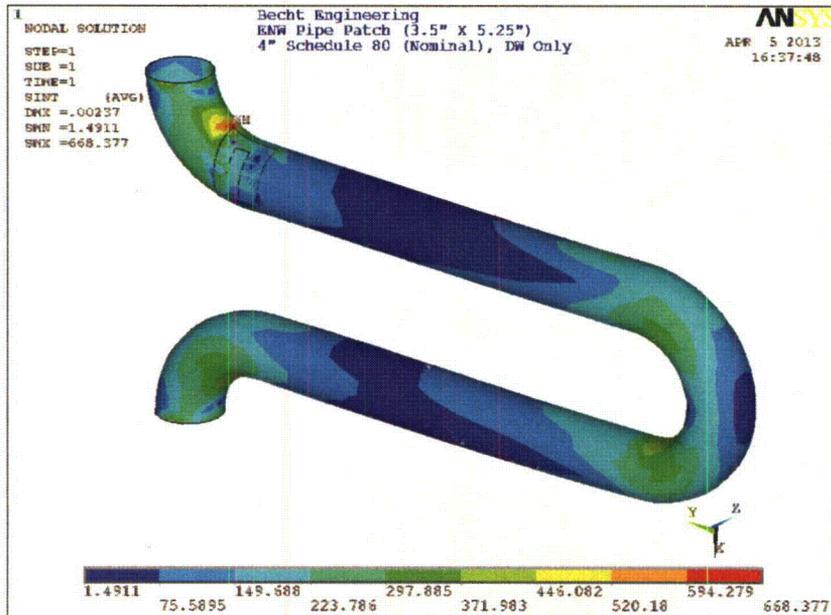
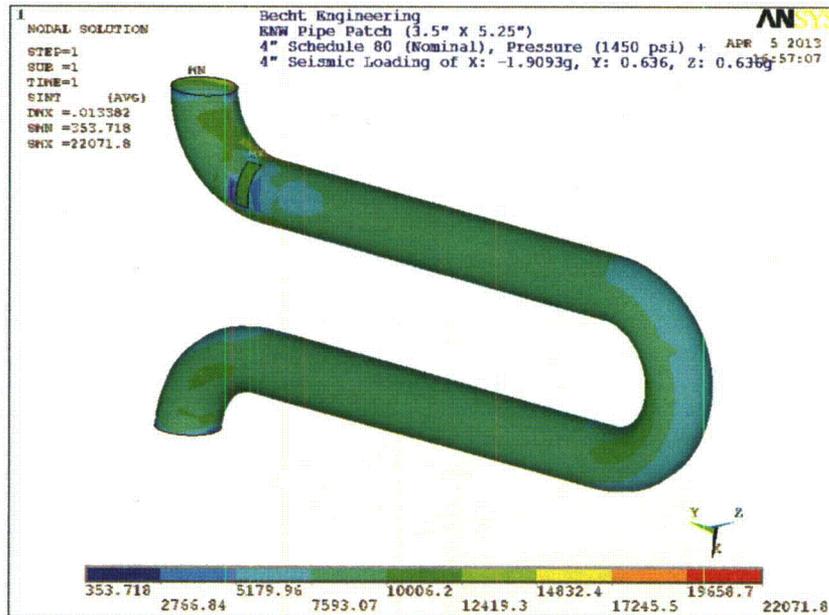Figure 3 – Membrane + Bending Stress Intensity Plot for Dead Weight Only

Figure 4 – Maximum Membrane + Bending Stress Intensity Plot of Pipe with Stress concentration of corroded area removed with Pressure + DW+ Seismic ZPA (1.5) in all three directions applied simultaneously
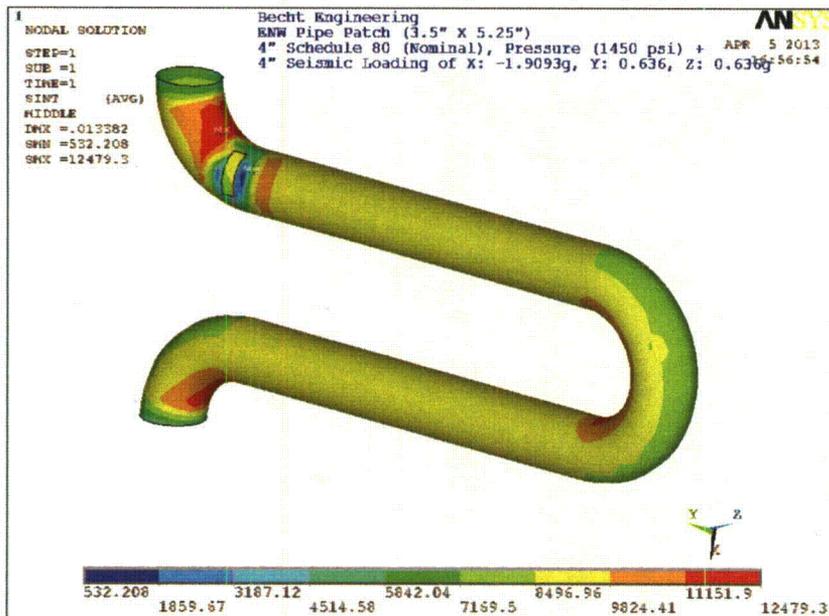

Figure 5 – Membrane Stress Intensity Plot of Pipe with Stress concentration of corroded area removed with Pressure + DW+ Seismic ZPA (1.5) in all three directions applied simultaneously
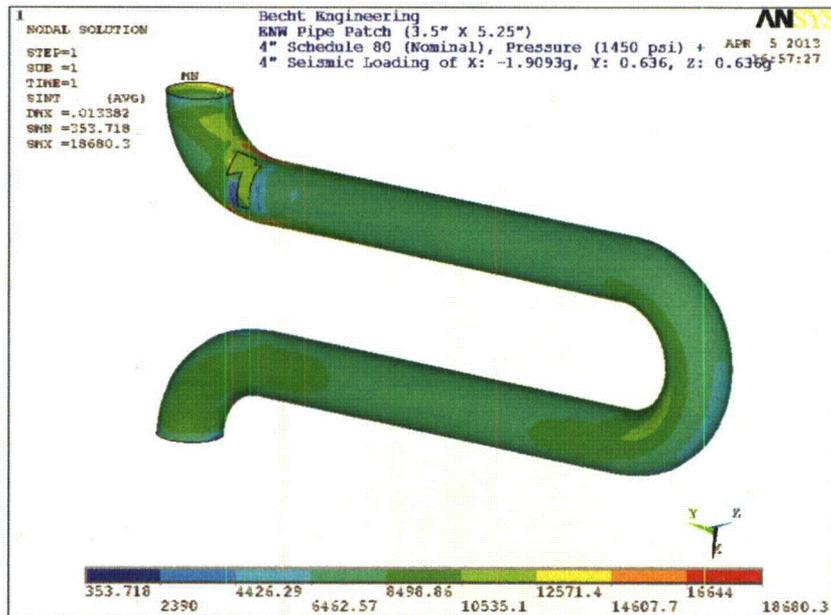
Figure 6 – Membrane + Bending Stress Intensity Plot of Pipe with Stress concentration of corroded area removed with Pressure + DW+ Seismic ZPA (1.5) in all three directions applied simultaneously
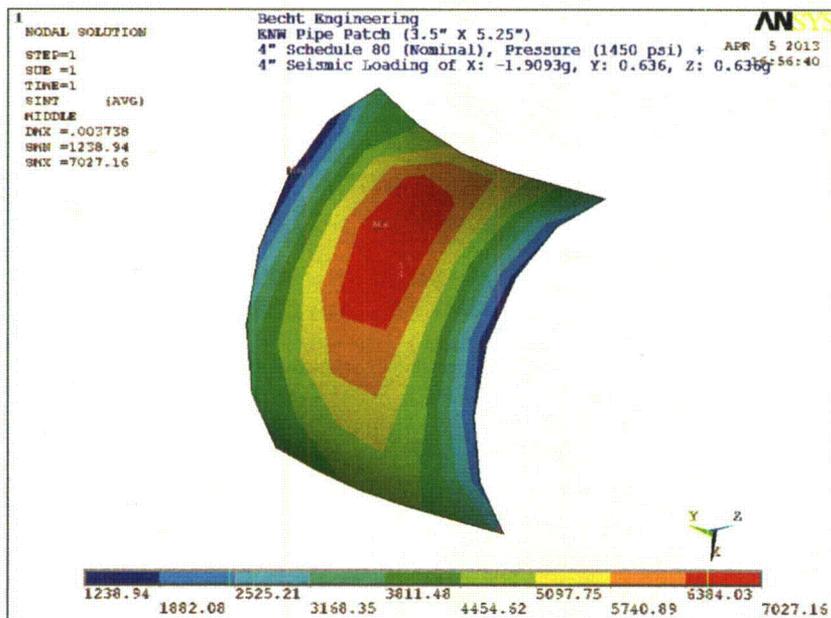

Figure 7 – Membrane Stress Intensity Plot of Patch Plate with Pressure + DW+ Seismic ZPA (1.5) in all three directions applied simultaneously
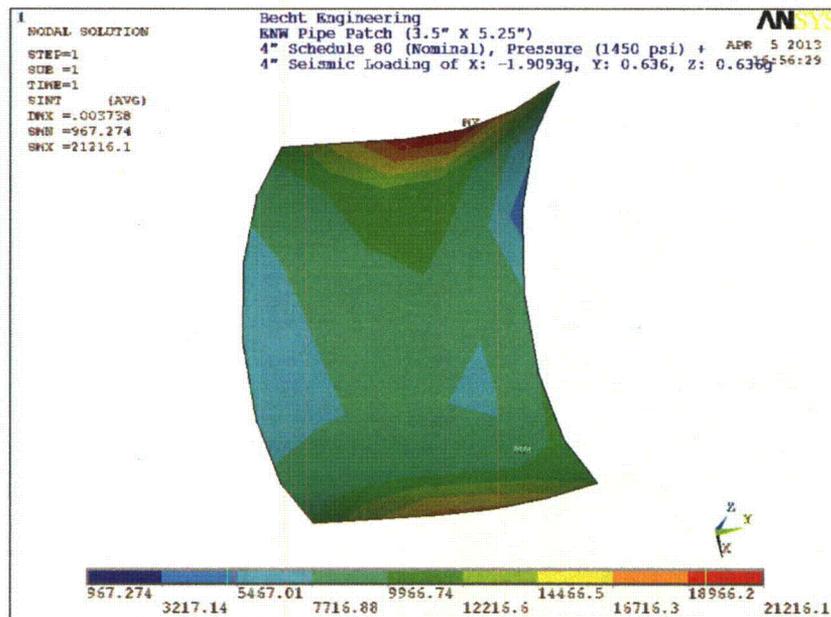
Figure 8 – Membrane + Bending Stress Intensity Plot of Patch Plate with Pressure + DW+ Seismic ZPA (1.5) in all three directions applied simultaneously

Table 1 –Stress Results

Stress Results: Maximum Membrane Stress Intensity				
Component	Design Pressure Only	DW + Pressure + Seismic	(1.0S) Allowable (psi)$_4$	D/C
Pipe	11,903	12,479	15,000	0.83
Patch Pipe	6,679	7,027	15,000	0.47

Stress Results: Maximum Membrane + Bending				
Component	Design Pressure Only	DW + Pressure + Seismic	(1.5S) Allowable (psi)$_4$	D/C
Pipe	18,551$_3$	18,680$_3$	22,500	0.83
Patch Pipe	21,378	21,216	22,500	0.95

Notes:
1. Pipe allowable stress from ASME B31.1-1971, which is equivalent to ASME Section III Class 3-1971
2. ASTM A 106 Grade B = 15 ksi @ 600°F .
3. Stress Conentration result has been from the pipe model where the sharp corner is located in the 1"x3" cut out.
4. Allowable Stress table does not take credit for the 1.33 occasional load factor.

Appendix A — Evaluation of Weld

A-1 – Blodgett Fillet Welded Patch Analysis

Weld Analysis of 5/16" (0.313") Fillet Weld between the Elbow/Pipe Patch and the existing Pipe.

Absolute sum of ANSYS Weld Loads

$Fweldx := 8211 lbf$	Force along the X-axis	
$Fweldy := 11853 lbf$	Force along the Y-axis	
$Fweldz := 19979 lbf$	Force along the Z-axis	

Weld Loads are in the Global Coordinate System (GCS). The Maximum weld load is obtained by absolute summation of the forces extracted from ANSYS COMBIN14 elements. The weld was modeled by using COMBIN14 elements to join the nodes of the two parts along the weld path.
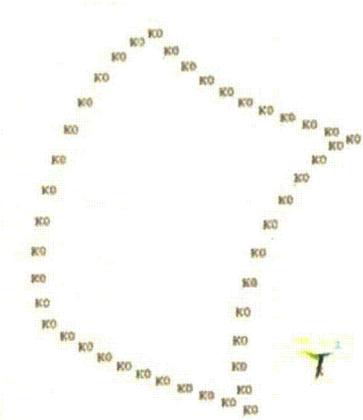
Weld analysis for rectangular line weld
Material Properties and Allowable Stresses

$S_{yield} := 27225 psi$ — Yield strength for A106 Gr B at 575 °F

$S_{FR} := 70000 psi$ — Filler rod 70XX nominal ultimate strength.

$\Omega_u := 0.3$ — Safety Factor applied to nominal tensile strength of filler metal.

$\Omega_b := 0.4$ — Safety factor applied to yield strength of base material.

$weldAllow := \Omega_u \cdot S_{FR} = 21000\,psi$ — Allowable shear stress on effective weld area.

$baseAllow := \Omega_b \cdot S_{yield} = 10890\,psi$ — Allowable tensile or compressive stress on effective weld area

Weld Section Properties:

$W_{size} := \dfrac{5}{16} in$ — Minimum weld size to be evaluated.

$b := 5.25 in$ — Length of weld

$d := 3.5 in$ — Weld line spacing

$Lweld := (b + d) = 8.75\,in$ — Total weld length.

$Fweld1 := \dfrac{Fweldz}{Lweld} = 2283 \dfrac{lbf}{in}$ — Axial load

$Fweld2 := \dfrac{Fweldy}{2 \cdot d} = 1693 \dfrac{lbf}{in}$ — Shear load

$Fweld3 := \dfrac{Fweldx}{2 \cdot b} = 782 \dfrac{lbf}{in}$ — Shear load

$Fweld := \sqrt{Fweld1^2 + Fweld2^2 + Fweld3^2} = 2948 \dfrac{lbf}{in}$

Check Weld shear   **Check base shear**

$weld := \dfrac{Fweld}{0.707 \cdot weldAllow} = 0.199 \cdot in$ $weld_b := \dfrac{Fweld}{baseAllow} = 0.271 \cdot in$

$max(weld, weld_b) = 0.271\,in < 0.313\,in.$, therefore a 5/16 in. fillet weld is OK.
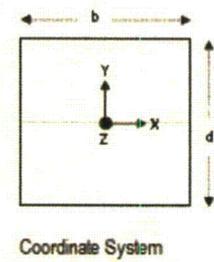
Coordinate System

Fx	Fy	Fz		abs (Fx)	Abs (Fy)	abs (Fz)
-36.77	-204.88	-258.82		36.77	204.88	258.82
58.73	-516.41	-142.39		58.73	516.41	142.39
-72.08	-401.96	-733.82		72.08	401.96	733.82
-57.62	-233.78	-84.42		57.62	233.78	84.42
-146.93	-179.49	-474.27		146.93	179.49	474.27
-201.59	-350.17	-1090.82		201.59	350.17	1090.82
-227.67	-494.47	-197.64		227.67	494.47	197.64
-149.8	-106.18	-620.27		149.8	106.18	620.27
-232.5	-51.9	-1247.99		232.5	51.9	1247.99
-106.92	165.69	-230.22		106.92	165.69	230.22
-267.94	226.23	-1193.75		267.94	226.23	1193.75
-168.32	101.58	-519.87		168.32	101.58	519.87
-160.61	60.94	-652.32		160.61	60.94	652.32
-206.65	310.95	-809.5		206.65	310.95	809.5
-174.03	550.69	-197.91		174.03	550.69	197.91
-138.06	202.72	-161.42		138.06	202.72	161.42
-96.6	-261.17	-146.14		96.6	261.17	146.14
-241.59	393.83	-405.77		241.59	393.83	405.77
-150.13	-536	-325.92		150.13	536	325.92
-85.05	213.92	-214.05		85.05	213.92	214.05
-158.35	432.84	-424.32		158.35	432.84	424.32
-130.02	-300.68	-138.84		130.02	300.68	138.84
-75.12	212.28	-209.36		75.12	212.28	209.36
-234.84	-530.74	-242.81		234.84	530.74	242.81
-142.81	428.94	-402.78		142.81	428.94	402.78
-158.16	-261.89	-138.08		158.16	261.89	138.08
-54.5	215.53	-213.31		54.5	215.53	213.31
-337.29	-469.12	-319.04		337.29	469.12	319.04
-83.05	402.74	-399.14		83.05	402.74	399.14
-114.37	-205.71	-226.89		114.37	205.71	226.89
13.91	193.86	-202.36		13.91	193.86	202.36
-201.2	-619.08	-345.9		201.2	619.08	345.9
-22.33	540.84	-188.24		22.33	540.84	188.24
-24.19	-205.95	-335.12		24.19	205.95	335.12
-389.23	-278.91	-815.23		389.23	278.91	815.23
-210.6	-75.39	-402.68		210.6	75.39	402.68
-472.86	-177.5	-904.23		472.86	177.5	904.23
-277.62	-68.83	-456.92		277.62	68.83	456.92
-575.12	-93.5	-924.39		575.12	93.5	924.39
-233.44	56.81	-431.45		233.44	56.81	431.45
-410.89	260.58	-668.7		410.89	260.58	668.7
-280.66	3.79	-499.6		280.66	3.79	499.6
-66.5	162.54	-248.67		66.5	162.54	248.67
-563.84	92.28	-933.46		563.84	92.28	933.46
			Sum	8210.49	11853.29	19778.83

List of Commitments

The following table identifies the regulatory commitments in this document. Any other statements in this submittal, including intended or planned actions, are provided for information purposes and are not considered to be regulatory commitments.

Commitment	Scheduled Completion Date
The post-maintenance testing will include a VT-2 examination.	Prior to return of RWCU to service
Energy Northwest will perform an augmented inspection via UT or RT to assess the overall degradation of the affected system. The inspection of at least 10 susceptible (and accessible) locations for high energy lines will be performed.	April 16, 2013
Energy Northwest will install a camera in the RWCU heat exchanger room to provide leak monitoring until the outage.	April 8, 2013
The non-code repair will be replaced with an ASME Code repair.	Prior to startup from Refueling Outage 21 (June 2013)