VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

November 27, 2019

10 CFR 50.55a

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

Serial No.: 19-483
NRA/GDM: R0
Docket No.: 50-281
License No.: DPR-37

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNIT 2
ASME SECTION XI INSERVICE INSPECTION PROGRAM
PROPOSED ALTERNATIVE REQUEST S2-I5-ISI-05 TO USE A MECHANICAL CLAMPING DEVICE FOR A ONE-INCH MAIN STEAM LINE PIPE REPAIR

Pursuant to 10 CFR 50.55a(z)(2), Virginia Electric and Power Company (Dominion Energy Virginia) hereby requests NRC approval to use an alternative repair for an identified pinhole leak recently identified in a one-inch Main Steam pipe at Surry Power Station (Surry) Unit 2. Specifically, on November 22, 2019, a pinhole steam leak was identified in the one-inch bypass piping in the Turbine Driven Auxiliary Feedwater Pump steam supply line. A permanent American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code (ASME Code), Section XI, Code repair is not currently possible since Surry Unit 2 is operating at full power, and the leak is unisolable, subject to full steam generator (SG) pressure, and constitutes part of the containment boundary.

10 CFR 50.55a(g) requires that nuclear power facility components must meet the requirements contained in specific editions of ASME Section XI Code for Inservice Inspection, and Repair and Replacement Programs. The applicable requirements for Surry Unit 2 are the 2004 Edition with No Addendum of the ASME Section XI Code. Article IX-1000 of Appendix IX, "Mechanical Clamping Devices for Class 2 and 3 Piping Pressure Boundary," Paragraph (c), states in part "Clamping devices shall not be used on the following: (1) Class 1 piping; (2) portions of a piping system that forms the containment boundary." Since the pinhole leak is located in a portion of a piping system that forms the containment boundary, use of a mechanical clamping device is not permitted by the Code. Also, Paragraph (a) of Article IX-6000 contains monitoring requirements associated with use of a clamping device. Paragraph (a) states: "Except as permitted by (b) below, or where precluded by the clamping device configuration, the area immediately adjacent to the clamping device shall be examined using a volumetric method."

NRC approval of an alternative repair to the ASME Code requirements noted above is requested to permit application of a mechanical clamping device to the pinhole leak location, as well as to use increased visual inspection of the repair location instead of

volumetric monitoring. Otherwise, performing a code repair in accordance with Appendix IX of ASME Section XI would require shutting down Unit 2, making the pipe repair, and then restarting Unit 2. This would result in a hardship without a compensating increase in quality and safety, since the shutdown and subsequent restart of Surry Unit 2 unnecessarily cycles plant systems and components, and the temporary use of a mechanical clamping device together with daily visual inspections will provide an acceptable leak-tight repair until a permanent repair can be made.

Verbal authorization of the proposed alternative is requested to permit expeditious repair of the leak to preclude the potential worsening of the leak and to eliminate the personnel hazard associated with an unisolated steam leak.

The proposed alternative request is provided in Enclosure 1. The alternative request has been approved by the Facility Safety Review Committee.

Should you have any questions or require additional information, please contact Mr. Gary D. Miller at (804) 273-2771.

Sincerely,

Mark D. Sartain
Vice President – Nuclear Engineering and Fleet Support

Commitment made in this letter:

1. The temporary repair of the pinhole leak in the one-inch Main Steam piping will be permanently repaired in accordance with ASME Section XI during the Surry Unit 2 spring refueling outage.

Attachment:

Alternative Request for Use of a Mechanical Clamping Device on Main Steam Pressure Boundary Leak

cc: U.S. Nuclear Regulatory Commission
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NRC Senior Resident Inspector
Surry Power Station

Attachment

ALTERNATIVE REQUEST FOR USE OF A MECHANICAL CLAMPING DEVICE ON MAIN STEAM PRESSURE BOUNDARY PIPING LEAK

ALTERNATIVE REQUEST S2-I5-ISI-05

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Unit 2

Alternative Request for the Use of a Mechanical Clamping Device on Main Steam Pressure Boundary Piping Leak

Alternative Request S2-I5-ISI-05

SURRY POWER STATION UNIT 2
DOMINION ENERGY VIRGINIA

--In Accordance with 10 CFR 50.55a(z)(2), Hardship or Unusual Difficulty without a Compensating Increase in the Level of Quality and Safety--

1. ASME Code Component(s) Affected

Code Class:	ASME Class 2 Piping
Component Number:	1-inch SHP-601 off 4-inch SHP-127-601
Description:	1-inch Main Steam Piping Upstream of Valve 2-MS-377
Reference:	Drawing 11548-CBM-064A-5, Sheet 3 of 6

2. Applicable Code Edition and Addenda

The following table identifies the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section XI Code of Record for performing inservice inspection (ISI) activities at Surry Power Station Unit 2 (Surry Unit 2).

Plant	10-Year ISI Interval	ASME Section XI Edition / Addenda	Interval Start Date	Interval End Date
Surry Unit 2	5th	2004 Edition / No Addenda [Ref.1]	May 10, 2014	May 9, 2024

3. Applicable Code Requirements

The applicable ASME Code requirements are ASME Section XI, 2004 Edition with No Addenda, Article IX-1000 of Appendix IX, "Mechanical Clamping Devices for Class 2 and 3 Piping Pressure Boundary."

Paragraph (c) of Article IX-1000 states, in part, "Clamping devices shall not be used on the following: (1) Class 1 piping; (2) portions of a piping system that forms the containment boundary:..."

Paragraph (a) of Article IX-6000 states, in part, "Except as permitted by (b) below, or where precluded by the clamping device configuration, the area immediately adjacent to the clamping device shall be examined using a volumetric method...."

Dominion Energy Virginia has reviewed 10 CFR 50.55a and has not identified any conditions regarding Article IX-1000 of Mandatory Appendix IX.

4. Reason for Request

Background – At 10:41 on November 22, 2019, during a routine walkdown by plant Operations personnel, a measured six drops per minute leak was found dripping from the insulation just upstream of valve 2-MS-377 (part of the "C" Main Steam Header, Penetration No. # 074). (See Enclosure 1.)

At 19:48 on November 22, 2019, after scaffolding was installed and pipe insulation was removed to facilitate investigation of the source of the leakage, Non-destructive Engineering and System Engineering personnel identified a potential through-wall leak on the 1-inch Main Steam (MS) piping upstream of valve 2-MS-377. A small through-wall leak (characterized as a pinhole) was confirmed using a mirror, as well as the sound of escaping steam. The location of the pinhole is on an elbow to pipe socket weld at approximately the 1:00 o'clock position. The pinhole was estimated to be 1/32-inch or less and was likely caused by a fabrication welding defect (i.e., lack of fusion). The defect was bounded to account for nondestructive limitations per Article IX-2000. Ultrasonic testing (UT) of the pipe was performed to obtain thickness readings on both sides of the 90-degree elbow next to the welds and extended to areas where a proposed mechanical clamp could be installed. (NDE Report BOP-UT-19-076.) The readings ranged from 0.170-inch to 0.186-inch. (The nominal pipe wall thickness is 0.179 inch.) No degradation of the piping was noted, and no pipe movement or vibration was observed.

The 1-inch MS piping is ASME Class 2 and is located outside the reactor containment in the Main Steam Valve House on the 27-foot elevation at 12 feet off the floor. The 1-inch piping is the bypass line around valve 2-MS-158, the Steam Generator (SG) C Turbine Driven Auxiliary Feedwater Pump (TDAFWP) Steam Supply Isolation Valve. Valve 2-MS-377 is normally closed during power operations. The SG C steam supply

line is one of three steam supply lines to the TDAFWP. The other two steam supply lines are supplied from SG A and SG B. An extent of condition evaluation of the other two steam supply lines was completed through piping walkdowns, and no other similar steam leaks were identified.

The piping is 1-inch, Schedule 80 (0.179-inch nominal wall thickness), seamless carbon steel pipe, A 106 Grade B piping. The ISI Classification Boundary Drawing is provided in Enclosure 1. The design and operating conditions for the 1-inch line are as follows:

- Design conditions: 1085 psig and 570°F

- Operating conditions (full power): 811 psig and 520°F

The steam supply lines to the TDAFWP are within the containment isolation boundary outside of containment. The MS system is considered a closed system (i.e., an extension of the primary containment) as described in the Surry Power Station Units 1 and 2 Updated Final Safety Analysis Report (UFSAR) (Ref. 3).

The UFSAR Chapter 14 accident analyses environmental consequences were reviewed to assess the potential radiological impact of the pinhole leak. It was determined that the steam releases and associated dose consequences for the Main Steam Line Break (MSLB) and the Steam Generator Tube Rupture (SGTR) (including releases from the TDAFWP exhaust) are of such a magnitude that the additional release from the pinhole steam leak on the 1-inch line for the duration of the event is negligible.

Reason for the Request - ASME Section XI requires that a permanent Code repair of the pinhole leak in the 1-inch MS piping be performed. While Dominion Energy Virginia intends to perform a permanent Code leak repair during the Surry Unit 2 spring 2020 refueling outage, it is not currently possible to perform the repair since Surry Unit 2 is in POWER OPERATION mode, and the MS piping leak is unisolable and subject to full SG pressure. Although a mechanical clamping device would provide an acceptable repair to control leakage and ensure continued structural integrity of the 1-inch pipe, Paragraph (c) of Article IX-1000 of Appendix IX of ASME Section XI prohibits the use of such devices on portions of a piping system that forms the containment boundary. Under these conditions, it would be necessary for Surry Unit 2 to shutdown from POWER OPERATION to COLD SHUTDOWN to perform a permanent ASME Code repair. When the plant is shutdown from POWER OPERATION to COLD SHUTDOWN and then returned to POWER OPERATION, plant inspections and Technical Specifications surveillances need to be performed, which result in radiological dose to personnel. In addition, a shutdown and subsequent restart of Surry Unit 2 unnecessarily cycles plant systems and components and may result in plant transients in addition to the shutdown and restart of the Surry Unit 2 reactor.

Dominion Energy Virginia has determined that shutting down Surry Unit 2 to perform a permanent ASME Code repair results in a hardship without a compensating increase in the level of quality and safety. Therefore, an alternative to Paragraph (c) of Article IX-1000 of Appendix IX and Paragraph (a) of Article IX-6000 of Appendix IX is proposed in Section 5 to permit the temporary repair of the 1-inch MS line leak until a permanent Code repair can be performed during the next Surry Unit 2 refueling outage.

5. Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(z)(2), an alternative to the ASME Section XI Code repair requirements is proposed for the repair of the 1-inch MS line piping. Specifically, Dominion Energy Virginia proposes to take an exception to the containment boundary restriction of Paragraph (c) of Article IX-1000 of Appendix IX of ASME Section XI and from the volumetric method monitoring requirements of Paragraph (a) of Article IX-6000, so that the 1-inch MS piping leak can be repaired using a mechanical clamping device that meets the remaining provisions of Article IX-1000 of Appendix IX of ASME Section XI. All other provisions of ASME Code, Section XI, Paragraph IWA-4133 and Appendix IX will be met.

As required by Paragraph (a) of Article IX-1000 of Appendix IX of ASME Section XI, the proposed clamping device will not remain in service beyond the next scheduled Surry Unit 2 refueling outage currently scheduled for spring 2020, at which time the defect will be repaired, or the piping replaced.

Dominion Energy Virginia proposes to use a mechanical clamping device to: 1) control the leak and maintain the MS containment boundary, and 2) ensure the structural integrity of the MS piping.

Leakage Control and Maintenance of the Containment Boundary

Paragraph (c) of Article IX-6000 of Appendix IX of ASME Section XI states: "The clamping device shall be monitored for leakage at least weekly. Any leakage at any time shall be dispositioned." The Surry Unit 2 clamping device will be visually monitored for leakage once per day (24 hours). This significantly exceeds the requirements of Paragraph (c) of Article IX-6000 and provides equivalent assurance that any leakage will be promptly identified without the performance of volumetric method inspections. In addition, Paragraph (a) of Article IX-6000 allows an exception to performing examinations of the area immediately adjacent to the clamping device using a volumetric method, when it is precluded by the clamping device configuration.

As discussed earlier, the pipe in question is part of the closed system outside containment and is considered an extension of the containment boundary. The mechanical clamping device will be located on a small 1-inch pipe outside

containment, and the closed system will continue to provide a passive containment isolation barrier. The normal operating pressure at the location of the mechanical clamping device is in the range of 800 - 1000 psig. The clamping device is in an area that is readily accessible for visual inspection. As such, positive verification of the leak-tight integrity of the mechanical clamping device will be accomplished by visual observations. As noted above, the clamping device will be visually monitored for leakage once per day (24 hours). This significantly exceeds the requirements of Paragraph (c) of Article IX-6000 of Appendix IX, which states "The clamping device shall be monitored for leakage at least weekly. Any leakage at any time shall be dispositioned."

Mandatory Appendix IX, Article IX-1000, Paragraph (d), requires that a Repair/Replacement Plan be developed in accordance with IWA-4150 and shall identify the defect characterization method, design requirements, and monitoring requirements. Dominion Energy Virginia is developing a Repair/Replacement Plan in accordance with IWA-4150 for the steam leak on the 1-inch MS pipe. A system leakage test (at normal operating temperature and pressure) in accordance with IWA-5000 will be performed on the portion of the piping system containing the mechanical clamping device. The leakage acceptance criterion for the installed clamping device, post maintenance testing, is zero leakage. Should leakage be identified during any of the daily inspections, a plant Condition Report will be written, and a leak evaluation will be performed.

Structural Integrity of the MS piping

The proposed mechanical clamping device will be designed to comply with the design requirements of Article IX-3000 of Appendix IX and the material requirements of Article IX-4000 of Appendix IX. These requirements meet or exceed the design rating of the piping. The clamping device enclosure material is carbon steel (SA 516 GR 70); therefore, the clamping device is suitable for the intended application and capable of performing its specified design functions. A sketch of the proposed clamping device is provided in Enclosure 2, as well as the design information for the clamping device.

Calculation CEM-0231, Rev. 0 [Ref. 4 and Enclosure 3], was prepared to provide the loading environment and stress levels for design basis conditions in the original design configuration of the piping and with the structural clamp installed together with a new temporary pipe support. The clamp weighs approximately 60 lbs. and is designed to provide more than adequate structural capacity to accommodate the postulated reaction forces in the event the 1-inch Carbon Steel, Schedule 80 socket welded elbow connection completely separated. In addition, the clamp provides more than adequate structural capacity to function as the structural element of the piping and will withstand all design basis loading conditions. The calculation demonstrates that with the clamp and additional vertical support installed, the piping system and pipe supports remain within the limits of the design code, with margins consistent with those of the original configuration, without the structural clamp installed.

The impact of the additional weight of the sealant and any supporting boxes, frames, or structures added during the repair process on the seismic adequacy of the piping system was evaluated in calculation CEM-0231 [Ref.4], and it was determined that an additional support needs to be installed.

Impact of system changes, with respect to the degraded component condition relative to the ability of the system to withstand a seismic event, has also been evaluated. Calculation CEM-0232 [Ref.5 and Enclosure 4] demonstrates the ability of the piping in the current configuration to withstand the design loading conditions, including seismic, given the identified degraded weld.

Paragraph (a) of Article IX-6000 contains monitoring requirements associated with use of a clamping device. Paragraph (a) states: "Except as permitted by (b) below, or where precluded by the clamping device configuration, the area immediately adjacent to the clamping device shall be examined using a volumetric method. The examination frequency shall not exceed three months and shall be specified in the Repair/Replacement Plan. When the examination reveals defect growth to a size that exceeds the projected size determined by IX-3100(b), the defect shall be removed or reduced to an acceptable size." Dominion Energy Virginia proposes to ensure the structural integrity of the 1-inch pipe containing the defect, as an alternative to the volumetric method monitoring requirements of paragraph (a) of Article IX-6000, by ensuring the clamping device being installed on the pipe will entirely encapsulate the piping section containing the flaw (see clamping device drawing in Enclosure 2). This configuration will prevent access to perform a volumetric method inspection of the piping immediately adjacent to the clamping device. However, as noted above, the clamping device will be visually monitored for leakage once per day (24 hours), which significantly exceeds the requirements of Paragraph (c) of Article IX-6000 of Appendix IX, which states "The clamping device shall be monitored for leakage at least weekly."

Therefore, the use of the proposed alternative will continue to provide an acceptable level of quality and safety.

6. Duration of Proposed Alternative

The proposed relief will apply until the next Surry Unit 2 refueling outage currently scheduled for spring 2020 (Refueling Outage 2R29).

7. Precedents

1. Waterford Steam Electric Station, Unit 3 (TAC No. MC8542) dated February 9, 2006 (ADAMS Accession No. ML060460590).

2. Turkey Point Nuclear Power Plant, Unit 4 (TAC No. MC7338) dated August 15, 2005 (ADAMS Accession No. ML052090182).

8. References

1. ASME Pressure Vessel and Boiler Code, Section XI Rules for Inservice Inspection of Nuclear Power Plant Components, 2004 Edition, No Addenda.

2. Mechanical Clamping Device Design Information, Eng. Order # 4211975, Rev 2, TEAM Industrial Services, 11/25/19.

3. Surry Unit 2 – Updated Final Safety Analysis Report (UFSAR), Revision 51.01.

4. Calculation CEM-0231, Revision 0, "Evaluation of Line 1"-SHP-601 off 4"-SHP-127-601 for Leak Seal Enclosure Device," dated 11/26/19.

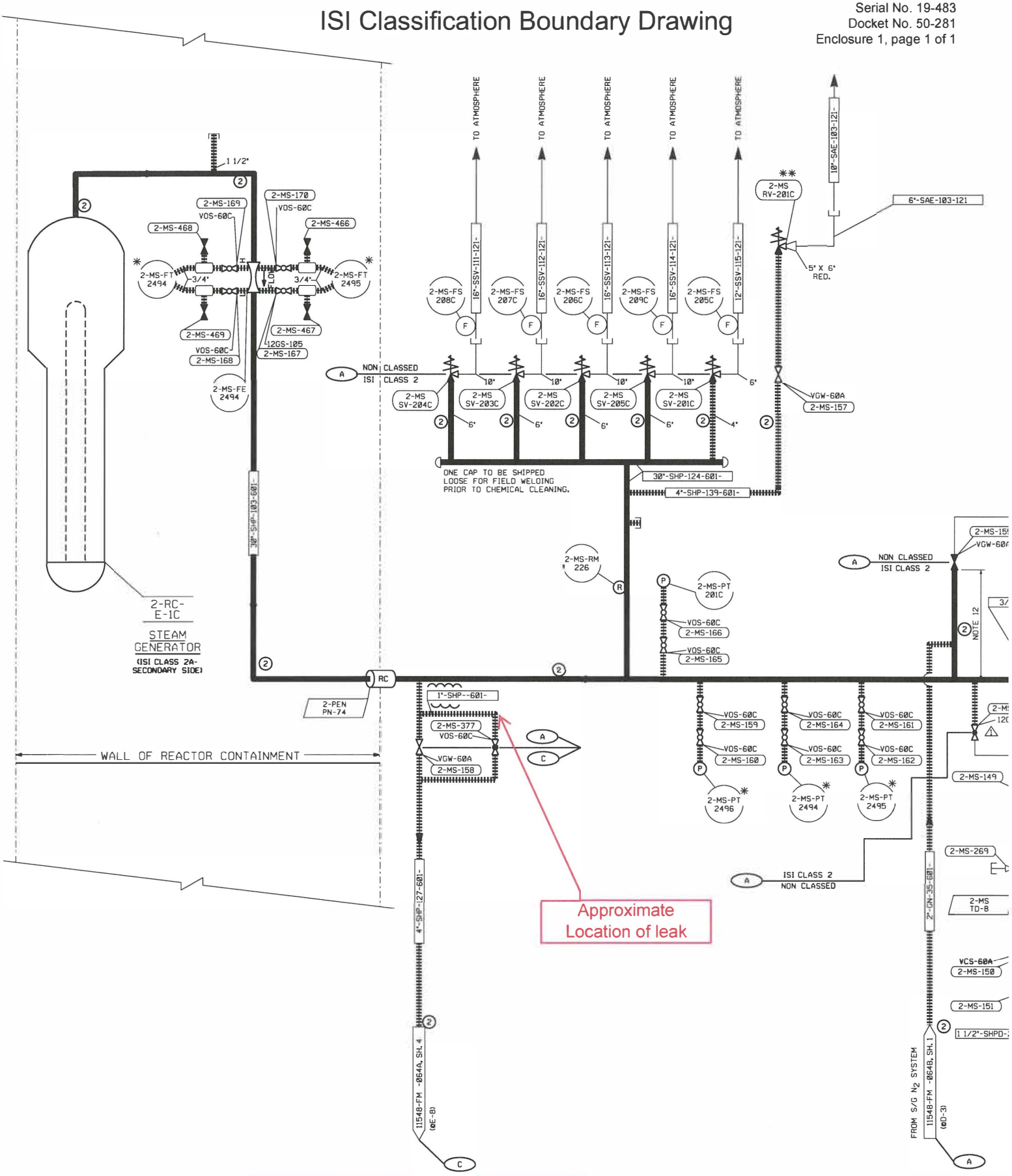
5. Calculation CEM-0232, Revision 0, "Evaluation of Degraded Socket Weld on 1" Diameter Steam Supply Bypass Line Through-Wall Leak Flaw Characterization as Reported in Condition Report CR1136592," dated 11/26/19.

Enclosure 1

ISI CLASSIFICATION BOUNDARY DRAWING

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Unit 2

ISI Classification Boundary Drawing



Enclosure 1 cropped from Drawing No: 11548-CBM-064A-5

Enclosure 2

MECHANICAL CLAMPING DEVICE DESIGN INFORMATION

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Unit 2

TEAM® Industrial Services

Registration# F-003143

Engineering Department. Tel: (281) 388-5695 Fax: (281) 388-5690

ROUTING SLIP & COVER SHEET FOR NUCLEAR SAFETY RELATED JOBS

Branch Work Order #: 140400181701	Status: Priority	Caller: J. JONES
Customer: DOMINION SURRY	Safety Review #: 4211975DS	Engr Order #: 4211975 REV 1

	Name:	Signature:	Date:	Time:
Data Taken By:			11/23/2019	1245
Designed By:			11/23/2019 11/24/2019	1530 1600
Verified By:			11/23/2019 11/23/2019 11/24/2019	1830 2359 1945
Shop Received By:				
QC Received By:				

Specifications:			
Design Pressure:	1085 psi	Design Temperature:	570 °F
Service:	STEAM	Torque Value:	5/8" STUDS 125 ft-lb 7/8" STUDS 351 ft-lb
Total Weight:	56.60 lb	Sealant Type:	FSC-N-3B
Routing:	ESTIMATE	Void:	24.60 in^3 BC
Maximum Injection Pressure:	1835 psi		26.07 in^3 AC
Estimated Quantity of Sealant:	29 STICKS	Do Not Paint:	
Seal Type:	CRUNCH TEETH	Revision Note:	ADDED STRONGBACKS FOR SEPARATION
Equipment Number:	2-MS-377		

QC FINAL INSPECTION REQUIRED

Nuclear - Safety Related
MTRs and COCs Required
PMI Required
Nuclear - Safety Related

SafetyFirst In Everything We Do

TEAM®

Registration # F-003143

MATERIAL SPECIFICATIONS

☐ Non-Critical/Nuclear ☒ Critical/Nuclear

Drawn By: KC/UMW Date: 11/24/19

Checked By: UMW/GVD/KC Date: 11/24/19

Engineering Order No.: 4211975 REV 1

Enclosures	Material Specification	MTR	COC	NR
PIPE				
FITTING				
ROLLED PLATE				
BLOCK / PLATE / SIDEBARS	**SA 516 GR 70**	**X**	**X**	
ENDPLATES				
STRONGBACK BARS	**SA 516 GR 70**	**X**	**X**	
S.B. EARS/FINGERS				
Fasteners				
STUDS ENCLOSURE	**SA 193 GR B7**	**X**	**X**	
STUDS STRONGBACK	**SA 193 GR B7**	**X**	**X**	
NUTS ENCLOSURE	**SA 194 GR 2H**	**X**	**X**	
NUTS STRONGBACK	**SA 194 GR 2H**	**X**	**X**	
SET SCREWS				
Misc.				
Material Requirements				

PMI Required	

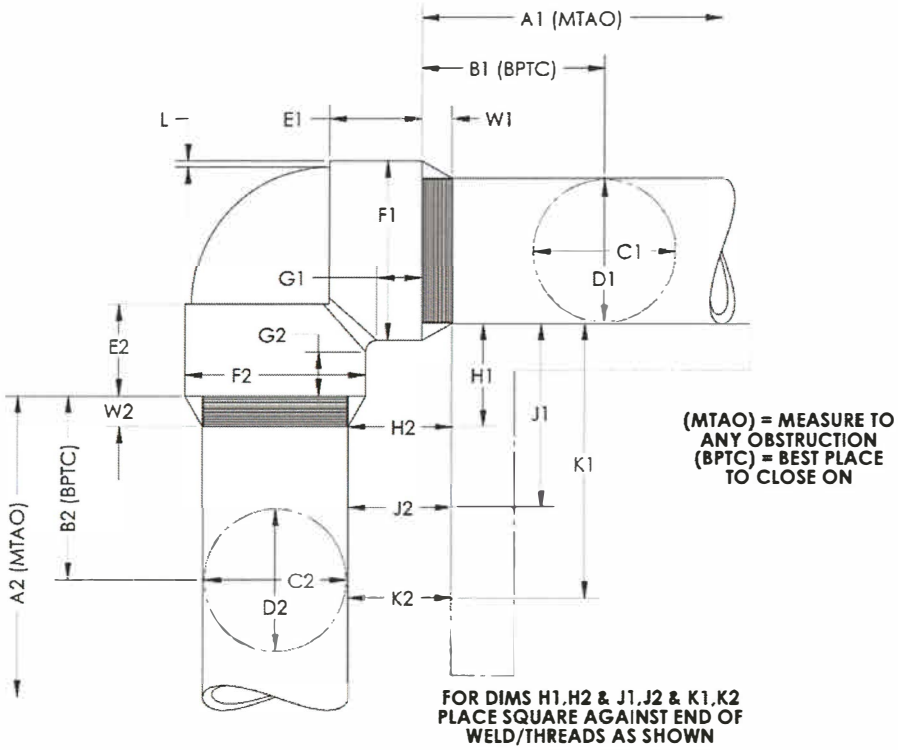
STATE OF TEXAS
GAURAV DESHPANDE
111366
LICENSED
PROFESSIONAL ENGINEER

TEAM®	Engineering Procedure Supplement Corporate	FORM 901.DS124 Rev: 3 Page 1 of 1

90° EII SCREWED/SOCKET FITTING

GIVEN BY:		DATE:	11/23/19	PLANT:	Surry	UNIT:	2
CHKD. BY:		DATE:	11/23/19	SURFACE CONDITION:	Good		
LINE SIZE:	1"	SEVERITY OF LEAK:		1ON 10	SHIP TO:	5570 Hog Island Rd. Surry, Va.	
TYPE SEAL: ☒ VOID FILL ☐ PERIMETER SEAL	☒ CRUNCH ☐ TONGUE ☒ OTHER: PEENING LIPS	☐ PACKING ☐ TUBING		SKIN TEMP.			
				LINE: 570	FLG.		

DIMENSIONAL DATA	
LTR.	DIM.
A1	17"
B1	1"
C1	1.315
D1	1.315
E1	1.300
F1	1.865
G1	.560
W1	.350
A2	17"
B2	1"
C2	1.315
D2	1.315
E2	.900
F2	1.865
G2	.400
W2	.350
H1	1"
H2	1"
J1	2"
J2	1"
K1	3"
K2	1"
L	.130



OBSTRUCTIONS
(Looking into C1/D1)

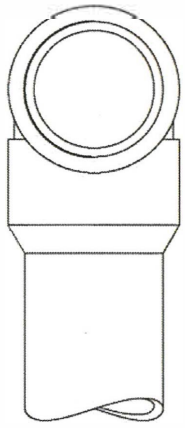
NOTE:
IF SQUARE CANNOT BE REPLACED AS SHOWN – "H1" & "H2" STILL MUST BE TAKEN AT WELDS/THREADS

3/8" UNC INJECTION PORTS REQUIRED

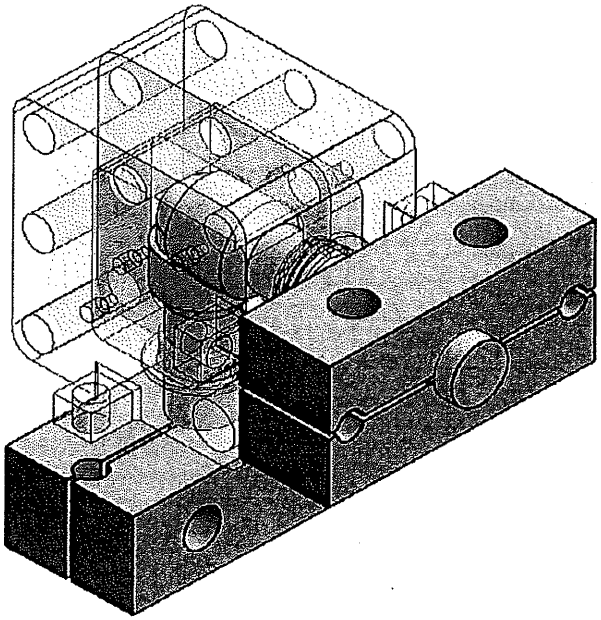
ASSUME SCH. 40/80 FOR CALCULATION

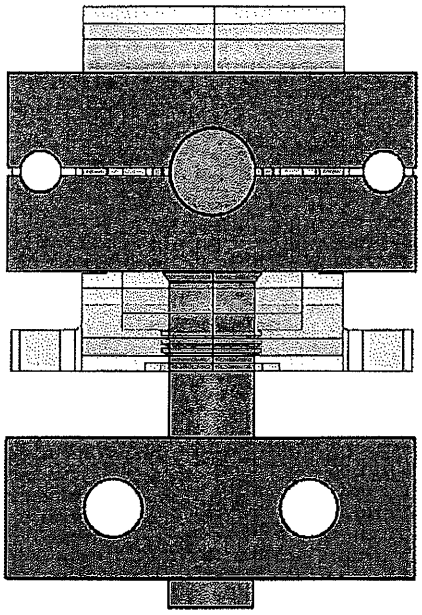
LOCATION OF BLOW: 12 W1
☐ THREADED
☒ WELDED

SEISMIC; KEEP WEIGHT DOWN TO A MINIMUM



Clamp





Clamp Details:
(2) Halves as shown
Nuclear Safety Related
Weight 56.6 lbs
Void Volume 24.6 in3
Overall Dimensions 5 ½" x 5 ½"

Summary of Calculations

Rectangular Plate Stress Calculations

Cover Plate

$Max_\sigma = 14453.93\ psi$ < $S_{allow} = 19580\ psi$

Design Margin = 1.35

Longer Side Wall (Worst Case)

$Max_\sigma = 5215.8\ psi$ < $S_{allow} = 19580\ psi$

Design Margin = 3.75

Shorter Side Wall (Worst Case)

$Max_\sigma = 12327.38\ psi$ < $S_{allow} = 19580\ psi$

Design Margin = 1.59

Bolting Calculations – 5/8" Stud

$SL = 15579.15\ lbf$ < $SH = 28250\ lbf$

Design Margin = 1.81

Bolting Calculations – 7/8" Stud

$SL = 9890.65\ lbf$ < $SH = 11542.5\ lbf$

Design Margin = 1.17

Buckling of Pipe Due to External Pressure

Circumferential Membrane stress

$\sigma_2 = -6.74 \cdot 10^3\ psi$ < $S_{pipe} = (1.71 \cdot 10^4)\ psi$

Design Margin = 2.54

Meridional Bending Stress

$\sigma_{1b} = 0.156\ psi$ < $S_{pipe} = (1.71 \cdot 10^4)\ psi$

Design Margin = 109685.65

Circumferential Bending Stress

$\sigma_{2b} = 0.047\ psi$ < $S_{pipe} = (1.71 \cdot 10^4)\ psi$

Design Margin 365618.84

Thrust Calculation Due to Separation

Thrust Produced 2492.169 *lbf*

Number of studs required

ND=0.703 < *NS*=2

Design Margin = 2.845

Bending Calculation: Ear
Force per Ear
Fs=1246.084 *lbf*
Thickness Required: Bending in Ears
tr=0.522 *in* < *W*=0.625 *in*
Design Margin = 1.197

Thrust and Bending Calculation: Crunch Ring
Force per Ear
Fs=1246.084 *lbf*
Thickness Required : Bending in Ears
tr=0.513 *in* < *W*=2.125 *in*
Design Margin = 4.144
Thickness Required: Bending in Diameter
tr=0.667 *in* < *W*=2.125 *in*
Design Margin=3.186

Enclosure 3

CALCULATION CEM-0231, REVISION 0, "EVALUATION OF LINE 1"-SHP-601 OFF 4"-SHP-127-601 FOR LEAK SEAL ENCLOSURE DEVICE," (EXCERPT) DATED 11/26/19

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Unit 2

Dominion Energy®

Complete Calculation

Complete the fields with text or an **X** as required.

Calculation Number:	Revision:	Addendum:	Sub type:	Decommissioning Record?
CEM-0231	0	N/A	000	☐ Yes ☒ No

Vendor (If not Dominion):
N/A

Contains Proprietary Information: ☐ Yes ☒ No

Proprietary Information Owner:

QA Program Owner: ☒ Dominion Energy ☐ Other: _____

Calculation Quality Class: ☒ Safety Related ☐ NSQ ☐ Non-Safety Related

Subject (Calculation Title):
Evaluation of Line 1" –SHP--601 off 4"-SHP-127-601 for Leak Seal Enclosure Device, Surry Unit 2

Addendum Title:
N/A

Station(s) and Unit(s):
NA ☐ 1 ☐ 2 ☐ ISFSI
SU ☐ 1 ☒ 2 ☐ ISFSI MP ☐ 1 ☐ 2 ☐ 3 ☐ ISFSI

Affected System(s), Structure(s), or Component(s):

AFW Pump Steam Supply Bypass
1"-SHP- - 601
4"-SHP-127-601
2-MS-377

Purpose (Executive Summary):

The purpose of the calculation is to document the acceptability of the seal enclosure device installed on the AFW Pump Steam Supply 1"-SHP--601 bypass line off of line 4"-SHP-127-601.

Originator (Qual. Required): Printed Name [1] [3]		Sig	Date: [1] [3] 11-26-19
Reviewer (Qual. Required): Printed Name [1]	Type of Review: [2] Independent	Signature:	Date: 11-26-19
Approver: Printed Name		Signature:	Date: 11-26-19

Note: Physical or electronic signatures are acceptable.

Note: (1) Add lines for additional originators or reviewers as necessary. (2) Note if reviews are "Independent," "Peer", "Subject Matter Expert", "Supervisor", or "Owner's". (3) Enter N/A for Owner's Review of Vendor Calculation

Calculation # CEM-0231 Rev. 0

Instructions: To update the Table of Contents page numbers, click within the Table of Contents to select the table, then select "**Print Preview**," (Click the **Office Button** at the upper left of the computer screen; then select "**Print**," and then "**Print Preview**") close "**Print Preview**." The page numbers should update.

Table of Contents

1. Record of Revisions and Addenda

Revision	Description
Revision 0	Original issue of this calculation dated November 2019. Issued to document acceptability of the seal enclosure device on the AFW Pump Steam Supply 1"-SHP- -601 bypass off of line 4"-SHP-127-601. This is to be a temporary condition until the flaw at the weld can be repaired at the next refueling outage.

2. Cumulative Effects Review

N/A

3. References

3.1 Code, ASA B31.1 "Standard Code for Power Piping", 1955 Edition including addenda thru Code Case N7 dated September 1962.

3.2 Code, ANSI / USAS B31.1.0 – 1967, "Power Piping"

3.3 Code, ANSI B31.7 – 1969 with addenda through 1970, "Nuclear Power Piping"

3.4 Calculation CE-0581 Rev. 0 Add. 00A, Pipe Stress Analysis of Problem 2746 of the Steam High Pressure System (DCP 84-80 Replacement of Control Valves).

3.5 Drawing 11548-MKS-131C1 Rev. 3, HP Steam to Aux. Feedwater Pump, 2-FW-T-2, Surry Power Station, Unit 2

3.6 Drawing 11548-CBM-064-5 Sheet 3, Rev. 2, ISI Classification Boundary Drawing Interval-5, Main Steam System, Surry Power Station Unit 2

3.7 Computer Code: "NUPIPE-II Version 3.0, Pipe Stress Analysis Software

3.8 Standard, DNES-SU-ME-0004, Rev. 0, Piping Class Design Standard

3.9 Calculation CEM-0232 Rev. 0, Evaluation of Degraded Socket Weld on 1" diameter Steam Supply Bypass Line with Through-Wall Leak for As-Found Flaw Characterization as Reported in Condition Report CR1136592

3.10 Standard DNES-SU-EM-0023, Rev. 0, Analysis of Safety Related Piping, Surry Power Station Units 1 & 2

3.11 Condition Report CR1136592, Through-wall leak identified upstream of 2-MS-377

3.12 Vendor Document 4211975-DPK-00002, TEAM Industrial Services Branch Work Order 140400181701, Engineering Order # 4211975 Rev. 2

3.13 Temporary Design Change, DC SU-19-00161 Rev.0

3.14 Drawing 11548-FM-064, Sheet 3 of 6, Revision 58

3.15 Dominion Index 4.1 Excalibur – A web based Document Storage Site located at http://index4/DBSSearch.aspx within Dominion's intranet site.

3.16 Navco Piping Datalog, Edition No. 11, 1984, National Valve and Manufacturing Co.

4. Computer Codes Used

- NUPIPE-II (Reference 3.7)

5. Identification of Computer Inputs and Outputs

Computer Code	Run ID	Run Date	Input File	Output File	Description
NUPIPE (Reference3.7)	19025464	25-Nov-2019	Corr_Seismic.inp	Corr_Seismic.out	**Correlation Run 1** – Correlation to CE-0581 Run AAAEPEM Dated 7-29-86 (Seismic Pipe Stress Run, TLoad =17) See Attachment I
NUPIPE (Reference3.7)	19121703	25-Nov-2019	Corr_DW.inp	Corr_DW.out	**Correlation Run 2** – Correlation to CE-0581 Run AAAEDCB Dated 8-11-86 (DW + TH Pipe Stress Run, TLoad =3) See Attachment J
NUPIPE (Reference3.7)	19263425	25-Nov-2019	DW_Seismic.inp	DW_Seismic.out	**Study Run 1 – Combine the Seismic and DW Runs into one Analysis** Deadweight, Thermal, Seismic Pipe Stress Analysis (TLoad = 3) of piping in correlation runs See Index 4 for the input and output files.
NUPIPE (Reference3.7)	19501858	25-Nov-2019	DW_Seismic_1Line.inp	DW_Seismic_1Line.out	**Study Run 2 - Results for use in Calculation CEM-0232 (Reference 3.9)** Deadweight, Thermal, Seismic Pipe Stress Analysis (TLoad = 3) with addition of the 1" Bypass line off of 4"-SHP-127-601 See Attachment H
NUPIPE (Reference3.7)	20404614	25-Nov-2019	DW_Seismic_1Line_Box.inp	DW_Seismic_1Line_Box.out	**Study Run 3 - To determine if support is required.** Deadweight, Thermal, Seismic Pipe Stress Analysis (TLoad = 3) with addition of the 1" Bypass line off of 4"-SHP-127-601 and a seal enclosure device See Index 4 for the input and output files.

Computer Code	Run ID	Run Date	Input File	Output File	Description
NUPIPE (Reference3.7)	20385315	25-Nov-2019	DW_Seismic_1Line_ Box_Sup.inp	DW_Seismic_1Line_ Box_Sup.out	**Study Run 4 –Results used for the evaluation in this calculation** Deadweight, Thermal, Seismic Pipe Stress Analysis (TLoad = 3) with addition of the 1" Bypass line off of 4"-SHP-127-601, seal enclosure device, and new support on 1" bypass line See Attachment G
NUPIPE (Reference3.7)	18153800	26-Nov-2019	DW_Seismic_1Line_ Box_Sup_Ins.inp	DW_Seismic_1Line_ Box_Sup_Ins.out	**Study Run 5 –Sensitivity Run for Insulation** Uses Study Run 4 with a change to the weight per foot for the 1" Bypass line as described in Assumptions/Comments Section. See Index 4 for the input and output files.
NUPIPE (Reference3.7)	11423936	26-Nov-2019	DW_Seismic_1Line_ Ins.inp	DW_Seismic_1Line_ Ins.out	**Study Run 6 –Sensitivity Run for Insulation** Uses Study Run 2 with a change to the weight per foot for the 1" Bypass line as described in Assumptions/Comments Section. See Index 4 for the input and output files.

6. Background

Condition Report CR1136592 (Reference 3.11) documents the discovery of a through-weld leak at a socket weld on the 1" diameter steam supply bypass line (labeled as 1"-SHP--601 on 11548-FM-064A, Sheet 3, Reference 3.14).

The following flaw characterization was provided by Surry Power Station and is documented in the IOD attached to Condition Report CR1136592:

> CR1136545 documented a measured 6dpm leak was found dripping from the insulation just upstream of 2-MS-377 (SG 1C AFW Pump Steam Supply Bypass). The leak target was 1-FW-MOV-160B (AFW Crosstie Isolation to Unit 1). NDE and System Engineering were tasked to investigate a potential through-wall leak on 1" main steam piping upstream of 2-MS-377 Unexplained water was identified in the general area and insulation was removed. A very small through-wall leak (characterized as a pinhole) was confirmed using a mirror and based on the sound of the leak. It is very difficult to see steam exiting the pinhole. The location appears to be at the fitting side weld toe at approximately 1:00 when looking upstream. The weld is a socket weld and is at a 90-degree fitting located two elbows upstream of 2-MS-377. This piping is shown on drawing 11548-CBM-064A-5 Sheet 3 of 6 and is located in the Main Steam Valve House 27' elevation approximately 12 feet off the floor. It is a 1" line that bypasses valve 2-MS-158. This 1" line is ASME Class 2 piping To summarize the flaw characterization, the flaw is located at or very near the fitting side weld toe at approximately 1:00 when looking upstream, is very small pinhole (1/32" or less) and is likely caused by a fabrication welding defect.
>
> An additional engineering walkdown confirmed no apparent leakage on the sister A and B trains. Minor low frequency movement of the 1" bypass line was observed.

Calculation CEM-0232 (Reference 3.9) evaluated the as-found weld flaw in the affected socket weld of the 1" SHP line to demonstrate that it would have remained structurally adequate for pressure thrust forces corresponding to the design pressure and for design basis loading conditions. Calculation CE-0232 was used to support the past operability of the line.

An integral leak seal enclosure / structural clamping device is to be installed to secure the leak until repairs of the line can be made. The qualification of the leak seal enclosure device is provided in Reference 3.12. This calculation evaluates the adequacy of the piping with the proposed leak seal enclosure device installed and also provides stresses, forces, and moments for the existing piping without the leak seal enclosure for use in Calculation CEM-0232 (Reference 3.9).

The analysis of the record for the piping associated with this 1" bypass line is CE-0581 (Reference 3.4). It should be noted that CE-0581 does not include the 1" bypass line. Thus, the analysis completed herein utilizes the stress analysis from CE-0581 and updates it to include the 1"-SHP- -601 line off of the 4"-SHP-127-601 line and the leak seal enclosure device.

Several NUPIPE runs were made in order to determine if the addition of the leak seal enclosure device would be acceptable and meet the piping code requirements. (Refer to Section 5 for a list of the NUPIPE input and output files used in this calculation.) Correlation runs were initially completed to ensure the results of the NUPIPE runs that were based on the runs of records in CE-0581 matched (refer to Assumptions/Comments Section). Since CE-0581 maintained separate runs of records for the Seismic case and the DW and Thermal case, a run was made to combine the two runs into one study run (Study Run 1) for use in this calculation. Study Run 2 was then made to add the 1" bypass line in question as the CE-0581 runs did not include this line. Study Run 3 was made to determine if a support would be required for the 1" bypass line with the leak seal enclosure device installed. Review of Study Run 3 indicated that the stresses exceed the code allowables (Reference 3.2), thus it was determined that a support would be required. Study Run 4 was made which includes the 1" bypass line, the weight of the leak seal enclosure and a vertical support on the 1" bypass line. The results documented in this calculation are based on Study Run 4. Note that both Study Runs 5 and 6 were made as sensitive runs for to determine impact of insulation on the 1"-SHP- -601 bypass line – refer to Assumptions / Comments Section for additional information.

7. Design Inputs

1. Existing NUPIPE Runs from Problem 2746, Calculation CE-0581 Rev. 0; in particular the Seismic Stress Run of Record, Run AAAEPEM, Dated 7-29-86 and the Deadweight and Thermal Stress Run of Record, Run AAAEDCB, Dated 8-11-86.
2. The leak seal enclosure device weighs 57 lbs. per Document 4211975-DPK-00002 which was provided by TEAM Industrial Services (Reference 3.12). Note that this pipe stress analyses made in this calculation conservatively uses a weight of 60 lbs. for the leak seal enclosure device.
3. As-built dimensions of the 1"-SHP - -601 bypass line off of line 4"-SHP-127-601 provided by Station Engineering (See Attachment B)

8. Assumptions / Comments

- The new support installed on the 1"-SHP- -601 bypass line off of line 4"-SHP-127-601 is modeled in the NUPIPE analysis (input file: DW_Seismic_1Line_Box_Sup.inp) at the mid-point (i.e., node point 6040) between the elbows at node points 6030 and 6060. In other words, the support is modeled 11.5" from the centerline of the elbow with the as-found weld flaw (node point 6030).
- Calculation CE-0581 Rev. 0 has an addendum (Addendum 00A) that reviews a proposed routing change to line 3"-SHP-129-601. The addendum did not re-analyze the piping. Given that the area of interest of this calculation was not near this re-routed piping, this change was not included in the NUPIPE analyses completed herein; however, as was previously documented in Add. 00A of CE-0581, the piping and support loads in the vicinity of the routing change for line 3"-SHP-129-601 will not significantly affect the structural integrity of the piping or the pipe supports.
- Insulation on the 1"-SHP- - 601 line was overlooked when the analysis was performed and thus it was not included as part of the weight of the 1" pipe. Based on the Navco Piping Datalog (Reference 3.16), the 1" line at 505 deg F should have 2" of insulation which would weigh 1.76 lbs/ft assuming calcium silicate insulation with a density of 11 lbs/cu.ft. Sensitivity runs were performed for comparison to Study Runs 2 and 4 to ensure that the added weight from the insulation would not adversely affect the results of the analyses used herein. Review of the sensitivity runs show that the resulting maximum stresses on the 1" line minimally increase. Therefore, the results of Study Runs 2 and 4 are still acceptable for use in both CEM-0232 and this calculation evaluation, respectively. (Note that the two sensitivity runs, Study Runs 5 and 6, are only provided in Index 4 as part of the source documents for this calculation.)
- The Correlations Runs 1 and 2 compared well to the results (both support reactions and stresses) documented on the microfiche for Calculation CE-0581 Rev. 0 Run of Records for the Seismic analysis (Run ID AAAEPEM, dated 7-29-86) and for the Deadweight and Thermal analysis (Run AAAEDCB, dated 8-11-86), respectively. Therefore, the NUPIPE Correlation Runs 1 and 2 are acceptable for use in this calculation.

9. Methodology

To determine acceptability of the leak seal enclosure device on the 1" line, pipe stress analyses are made and the stresses are compared to the code allowables as defined in Dominion Standard DNES-SU-EM-0023 which follows the requirements of ANSI B31.1-67 (References 3.10 and 3.2, respectively). The piping stresses are analyzed in NUPIPE-II (Reference 3.7).

The basic method of analysis used in NUPIPE-II is the finite element stiffness method. In accordance with this method, the continuous piping is mathematically idealized as an assembly of elastic structural members connecting discrete nodal points. Nodal points are placed in such a manner as to isolate particular types of piping elements, such as straight runs of pipe, elbows, valves etc., for which force-deformation characteristics can be categorized. Nodal points are also placed at all discontinuities; such as piping supports, concentrated weights, branch lines and changes in cross section. System loads, such as weights are applied at the nodal points. Stiffness characteristics of the interconnecting members are related to the effective shear area and moment of inertia of the pipe.

10. Calculations

The computer code, NUPIPE (Reference 3.7), is used to evaluate the piping system in this calculation. Thus, refer to the NUPIPE output file for Study Run 4 in Attachment G and for Study Run 2 in Attachment H.

The supports are compared in a table provided in Attachment E for the Support Load Comparison.
The temporary new support evaluation is provided in Attachment F.

11. Acceptance Criteria

1. PIPING CODE APPLICABILITY

The code of record for Surry Power Station Pressure Piping is ASA B31.1-1955 including addenda thru Code Case N7 dated September 1962. For the purpose of piping analysis, Power Piping Code USAS B31.1.0 - 1967 is used. The 1967 code meets or exceeds the requirements of the 1955 code.

2. PIPING SPECIFICATION

- DNES-SU-ME-0004 "Pipe Class Design Standard", (Reference 3.8).

12. Results

12.1 Review of Maximum Pipe Stress Summary of Entire Piping System Analyzed in Study Run 4

NUPIPE Input File: DW_Seismic_1Line_Box_Sup.inp
NUPIPE Run ID: 20385315
NUPIPE Run Date: 25-Nov-2019

Eqn.	Criteria	Node Point(s)	Maximum Calculated Stress (psi)	Allowable Stress (psi)
(1)	$S_{LP}+S_{DW}<S_H$	1325	2,830 + 3,311 = 6,141	15,000
(2)	$S_{lp} + (S_{dl} + S_{obei} * B + S_{obea}) < 1.2S_h$	400	2,830 + 13,232 = 16,062	18,000
(3)	$S_{lp} + (S_{dl} + S_{dbei} * B + S_{dbea}) < 1.8S_h$	260	2,376 + 19363 = 21,739	27,000
(4)	$S_{TH} < f*(1.25*S_C+0.25*S_H) = S_a$	100	24,244	22,500 *
(5)	$S_{LP}+S_{DW} + S_{TH} < S_h + S_a$	100	2,376 + 2,778 + 24,244 = 29,398	37,500
For Material A106 Grade B, S_h = 15,000 psi at T = 505 deg F. and S_c = 15,000 psi * Thermal stresses are acceptable based on satisfying Eqn (5).				

12.2 Review of Pipe Stress Summary of the 1"-SHP- -601 Bypass Line off of 4"-SHP-127-601 (Node Points 6000-6110 only) Analyzed in Study Run 4

NUPIPE Input File: DW_Seismic_1Line_Box_Sup.inp
NUPIPE Run ID: 20385315
NUPIPE Run Date: 25-Nov-2019

Eqn.	Criteria	Node Point(s)	Maximum Calculated Stress (psi)	Allowable Stress (psi)
(1)	$S_{LP}+S_{DW}<S_H$	6000	2,830 + 2,780 = 5,610	15,000
(2)	$S_{lp} + (S_{dl} + S_{obei} * B + S_{obea}) <1.2S_h$	6010	1,222 + 13,529 = 14,751	18,000
(3)	$S_{lp} + (S_{dl} + S_{dbei} * B + S_{dbea}) <1.8S_h$	6000	2,830 + 16155 = 18,985	27,000
(4)	$S_{TH} < f*(1.25*S_C+0.25*S_H)$	6110	7,669	22,500
For Material A106 Grade B, S_h = 15,000 psi at T = 505 deg F. and S_c = 15,000 psi				

12.3 Review of the Pipe Vertical Displacement on the 1"-SHP- - 601 Bypass Line off of 4"-SHP-127-601

The maximum vertical deadweight displacement is 0.026" at Node Point 6060 (from Study Run 4, NUPIPE Run ID: 20385315), which is less than the generally accepted value of 1/16" (0.0625") for vertical deadweight displacement. Therefore, the vertical deadweight displacement is acceptable for the 1"-SHP- - 601 bypass line with the leak seal enclosure device and the new support at node point 6040 installed.

12.4 Review of the Pipe Support Loads

The supports have been reviewed to determine if the support loads for each load case (i.e, Deadweight, Thermal, OBET, DBEI) have changed from the correlation runs (Correlation Runs 1 and 2) to the Study Run 4 of this calculation. Attachment E contains the Support Load Comparison table. Based on the load comparisons provided in the table, only the support at node point 1335 will require additional review. All other existing supports have minimal to no change from the existing analysis completed in the Run of Record Calculation CE-0581 Rev. 0 (Correlation Runs 1 and 2) to Study Run 4 of this calculation.

The support at node point 1335 is actually the location that line 4"-SHP-127-601 connects to line 30"-SHP-103-601. Thus, as long as the stresses on the piping at this location are acceptable then the "support" loads at this connection point are considered acceptable. Reviewing the stress at this point as shown in the following table indicates that all stresses at this location meet the code allowables. Therefore, this "support" location is considered acceptable without further review.

Eqn.	Criteria	Node Point	Maximum Calculated Stress from Study Run 4 (psi)	Allowable Stress (psi)
(1)	$S_{LP}+S_{DW}<S_H$	1335	2,830 + 1,602 = 4,432	15,000
(2)	$S_{lp} + (S_{dl} + S_{obei} * B + S_{obea}) < 1.2S_h$	1335	2,830 + 6,883 = 9,713	18,000
(3)	$S_{lp} + (S_{dl} + S_{dbei} * B + S_{dbea}) < 1.8S_h$	1335	2,830 + 9253 = 12,083	27,000
(4)	$S_{TH} < f*(1.25*S_C+0.25*S_H) = S_a$	1335	1,327	22,500
For Material A106 Grade B, S_h = 15,000 psi at T = 505 deg F. and S_c = 15,000 psi				

A new support is added at Node Point 6040 on the 1"-SHP- - 601 to support the 60 lb. leak seal enclosure device. Per Reference 3.13, this new support will be a temporary support. It is reviewed and analyzed in Attachment F. The new support will be installed per Design Change SU 19-00161 (Reference 3.13). Based on the review provided in Attachment F, the new support is acceptable for all design bases loading conditions.

Based on the results of the support reviews provided above and in Attachments E and F, the supports are acceptable for the loads calculated in Study Run 4 of this calculation.

13. Conclusions

Based on the review of the stresses for the analyzed piping system and in particular the 1"-SHP- -601 bypass line with the leak seal enclosure device, the piping meets the requirements of the ANSI B31.1 Power Piping Code provided that a vertical support is installed (at node point 6040, see Attachment C) downstream of the leak seal enclosure device. Refer to the design change (Reference 3.13) for the details on the installation of the new support.

14. Precautions and Limitations

The analysis in this calculation is only to determine acceptability of a temporary condition until the as-found weld flaw at the socket weld elbow connection (Node Point 6030) on the 1"-SHP- - 601 bypass line can be repaired at the next refueling outage. This analysis and its results bound the temporary piping configuration with the clamp installed. The analysis documented in Calculation CE-0581 Rev. 0 is considered to be the run of record for the permanent design configuration.

15. Calculation Review Checklist

See Attachment A.

16. Attachments

Attachment A – Calculation Review Checklist (1 page)
Attachment B - As-built Dimensions and Pictures from Station Engineering (3 pages)
Attachment C - Math Models (3 pages)
Attachment D – Support Load Summary Sheets for the Study Run 4 (22 pages)
Attachment E – Support Load Comparisons Table (3 Pages)
Attachment F – Evaluation of the New Support on the 1"-SHP- - 601 Bypass Line (7 pages)
Attachment G – NUPIPE Input and Output for Study Run 4 (1429 pages)
Attachment H – NUPIPE Input and Output for Study Run 2 (1402 pages)
Attachment I – NUPIPE Input and Output Files for the Correlation Run 1 (Seismic) (1229 pages)
Attachment J – NUPIPE Input and Output Files for the Correlation Run 2 (DW + TH) (102 pages)

Attachment A – Calculation Review Checklist

NOTE: If "Yes" is not answered, an explanation may be provided below. Reference may be made to explanations contained in the calculation or addendum.

Questions:		Yes	N/A
1.	Have the sources of design inputs been correctly selected and referenced in the calculation?	[X]	[ ]
2.	Are the sources of design inputs up-to-date and retrievable/attached to the calculation?	[X]	[ ]
3.	Where appropriate, have the other disciplines reviewed or provided the design inputs for which they are responsible?	[X]	[ ]
4.	Have design inputs been confirmed by analysis, test, measurement, field walkdown, or other pertinent means as appropriate for the configuration analyzed?	[X]	[ ]
5.	Have the bases for assumptions been adequately and clearly presented and are they bounded by the Station Design Basis?	[X]	[ ]
6.	Were appropriate calculation/analytic methods used and are outputs reasonable when compared to inputs?	[X]	[ ]
7.	Are computations technically accurate?	[X]	[ ]
8.	Has the calculation made appropriate allowances for instrument errors and calibration equipment errors?	[ ]	[X]
9.	Have those computer codes used in the analysis been referenced in the calculation?	[X]	[ ]
10.	Have all exceptions to station design basis criteria and regulatory requirements been identified and justified in accordance with NQA-1-1994?	[ ]	[X]
11.	Has the design authority/original preparer for this calculation been informed of its revision or addendum, if required?	[X]	[ ]
12.	Was the pre-job brief completed without any identified HU error precursors/compensating actions? (If HU error precursors/compensating actions were identified, then mark N/A and provide explanation/summary below or attach pre-job brief form to calculation.)	[X]	[ ]

Comments: (Attach additional pages if needed)

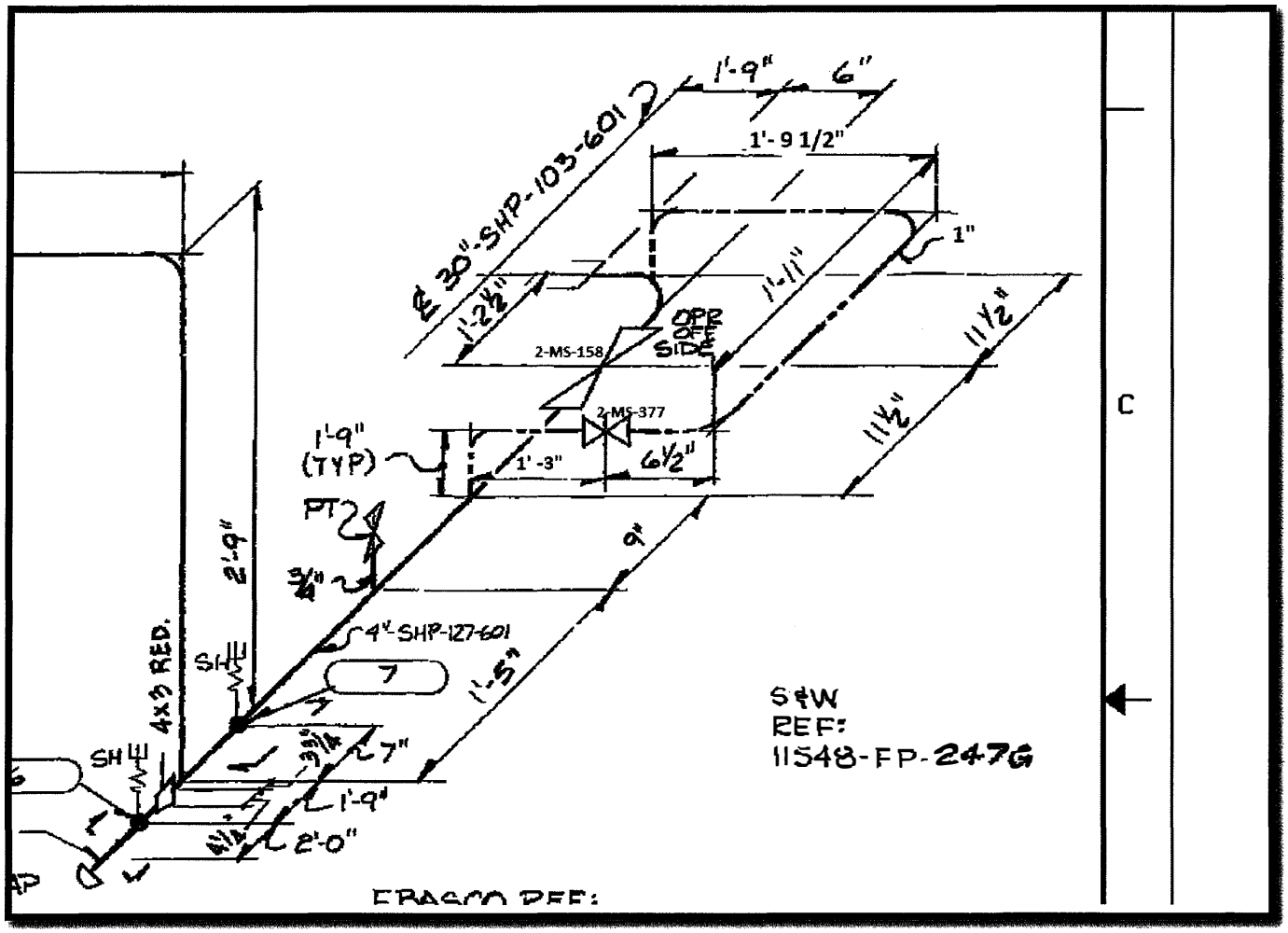
Signature: _____ (Reviewer) Date: 11-26-19

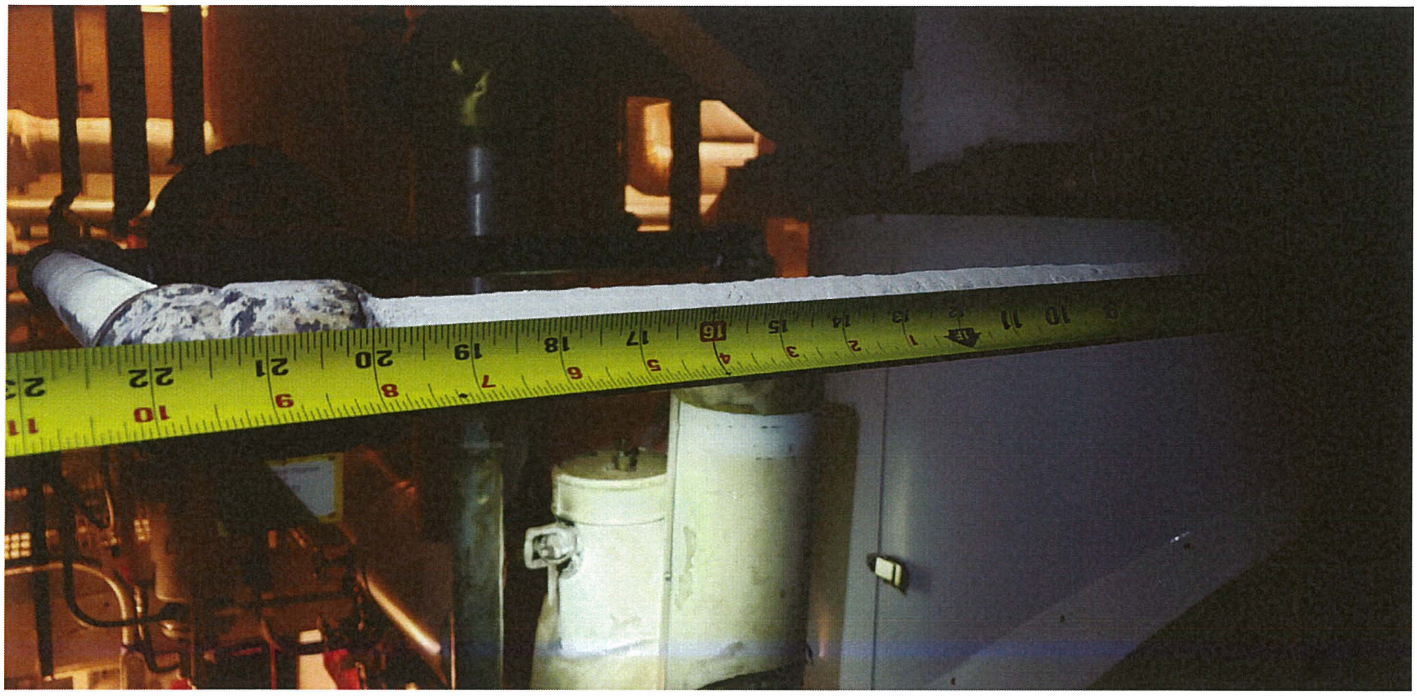
Signature: N/A (Owner's Review, if applicable) Date: _____

Note: Physical or electronic signatures are acceptable.

Attachment B - As-built Dimensions and Pictures of the 1" Bypass line from Station Engineering

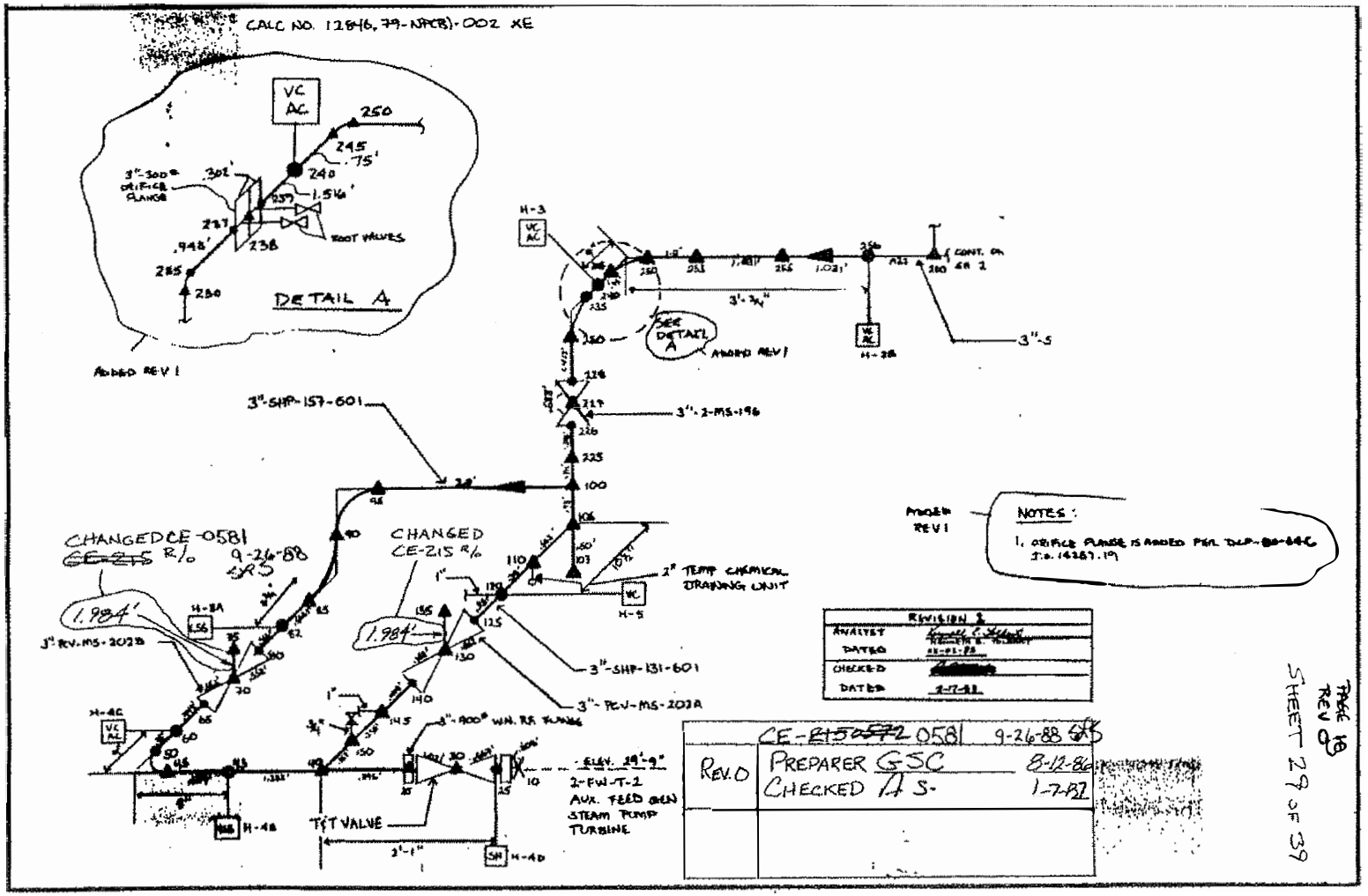
Section of Drawing 11548-MKS-131C1 Marked Up with Field Conditions

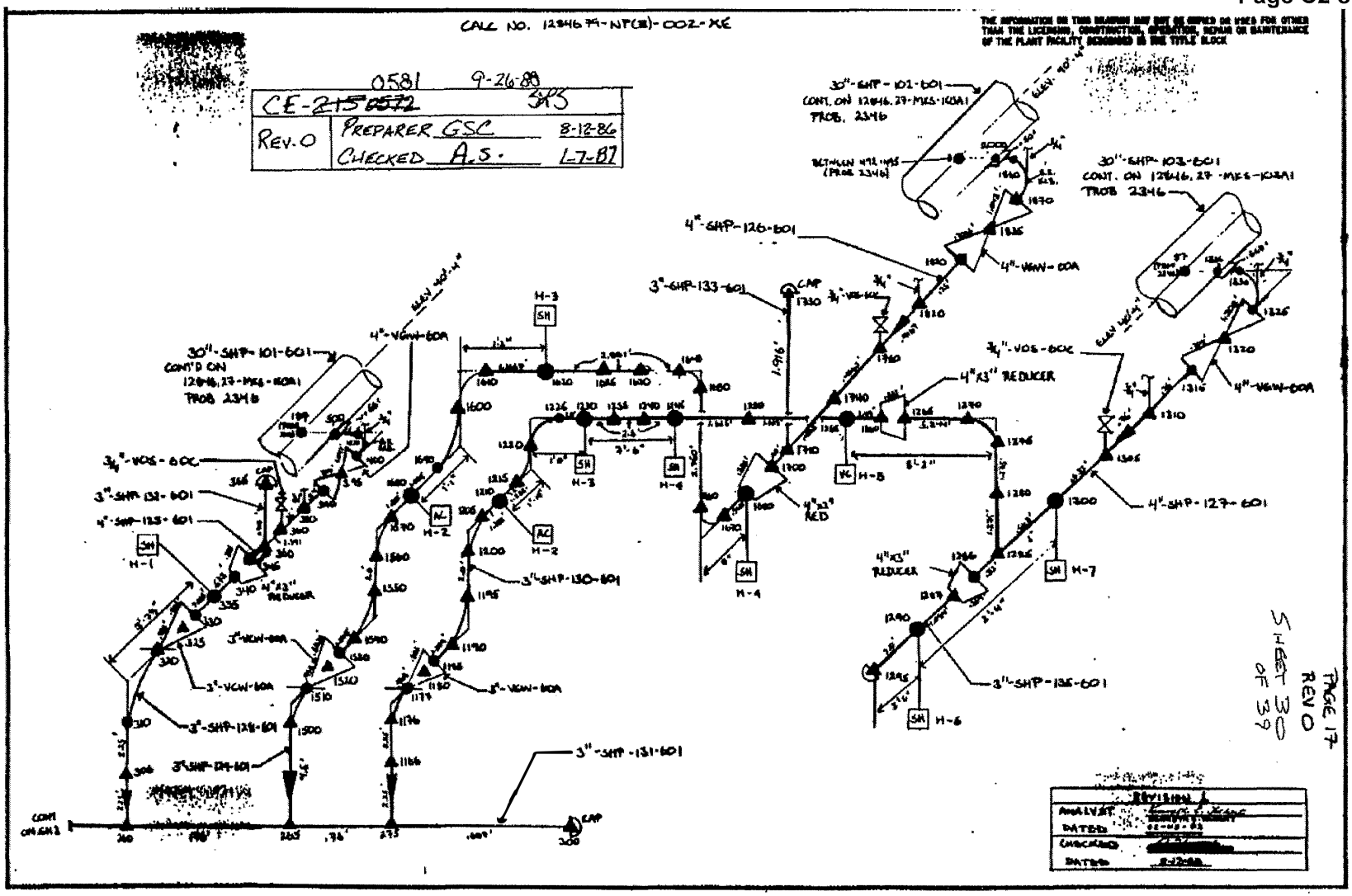




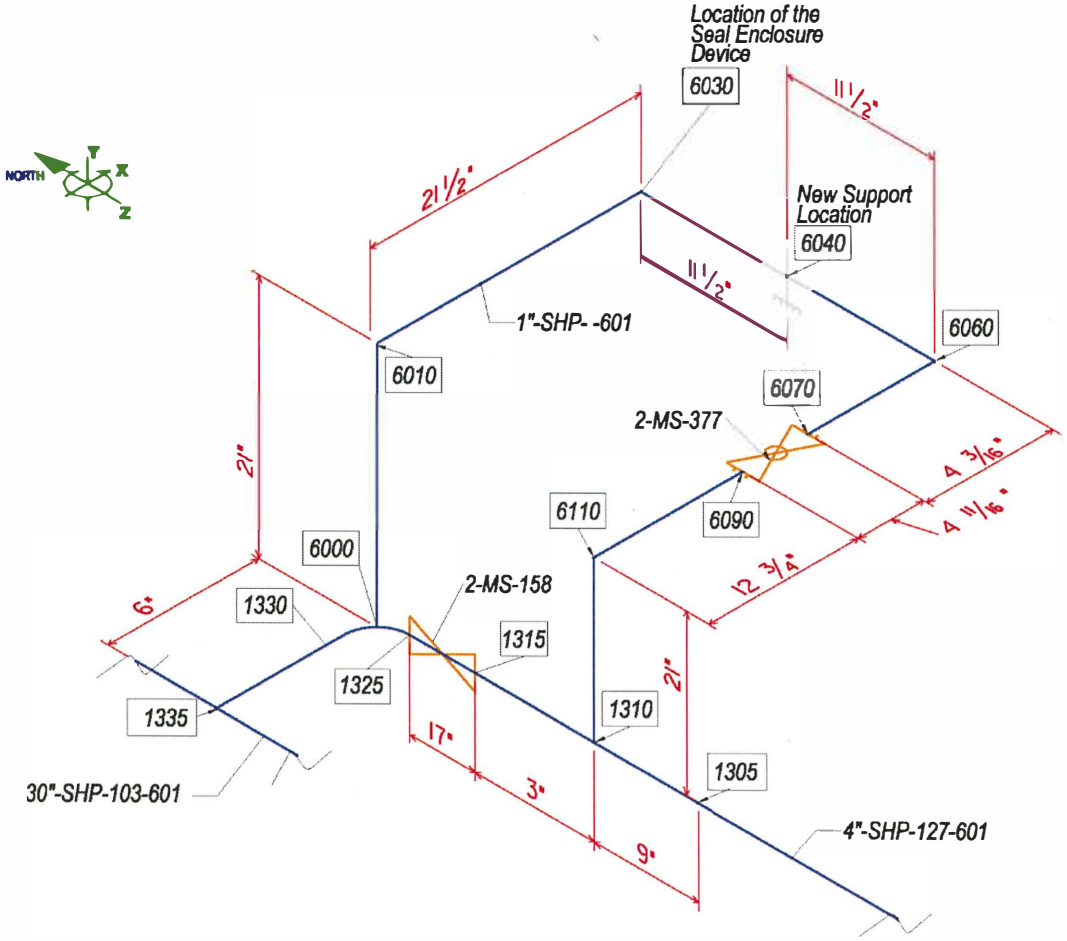
Attachment C – Math Models

Note the following Math Models shown on Pages C1 and C2 are from CE-0581 Rev. 0




CALC NO. 12846.29-NP(B)-002-XE
0581 9-26-88
CE-215 0572
REV. 0
PREPARER GSC 8-12-86
CHECKED A.S. 1-7-87
30"-SHP-101-601
CONT. ON 12846.29-MES-100A1
TROB. 2346
4"-SHP-126-601
3"-SHP-133-601
4"-VGW-60A
3/4"-VDS-60C
4"X3" REDUCER
30"-SHP-103-601
CONT. ON 12846.29-MES-100A1
TROB 2346
4"-SHP-127-601
3"-SHP-130-601
3"-SHP-131-601
3"-SHP-132-601
4"-SHP-125-601
3"-SHP-128-601
3"-SHP-129-601
3"-VGW-60A
H-1
H-2
H-3
H-4
H-5
H-6
H-7
SH
AC
CAP
SHEET 30 OF 39
PAGE 17
REV 0

The following Math Model is generated for this calculation to show the layout and node points of the 1"-SHP- - 601 Bypass Line off of the 4"-SHP-127-601. As shown the 1" line ties into the 4"-SHP-127-601 line at Node Points 1310 and 6000. See the math model on page C2 for additional details of the 4" line.



Attachment D – Support Load Summary Sheets for the Study Run 4

The following Support Load Summary Sheets are for Study Run 4 (Input File: DW_Seismic_1Line_Box_Sup.inp), which is the analysis that includes the Leak Seal Enclosure Device and the new support on the 1" bypass line.

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[5] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	115	118	83	286	1136	1680
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	209	140	153	295	2066	1962
5	DEADLOAD	31	228	51	-949	762	1506
6	THERMAL (+)NORMAL	0	0	279	0	2064	11260
7	THERMAL (-)NORMAL	-227	-320	0	-5389	0	0
8	DESIGN LOAD1	+ 146 - 311	+ 346 - 210	+ 413 - 32	+ 0 - 6624	+ 3962 - 374	+ 14446 - 174
9	DESIGN LOAD2	+ 31 - 196	+ 228 - 92	+ 330 - 0	+ 0 - 6338	+ 2826 - 0	+ 12766 - 0
10	DESIGN LOAD3	+ 240 - 178	+ 368 - 0	+ 204 - 102	+ 0 - 1244	+ 2828 - 1304	+ 3468 - 456
11	THERMAL MVMTS (Global-in.)	(Fx) + 0 - .058	(Fy) + .036 - 0	(Fz) + .045 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[25] SUPPORT TYPE: [ ]

COL		LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1		LARGEST POSITIVE	0	0	0	0	0	0
2	C O C	LARGEST NEGATIVE	0	0	0	0	0	0
3		EARTHQUAKE OBEI + OBEA (+ OR -)	0	1	0	0	0	0
4		EARTHQUAKE DBE (NOTE1) (+ OR -)	0	0	0	0	0	0
5		DEADLOAD	0	0	0	0	0	0
6	T H E R M	(+)NORMAL	0	4	0	0	0	0
7		(-)NORMAL	0	0	0	0	0	0
8		DESIGN LOAD1	+ 0 - 0	+ 5 - 1	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9		DESIGN LOAD2	+ 0 - 0	+ 4 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10		DESIGN LOAD3	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
11		THERMAL MVMTS (Global-in.)	(Fx) + 0 - .066	(Fy) + .036 - 0	(Fz) + .045 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[43] SUPPORT TYPE: [ ]

COL		LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1		LARGEST POSITIVE	0	0	0	0	0	0
2	OCC	LARGEST NEGATIVE	0	0	0	0	0	0
3		EARTHQUAKE OBEI + OBEA (+ OR -)	0	149	0	0	0	0
4		EARTHQUAKE DBE (NOTE1) (+ OR -)	0	146	0	0	0	0
5		DEADLOAD	0	0	0	0	0	0
6	THER	(+)NORMAL	0	0	0	0	0	0
7	M	(-)NORMAL	0	0	0	0	0	0
8		DESIGN LOAD1	+ 0 - 0	+ 149 - 149	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9		DESIGN LOAD2	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10		DESIGN LOAD3	+ 0 - 0	+ 146 - 146	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
			(Fx)	(Fy)	(Fz)			
11		THERMAL MVMTS (Global-in.)	+ 0 - .191	+ .016 - 0	+ .035 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[60] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	349	91	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	351	158	0	0	0
5	DEADLOAD	0	-453	-27	0	0	0
6	THERMAL (+)NORMAL	0	0	440	0	0	0
7	THERMAL (-)NORMAL	0	-385	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 0 - 1187	+ 504 - 118	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 0 - 838	+ 413 - 27	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 0 - 804	+ 131 - 185	+ 0 - 0	+ 0 - 0	+ 0 - 0

		(Fx)	(Fy)	(Fz)		
11	THERMAL MVMTS (Global-in.)	+ 0 - .212	+ 0 - .002	+ .002 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[82] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	131	0	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	146	0	0	0	0	0
5	DEADLOAD	0	0	0	0	0	0
6	THERMAL (+)NORMAL	0	0	0	0	0	0
7	THERMAL (-)NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 131 - 131	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 146 - 146	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0

		(Fx)	(Fy)	(Fz)		
11	THERMAL MVMTS (Global-in.)	+ 0 - .207	+ 0 - .04	+ 0 - .075	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[120] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	239	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	345	0	0	0	0
5	DEADLOAD	0	-941	0	0	0	0
6	THERMAL (+)NORMAL	0	0	0	0	0	0
7	THERMAL (-)NORMAL	0	-326	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 0 - 1506	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 0 - 1267	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 0 - 1286	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
11	THERMAL MVMTS (Global-in.)	(Fx) + 0 - .131	(Fy) + 0 - .002	(Fz) + 0 - .049	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET RUN ID. [20385315]
SURRY POWER STATION RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[240] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	551	303	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	512	126	0	0	0
5	DEADLOAD	0	155	-34	0	0	0
6	THERMAL (+)NORMAL	0	688	52	0	0	0
7	THERMAL (-)NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 1394 - 396	+ 321 - 337	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 843 - 0	+ 18 - 34	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 667 - 357	+ 92 - 160	+ 0 - 0	+ 0 - 0	+ 0 - 0
11	THERMAL MVMTS (Global-in.)	(Fx) + 0 - .185	(Fy) + .003 - 0	(Fz) + 0 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[256] SUPPORT TYPE: [ ]

COL		LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1		LARGEST						
	O	POSITIVE	0	0	0	0	0	0
	C							
2	C	LARGEST						
		NEGATIVE	0	0	0	0	0	0
3		EARTHQUAKE OBEI + OBEA (+ OR -)	474	580	0	0	0	0
4		EARTHQUAKE DBE (NOTE1) (+ OR -)	379	625	0	0	0	0
5		DEADLOAD	-78	-791	0	0	0	0
6	T	(+)NORMAL	0	0	0	0	0	0
	H							
	E							
	R							
7	M	(-)NORMAL	-52	-55	0	0	0	0
8		DESIGN LOAD1	+ 396 - 604	+ 0 - 1426	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9		DESIGN LOAD2	+ 0 - 130	+ 0 - 846	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10		DESIGN LOAD3	+ 301 - 457	+ 0 - 1416	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0

		(Fx)	(Fy)	(Fz)		
11	THERMAL MVMTS (Global-in.)	+ 0 - 0	+ 0 - 0	+ .367 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET RUN ID. [20385315]
SURRY POWER STATION RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[335] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	13	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	2	0	0	0	0
5	DEADLOAD	0	-1	0	0	0	0
6	THERMAL (+)NORMAL	0	23	0	0	0	0
7	THERMAL (-)NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 35 - 14	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 22 - 1	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 1 - 3	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
11	THERMAL MVMTS (Global-in.)	(Fx) + .059 - 0	(Fy) + .249 - 0	(Fz) + .666 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[500] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	212	285	592	21240	18018	5025
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	154	104	308	3372	7374	2982
5	DEADLOAD	13	-345	-44	2770	2095	-2818
6	THERMAL (+)NORMAL	0	305	0	0	0	3734
7	THERMAL (-)NORMAL	-32	0	-1125	-16127	-3174	0
8	DESIGN LOAD1	+ 225 - 231	+ 245 - 630	+ 548 - 1761	+ 24010 - 34597	+ 20113 - 19097	+ 5941 - 7843
9	DESIGN LOAD2	+ 13 - 19	+ 0 - 345	+ 0 - 1169	+ 2770 - 13357	+ 2095 - 1079	+ 916 - 2818
10	DESIGN LOAD3	+ 167 - 141	+ 0 - 449	+ 264 - 352	+ 6142 - 602	+ 9469 - 5279	+ 164 - 5800

		(Fx)	(Fy)	(Fz)		
11	THERMAL MVMTS (Global-in.)	+ .091 - 0	+ .15 - 0	+ .43 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1580] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	0	213	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	0	115	0	0	0
5	DEADLOAD	0	0	18	0	0	0
6	THERMAL (+)NORMAL	0	0	319	0	0	0
7	THERMAL (-)NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 0 - 0	+ 550 - 195	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 0 - 0	+ 337 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 0 - 0	+ 133 - 97	+ 0 - 0	+ 0 - 0	+ 0 - 0

		(Fx)	(Fy)	(Fz)		
11	THERMAL MVMTS (Global-in.)	+ 0 - .192	+ 0 - .016	+ .002 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET RUN ID. [20385315]
SURRY POWER STATION RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1620] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	15	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	9	0	0	0	0
5	DEADLOAD	0	1	0	0	0	0
6	THERMAL (+)NORMAL	0	0	0	0	0	0
7	THERMAL (-)NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 16 - 14	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 1 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 10 - 8	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0

		(Fx)	(Fy)	(Fz)		
11	THERMAL MVMTS (Global-in.)	+ 0 - .139	+ 0 - .006	+ 0 - .013	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1680] SUPPORT TYPE: [ ]

COL		LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1		LARGEST POSITIVE	0	0	0	0	0	0
2	O C C	LARGEST NEGATIVE	0	0	0	0	0	0
3		EARTHQUAKE OBEI + OBEA (+ OR -)	0	23	0	0	0	0
4		EARTHQUAKE DBE (NOTE1) (+ OR -)	0	3	0	0	0	0
5		DEADLOAD	0	-1	0	0	0	0
6	T H E R M	(+)NORMAL	0	14	0	0	0	0
7		(-)NORMAL	0	0	0	0	0	0
8		DESIGN LOAD1	+ 0 - 0	+ 36 - 24	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9		DESIGN LOAD2	+ 0 - 0	+ 13 - 1	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10		DESIGN LOAD3	+ 0 - 0	+ 2 - 4	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
11		THERMAL MVMTS (Global-in.)	(Fx) + .18 - 0	(Fy) + .147 - 0	(Fz) + .554 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[2000] SUPPORT TYPE: [ ]

COL		LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1		LARGEST POSITIVE	0	0	0	0	0	0
2	C O C	LARGEST NEGATIVE	0	0	0	0	0	0
3		EARTHQUAKE OBEI + OBEA (+ OR -)	271	138	128	7769	11679	6480
4		EARTHQUAKE DBE (NOTE1) (+ OR -)	329	160	156	6516	13921	5931
5		DEADLOAD	19	-298	-13	2116	853	-1923
6	T H E R M	(+) NORMAL	117	0	0	0	365	0
7		(-) NORMAL	0	-15	-87	-3988	0	-463
8		DESIGN LOAD1	+ 407 - 252	+ 0 - 451	+ 115 - 228	+ 9885 - 9641	+ 12897 - 10826	+ 4557 - 8866
9		DESIGN LOAD2	+ 136 - 0	+ 0 - 313	+ 0 - 100	+ 2116 - 1872	+ 1218 - 0	+ 0 - 2386
10		DESIGN LOAD3	+ 348 - 310	+ 0 - 458	+ 143 - 169	+ 8632 - 4400	+ 14774 - 13068	+ 4008 - 7854
			(Fx)	(Fy)	(Fz)			
11		THERMAL MVMTS (Global-in.)	+ .114 - 0	+ .148 - 0	+ .405 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1210] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	0	233	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	0	188	0	0	0
5	DEADLOAD	0	0	53	0	0	0
6	THERMAL (+)NORMAL	0	0	181	0	0	0
7	THERMAL (-)NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 0 - 0	+ 467 - 180	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 0 - 0	+ 234 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 0 - 0	+ 241 - 135	+ 0 - 0	+ 0 - 0	+ 0 - 0
		(Fx)	(Fy)	(Fz)			
11	THERMAL MVMTS (Global-in.)	+ 0 - .464	+ 0 - .025	+ .001 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1230] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	25	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	18	0	0	0	0
5	DEADLOAD	0	6	0	0	0	0
6	THERMAL (+)NORMAL	0	0	0	0	0	0
7	THERMAL (-)NORMAL	0	-12	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 31 - 31	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 6 - 6	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 24 - 12	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
		(Fx)	(Fy)	(Fz)			
11	THERMAL MVMTS (Global-in.)	+ 0 - .471	+ 0 - .13	+ 0 - .107	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1245] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR −)	0	5	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR −)	0	4	0	0	0	0
5	DEADLOAD	0	1	0	0	0	0
6	THERMAL (+)NORMAL	0	0	0	0	0	0
7	THERMAL (−)NORMAL	0	−2	0	0	0	0
8	DESIGN LOAD1	+ 0 − 0	+ 6 − 6	+ 0 − 0	+ 0 − 0	+ 0 − 0	+ 0 − 0
9	DESIGN LOAD2	+ 0 − 0	+ 1 − 1	+ 0 − 0	+ 0 − 0	+ 0 − 0	+ 0 − 0
10	DESIGN LOAD3	+ 0 − 0	+ 5 − 3	+ 0 − 0	+ 0 − 0	+ 0 − 0	+ 0 − 0
		(Fx)	(Fy)	(Fz)			
11	THERMAL MVMTS (Global-in.)	+ 0 − .196	+ 0 − .038	+ .203 − 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1255] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	206	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	107	0	0	0	0
5	DEADLOAD	0	20	0	0	0	0
6	THERMAL (+) NORMAL	0	214	0	0	0	0
7	THERMAL (-) NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 440 - 186	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 234 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 127 - 87	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0

	(Fx)	(Fy)	(Fz)		
11 THERMAL MVMTS (Global-in.)	+ 0 - .077	+ .001 - 0	+ .354 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET RUN ID. [20385315]
SURRY POWER STATION RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1290] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	34	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	13	0	0	0	0
5	DEADLOAD	0	9	0	0	0	0
6	THERMAL (+) NORMAL	0	11	0	0	0	0
7	THERMAL (-) NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 54 - 25	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 20 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 22 - 4	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0

		(Fx)	(Fy)	(Fz)		
11	THERMAL MVMTS (Global-in.)	+ .249 - 0	+ .086 - 0	+ .626 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1300] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	31	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	6	0	0	0	0
5	DEADLOAD	0	5	0	0	0	0
6	THERMAL (+)NORMAL	0	13	0	0	0	0
7	THERMAL (-)NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 49 - 26	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 18 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 11 - 1	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
11	THERMAL MVMTS (Global-in.)	(Fx) + .231 - 0	(Fy) + .106 - 0	(Fz) + .541 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[1335] SUPPORT TYPE: [ ]

COL		LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	O C	LARGEST POSITIVE	0	0	0	0	0	0
2	C	LARGEST NEGATIVE	0	0	0	0	0	0
3		EARTHQUAKE OBEI + OBEA (+ OR -)	372	346	176	15843	16993	5915
4		EARTHQUAKE DBE (NOTE1) (+ OR -)	505	162	272	10662	21763	6211
5		DEADLOAD	15	-174	-5	-6791	626	-535
6	T H E R M	(+)NORMAL	194	0	0	4670	2276	0
7		(-)NORMAL	0	-243	-58	0	0	-2272
8		DESIGN LOAD1	+ 581 - 357	+ 172 - 763	+ 171 - 239	+ 13722 - 22634	+ 19895 - 16367	+ 5380 - 8722
9		DESIGN LOAD2	+ 209 - 0	+ 0 - 417	+ 0 - 63	+ 0 - 6791	+ 2902 - 0	+ 0 - 2807
10		DESIGN LOAD3	+ 520 - 490	+ 0 - 336	+ 267 - 277	+ 3871 - 17453	+ 22389 - 21137	+ 5676 - 6746
			(Fx)	(Fy)	(Fz)			
11		THERMAL MVMTS (Global-in.)	+ .147 - 0	+ .146 - 0	+ .417 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[6040] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	122	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	33	0	0	0	0
5	DEADLOAD	0	-68	0	0	0	0
6	THERMAL (+) NORMAL	0	87	0	0	0	0
7	THERMAL (-) NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 141 - 190	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 19 - 68	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 0 - 101	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
		(Fx)	(Fy)	(Fz)			
11	THERMAL MVMTS (Global-in.)	+ .329 - 0	+ 0 - 0	+ .434 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South	

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

Attachment E – Support Load Comparison Table

NODE	LOAD TYPE	DIRECTION		Deadweight Case			Thermal Case			OBET x Bump			DBEI x Bump			Comments
				Correlation Run 1 (DW+TH Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 1 (DW+TH Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 2 (Seismic Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 2 (Seismic Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	
				lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		
5	FORCE	X	COORD	-31	-31	1.00	227	227	1.00	116	115	0.99	210	209	1.00	Minimal changes to loads, further review not required.
5	FORCE	Y	COORD	-228	-228	1.00	320	320	1.00	119	118	0.99	141	140	0.99	Minimal changes to loads, further review not required.
5	FORCE	Z	COORD	-51	-51	1.00	-279	-279	1.00	83	83	1.00	153	153	1.00	Minimal changes to loads, further review not required.
5	MOMENT	X	COORD	949	949	1.00	5389	5389	1.00	286	286	1.00	290	295	1.02	Minimal changes to loads, further review not required.
5	MOMENT	Y	COORD	-762	-762	1.00	-2062	-2064	1.00	1134	1136	1.00	2061	2066	1.00	Minimal changes to loads, further review not required.
5	MOMENT	Z	COORD	-1507	-1506	1.00	-11259	-11260	1.00	1692	1680	0.99	1968	1962	1.00	Minimal changes to loads, further review not required.
25	FORCE	Y	COORD	0	0	1.00	-4	-4	1.00	0	1	Existing = 0, Review	0	0	1.00	Minimal changes to loads, further review not required.
43	FORCE	Y	COORD	Snubber			Snubber			149	149	1.00	144	146	1.01	Minimal changes to loads, further review not required.
60	FORCE	Y	COORD	453	453	1.00	386	385	1.00	350	349	1.00	348	351	1.01	Minimal changes to loads, further review not required.
60	FORCE	Z	COORD	27	27	1.00	-440	-440	1.00	91	91	1.00	156	158	1.01	Minimal changes to loads, further review not required.
82	FORCE	X	COORD	Snubber			Snubber			132	131	0.99	145	146	1.01	Minimal changes to loads, further review not required.
120	FORCE	Y	COORD	941	941	1.00	326	326	1.00	239	239	1.00	344	345	1.00	No changes to the support loads, further review not required.
240	FORCE	Y	COORD	-155	-155	1.00	-686	-688	1.00	561	551	0.98	530	512	0.97	Minimal changes to loads, further review not required.
240	FORCE	Z	COORD	34	34	1.00	-53	-52	0.98	305	303	0.99	126	126	1.00	Minimal changes to loads, further review not required.
256	FORCE	X	COORD	78	78	1.00	53	52	0.98	482	474	0.98	394	379	0.96	Minimal changes to loads, further review not required.
256	FORCE	Y	COORD	791	791	1.00	54	55	1.02	607	580	0.96	651	625	0.96	Minimal changes to loads, further review not required.
335	FORCE	Y	COORD	1	1	1.00	-23	-23	1.00	0	13	Existing = 0, Review	0	2	Existing = 0, Review	Loads are minimal (only 13 lbf), further review not required.)

NODE	LOAD TYPE	DIRECTION		Deadweight Case			Thermal Case			OBET x Bump			DBE! x Bump			Comments
				Correlation Run 1 (DW+TH Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 1 (DW+TH Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 2 (Seismic Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 2 (Seismic Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	
				lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		
500	FORCE	X	COORD	-13	-13	1.00	32	32	1.00	213	212	1.00	156	154	0.99	Minimal changes to loads, further review not required.
500	FORCE	Y	COORD	345	345	1.00	-305	-305	1.00	278	285	1.03	101	104	1.03	Minimal changes to loads, further review not required.
500	FORCE	Z	COORD	45	44	0.98	1124	1125	1.00	580	592	1.02	304	308	1.01	Minimal changes to loads, further review not required.
500	MOMENT	X	COORD	-2765	-2770	1.00	16125	16127	1.00	21251	21240	1.00	3605	3372	0.94	Minimal changes to loads, further review not required.
500	MOMENT	Y	COORD	-2095	-2095	1.00	3198	3174	0.99	18184	18018	0.99	7634	7374	0.97	Minimal changes to loads, further review not required.
500	MOMENT	Z	COORD	2818	2818	1.00	-3741	-3734	1.00	5002	5025	1.00	2919	2982	1.02	Minimal changes to loads, further review not required.
1580	FORCE	Z	COORD	-18	-18	1.00	-319	-319	1.00	213	213	1.00	120	115	0.96	Minimal changes to loads, further review not required.
1620	FORCE	Y	COORD	-1	-1	1.00	0	0	1.00	0	15	Existing = 0, Review	0	9	Existing = 0, Review	Loads are minimal (under 25 lbf) further review not required.
1680	FORCE	Y	COORD	1	1	1.00	-14	-14	1.00	0	23	Existing = 0, Review	0	3	Existing = 0, Review	Loads are minimal (under 25 lbf) further review not required.
2000	FORCE	X	COORD	-19	-19	1.00	-116	-117	1.01	277	271	0.98	338	329	0.97	Minimal changes to loads, further review not required.
2000	FORCE	Y	COORD	298	298	1.00	15	15	1.00	123	138	1.12	160	160	1.00	Load increase is minimal (only 15 lbf), further review not required.
2000	FORCE	Z	COORD	13	13	1.00	87	87	1.00	128	128	1.00	155	156	1.01	Minimal changes to loads, further review not required.
2000	MOMENT	X	COORD	-2116	-2116	1.00	3988	3988	1.00	7066	7769	1.10	6560	6516	0.99	Minimal changes to loads, further review not required.
2000	MOMENT	Y	COORD	-851	-853	1.00	-345	-365	1.06	11918	11679	0.98	14325	13921	0.97	Minimal changes to loads, further review not required.
2000	MOMENT	Z	COORD	1924	1923	1.00	454	463	1.02	6727	6480	0.96	6113	5931	0.97	Minimal changes to loads, further review not required.
1210	FORCE	Z	COORD	-53	-53	1.00	-180	-181	1.01	229	233	1.02	192	188	0.98	Minimal changes to loads, further review not required.
1230	FORCE	Y	COORD	-7	-6	0.86	12	12	1.00	0	25	Existing = 0, Review	0	18	Existing = 0, Review	Load increase is minimal (upto 25 lbf), further review not required.
1245	FORCE	Y	COORD	-1	-1	1.00	2	2	1.00	0	5	Existing = 0, Review	0	4	Existing = 0, Review	Load increase is minimal (upto 5 lbf), further review not required.

NODE	LOAD TYPE	DIRECTION		Deadweight Case			Thermal Case			OBET x Bump			DBEI x Bump			Comments
				Correlation Run 1 (DW+TH Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 1 (DW+TH Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 2 (Seismic Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	Correlation Run 2 (Seismic Analysis) - Existing Loads	Study Run 4: Revised Loads	Ratio Revised to Existing	
				lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		lbf or in-lbf	lbf or in-lbf		
1255	FORCE	Y	COORD	-18	-20	1.11	-215	-214	1.00	213	206	0.97	109	107	0.98	Load increase is minimal (only 2 lbf), further review not required.
1290	FORCE	Y	COORD	-8	-9	1.13	-12	-11	0.92	0	34	Existing = 0, Review	0	13	Existing = 0, Review	Load increase is minimal (only 1 lbf), further review not required.
1300	FORCE	Y	COORD	-4	-5	1.25	-14	-13	0.93	0	31	Existing = 0, Review	0	6	Existing = 0, Review	Load increase is minimal (only 1 lbf), further review not required.
1335	FORCE	X	COORD	-15	-15	1.00	-196	-194	0.99	366	372	1.02	496	505	1.02	Minimal changes to loads, further review not required.
1335	FORCE	Y	COORD	144	174	1.21	158	243	1.54	202	346	1.71	170	162	0.95	Further Review Required - Refer to Section 12.4 for Review
1335	FORCE	Z	COORD	5	5	1.00	59	58	0.98	148	176	1.19	225	272	1.21	Further Review Required - Refer to Section 12.4 for Review
1335	MOMENT	X	COORD	6598	6791	1.03	-3776	-4670	1.24	12290	15843	1.29	10975	10662	0.97	Further Review Required - Refer to Section 12.4 for Review
1335	MOMENT	Y	COORD	-618	-626	1.01	-2347	-2276	0.97	16689	16993	1.02	21200	21763	1.03	Minimal changes to load cases, further review not required.
1335	MOMENT	Z	COORD	-112	535	4.78	-513	2272	4.43	8625	5915	0.69	6380	6211	0.97	Further Review Required - Refer to Section 12.4 for Review

Prepared By: [redacted] per telecom Date:11/26/19

Reviewed By: [redacted] Date:11/26/19

The temporary pipe support is evaluated in this attachment using the following:
DNES-VA-EM-0024
DNES-VA-EM-0019
DNES-VA-EM-0018
AISC Allowable Stress Design, 9th Edition
GTSTRUDL Baseplate Wizard

See Attachment 1 to DC SU-19-00161, Pipe Support Design Drawing

Design Loads from Stress Model (Stress Point 6040):

$F_{Y\_up} := 141lb$ $F_{Y\_down} := -190lb$ $F_{Y\_Dead} := 68lb$

Angle Iron Properties, 4x4x1/4: $F_{friction} := 0.3 \cdot F_{Y\_Dead} = 20.4lb$

$wt_{angle} := 6.6\frac{lb}{ft}$ $length_{angle} := 39in$

$Wt_{angle} := -wt_{angle} \cdot length_{angle} = -21.45lb$

Forces and Moments for Baseplate and Anchor Bolt Assessment:

$M_X := Wt_{angle} \cdot \frac{length_{angle}}{2} + F_{Y\_down} \cdot length_{angle} = -7828in \cdot lb$ $F_Y := F_{Y\_down} = -190lb$

$M_Y := F_{friction} \cdot length_{angle} = 796in \cdot lb$ $F_X := F_{friction} = 20.4lb$

$M_Z := 0in \cdot lb$ (No significant torsion on angle section) $F_Z := F_X = 20.4lb$

Check Stresses in Angle Section:

$S_{angle} := 1.05in^3$ $A_{angle} := 1.94in^2$

$F_{shear} := \sqrt{F_Y^2 + F_Z^2} = 191lb$ $\tau_{shear} := \frac{F_{shear}}{A_{angle}} = 99\frac{lb}{in^2}$ OKAY, Negligible

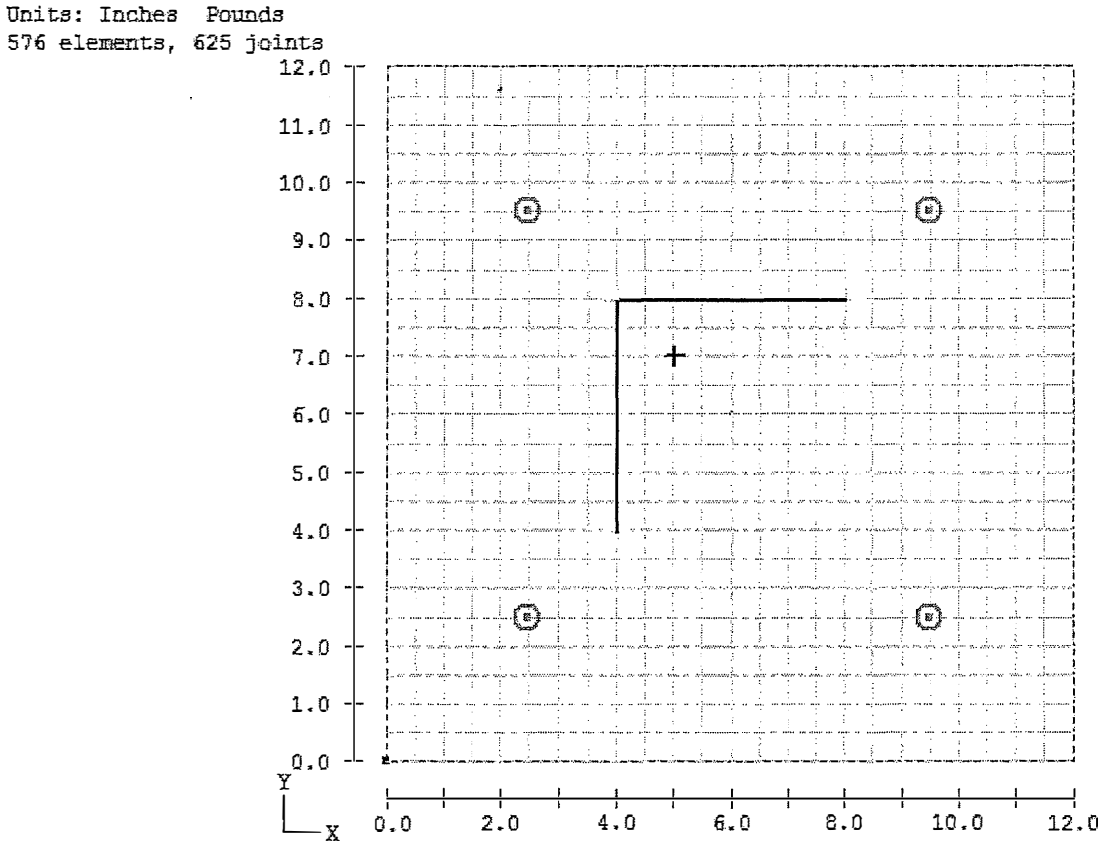
$\sigma_{bending} := \frac{1.25\sqrt{M_X^2 + M_Y^2}}{S_{angle}} = 9367\frac{lb}{in^2} < 0.6 \cdot 36000\frac{lb}{in^2} = 21600\frac{lb}{in^2}$

Bending moments increased by factor of 1.25 per AISC, Section C5.2.2, Design of Single Angle Members. This factor accounts for lateral torsional buckling

The support is intended to be a vertical restraint only. There is approximately 0.7" displacement from seismic event in the X direction. The thermal movements are 0.329" in the X direction. The gap on either side (if centered initially) is the following:

$gap := \frac{4in - 1.315in}{2} = 1.343in$

$actual\_movement := 0.7in + 0.329in = 1.029in$ Therefore, adequate spacing exists.



Baseplate Wizard Model

Input File: tempsupportBP.GTBP

```
GTSTRUDL Base Plate save file, version 1.1
$ This is NOT a GTSTRUDL input file,
$ and can only be processed by the Base Plate Wizard.

$ Generated by Base Plate Wizard version 2017
$ at 13:59:46  November 26, 2019.

$ ---- Plate data ----------------------------------------
  10 12.000000 12.000000 0.500000 0.500000 1 1 1
  80 1  28000000.0 0.290000 27000.0

$ ---- Job ID + description ------------------------------
  13 'GT_BPW' 'Base plate model from GTSTRUDL Base Plate Wizard'

$ ---- Attachments: 1 attachments specified ---------------
 100 1 0 1 -1.0000 1.0000 0.0000 0.0000 90.0000 0.0000
```

```
 110 1 6 0 L4x4x1/4 ANGLES 4.0000 4.0000 0.2500 0.0000 0.0000 0.0000

$ ---- Anchors: 4 anchors specified ---------------
 200 2 2.5000 2.5000 0.5000 0.0000 0.0000 1 1 1 0
 220 1 240000.0000 0 0.0000 0.0000
 230 1 0 150000.0000 0 0.0000
 240 1 1160.0000 0.0000 0.0000 0.0000 1.0000 1500.0000 0.0000 1.0000 1.0000
 200 2 9.5000 2.5000 0.5000 0.0000 0.0000 2 2 2 0
 220 2 240000.0000 0 0.0000 0.0000
 230 2 0 150000.0000 0 0.0000
 240 2 1160.0000 0.0000 0.0000 0.0000 1.0000 1500.0000 0.0000 1.0000 1.0000
 200 2 9.5000 9.5000 0.5000 0.0000 0.0000 3 3 3 0
 220 3 240000.0000 0 0.0000 0.0000
 230 3 0 150000.0000 0 0.0000
 240 3 1160.0000 0.0000 0.0000 0.0000 1.0000 1500.0000 0.0000 1.0000 1.0000
 200 2 2.5000 9.5000 0.5000 0.0000 0.0000 4 4 4 0
 220 4 240000.0000 0 0.0000 0.0000
 230 4 0 150000.0000 0 0.0000
 240 4 1160.0000 0.0000 0.0000 0.0000 1.0000 1500.0000 0.0000 1.0000 1.0000

$ ---- Bearing surface ---------------
$ User specified concrete Fcp of 4.000 ksi
 600 4.000 0.000 0.000000 0.000 0.0000 0.0

$ ---- Load Cases ---------------
 700 0 1 '1'

$ ---- Load values ---------------
 701 0 1 20.000 -190.000 20.000 7828.000 796.000 0.000
```

Results File: tempsupportBP.txt

```
=====================================================================
GTSTRUDL Base Plate Wizard 2017 Results Summary
          Job ID: GT_BPW
  Job Description: Base plate model from GTSTRUDL Base Plate Wizard

  PASSED: Anchors, Plate Stress
=====================================================================
  Input file: \\inbfscdata4\data4_3\nuclear engineering documents\Engineering
Mechanics\Calculations\Minton\SPS Main Steam Leak Evaluation\tempsupportBP.gti

  Plate: 12.000 in X 12.000 in x 0.5000 in
  1 load case
  1 attachment
    # FE ext LoadPoint  Section, Offset, Rotation
   -- ------ ---------  ------------------------------------------------
    1   No   Plt surf   ANGLES::L4x4x1/4
                        Offset Plt Center: -1.000, 1.000  Rotation: 90.0
  No stiffeners
```

4 anchors
No constraints
No cutouts
Bearing surface: Specified concrete Fcp of 4.000 ksi

Applied Loads - Units: Inches Pounds

Name	Att	FX	FY	FZ	MX	MY	MZ
1	1	20.0	-190.0	20.0	7828.0	796.0	0.0

Bearing Surface Pressure Results

Maximum pressure of 154.654 psi occurs at
joint 185 (4.500, 3.500), load 1

Plate Displacement Results

Maximum uplift (+Z) of 0.004697 in occurs at
joint 611 (5.000, 12.000), load 1

Maximum depression (-Z) of -0.000475 in occurs at
joint 185 (4.500, 3.500), load 1

Plate Stress Results for Stress Types: Von Mises, S1, S2

PASSED: Maximum Von Mises criteria less than allowable of 27000.0 psi
PASSED: Maximum Principal plate stress S1 less than allowable of 27000.0 psi
PASSED: Maximum Principal plate stress S2 less than allowable of 27000.0 psi

Maximum Von Mises criteria of 15807.716 psi occurs at
joint 209 (4.031, 3.969), load 1
Maximum Principal stress S1 of 17494.050 psi occurs at
joint 209 (4.031, 3.969), load 1
Maximum Principal stress S2 of -17549.780 psi occurs at
joint 209 (4.031, 3.969), load 1

Anchor Results: Axial and Shear forces in lbs

Interaction exponents: Axial = 1.0000, Shear = 1.0000, Allow = 1.00
All anchors pass the specified allowables

Anchor	P/F	Intact	Tension	T allow	Ratio	Shear	V allow	Ratio
B1	P	0.0365	-0.0	1160.0	-0.000	54.7	1500.0	0.036
		1	1			1		

B2	P	0.0285	-0.0	1160.0	-0.000	42.8	1500.0	0.029
		1	1			1		
B3	P	0.3330	354.3	1160.0	0.305	41.5	1500.0	0.028
		1	1			1		
B4	P	0.7476	825.7	1160.0	0.712	53.6	1500.0	0.036
		1	1			1		

Individual anchor results, by load

Anchor	Load	I_ratio	P/F	Axial	A_Allow	A_Ratio	Shear	V_Allow	V_Ratio
B1	1	0.0365	P	0.0	1160.0	0.0000	54.7	1500.0	0.0365
B2		0.0285	P	0.0	1160.0	0.0000	42.8	1500.0	0.0285
B3		0.3330	P	-354.3	1160.0	0.3054	41.5	1500.0	0.0276
B4		0.7476	P	-825.7	1160.0	0.7118	53.6	1500.0	0.0358

Baseplate Stress Check:
Mp = 2 x 826 lb x 4 in = 6608 in*lb (Assume 4" for L1)
S = 12 in x $(1/2in)^2$ / 6 = 0.5 in^3
Fb = Mp / S = 13,216 psi < 27 ksi, OKAY

The following weld check is for the all-around fillet weld at the baseplate attachment. Uses 3/16" all-around weld; drawing specifies 1/4"; therefore results are conservative. All other welds are acceptable by inspection.

WELD CALCULATION: (Angle Shapes – Weld All Around Conservative Eq. 11)

DETERMINE WELD SIZE BETWEEN: _____

LOADS FROM: ☐ STRUDL ☐ CALC. ☐ OTHER _____

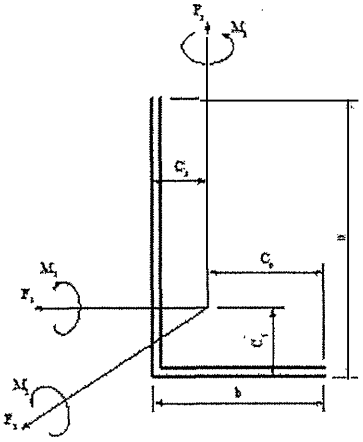
MEMBER _____ JOINT _____ START _____ END _____

COORDINATE SYSTEM: ☐ LOCAL( ) ☐ GLOBAL Material Thickness of Thicker Part Joined: 0.500 in

LOADING CASE: ☐ ENVELOPE ☐ LOADING CONDITION _____

FORCES & MOMENTS AT CENTER OF WELD:

$F_1 = F_Y =$	200	lbf	$M_1 = M_Y =$	8000	in-lbf
$F_2 = F_X =$	20	lbf	$M_2 = M_X =$	0	in-lbf
$F_3 = F_Z =$	20	lbf	$M_3 = M_Z =$	8000	in-lbf
$F_{(ALLOW)} =$	21000	psi	PROVIDED WELD SIZE:	0.250	in
$F_{Y(Base\ Metal)} =$	36000	psi			



WELD PROPERTIES: (TREATED AS A LINE)

$a =$	4.00	in	$b =$	4.00	in		
$A = a + b =$	8.00	in	$C_a = b^2/[2(a+b)] =$	1.00	in		
$Z_1 = a(a+4b)/6 =$	13.33	in^2	$C_1 = a^2/[2(a+b)] =$	1.00	in	$I_1/C_O = Z_1 a/(a+2b) =$	4.44 in^2
$Z_3 = b(4a+b)/6 =$	13.33	in^2	$C_p = b - C_3 =$	3.00	in	$I_3/C_p = Z_3 b/(2a+b) =$	4.44 in^2
$J/C_O = Z_1 a/(a+2b) + Z_3 b^2/[a(a+2b) =$	8.89	in^2				$J/C_p = Z_1(a^2)/[b(2a+b)] + Z_3 b/(2a+b) =$	8.89 in^2

$$F = \left[\left(\frac{F_2}{A} + \frac{M_1}{I_1/C_O} + \frac{M_3}{I_3/C_p} \right)^2 + \left(\frac{F_1}{A} + \frac{M_2}{J/C_O} \right)^2 + \left(\frac{F_3}{A} + \frac{M_2}{J/C_p} \right)^2 \right]^{1/2} / 2 \quad \text{EQ. 11}$$

$$F = \left[\left(\frac{20}{8.00} + \frac{8000}{4.44} + \frac{8000}{4.44} \right)^2 + \left(\frac{200}{8.00} + \frac{0}{8.89} \right)^2 + \left(\frac{20}{8.00} + \frac{0}{8.89} \right)^2 \right]^{1/2} / 2$$

FORCE ON WELD: F = 1801 lbf/in

REQUIRED WELD SIZE: "Base Metal Governs) FY (Base Metal) <= 36000 psi"

$$W_{REQ} = \frac{F}{0.4\,(FY\ (Base\ Metal))} = \frac{1801}{.4\,(\ 36000\ )} = 0.125 \text{ in} < 0.250 \text{ in}$$

CONCLUSION: USE OF 1/4 INCH WELD IS ACCEPTABLE.

SUPPORT LOAD TABULATION SHEET — RUN ID. [20385315]
SURRY POWER STATION — RUN DATE [11/25/19]

SUPPORT NO. [ ] LINE NO. [ ]

PROB NO. [ ] STRESS POINT NO.[6040] SUPPORT TYPE: [ ]

COL	LOAD TYPE	Fx (lb)	Fy (lb)	Fz (lb)	Mx (in-lb)	My (in-lb)	Mz (in-lb)
1	LARGEST POSITIVE	0	0	0	0	0	0
2	OCC LARGEST NEGATIVE	0	0	0	0	0	0
3	EARTHQUAKE OBEI + OBEA (+ OR -)	0	122	0	0	0	0
4	EARTHQUAKE DBE (NOTE1) (+ OR -)	0	33	0	0	0	0
5	DEADLOAD	0	-68	0	0	0	0
6	THERM (+)NORMAL	0	87	0	0	0	0
7	THERM (-)NORMAL	0	0	0	0	0	0
8	DESIGN LOAD1	+ 0 - 0	+ 141 - 190	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
9	DESIGN LOAD2	+ 0 - 0	+ 19 - 68	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0
10	DESIGN LOAD3	+ 0 - 0	+ 0 - 101	+ 0 - 0	+ 0 - 0	+ 0 - 0	+ 0 - 0

	(Fx)	(Fy)	(Fz)		
11 THERMAL MVMTS (Global-in.)	+ .329 - 0	+ 0 - 0	+ .434 - 0	(Positive) (Negative)	+Fx = East +Fy = Vertical (up) +Fz = South

DESIGN LOAD 1 = DL + THERMAL + SRSS[(OBEI+OBEA),OCCASIONAL]
DESIGN LOAD 2 = DL + THERMAL
DESIGN LOAD 3 = DL + DBE

+Fx = East : +Fy = Vertical (UP) : +Fz = South

NOTES:
1) DBEA MUST BE INCLUDED WITH DBEI WHEN N411 CURVES ARE USED
2) REFER TO STD-CEN-0023
3) OBEI HAS BEEN BUMPED BY 1.25
4) DBEI HAS BEEN BUMPED BY 1.50

Enclosure 4

CALCULATION CEM-0232, REVISION 0, "EVALUATION OF DEGRADED SOCKET WELD ON 1" DIAMETER STEAM SUPPLY BYPASS LINE THROUGH-WALL LEAK FLAW CHARACTERIZATION AS REPORTED IN CONDITION REPORT CR1136592," DATED 11/26/19

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Unit 2

Dominion Energy®

Complete Calculation

Complete the fields with text or an **X** as required.

Calculation Number:	Revision:	Addendum:	Sub type:	Decommissioning Record?
CEM-0232	0	N/A	000	☐ Yes ☒ No

Vendor (If not Dominion):

--

Contains Proprietary Information: ☐ Yes ☒ No

Proprietary Information Owner: N/A

QA Program Owner: ☒ Dominion Energy ☐ Other:_____

Calculation Quality Class: ☒ Safety Related ☐ NSQ ☐ Non-Safety Related

Subject (Calculation Title):

Evaluation of Degraded Socket Weld on 1" diameter Steam Supply Bypass Line with Through-Wall Leak for As-Found Flaw Characterization as Reported in Condition Report CR1136592

Addendum Title:

N/A

Station(s) and Unit(s):

NA ☐ 1 ☐ 2 ☐ ISFSI

SU ☐ 1 ☒ 2 ☐ ISFSI MP ☐ 1 ☐ 2 ☐ 3 ☐ ISFSI

Affected System(s), Structure(s), or Component(s):

38-02-MS-PP-4.00-SHP-PIPE-127-601
38-02-MS--377-VALVE-

Purpose (Executive Summary):

See page 2 of this calculation.

Originator (Qual. Required): Printed Name [1][3]		Signature: [1][3]	Date: [1][3]
			11/25/19
Reviewer (Qual. Required): Printed Name [1]	Type of Review: [2] Independent	Signature:	Date: 11/26/19
Approver: Printed Name		Signature:	Date: 11/26/19

Note: Physical or electronic signatures are acceptable.

Note: (1) Add lines for additional originators or reviewers as necessary. (2) Note if reviews are "Independent," "Peer", "Subject Matter Expert", "Supervisor", or "Owner's". (3) Enter N/A for Owner's Review of Vendor Calculatio

Table of Contents

1. *Record of Revisions and Addenda*

Initial issue

2. *Cumulative Effects Review (required for Revisions and Addenda)*

N/A

3. *References*

[1] Calculation CEM-0049, Revision 0, Add. 00A, "Evaluation of Socket Weld to Valve 2-RH-33 with Through-Weld Leak for As-Found Flaw Characterization"
[2] Calculation CEM-0231, Revision 0, "Evaluation of Line 1" –SHP--601 off 4"-SHP-127-601 for Leak Seal Enclosure Device"
[3] Condition Report CR1136592, "Through-wall leak identified upstream of 2-MS-377"
[4] Drawing 11548-FM-064, Sheet 3 of 6, Revision 58
[5] Formulas for Stress and Strain, 5th Edition, Roark and Young

4. *Computer Codes Used*

None

5. *Identification of Computer Inputs and Outputs*

N/A

6. *Purpose*

The purpose of this calculation is to evaluate the as-found weld flaw on the 1" SHP bypass line off Line 4"-SHP-127-60 as reported in Condition Report CR1136592 [3] in order to provide additional justification for the Initial Operability Determination (IOD) and to support the Prompt Operability Determination (POD). The subject 1" line is labeled as 1"-SHP--601 on 11548-FM-064A, Sheet 3 [4].

7. Background

Condition Report CR1136592 [3] identifies through wall leakage at a socket weld on the 1" diameter steam supply bypass line (labeled as 1"-SHP--601 on 11548-FM-064A, Sheet 3 [4]).

The following flaw characterization was provided by Surry Power Station and is documented in the IOD attached to Condition Report CR1136592 [3]:

> CR1136545 documented a measured 6dpm leak was found dripping from the insulation just upstream of 2-MS-377 (SG 1C AFW Pump Steam Supply Bypass). The leak target was 1-FW-MOV-160B (AFW Crosstie Isolation to Unit 1). NDE and System Engineering were tasked to investigate a potential through-wall leak on 1" main steam piping upstream of 2-MS-377 Unexplained water was identified in the general area and insulation was removed. A very small through-wall leak (characterized as a pinhole) was confirmed using a mirror and based on the sound of the leak. It is very difficult to see steam exiting the pinhole. The location appears to be at the fitting side weld toe at approximately 1:00 when looking upstream The weld is a socket weld and is at a 90-degree fitting located two elbows upstream of 2-MS-377. This piping is shown on drawing 11548-CBM-064A-5 Sheet 3 of 6 and is located in the Main Steam Valve House 27' elevation approximately 12 feet off the floor. It is a 1" line that bypasses valve 2-MS-158. This 1" line is ASME Class 2 piping. To summarize the flaw characterization, the flaw is located at or very near the fitting side weld toe at approximately 1:00 when looking upstream, is very small pinhole (1/32" or less) and is likely caused by a fabrication welding defect.
>
> An additional engineering walkdown confirmed no apparent leakage on the sister A and B trains. Minor low frequency movement of the 1" bypass line was observed.

The as-found weld flaw in the affected socket weld of the 1" SHP line is conservatively evaluated compared to the characterized degradation and demonstrated herein to remain structurally adequate for pressure thrust forces corresponding to the design pressure and for design basis loading conditions. The results of this evaluation demonstrate that the degraded socket weld connection will maintain structural integrity.

Note that a leak seal enclosure (clamping device) will be installed to secure the leak until repairs of the line can be made. Calculation CEM-0231 [2] evaluates the adequacy of the piping for the proposed enclosure and also provides stresses, forces, and moments for the existing piping for purposes of this evaluation.

8. Design Inputs

- NUPIPE-II computer pipe stress analysis results from Calculation CEM-0231 [2] for the nominal piping configuration. (This line was previously decoupled from the stress analysis of the 4" line and, hence, a design basis run needed to be developed.)
- Flaw characterization per [3].

9. Assumptions

- It is assumed that there is no active degradation mechanism for the subject flaw in the weld. This is supported by the characterization statement provided which indicates that the likely cause is a lack of fusion in the weld at the time of installation. Field reports also indicate that this line is not subject to excessive vibrations at power. Until installation of the leak seal device, measures are currently in place to monitor the leak to ensure that the identified pin hole leak remains stable.

- For purposes of this evaluation, the degradation is postulated to be at the 12 o'clock location; whereas, based on the characterization, the pin hole is actually located at the 1 o'clock location. The use of the larger size flaw of ½" adequately compensates for this inconsistency as the actual flaw is enveloped within the postulated degradation.

10. Methodology

The indication in the socket weld is characterized as less than a 1/32" pin hole at the toe of the weld on the fitting side at the 1 o'clock position. For conservatism, a degraded cross section is considered that accounts for a much larger pin hole by assuming a flaw size of ¼". Properties of this conservatively postulated

degraded cross section are estimated and the shift in neutral axis, reduction in weld area, and change in section modulus are accounted for to increase loads and therefore stresses in the weld.

The method used is consistent with the methodology outlined in Calculation CEM-0049, Revision 0, Addendum 00A [1]. Use of this method is appropriate based on the similarity between flaws. Application of the method in this calculation is verified by independent review.

11. Calculations

Review of Nominal Socket Weld for Pressure Thrust plus Applied Mechanical Loads

Stresses in the un-degraded weld are calculated in Attachment A. The minimum factor of safety for the nominal (i.e., un-degraded) weld is 3.11 based on allowable shear stress in the pipe. This demonstrates significant reserve strength in the existing socket weld to accommodate substantial degradation.

Review of Degraded Socket Weld for Pressure Thrust plus Applied Mechanical Loads

As is shown in Attachment B, the moment of inertia for a degraded cross section considering a through weld leak 1/2" in size (diameter) is 78.5% of nominal. (Note that per [3], the maximum diameter of the flaw is reported to be only 1/32"; whereas for purposes of this evaluation a diameter of ½" is conservatively postulated in order to assure a bounding configuration.) In addition, there is a shift in the neutral axis which applies additional bending stress due to the axial force. The recalculated bending stress for the reduction in section modulus also includes an additional stress intensification of 2.0 for the pinhole. Also in Attachment B, the metal area is reported to be reduced approximately to 90% of nominal due to consideration of a 1/2" diameter through-weld indication.

The stresses as calculated in Attachment A for the un-degraded configuration, the multipliers accounting for the effect of the degradation, and the resulting stresses in the degraded configuration are given in the table below.

	Nominal Socket Weld	Stress Multiplier	Degraded Socket Weld
Axial Stress [psi]	2,032	1.111	2,258
Bending Stress [psi]	694	See Attachment B	2,750
Combined Stress [psi]	2,725		5,008
Allowable Combined Stress [psi]	15,000		15,000
Maximum Shear Stress [psi]	3,854		$(2)^{0.5}(2258+2750)$ = 7,082
Allowable Shear Stress [psi]	12,000		12,000 **
Factor of Safety	3.11		1.69

** *Allowable stress could be increased for purposes of an operability evaluation.*

12. Conclusions

This calculation has conservatively demonstrated that the nominal socket weld configuration (i.e., un-degraded) has a Factor of Safety of over 3 for all design loads including pressure thrust, using design allowables. The degraded configuration has been very conservatively modeled using a bounding flaw size of ½" and it is shown that reduced factors of safety remain greater than unity for design allowables. No credit is taken in this analysis for increases in allowables that could be used corresponding to operability evaluations, as allowed per NRC Inspection Manual Guidance, Chapter IMC-0326. Therefore, it is concluded that the as-found socket weld will maintain structural integrity for design basis loads including seismic and pressure thrust forces.

13. Precautions and Limitations

The flaw size postulated in this analysis is conservative compared to the characterized flaw as reported in the Condition Report [3] for purposes of assuring a bounding analysis.
This analysis presumes no active degradation mechanisms exist and that the flaw is stable.

14. Calculation Review Checklist

See next page.

15. Attachments

A. Review of Existing Un-Degraded Weld for Pressure Thrust Plus Applied Mechanical Loads (2 pages)
B. Calculation of Properties for the Degraded Socket Weld (3 pages)

Calculation # CEM-0232 Rev.0 Add. N/A

NOTE: If "Yes" is not answered, an explanation may be provided below. Reference may be made to explanations contained in the calculation or addendum.

Questions:		Yes	N/A
1.	Have the sources of design inputs been correctly selected and referenced in the calculation?	[X]	[ ]
2.	Are the sources of design inputs up-to-date and retrievable/attached to the calculation?	[X]	[ ]
3.	Where appropriate, have the other disciplines reviewed or provided the design inputs for which they are responsible?	[X]	[ ]
4.	Have design inputs been confirmed by analysis, test, measurement, field walkdown, or other pertinent means as appropriate for the configuration analyzed?	[X]	[ ]
5.	Have the bases for assumptions been adequately and clearly presented and are they bounded by the Station Design Basis?	[X]	[ ]
6.	Were appropriate calculation/analytic methods used and are outputs reasonable when compared to inputs?	[X]	[ ]
7.	Are computations technically accurate?	[X]	[ ]
8.	Has the calculation made appropriate allowances for instrument errors and calibration equipment errors?	[ ]	[X]
9.	Have those computer codes used in the analysis been referenced in the calculation?	[ ]	[X]
10.	Have all exceptions to station design basis criteria and regulatory requirements been identified and justified in accordance with NQA-1-1994?	[ ]	[X]
11.	Has the design authority/original preparer for this calculation been informed of its revision or addendum, if required?	[ ]	[X]
12.	Was the pre-job brief completed without any identified HU error precursors/compensating actions? (If HU error precursors/compensating actions were identified, then mark N/A and provide explanation/summary below or attach pre-job brief form to calculation.)	[X]	[ ]

Comments: (Attach additional pages if needed)

Signature: _____ Date: 11/26/19
(Reviewer)

Signature: N/A Date: _____
(Owner's Review, if applicable)

Note: Physical or electronic signatures are acceptable.

Review of Existing Socket Weld for Pressure Thrust Plus Applied Mechanical Loads

Pipe Thickness, $t := 0.179in$ Schedule 80S, Class 601

Design Pressure, $P := 1085psi$

Inside Diameter of Fitting, $d_{i\_fitting} := 1.33in$ (minimum)

Design Temperature, $T := 570$ degrees

Pipe Outside Diameter, $D_o := 1.315in$

Weld Size, $w := 0.195in$

Force due to PressureThrust, $F_p := \frac{\pi \cdot d_{i\_fitting}^2 \cdot P}{4} = 1507.38 \cdot lbf$

Axial Force for Design Basis Loading (Deadweight + Seismic), $F_{ax} := 2lbf + 10lbf$ ref. CEM-0231

Metal Area based on Pipe Wall, $MA_{pipe} := t \cdot \pi \cdot d_{i\_fitting} = 0.75 \cdot in^2$

Metal Area based on Weld Size, $MA_{weld} := w \cdot \pi \cdot d_{i\_fitting} = 0.81 \cdot in^2$ Note: $d_{i\_fitting}$ is conservatively used here

Use minimum Metal Area, $MA := if\left(MA_{pipe} < MA_{weld}, MA_{pipe}, MA_{weld}\right) = 0.75 \cdot in^2$

Axial Stress in Weld, $\sigma_{axial} := \frac{F_p + F_{ax}}{MA} = 2031.48 \cdot psi$

Maximum Resultant Bending Moment for Design Basis Loading (Faulted), ref. CEM-0231 (Faulted Condition)

$M_r := \sqrt{(153in \cdot lbf)^2 + (69in \cdot lbf)^2} = 167.84 \cdot in \cdot lbf$

Section Modulus for weld, $Z := \frac{0.0982 \cdot \left[\left(D_o + 2 \cdot w\right)^4 - \left(D_o\right)^4\right]}{D_o + 2 \cdot w} = 0.3145 \cdot in^3$

Maximum Resultant Stress due to Bending, $\sigma_b := \frac{1.3 M_r}{Z} = 693.76 \cdot psi$

Note: Includes an SIF of 1.3 for the socket weld.

Maximum Total Combined Axial Stress in the Weld: $\sigma := \sigma_{axial} + \sigma_b = 2725.2 \cdot psi$

Maximum Shear Stress in Weld at 45: $\upsilon := \sigma \cdot \sqrt{2} = 3854.1 \cdot psi$

For the subject piping at 570 degF (Design Temperature), $S_h := 15000psi$

Per B31.1, Shear stresses in the pipe are limited to 80% of allowable stress, $Allow := 0.8S_h = 12000 \cdot psi$

Safety Factor using Code allowable stress = $FS := \frac{Allow}{\upsilon} = 3.11$

Calculation of Properties for the Degraded Socket Weld

Moment of Inertia For Nominal Weld

$t := \frac{0.195in}{\sqrt{2}} = 0.138 \cdot in$ Weld Thickness, Based on Corporate Weld Manual

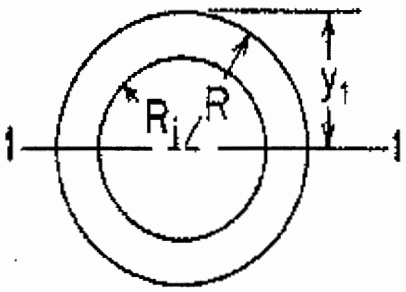
$D_o := 1.315in + 2 \cdot t = 1.591 \cdot in$ Outside Diameter - Weld

$R_o := \frac{D_o}{2} = 0.795 \cdot in$ Outside Radius - Weld

Inside Radius - Weld

$R_i := R_o - t = 0.658 \cdot in$

$I_{1\_n} := \frac{\pi}{4}\left(R_o^4 - R_i^4\right) = 0.168 \cdot in^4$



Moment of Inertia of a Sector of a Hollow Circle (Reference 10)

$t = 0.138 \cdot in$ Thickness of Missing Section (Through Weld)

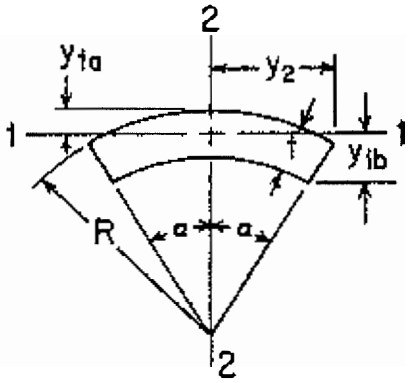
$D_o = 1.591 \cdot in$ Outside Diameter

$R_o = 0.795 \cdot in$ Outside Radius

$R_i = 0.658 \cdot in$ Inside Radius

$\alpha := \frac{1}{2} \frac{\frac{1}{2}in}{\frac{D_o}{2}} = 18.009 \cdot deg$ Half-Angle of Sector

Actual measure pinhole = 1/32"
Conservatively, consider 1/2"



Calculation of Properties for the Degraded Socket Weld

$$A := \left(1 - \frac{3 \cdot t}{2R_o} + \frac{t^2}{R_o^2} - \frac{t^3}{4R_o^3}\right)\left[\alpha + \sin(\alpha)\cdot\cos(\alpha) - \frac{2\cdot(\sin(\alpha))^2}{\alpha}\right]$$

$$B := \frac{t^2\cdot(\sin(\alpha))^2}{3\cdot R_o^2\cdot\alpha\cdot\left(2 - \frac{t}{R_o}\right)}\cdot\left(1 - \frac{t}{R_o} - \frac{t^2}{6\cdot R_o^2}\right)$$

$$C := 1 - \frac{3\cdot t}{2R_o} + \frac{t^2}{R_o^2} - \frac{t^3}{4R_o^3}$$

$$D := \alpha - \sin(\alpha)\cdot\cos(\alpha)$$

$I_{1\_SEC} := R_o^3\cdot t\cdot(A + B) = 0.0001\cdot in^4$ Moment of Inertia about 1-1 for Missing Section

$I_{2\_SEC} := R_o^3\cdot t\cdot C\cdot D = 0.00108\cdot in^4$ Mo ment of Inertia about 2-2 for Missing Section

Apply Parallel Axis Theorem:

$$y_{1s} := R_o\cdot\left[1 - \left[\left(\frac{2\cdot\sin(\alpha)}{3\cdot\alpha}\right)\cdot\left(1 - \frac{t}{R_o} + \frac{1}{2 - \frac{t}{R_o}}\right)\right]\right] = 0\ .079\cdot in$$

$d := R_o - y_{1s} = 0\ 7\ 17\cdot in$

$Area := \alpha\cdot t\cdot(2\cdot R_o - t) = 0.06297\cdot in^2$

Location of Ne utralxis (i.e distance between the parallel axis):

Outside diameter of weld $D_o = 1.591\cdot in$

Inside diameter of weld $D_i := D_o - 2\cdot t = 1.315\cdot in$

Metal Area of the weld $Area_S := \frac{\pi}{4}\cdot\left(D_o^2 - D_i^2\right) = 0.629\cdot in^2$

Distance of neutral axis $\Delta := \frac{Area\cdot d}{Area_S - Area} = 0\ \ .0\ \ 8\cdot in$

$I_{1\_SEC\_PA} := I_{1\_SEC} + Area\cdot(d + \Delta)^2 = 0.04\cdot in^4$ Moment of Inertia of missing section about the neutral axis

Moment of Inertia of Composite Section

Moment of Inertia of the Composite section about the neutral axis = I_{n_n}

$I_{n\_n} := I_{l\_n} + (Area_S)\cdot(\Delta)^2 - I_{l\_SEC\_PA}$ $\quad I_{n\_n} = 0.132\cdot in^4$

Bending Stress Increase Factor = $Factor_{bending} := \frac{I_{l\_n}}{I_{n\_n}} = 1.27$

From Attachment A, the Total Axial Force is, $F_{ax} := 1507.38lbf + 12lbf = 1519.38\cdot lbf$

Additional bending moment due to shift in N.A. = $M_{add} := F_{ax}\cdot\Delta = 121.057\cdot in\cdot lbf$

From Attachment A, the resultant moment is $M_r := 168in\cdot lbf$

Also in Attachment A, the section modulus used was $Z := 0.3145in^3$

Reduced Section Modulus for Degradation = $Z_{degraded} := Z\cdot\frac{I_{n\_n}}{I_{l\_n}} = 0.247\cdot in^3$

Therefore, the maximum bending stress for the degraded weld is recaculated as:

$\sigma_{b\_degraded} := 2.0\frac{1.3\cdot M_r + M_{add}}{Z_{degraded}} = 2750.256\cdot psi$

Note: An SIF of 2 was applied for the pinhole.

Calculation of Reduced Metal Area

Non-Degraded Metal Area = $Area_S = 0.629\cdot in^2$

Reduced Metal Area = $MA_{reduced} := Area_S - Area = 0.566\cdot in^2$

Axial Stress Increase Factor = $Factor_{axial} := \frac{Area_S}{MA_{reduced}} = 1.111$