TENNESSEE VALLEY AUTHORITY
1101 Market Street, Chattanooga, Tennessee 37402

CNL-23-009

January 4, 2023

10 CFR 50.90

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

Sequoyah Nuclear Plant, Units 1 and 2
Renewed Facility Operating License Nos. DPR-77 and DPR-79
NRC Docket Nos. 50-327 and 50-328

Watts Bar Nuclear Plant, Units 1 and 2
Facility Operating License Nos. NPF-90 and NPF-96
NRC Docket Nos. 50-390 and 50-391

Subject: Response to Request for Additional Information Regarding Sequoyah Nuclear Plant, Units 1 and 2 and Watts Bar Nuclear Plant, Units 1 and 2, Request to Revise Technical Specification 3.4.12 (EPID L-2022-LLA-0103)

Reference:

1. TVA letter to NRC, CNL-22-030, "Application to Revise Technical Specification 3.4.12, "Low Temperature Overpressure Protection System" for Sequoyah Nuclear Plant (SQN-TSC-22-01) and TS 3.4.12 "Cold Overpressure Mitigation System" for Watts Bar Nuclear Plant (WBN-TS-22-03)," dated July 27, 2022 (ML22209A002)

2. NRC Electronic Mail to TVA, "Request for Additional Information - Sequoyah Nuclear Plant, Units 1 and 2, and Watts Bar Nuclear Plant, Units 1 and 2, License Amendment Request to Revise Technical Specification 3.4.12 (L-2022-LLA-0103)," dated December 8, 2022 (ML22343A069)

In Reference 1, Tennessee Valley Authority (TVA) requested an amendment to the Operating Licenses (OL) for Sequoyah Nuclear Plant (SQN), Units 1 and 2, and Watts Bar Nuclear Plant (WBN), Units 1 and 2, to revise each plant's Technical Specification 3.4.12. In Reference 2, the Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI). TVA agreed to respond within 30 days.

Enclosures 1 and 2 to this submittal provide the TVA response to the RAI.

This submittal does not change the no significant hazards consideration or the environmental consideration contained in Reference 1. In accordance with 10 CFR 50.91, "Notice for Public Comment; State Consultation," a copy of this supplement is being provided to the Tennessee Department of Environment and Conservation.

There are no new regulatory commitments associated with this submittal. Please address any questions regarding this submittal to Stuart L. Rymer, Director (Acting), Nuclear Regulatory Affairs, at slrymer@tva.gov.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 4th day of January 2023.

Respectfully,

Digitally signed by Rearden, Pamela S
Date: 2023.01.04 15:03:43 -05'00'

James Barstow
Vice President, Nuclear Regulatory Affairs & Support Services

Enclosures:

1. Response to Request for Additional Information
2. PFE-4237, "PZR Manway Evaluation for COMS/LTOPS Requirements," Revision 3, TVA, January 2023

cc (Enclosures):

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Sequoyah Nuclear Plant
NRC Project Manager - Sequoyah Nuclear Plant
NRC Senior Resident Inspector - Watts Bar Nuclear Plant
NRC Project Manager - Watts Bar Nuclear Plant
Director, Division of Radiological Health – Tennessee State Department of Environment and Conservation

Enclosure 1

Response to Request for Additional Information

(1 page)

Response to Request for Additional Information

NRC Introduction:

By letter dated July 27, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML 22209A002), Tennessee Valley Authority (TVA, the licensee) submitted a license amendment request (LAR) for the Sequoyah Nuclear Plant (SQN), Units 1 and 2, and the Watts Bar Nuclear Plant (WBN), Units 1 and 2 respectively, to the U.S. Nuclear Regulatory Commission (NRC, the Commission).

The requested change would revise SQN Units 1 and 2 Technical Specification (TS) 3.4.12, "Low Temperature Overpressure Protection (LTOP) System," and the WBN Units 1 and 2 TS 3.4.12 "Cold Overpressure Mitigation System (COMS)," to add a note to the Limiting Condition for Operation (LCO) that one safety injection pump and one charging pump may be capable of injecting into the reactor coolant system (RCS) for purpose of testing in MODE 5 (cold shutdown) or MODE 6 (refueling) with the pressurizer manway cover removed to provide a vent path for adequate pressure relief. For the review of this LAR, the NRC Staff has drafted the request for additional information (RAI) below.

NRC Regulatory Basis:

10 CFR 50 Appendix A- General Design Criterion 15 which states:

> *The Reactor Coolant (RC) System and associated auxiliary, control, and protection systems shall be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences.*

NRC Request:

SNSB-RAI-1

In section 3.0 of the enclosure to the LAR, the licensee states that an analysis was performed, for both SQN and WBN, to justify that the pressurizer manway opening is sufficient to prohibit the pressurization of the RCS if a safety injection pump was also capable of injecting during the LTOP/COMS modes of applicability. Based on the analysis performed, the licensee concluded that the relief capacity of the of the pressurizer manway is more than sufficient to address the combined multiple injection transient of the charging pump and safety injection pump.

Please provide the calculations performed for both SQN and WBN units which verify the licensee conclusion of the pressurizer manway being sufficient to relief the RCS pressure during combined multiple injection transient of the charging pump and safety injection pump.

<u>TVA Response</u>

The requested calculation is provided in Enclosure 2. This non-proprietary version was prepared to allow public disclosure.

Enclosure 2

PFE-4237
“PZR Manway Evaluation for COMS/LTOPS Requirements”
Revision 3
Tennessee Valley Authority

January 2023

(26 pages)

CALCULATION FILE COVER SHEET

QA RECORD

File No. / Rev. **PFE-4237 / 3**

EDMS No. **L94 230104 800**

Page 1 of 26

Nuclear Plant/Unit/Cycle: Sequoyah & Watts Bar/ Unit 1 & 2 / Cycle Independent

Title: PZR Manway Evaluation for COMS/LTOPS Requirements

Preparer: [signature] Digitally signed by Decker, Kasey C
DN: dc=gov, dc=tva, dc=main, ou=Main, ou=Remote Sites, ou=Users, ou=WBN, cn=Decker, Kasey C, email=kcdecker@tva.gov
Reason: I am the author of this document
Date: 2023.01.03 13:54:51 -05'00'

K.C. Decker — **Date**

Verifier: [signature] Digitally signed by Carey, Christopher
Date: 2023.01.03 14:03:47 -05'00'

C. Carey — **Date**

Manager: Brown, David Michael Digitally signed by Brown, David Michael
Date: 2023.01.03 14:42:26 -05'00'

D.M. Brown — **Date**

TVA 40607 Page 1 of 1 NFDP-112-1 [09-01-2015]

FORM NFDP-112-2
CALCULATION FILE VERIFICATION SHEET

Document / Data Being Verified	PFE-4237: Sequoyah & Watts Bar Units 1 & 2 Cycle Independent Calculation File: PZR Manway Evaluation for COMS/LTOPS Requirements						
Method of Verification	✓	Design Review		Alternate Calculation		Other (Describe)	

Scope of Verification (*Required scope for each method or describe why not applicable)

Design Review	Alternate Calc.		Scope of Verification
*		1.	Input data applicable, correctly used, and properly referenced
*		2.	Assumptions described and reasonable
*		3.	Design criteria identified and met
*		4.	Applicable operating experience properly considered
*		5.	Interface requirements satisfied
*		6.	Appropriateness of design method
*		7.	Output reasonable
		8.	Data transfer to and from computer programs correct
		9.	Conclusions correctly drawn
*		10.	Documentation complete
		11.	Other (specify)
		12.	Consistent results obtained with alternate calculations

Results of Verification

✓	Accepted (No Comments)
	Accepted (Comments Attached)

TVA 40608 Page 1 of 1 NFDP-112-2 [09-01-2015]

Table of Contents

Total Number of Pages = 26 (*including review cover sheet*) R3

Revision Log

Rev #	EDMS #	Description of Revision/Change	Affected Pages
0	L94 211021 800	Initial Issue	All
1	L94 220307 800	Various modifications were performed to extend the calculation's applicability to both Sequoyah units in addition to Watts Bar. This included: • Adding applicable WBN references. • Section 4.2 – Increased combined CCP/SIP flowrate to bound both sites. • Section 4.3 – Added PORV setpoints from both units at both sites, and selected new lower bounding value of 400 psi. • Section 5.3 – Recalculated all results using new inputs from 4.2 and 4.3. • Section 5.4 & 5.5 – Expanded conclusion to both sites. • Throughout – Modified language to refer to WBN's "COMS" system in lieu of only SQN's "LTOPS" Enhancements for documentation of critical thinking: • Sections 1.2 & 1.3 – Added detail regarding the intent of the calculation. • Section 4.1 – Clarified application of WBN's manway diameter to SQN based on documented assumptions. Updated Table of Contents / page count. Fixed various minor typographical and formatting issues. Revision bars were not used for these minor changes to maintain traceability of major Revision 1 changes. Calculation preparation files were added to Filekeeper as documented in Section 7.	Coversheet, ii - v, vii - viii, 1-1, 4-1, 4-2, 5-2, 5-5 - 5-8, 6-1, 7-1.

Rev #	EDMS #	Description of Revision/Change	Affected Pages
2	L94 220607 800	Revision 2 documents the critical thinking for not considering the PZR surge line in the calculation. This included: • Adding references 10-12 for information regarding the surge line configuration. • Modified Scope (Section 1.2) to more clearly delineate the region of overpressurization concern and align this section with the extent of the hydraulics analyzed. • Modifying the heading of Justified Assumption 3.1.1 to align the title to the subject matter of the assumption -- i.e., piping upstream of the RCS vs. all piping upstream of the PZR. • Updated Filekeeper reference in Section 7.0. Updated Table of Contents / page count.	Coversheet, ii - iv, vi, x, 1-1, 3-1, 7-1.
3	L94 230104 800	Revised entire calculation to remove “PROPRIETARY” and TVA-SPP-12.002 “TVA CONFIDENTIAL” classifications based on review of calculation for inclusion in the publicly-accessible NRC ADAMS database. The only changes beyond the removal of the aforementioned markings are: page count (from removal of the “TVA CONFIDENTIAL” coversheet), reviewer, approver, revision level, TVA document accession number (EDMS number), this revlog entry, and the digital file storage location (page 7-1).	All.

Notes

A. In accordance with NFDP-112, a pre-job brief may be required per NPG-SPP-22.209. This pre-job brief is documented in Appendix A.

Nomenclature

TS	Technical Specifications
LCO	Limiting Condition for Operation
RCS	Reactor Coolant System
COMS	See LTOPS
LTOPS	Low Temperature Overpressure Protection System (also referred to as a Cold Overpressure Mitigation System, or COMS)
CCP	Centrifugal Charging Pump
SIP	Safety Injection Pump
PORV	Power Operated Relief Valve
PZR	Informal shortening of “Pressurizer”
MI	Mass Injection, in reference to one of the two design basis LTOPS transients
ID	Inside diameter

R1

References

1. TVA Procedure NFDP-112 **Technical Analyses and Documentation** Revision 5.
2. Technical Specifications R1
    a. SQN Amendments 355 and 350 (Units 1 and 2, respectively).
    b. WBN Amendments 150 and 58 (Units 1 and 2, respectively).
3. Technical Specification Bases
    a. SQN Revisions 65 and 65 (Units 1 and 2, respectively)
    b. WBN Revisions 181 and 55 (Units 1 and 2, respectively)
4. System Description Documents for the **Safety Injection System**
    a. SQN Design Criteria SQN-DC-V-27.3 Revision 28.
    b. WBN System Description N3-63-4001 Revision 37.
5. System Description Documents for the **Reactor Coolant System**
    a. SQN Design Criteria SQN-DC-V-27.4 Revision 26.
    b. WBN System Description N3-68-4001 Revision 45.
6. PZR Manway Drawings
    a. 1099J91 **SQN Pressurizer (1800 cu ft) – Outline** Revision 4.
    b. 1100J48 (WBN) **Pressurizer 1800 cu ft – Outline** Revision 10.
    c. 10010E95 **Watts Bar Unit 2 Model '84 Pressurizer 1800 cu ft–Outline** Revision 0.
7. Westinghouse Letter WAT-D-8936 **Overpressure Vent Size** dated August 4, 1992
8. Crane Engineering Division **Technical Paper 410: Flow of Fluids through Valves, Fittings and Pipes** Sixteenth Printing.
9. Pressure and Temperature Limits Reports R1
    a. Sequoyah (located at the end of the Technical Specifications, Reference 2a)
        i. Unit 1 Revision 6.
        ii. Unit 2 Revision 7.
    b. Watts Bar (located at the end of the RCS Description, Reference 5b)
        i. Unit 1 Revision 13.
        ii. Unit 2 Revision 6.

10. PZR Surge Line Drawings R2
    a. 1-47K464-83 (SQN Unit 1) **Reactor Coolant System Problem 0600104-13-01 Pressure Surge Line** Revision 2.
    b. 2-47K465-84 (SQN Unit 2) **Reactor Coolant System Problem 0600154-13-01 Pressure Surge Line** Revision 1.
    c. 47W465-221 (WBN Unit 1) **Problem No. 0600200-13-01 14" Pressurizer Surge Line** Revision C.
    d. 2-47W465-221 (WBN Unit 2) **Problem No. 0600250-13-01 068-Reactor Coolant 14" Pressurizer Surge Line at Hot Leg Loop 2 to Base of Pressurizer** Revision 1.
11. PZR Surge Line Thermal Sleeve Drawings
    a. ISI-0394-C-05 (SQN) **Unit 1 Pressurizer Surge Nozzle Details** Revision 1.
    b. 9392-3N (WBN-9392-3N-MD-5411401) (WBN) **U1&2 Thermal Sleeve** Revision 0.
12. Final Safety Analysis Report (FSAR) Sections
    a. SQN FSAR Amendment 30 Section 5.5.3 **Reactor Coolant Piping** Subsection 5.5.3.2 *Design Description*
    b. WBN FSAR Amendment 4 Section 5.5.3 **Reactor Coolant Piping** Subsection 5.5.3.2 *Design Description*

Document: PFE-4237, Revision 3
Author: K.C. Decker
Reviewer: C. Carey

Subject: Sequoyah & Watts Bar Unit 1&2 Calculation File: PZR Manway Evaluation for COMS/LTOPS Requirements

1 Introduction

1.1 Purpose

Watts Bar's Cold Overpressure Mitigation System (COMS) and Sequoyah's Low Temperature Overpressure Protection System (LTOPS) are designed to protect the Reactor Coolant System (RCS) from a mass injection (MI) transient equivalent that bounds a Centrifugal Charging Pump (CCP) injecting at maximum flow with minimum letdown. This forms the basis of prohibiting the Safety Injection Pump (SIP) from being capable of injecting during COMS/LTOPS applicability via Technical Specification (TS) Limiting Condition for Operation (LCO) 3.4.12. The purpose of this calculation is to justify that the pressurizer (PZR) manway opening is sufficient to prohibit the pressurization of the RCS if a SIP was also capable of injecting during the COMS/LTOPS modes of applicability (i.e., Modes 4 and 5, and Mode 6 with the reactor vessel head on). Such a conclusion would enable testing the SIP with the reactor head installed without requiring revision of the PZR Power-Operated Relief Valve (PORV) setpoints. R1 R1

1.2 Scope

The scope of this calculation file is limited to determining if the RCS, when vented via the PZR manway, is capable of passing the flow from the worst case MI transient without concern for Low Temperature Overpressurization. The primary area of concern with respect to Low Temperature Overpressure is at the beltline of the reactor vessel; therefore both the PZR manway and the surge line were considered. The calculation is not used to determine the realistic flow capability or backpressure developed in the RCS, but instead conservatively justify that the manway opening is sufficient to protect the RCS from overpressurization if the SIP and CCP injected simultaneously. R2

1.3 Acceptance Criteria

A specific acceptance criteria is not specified for this calculation. The goal will be to show that the flow required to develop any substantial RCS backpressure is higher than the capabilities of the CCP and SIP, or alternatively, to demonstrate that the flow capability of the aforementioned pumps cannot develop any substantial backpressure across the PZR manway opening.

2 Codes

No computer codes were used in the development of this calculation file. The preparer used a MS EXCEL worksheet to speed implementation of the involved hydraulic formulas.

3 Major Assumptions

3.1 Verified Assumptions

3.1.1 Piping between the pump discharge and the RCS can be ignored. R2

Technical Justification: Adding piping between the CCPs/SIPs and the RCS would only serve to reduce the flow to the RCS, thereby reducing the possible backpressure accumulated in the RCS and reducing the challenge to COMS/LTOPS. Therefore, ignoring this piping is conservative.

3.1.2 The Watts Bar and Sequoyah PZR manways are identical.

Technical Justification: Per a review of the drawings in Reference 6, the PZRs appear to be essentially identical, with a 16” ID manway opening.

3.1.3 The hydraulic resistance of the PZR surge line does not contribute meaningfully to the pressurization of the RCS. R2

Technical Justification: Unlike the piping discussed in assumption 3.1.1, the PZR surge line resistance would increase the possible backpressure accumulated in the RCS. From a review of the drawings in Reference 10, the PZR surge line is approximately 70 ft of 14” Schedule 160 pipe with large (70”) bend radii. Schedule 160 pipe of 14” nominal diameter has an ID of 11.188”; however, the PZR surge lines also have thermal sleeves (Reference 12). Per a review of the drawings in Reference 11, the thermal sleeves reduce the effective pipe ID inside the end nozzles of the surge lines.

From the review of the surge line piping geometry described above, it is estimated from Appendix B of Reference 8 that a 100 ft length of 10” Schedule 40 piping would conservatively bound the surge line in terms of hydraulic resistance. Per Reference 8, a 100 ft length of 10” Schedule 40 steel piping, when passing 1,500 gpm of water (see Section 4.2 of this calculation), would produce a pressure drop of only 0.466 psi. Since this pressure drop is less than 1 psi, and furthermore, less than < 1% of the lowest PORV setpoints in Section 4.3 of this calculation, the effects of the PZR surge line hydraulic resistance will not contribute meaningfully to the pressurization of the RCS.

3.2 Unverified Assumptions

There are no unverified assumptions associated with this calculation.

4 Source Data

4.1 PZR Manway Hydraulic Characteristics

R1

4.1.1 Inner Diameter: 16" (Reference 6, using Assumption 3.1.2)

4.1.2 Hydraulic Resistance: 0.70874×10^{-7} ft/gpm^2 (Reference 7, using Assumption 3.1.2)

4.1.3 Flow Coefficient: 2.0 (Reference 8 for a pipe exit provides a value of 1.0; however, higher values would produce conservative results (i.e., indicating that higher backpressures could be produced with lower flow values)

4.2 CCP and SIP Flowrates

R1

From Reference 4a, the runout flows of Sequoyah's CCP and SIP are approximately 550 and 650 gpm, respectively. Reference 4b confirms these runout flows for Watts Bar; however, the Watts Bar System Description provides added detail that in recirculation mode, the pumps could theoretically runout at 560 and 675 gpm for the CCP and SIP, respectively. Revision 0 of the calculation assumed a combined flow of 1,200 gpm for the MI transient. To bound unexpected hydraulic configurations that might boost the pump suction pressure, Revision 1 will assume the CCP and SIP could output a combined 1,500 gpm.

Note that all of these values are unrealistic as at these flowrates, the pumps would be incapable of developing any measurable head, and therefore incapable of overcoming any backpressure.

4.3 COMS/LTOPS Setpoints

The PORV setpoints when COMS/LTOPS is armed are from Reference 9. R1

From the SQN Unit 1 PTLR:

Indicated RCS Temperature (°F)	Lowest PORV Setpoint (psig)
50	406
73	406
123	430
148	455
223	525
277	626
373	626
500	2335

From the SQN Unit 2 PTLR:

Indicated RCS Temperature (°F)	Lowest PORV Setpoint (psig)
50	454
73	454
123	525
173	616
200	626
327	626
373	626
500	2335

From the WBN Unit 1 PTLR:

Indicated RCS Temperature (°F)	Lowest PORV Setpoint (psig)
60	462
105	462
125	481
200	566
225	604
250	664
300	688
350	688

From the WBN Unit 2 PTLR:

Indicated RCS Temperature (°F)	Lowest PORV Setpoint (psig)
60	409
117	409
125	483
167	483
190	590
225	590
350	590
450	2335

From this input, the lowest PORV setpoint for all four units is 406 psig from Sequoyah Unit 1. This will be conservatively assumed to be 400 psig in all calculations.

4.4 Water Properties

4.1.1 Density of Water at 60°F: 62.4 lb/ft^3 (Reference 8)

5 Calculation

5.1 Objective

The objective of this file will be to conservatively ensure PZR manway will prevent RCS overpressurization, such that the COMS/LTOPS setpoints would not require revision to enable SIP injection with the reactor head installed.

5.2 Methodology

Due to the need to quickly provide assurance the manway is of sufficient size to prevent overpressurization, the calculation will not attempt to analyze the entire injection path (see Assumption 3.1.1). The calculation will instead use rough estimation to produce a certain, but very conservative, conclusion. Due to the bluntness of these estimations, several methods will be used in parallel to analyze the manway.

5.2.1 Specific analysis using Westinghouse provided flow resistance

The first evaluation will calculate the backpressure that could be developed across the manway using the Westinghouse provided hydraulic resistance of the manway (Input 4.1.2). The Westinghouse-provided hydraulic resistance is in terms of feet of head per flow squared (ft/gpm^2). Therefore, backpressure developed across the manway for a given flow can be calculated simply by:

$$dP = \frac{Q^2 R}{2.31}$$

where:

dP	= backpressure, in psi
Q	= flow rate, gpm
R	= hydraulic resistance (ft/gpm^2)
2.31	= conversion factor to convert feet of head to psi

For demonstrational purposes, after the formulas are implemented in Excel, Excel's Goal Seek will be used to determine the flow required for various pressures of interest.

5.2.2 Analysis using Crane No. 410 / Darcy Formula

Because the flow values yielded by the method described in Section 5.2.1 are extremely high, a check of the order of magnitude of the results was performed using the generalized hydraulic equations of Reference 8. Specifically, equation 6-27 of Reference 8 describes the computation of a flowrate through valves, fittings and pipe using K-values and pressure difference. This equation is:

$$Q = 235.6d^2\sqrt{\frac{dP}{Kp}}$$

Where:

Q = flow rate (gpm)
d = diameter (inches)
dP = pressure differential across component (psi)
K = resistance coefficient (unitless)
p = density (lb/ft^3)

As with the previous method, several demonstrational checks will also be performed to calculate the flow and backpressure at several points of interest. A “K” value of 1.0 would typically be used for a pipe exit per Reference 8; however, a value of 2.0 will be used here to conservatively inflate the resistance of the manway opening. R1

5.2.3 Analysis using Crane No. 410 / Orifice Formula

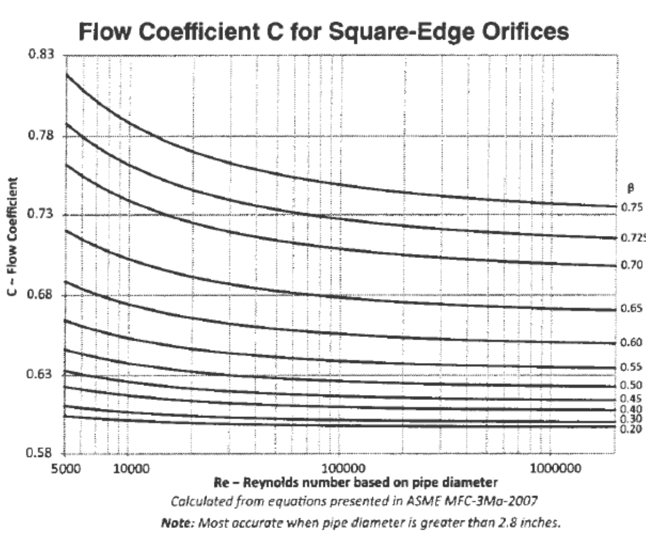
As yet another check of the calculation, the Crane No. 410 orifice, nozzle & venturi formula was used. Specifically, equation 6-31 of Reference 8 describes the computation of a flowrate through an orifice using a discharge coefficient (C-value) and pressure difference. This equation is:

$$Q = 235.6 d_1^2 C \sqrt{\frac{dP}{p}}$$

Where:

Q	= flow rate (gpm)
d_1	= orifice diameter (inches)
C	= flow coefficient (unitless)
dP	= pressure differential across component (psi)
p	= density (lb/ft^3)

Calculation of "C" for the PZR manway typically requires knowing the Reynolds Number for the flow, requiring some estimation and iteration. However, the chart to generate C in Crane No. 410 uses the ratio of orifice diameter to pipe diameter as an input:



From Reference 6, the manway diameter divided by the PZR inner diameter, or 16” / 84”, is approximately 0.19. For this diameter ratio, the flow coefficient is relatively insensitive to Reynolds number and falls around 0.6. Therefore, the C of 0.6 will be used for all flows.

As with the previous method, several demonstrational checks will also be performed to calculate the flow and backpressure at several points of interest.

5.3 Implementation

5.3.1 Backpressure calculation via Westinghouse flow resistance

Via Excel implementation of the operation described in Section 5.2.1 above, the following table provides the backpressure generated by the manway for various pump flow rates:

Flow Rate (gpm)	Pressure (psi)
1	3.07E-08
10	3.07E-06
100	3.07E-04
1000	3.07E-02
10,000	3.07

R1

For additional demonstration, the flow rate required to produce 1 psi of backpressure via the manway is as follows:

Flow Rate (gpm)	Pressure (psi)
5,710	1

R1

And the flow rate required to produce 400 psi of backpressure (i.e., the equivalent of the lowest PORV setpoint when LTOPS is armed, see Section 4.3):

R1

Flow Rate (gpm)	Pressure (psi)
114,000	400

The combined flow rate of a CCP and SIP, at runout, would produce the following backpressure:

Flow Rate (gpm)	Pressure (psi)
1,500	0.069

R1

5.3.2 Crane No. 410 with Darcy Formula

Similar to the above, method 5.2.2 was implemented in Excel. The following table provides the backpressure generated by the manway for various pump flow rates:

Flow Rate (gpm)	Pressure (psi)
1	3.43E-08
10	3.43E-06
100	3.43E-04
1000	3.43E-02
10000	3.43

R1

Using the Darcy formula, the flow rate required to produce 1 psi of backpressure via the manway is as follows:

Flow Rate (gpm)	Pressure (psi)
5,400	1

R1

And the flow rate required to produce 400 psi of backpressure (i.e., the equivalent of the lowest PORV setpoint when LTOPS is armed, see Section 4.3): R1

Flow Rate (gpm)	Pressure (psi)
108,000	400

The combined flow rate of a CCP and SIP would produce the following backpressure:

Flow Rate (gpm)	Pressure (psi)
1,500	0.077

R1

R1

5.3.3 Crane No. 410 with Orifice Formula

Similar to the above, method 5.2.3 was implemented in Excel. The following table provides the backpressure generated by the manway for various pump flow rates:

Flow Rate (gpm)	Pressure (psi)
1	4.76E-08
10	4.76E-06
100	4.76E-04
1000	4.76E-02
10000	4.760

R1

Using the Darcy formula, the flow rate required to produce 1 psi of backpressure via the manway is as follows:

Flow Rate (gpm)	Pressure (psi)
4,580	1

R1

And the flow rate required to produce 400 psi of backpressure (i.e., the equivalent of the lowest PORV setpoint when LTOPS is armed, see Section 4.3): R1

Flow Rate (gpm)	Pressure (psi)
91,600	400

The combined flow rate of a CCP and SIP would produce the following backpressure:

Flow Rate (gpm)	Pressure (psi)
1,500	0.11

R1

R1

5.4 Results

The Westinghouse hydraulic characteristics of the PZR manway indicate that its relief capacity is more than sufficient to address the combined MI transient of the CCP and SIP combined. The Crane No. 410 methods did not arrive at the same values. This is attributed to the vast over-simplification of the hydraulics at play in this scenario, in addition to the use of the Darcy-based equations outside the ranges for which they are optimized (for example, the PZR is a tank, not a pipe). However, the implications are the same--although the hydraulic methods are crude, the calculation demonstrates that the flow capabilities of the CCP and SIP combined, or less than 1,500 gpm, are nowhere near capable of inducing a backpressure anywhere near the order of magnitude of the lowest PORV setpoint. The manway is capable of relieving much more than these pumped flowrates before developing any substantial RCS pressure. R1

By lowering the pressure assumed for the lowest PORV setpoint to 400 psi, and increasing the flow used in the developed backpressure calculation, the results of the calculation now bound both Watts Bar and Sequoyah. R1

6 Summary and Conclusions

The results of the calculation are presented in Section 5.3 and interpreted in Section 5.4.

The COMS/LTOPS would not have to be resized to accommodate the additional mass injection of a safety injection pump, provided the PZR manway is open.

This conclusion is valid for both Watts Bar and Sequoyah. R1

7 Computer Run Index

No computer runs were developed as part of this calculation file. Although section 5.0 of the calculation details how the fluid calculations were derived and presents results in-line with the text of the calculation, the operation was originally performed in MS EXCEL.

For convenience, the MS WORD files for the calculation and the MS EXCEL spreadsheets are contained in Filekeeper and are retrievable using document identifier *PFE-4237-R3*. R3

Appendix A Pre-Job Briefing

No paper pre-job briefing (PJB) was retained for this calculation, as it was classified as a relatively routine/repetitive task (i.e., a relatively simple hydraulic calc confirming of PZR vent relief capacity being far greater than required to handle an additional pump being allowed to inject). Note that, for the purposes of Pre-Job Briefing as discussed here, the activity scope does not consider the License Amendment Request to modify the COMS/LTOPS TS to permit this configuration, nor the effort to derive a workable procedure for performing the SIP comprehensive test with the reactor head installed. The scope of the PJB referenced in this section is only for the preparation of this calculation. R1