FORM APF 05D-001-01, REV. 10

CALCULATION COVER SHEET	CALCULATION NO. XX-E-013
	REVISION NO. 4
	Page 1

CALCULATION TITLE - Enter this item in *CALCULATION TITLE* field in EIS:
Post-Fire Safe Shutdown (PFSSD) Analysis

Type of Calculation: ☐ Design Analysis ☒ Engineering Evaluation ☐ N/A - N/A only if status is Preliminary, Void, or Superseded

COMPUTER CODE: N/A VERSION:

Associated Change Number: CP 014986 ☐ None

Enter the DCP/CCP Number in the INDUSTRY REFERENCE field in EIS.

REGULATORY REVIEWS: ☐ Attached Evaluation #
☒ Attached to: CP 014986

USAR STATEMENT: ☒ Requires a change to the USAR
☐ Does not require a change to the USAR

ANY DOCUMENTS IMPACTED? ☐ Yes ☒ No If yes, enter: Work Management Tool #, SWO #, or Condition Report #, if applicable

REV.	ORIGINATOR *QUALIFICATION REQUIRED: ES9280479*	DATE	VERIFIER *QUALIFICATION REQUIRED: ES9280479*	DATE	APPROVER	DATE
04	DigsigOrg 2.2, 0.45 William M. Wilkins *Printed Name* [signature] *Signature*	10/1/15	DigsigVer 2.2, 0.45 Brian Masters *Printed Name* [signature] *Signature*	10/22/15	DigsigApp 2.2, 0.45 Jeff Suter *Printed Name* [signature] *Signature*	10/22/15
	Printed Name *Signature*		*Printed Name* *Signature*		*Printed Name* *Signature*	

DigsigCert 3.5 1.75 DigsigCert 3.5 1.75

HOWARD L. MEYER
LICENSED
7291
10-26-15
KANSAS
PROFESSIONAL ENGINEER

RPE Certification (For ASME Section III Stress Reports/Design Reports refer to AP 05D-001 for Qualifications)

CALCULATION COVER SHEET	CALCULATION NO. XX-E-013
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	Page 2

CALCULATION SUBJECT (Statement Of Problem) - Enter this in *SUBJECT* field in EIS**:**

Revision 4 Post-Fire Safe Shutdown (PFSSD) Analysis. This analysis ensures the capability to achieve and maintain safe shutdown following a fire for any plant fire area. Revision 4 includes the following:

1. Incorporation of CCNs XX-E-013-003-CN002, XX-E-013-003-CN003, XX-E-013-003-CN004, XX-E-013-003-CN006, & XX-E-013-003-CN008.
2. Attachment 1 revised to identify definition sources
3. Attachments 2 & 3 now referred to as Appendices 5 & 6, respectively
4. Changes in support of and/or allow by License Amendment 214 (Reference Correspondence 15-00793, ET 13-0035):
   - 3-A-4 revised to take credit for automatic feedwater isolation signal (FWIS).
   - 3-B-3 revised to remove SNUPPS Letter SLNRC 84-0109 and add E-1F9915 as a licensing basis document.
   - Section 5 References revised add E-1F9915 and clarify SLNRC 84-0109 is superseded by E-1F9915.

CALCULATION DATABASE INPUT

CALCULATION NO. XX-E-013

REVISION NO. 4

DISCIPLINE:

- ☐ **C = Civil**
- ☒ **E = Electrical**
- ☐ **J = Instrumentation**
- ☐ **M = Mechanical**
- ☐ **N = Nuclear/Safety Analysis**
- ☐ **P = Plant Design/Layout/ Pipe Supports/Architectural**
- ☐ **Q = Equipment Qualification**
- ☐ **S = Stress**
- ☐ **U = Electrical Supports**
- ☐ **X = Other**

SAFETY CLASSIFICATION:

- ☐ **Safety-Related**
- ☐ **Non-Safety-Related**
- ☒ **Special Scope**

Special Scope Classification:

- ☐ **A = ATWS Mitigation System Actuation Circuitry**
- ☒ **F = Fire Protection**
- ☐ **2 = Non-Category I Seismic or Seismic II/I**
- ☐ **D = Quality Group D (Augmented)**
- ☐ **E = Environmental Monitoring**
- ☐ **S = Security**
- ☐ **B = Station Blackout**

STATUS DESIGNATION:

- ☐ **P = Preliminary**
- ☐ **C = Committed**
- ☒ **F = Final**
- ☐ **S = Superseded**
- ☐ **V = Void**

SYSTEMS - Link systems to the calculation in EIS:

XX, AB, AC, AE, AL, AP, BB, BG, BM, BN, EF, EG, EJ, EM, EN, EP, FB, FC, GD, GF, GK, GL, GM, GN, JE, KA, KC, KH, KJ, MA, MR, NB, NE, NF, NG, NK, NN, PA, PB, PG, PK, PL, PN, QB, QD, QJ, RL, RP, SA, SB, SC, SE, SY

CALCULATION DATABASE INPUT	**CALCULATION NO.** XX-E-013 **REVISION NO.** 4 **Page 4**

REFERENCE CALCULATIONS - Develop relationships between interdependent calculations in EIS:

Inputs to this calculation:	AN-96-062, WCNOC-CP-002
Impacted by this calculation:	None

CONTROLLED REFERENCE DOCUMENTS - Develop relationships between the calculation and controlled reference documents in EIS:

CALCULATION DATABASE INPUT

CALCULATION NO. XX-E-013

REVISION NO. 4

Inputs to this calculation:	E-1000-SY00/4, E-1000-SY12/2, E-1000-UU00/18, E-1005-SY01/14, E-1005-SY07/1, E-13AB01/3, E-13AB01A/3, E-13AB02A/3, E-13AB02B/2, E-13AB02C/0, E-13AB03A/1, E-13AB03B/1, E-13AB04/1, E-13AB06A/4, E-13AB06B/4, E-13AB06C/2, E-13AB07/1, E-13AB08/5, E-13AB09/5, E-13AB10/2, E-13AB11A/4, E-13AB11B/5, E-13AB11C/5, E-13AB12/10, E-13AB17/1, E-13AB18/0, E-13AB19/2, E-13AB20A/1, E-13AB20B/3, E-13AB21/2, E-13AB22/0, E-13AB23A/3, E-13AB23B/2, E-13AB25/1, E-13AB26/4, E-13AB27/4, E-13AB28/6, E-13AB29/5, E-13AB30/1, E-13AB31/1, E-13AB32/7, E-13AE01/1, E-13AE02A/0, E-13AE02B/0, E-13AE02C/0, E-13AE02D/0, E-13AE05/4, E-13AE06/1, E-13AE07/0, E-13AE08/1, E-13AE09/0, E-13AE10/0, E-13AE11/2, E-13AE12/1, E-13AE13/3, E-13AE14/5, E-13AE15/3, E-13AE16/3, E-13AE17/3, E-13AE18/2, E-13AE19/1, E-13AE20/4, E-13AL01A/5, E-13AL01B/4, E-13AL02A/6, E-13AL02B/6, E-13AL03A/5, E-13AL03B/6, E-13AL04A/7, E-13AL04B/9, E-13AL05A/2, E-13AL05B/1, E-13AL06/0, E-13AL07A/0, E-13AL07B/0, E-13AL08/0, E-13AL09/2, E-13AL10/1, E-13BB01/15, E-13BB02/3, E-13BB03/9, E-13BB04/3, E-13BB05/0, E-13BB07/0, E-13BB08/0, E-13BB09/0, E-13BB11/0, E-13BB12A/6, E-13BB12B/5, E-13BB12C/4, E-13BB13/0, E-13BB14/2, E-13BB15/4, E-13BB15A/2, E-13BB16/2, E-13BB17/3, E-13BB18/2, E-13BB19/6, E-13BB20/0, E-13BB21/1, E-13BB22/2, E-13BB23/0, E-13BB24/2, E-13BB25/0, E-13BB26/2, E-13BB27/6, E-13BB28/2, E-13BB29/1, E-13BB30/3, E-13BB31/5, E-13BB32/2, E-13BB33/8, E-13BB34/0, E-13BB35/5, E-13BB36/2, E-13BB37/1, E-13BB38/5, E-13BB39/8, E-13BB40/5, E-13BB41/2, E-13BG01/4, E-13BG01A/2, E-13BG02/0, E-13BG03/0, E-13BG04/0, E-13BG05/1, E-13BG06/2, E-13BG07/1, E-13BG08/1, E-13BG09/1, E-13BG10/4, E-13BG11A/4, E-13BG11B/5, E-13BG11C/1, E-13BG12/3, E-13BG12A/6, E-13BG13/3, E-13BG14/1, E-13BG15/0, E-13BG16/3, E-13BG17/2, E-13BG18/1, E-13BG19/0, E-13BG20/2, E-13BG21/2, E-13BG22/1, E-13BG23/2, E-13BG24/4, E-13BG25/1, E-13BG26/1, E-13BG27/1, E-13BG28/2, E-13BG29/1, E-13BG30/2, E-13BG31/1, E-13BG32/1, E-13BG33/3, E-13BG35/4, E-13BG36/1, E-13BG37/4, E-13BG38/2, E-13BG39/1, E-13BG40/1, E-13BG41/2, E-13BG42/1, E-13BG43/0, E-13BG44/2, E-13BG45/2, E-13BG46/0, E-13BG47/1, E-13BG48/0, E-13BG50/3, E-13BG51/1, E-13BG52/3, E-13BM01/0, E-13BM02/0, E-13BM03/0, E-13BM04/0, E-13BM05/0, E-13BM06A/2, E-13BM06B/1, E-13BM06C/0, E-13BM06D/1, E-13BM07/0, E-13BM08/0, E-13BM09/0, E-13BM10/0, E-13BM11/0, E-13BM12/3, E-13BM13/2, E-13BM14/2, E-13BM15/0, E-13BM16/2, E-13BM17/1, E-13BM18/1, E-13BM19/1, E-13BM20/1, E-13BN01/4, E-13BN01A/1, E-13BN02/0, E-13BN03/8, E-13BN03A/8, E-13BN04/2, E-13BN06/2, E-13BN07/2, E-13BN08/4, E-13BN09/0, E-13BN10/1, E-13EC01/1, E-13EC02/5, E-13EC03/1, E-13EC04/0, E-13EC05/1, E-13EC06/1, E-13EC07/0, E-13EC08/1, E-13EF01/1, E-K3EF01/19, E-K3EF01A/11, E-13EF02/5, E-K3EF02/16, E-13EF02A/5, E-13EF03/3, E-K3EF03/11, E-13EF04/2, E-13EF04A/0, E-K3EF04/13, E-13EF05/4, E-K3EF05/6, E-13EF05A/1, E-13EF06/3, E-K3EF06/11, E-13EF06A/5, E-13EF07/3, E-13EF08/9, E-K3EF08/10, E-13EF09/4, E-K3EF09/8, E-K3EF10/3, E-13EF11/2, E-K3EF11/17, E-K3EF12/2, E-13EG01A/6, E-13EG01B/4, E-13EG01C/3, E-13EG01D/4, E-13EG02/2, E-13EG03/1, E-13EG04/6, E-13EG05A/6, E-13EG05B/6, E-13EG05D/2, E-13EG06/3, E-13EG07/6, E-13EG08/3, E-13EG08A/3, E-13EG09/6, E-13EG09A/3, E-13EG10/4, E-13EG11/2, E-13EG12/2, E-13EG13/0, E-13EG14/1, E-13EG15/1, E-13EG16/0, E-13EG17/4, E-13EG17A/4, E-13EG18/7, E-13EG18A/5, E-13EG19/0, E-13EG20/3, E-13EJ01/4, E-13EJ02/0,

E-13EJ03/2, E-13EJ04A/5, E-13EJ04B/7, E-13EJ05A/4, E-13EJ05B/6, E-13EJ05C/3, E-13EJ06A/7, E-13EJ06B/9, E-13EJ07/2, E-13EJ08/6, E-13EJ09A/6, E-13EJ09B/2, E-13EJ10/2, E-13EJ11/1, E-13EJ12/1, E-13EM01/4, E-13EM02/5, E-13EM02B/1, E-13EM02C/1, E-13EM03/5, E-13EM04/0, E-13EM04A/0, E-13EM05/0, E-13EM05A/0, E-13EM08/2, E-13EM09/6, E-13EM11/5, E-13EM11A/4, E-13EM12/0, E-13EM13A/6, E-13EM13B/1, E-13EM13C/3, E-13EM14/5, E-13EM15/0, E-13EM16/1, E-13EP01/1, E-13EP02A/4, E-13EP02B/2, E-13EP03/1, E-13EP04/0, E-13EP05/0, E-13EP06/1, E-13EP07/1, E-13EP08/2, E-13EP09/0, E-13FC01/1, E-13FC01A/1, E-13FC02/2, E-13FC03/1, E-13FC04/3, E-13FC05/5, E-13FC06/1, E-13FC07/1, E-13FC08A/1, E-13FC08B/1, E-13FC09/6, E-13FC10/3, E-13FC11/1, E-13FC12 /1, E-13FC13/1, E-13FC14/1, E-13FC15/1, E-13FC16/2, E-13FC17/0, E-13FC18/4, E-13FC19A/2, E-13FC19B/3, E-13FC20/2, E-13FC21/3, E-13FC22/2, E-13FC23/12, E-13FC24/3, E-13FC25/1, E-13FC26/6, E-13FC27/2, E-13FC29A/1, E-13FC29B/1, E-13FC35/1, E-K3GD01/6, E-K3GD01A/7, E-K3GD02/6, E-K3GD02A/2, E-K3GD03/4, E-K3GD04/6, E-K3GD04A/2, E-K3GD05/5, E-13GF01/0, E-13GF02/0, E-13GF03/2, E-13GF04/0, E-13GF05/0, E-13GF06/0, E-13GF07/0, E-13GF08/0, E-13GF09/0, E-13GF10/0, E-13GF11/0, E-13GF12/0, E-13GF13/0, E-13GF14/0, E-13GG01/6, E-13GG02/3, E-13GG03/1, E-13GG04/0, E-13GG05/0, E-13GG06/1, E-13GG07/0, E-13GG07A/0, E-13GG08/0, E-13GG09/1, E-13GG10/0, E-13GG11/0, E-13GG12/0, E-13GG14/0, E-13GG15/0, E-13GG16/0, E-13GG17/5, E-13GG18/0, E-13GG40/3, E-13GK01A/4, E-13GK01B/2, E-13GK02A/0, E-13GK02B/1, E-13GK02C/2, E-13GK02D/4, E-13GK03A/0, E-13GK03B/0, E-13GK04/0, E-13GK05A/0, E-13GK05B/0, E-13GK05C/1, E-13GK06/0, E-13GK07/3, E-13GK08/0, E-13GK09A/0, E-13GK09B/0, E-13GK10A/2, E-13GK10B/0, E-13GK11/6, E-13GK12/0, E-13GK13/5, E-13GK13A/6, E-13GK14/0, E-13GK15A/0, E-13GK15B/0, E-13GK16/0, E-13GK17/0, E-13GK18/1, E-13GK19/0, E-13GK20/2, E-13GK21/2, E-13GK22/0, E-13GK23/0, E-13GK24/0, E-13GK25/6, E-13GK26/5, E-13GK28/0, E-13GK29/2, E-13GK30A/0, E-13GK30B/0, E-13GK31/4, E-13GK33/1, E-13GL01/0, E-13GL02/0, E-13GL03/0, E-13GL04/1, E-13GL05/1, E-13GL06/3, E-13GL07/2, E-13GL08/1, E-13GL09/0, E-13GL10/0, E-13GL11/0, E-13GL12/3, E-13GL12A/4, E-13GL13/0, E-13GL14/0, E-13GL14A/0, E-13GL15/0, E-13GL16/0, E-13GL17/2, E-13GL18/0, E-13GL21/2, E-13GL23/1, E-13GL24/0, E-13GL25/0, E-13GL26/0, E-13GL27/1, E-13GL28/0, E-13GL29/0, E-13GL30/0, E-13GL31/0, E-13GL32/0, E-13GL33/0, E-13GL34/0, E-13GL35/2, E-13GM01/4, E-13GM01A/4, E-13GM02/0, E-13GM03/0, E-13GM04/0, E-13GM04A/0, E-13GN01/8, E-13GN02/15, E-13GN02A/14, E-13GN03/7, E-13GN04/4, E-13GN05/2, E-13GN06/7, E-13GN07/2, E-13GN09/9, E-13JE01/6, E-13JE01A/1, E-13JE02/4, E-13JE02A/1, E-13JE03/0, E-13JE04/4, E-13KJ01A/13, E-13KJ01B/2, E-13KJ02/7, E-13KJ03A/13, E-13KJ03B/3, E-13KJ04/8, E-13KJ05/4, E-13KJ06/5, E-13KJ07/5, E-13KJ08/2, E-13KJ09/1, E-13KJ10/5, E-13KJ11/2, E-13KJ12/2, E-13KJ13/2, E-13KJ16/1, E-13KJ19/1, E-13LE01/1, E-13LE02/1, E-13LE03/1, E-13LE04/1, E-13LE05/1, E-13LE06/1, E-13LE08/1, E-13LE09/1, E-13LE10/1, E-13LE11/1, E-13LE12/1, E-13LE13/1, E-13LF01/1, E-13LF02/2, E-13LF03/2, E-13LF04/2, E-13LF05/2, E-13LF06/7, E-13LF07/5, E-13LF08/3, E-13LF09A/3, E-13LF09B/2, E-13LF10/1, E-13LF11/1, E-13LF12/1, E-13LF13/1, E-13LF14/2, E-13LF15/10, E-13LF16/6, E-13LF17/1, E-13LF18/1, E-13LF19/1, E-13LF20/3, E-13MR01/3, E-13MR10/8, E-13MR11/1, E-13NB01/2, E-13NB02/2, E-13NB03/4, E-13NB04/2, E-13NB05/1, E-13NB06/2, E-13NB10/2, E-13NB11/4, E-13NB12/5, E-13NB13/5,

E-13NB14/6, E-13NB15/5, E-13NB16/0, E-13NE01/12, E-13NE02/10,
E-13NE10/15, E-13NE11/13, E-13NE12/9, E-13NE13/10, E-13NF01/3,
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E-11NG02/8, E-11NB01/2, E-11NB02/2, E-11NE01/8, E-11NG01/9,
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E-13PG11/1, E-13PG12/4, E-13PG12A/3, E-13PG13/0, E-13PG14/0,
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E-13SB01/0, E-13SB02/1, E-13SB03/1, E-13SB04/1, E-13SB05/2,
E-13SB06/0, E-13SB07/2, E-13SB08A/1, E-13SB08B/1, E-13SB08C/1,
E-13SB08D/1, E-13SB09/0, E-13SB10/0, E-13SB11/2, E-13SB12A/2,
E-13SB12B/3, E-13SB13/1, E-13SB14/1, E-13SB15/2, E-13SB16/0,
E-13SB17/0, E-13SB18/0, E-13SB19/1, E-13SC12/0, E-13SE01/6,
E-13SE02/7, E-13SE03/2, E-13SE04/2, E-13SE05/1, E-13SE06/0,
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E-1R0223/0, E-0R0224/3, E-KR0231/9, E-KR0232/16, E-KR0232A/7,
E-KR0234/4, E-KR0235/2, E-KR0901/15, E-0R0901/1, E-KR0902/6,
E-OR1111/15, E-OR1112/5, E-1R1113/14, E-1R1114/3, E-1R1121/0,
E-1R1122/1, E-1R1123/16, E-1R1124/9, E-1R1131/2, E-1R1132/0,
E-1R1133/8, E-1R1141/1, E-1R1142/0, E-1R1143A/2, E-1R1143B/5,
E-1R1143C/5, E-1R1143D/5, E-1R1143E/3, E-1R1153/8, E-1R1233/4,
E-1R1311/3, E-0R1312/2, E-1R1313A/3, E-1R1313B/4, E-1R1313C/0,
E-1R1313D/5, E-1R1321/2, E-0R1322/6, E-1R1323A/10, E-1R1323B/6,
E-1R1323C/4, E-1R1323D/7, E-1R1323E/4, E-0R1331/11, E-0R1332/2,
E-1R1333A/5, E-1R1333B/10, E-1R1333C/10, E-1R1341/3, E-0R1342/5,
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E-1R1423B/8, E-1R1423C/7, E-1R1423D/5, E-1R1424/7, E-1R1431/2,
E-1R1433A/11, E-1R1433B/9, E-1R1433C/4, E-1R1441/6, E-1R1443A/7,
E-1R1443B/12, E-1R1443C/12, E-1R1444A/4, E-1R1444B/7, E-1R1444C/13,
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E-1R1523C/3, E-1R1523D/3, E-1R1524/6, E-1R1531/0, E-1R1533A/5,
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E-0R1903/12, E-1R1904/0, E-0R1905/4, E-0R1906/9, E-0R1907/5,
E-1R1908/2, E-1R1909/0, E-1R1910/4, E-1R1911/10, E-1R1912/1,
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E-1R1918/5, E-1R1919/0, E-1R2112/3, E-1R2122/1, E-1R2311/1,

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Impacted by this calculation:	Fire Pre-Plan Procedures (FPPs), AP 10-106, ALR KC-888, OFN RP-014, OFN RP-017, E-15000/67, E-1F9001/5, E-1F9101/4, E-1F9102/4, E-1F9103/4, E-1F9201/3, E-1F9202/3, E-1F9203/2, E-1F9204/2, E-1F9205/2, E-1F9301/4, E-1F9302/7, E-1F9401A/3, E-1F9401B/1, E-1F9402A/1, E-1F9402B/1, E-1F9403/3, E-1F9411A/0, E-1F9411B/1, E-1F9412A/0, E-1F9412B/0, E-1F9421/4, E-1F9422A/2, E-1F9422B/1, E-1F9422C/2, E-1F9423/0, E-1F9424A/7, E-1F9424B/6, E-1F9424C/4, E-1F9424D/2, E-1F9424E/3, E-1F9425/1, E-1F9426/1, E-1F9431/0, E-1F9432/0, E-1F9433/4, E-1F9441/0, E-1F9442/1, E-1F9443/1, E-1F9444/2, E-1F9910/6, AN 95-029, AN 98-023
The reference documents listed below are those that cannot be linked to the calculation and shall be entered in the INDUSTRY REFERENCE field in EIS, e.g., ASME Codes, ANSI Standards, letters, etc.	
OTHER REFERENCE DOCUMENTS:	PIRs 94-1436, 95-2327, 97-0991, 99-1245, 99-2290, 99-2482, 99-1100, 02-2474, 04-0089, 05-3209, 05-3314, 05-3333, 2006-000551, 2006-000860, 2007-003000, 2007-003037 CRs 23410, 24281, 25002, 41746, 46637 TMO 10-004-NE (CP 013095) Westinghouse Technical Bulletin TB-04-22, Rev. 1 NRC Information Notice 2005-14 M-622.1A NEI-00-01, Rev. 2 NUREG-1852 Westinghouse WCAP-17541-P, Rev. 0
Link components to the calculation in EIS.	

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Develop relationships between interdependent calculations in EIS:

This Calculation Supersedes:	None
This Calculation Superseded By:	None

REFER TO DESKTOP GUIDE FOR PROCESSING CALCULATIONS IN EIS.

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The entire calculation has been revised to Revision 4. Actual changes are indicated by revision bars in the right hand column. Changes to Appendices 3 and 4 are indicated by revision number in the right hand column.

1. Purpose

This analysis provides the assumptions and methodology utilized to determine which components and systems provide the functions necessary to achieve and maintain PFSSD.

This analysis identifies how WCGS uses the assumptions and methodology to achieve and maintain safe shutdown following a fire in any plant fire area.

2. Results, Conclusions and Recommendations

2.A. Results

WCGS commitments have been reviewed and applied in the methodology and criteria of this analysis. This analysis establishes the updated design bases for achieving and maintaining a PFSSD condition. PFSSD logic diagrams, PFSSD component list, PFSSD relay list, and updated E-15000/SETROUTE database have been created from this methodology.

The logic diagrams depict the processes, systems, components, and redundant components necessary to affect the functions required for PFSSD. The PFSSD component list (Appendix 3) is derived from the logic diagrams.

E-15000/SETROUTE reflects the results of this analysis and references the applicable PFSSD logic diagrams against each PFSSD component. The components/cables required to achieve and maintain PFSSD have been evaluated and identified as post fire safe shutdown (S.) in E-15000. Cables have been evaluated and those identified as potentially initiating a loss of off site power (LOOP) have been labeled in E-15000 as “O.” or “D.”.

2.B. Conclusions

This analysis establishes the PFSSD design bases. It demonstrates WCGS’s ability to achieve and maintain post-fire safe shutdown in the event of a fire in any area in the plant.

2.C. Recommendations

The evaluations and results as documented in this analysis should be applied as a part of the Fire Protection Review Program, when maintaining, modifying, or replacing the PFSSD components listed in this analysis or its attachments and appendices.

3. Assumptions and Design Inputs

3.A. Assumptions

3-A-1 A fire involving either transient or in situ combustibles is assumed to occur in only one plant fire area at a time. Unrelated fires in two or more fire areas do not occur simultaneously.

Basis: 10 CFR 50, Appendix R, Introduction and Scope; G.L. 86-10, Enclosure 1, Paragraph 4; NEI 00-01, Rev. 2, Paragraph 3.4.1.1.

3-A-2 It is assumed that the only failures during a fire are those that are directly attributable to the fire.

Basis: NRC Generic Letter 86-10, Response to Question 7.2; NEI 00-01, Rev. 2, Paragraph 3.1.1.6.

3-A-3 Design basis fires are not assumed to occur concurrently with non-fire related failures in safety systems, plant accidents, or the most severe natural phenomena.

Basis: NRC Generic Letter 86-10, Response to Question 7.2; NUREG 0800, Section 9.5-1, Rev. 3, paragraph C.1.b.

3-A-4 Except for an automatic feedwater isolation signal (FWIS), a fire in areas requiring alternative shutdown capability (i.e., control room) is assumed to cause a loss of automatic function of valves and pumps with control circuits that could be affected by a control room fire. For example, in the event of a loss of offsite power the emergency diesel generators will normally start automatically on undervoltage. However, in developing the alternative shutdown strategy, capability of this automatic feature to operate is not assumed. In the case of an automatic FWIS it is assumed that a FWIS is unaffected by a fire in the control room and that the FWIS will automatically close the main feedwater isolation valves and/or the main feedwater regulating valves (MFRVs) and MFRV bypass valves.

Basis: NRC Generic Letter 86-10, Response to Question 3.8.4; NEI 00-01, Rev. 2, Paragraph 3.3.1.1.4.1; License Amendment 214.

3-A-5 For fire areas not requiring an alternative shutdown capability, automatic operation of components and logic circuits is credited in the analysis only where the control circuits associated with the automatic operation are known to be unaffected by the postulated fire (i.e., III.G.2 separation requirements are satisfied).

Basis: 10 CFR 50, Appendix R, Specific Requirements Sections III.G.1 and III.G.2; NEI 00-01, Rev. 2, Paragraphs 3.1.1.10 and 3.3.1.1.4.1.

3-A-6 Off-site power may or may not be available. The maximum duration of any loss of offsite power event is assumed to be 72 hours.

Basis: 10 CFR 50, Appendix R, Section III.L.3; NUREG 0800, Section 9.5-1, Rev. 3, paragraph C.1.b.

3-A-7 Loss of offsite power has been specifically evaluated for every fire area to demonstrate where a LOOP may occur as a result of a fire. For alternate shutdown, a LOOP is considered as a simultaneous event. (Appendix 2 identifies fire areas where a fire may cause a LOOP)

Basis: 10 CFR 50, Appendix R, Section III.L.3; NUREG 0800 Position C5.c.(3); NEI 00-01, Rev. 2 paragraph 3.1.1.7.

3-A-8 Failure of onsite power supplies is not assumed unless it is caused as a direct consequence of a fire.

Basis: 10 CFR 50, Appendix R, Section III.L.3; NUREG 0800 Position C5.c.(4); NEI 00-01, Rev. 2, Paragraph 3.1.1.7.

3-A-9 Only those local manual operations (valve positioning using manual valve operators, circuit breaker operation, switch positioning, fusible switch operation, reading local indicators, etc.) that are documented as being feasible and reliable and are allowed by the Wolf Creek Operating License are acceptable in achieving post fire safe shutdown for fires in redundant shutdown fire areas.

Basis: NUREG-1852 dated October 2007.

3-A-10 The reactor is tripped manually from the control room prior to control room evacuation.

Basis: NRC Generic Letter 86-10, Response to Question 3.8.4

3-A-11 Assumption has been deleted.

3-A-12 Assumption has been deleted.

3-A-13 The plant is operating at 100% power upon the occurrence of the fire.

Basis: NEI 00-01, Rev. 2, Paragraph 3.1.1.5 (** See note at end of section 3-A.)

3-A-14 Where it can be demonstrated that a repair can be accomplished within 72 hours, modification and repairs are allowed to achieve and maintain cold shutdown from either the control room or emergency control station (s).

Basis: 10 CFR 50, Appendix R, Section III.G.1.b; Information Notice IN 84-09, Attachment 1, Item XI; NUREG 0800 Position C5.b(1)(b)

3-A-15 Modification and repair activities are allowed for cold shutdown systems provided the repair can be performed and cold shutdown achieved within 72 hours for areas requiring alternative shutdown capability.

Basis: 10 CFR 50, Appendix R, Section III.L.5; NUREG 0800 Position C5.c.(5)

3-A-16 Three-phase AC Circuits: For three-phase AC circuits, it is assumed that the probability of having a hot short on all three phases, in the proper sequence, to cause spurious operation of a motor is extremely low and does not require evaluation, except those involving high/low pressure interface components.

Basis: Generic Letter 86-10 Question 5.3.1

3-A-17 For ungrounded DC circuits, it is assumed that two or more proper polarity faults in multi-conductor cables is not credible except in cases involving high/low pressure interface components.

Basis: Reg Guide 1.189, Rev. 1, Section 5.4.2.b

3-A-18 Assumption has been Deleted per CCN-XX-E-013-000-CN006.

3-A-19 An automatic signal is assumed to be present if it initiates an adverse spurious operation or prevents a required operation unless a specific evaluation has been performed to determine the status of the automatic signal.

Basis: Generic Letter 86-10, answer b to Question 5.3.10; NEI 00-01, Rev. 2, Paragraph 3.3.1.1.4.1.

3-A-20 For fires in areas requiring alternative or dedicated shutdown capability, one worse-case spurious actuation is assumed in conjunction with a loss of off-site power. Since any spurious actuation can occur, procedures provide mitigating actions for all potential failures. The one worse-case failure assumption is used only for analysis of the operational baseline and to define the scope of actions to restore systems necessary to accomplish the required reactor performance criteria.

Basis: NRC Generic Letter 86-10, answer a to question 5.3.10

3-A-21 Components or systems required for post fire safe shutdown are available at the time of the fire (i.e., not out of service).

Basis: NEI 00-01, Rev. 2, Paragraph 3.1.1.5. (** See note at end of section 3-A.)

3-A-22 Systems and components are in their normal operating position or status prior to the fire. All relay, position switch, and control switch contacts in the control circuits are in the position or status that correspond to the normal operation of the device.

Basis: NEI 00-01, Rev. 2, Paragraph 3.1.1.5. (** See note at end of section 3-A.)

3-A-23 All valves are assumed to be in the position depicted on the P&ID or applicable Operating Instruction System Valve Line Up for 100% power operation.

Basis: NEI 00-01, Rev. 2, Paragraph 3.2.1.3. (** See note at end of section 3-A.)

3-A-24 Piping (welded and flanged), tanks, heat exchangers, manually operated valves, check valves, relief valves and pressure vessels are assumed to remain functional during and after a fire. Manually operated components (such as manually operated valves) are assumed to remain in their pre-fire position. Electrical components subject to fire damage (such as motors, solenoid operated valves or MOV valve operators) will be evaluated as necessary for post fire operability. Check valves close in the direction of potential flow diversion and seat properly with sufficient leak tightness to prevent flow diversion. Therefore, check valves do not adversely affect the flow rate capability of the safe shutdown systems being used for inventory control, decay heat removal, equipment cooling or other related safe shutdown functions.

Basis: NEI 00-01, Rev. 2, Paragraphs 3.2.1.2 and 3.2.1.4. (** See note at end of section 3-A.)

3-A-25 “Chattering” or cycling of the contact (i.e., open/close/open...) by the fire is not postulated.

Basis: NRC Generic Letter 86-10 Response to Question 5.3.2

3-A-26 A high impedance fault is assumed to exist until corrective action is performed to isolate the high impedance fault.

Basis: NRC Generic Letter 86-10 Response to Question 5.3.8; NRC Generic Letter 86-10 Response to Question 5.3.2

3-A-27 Assumption has been deleted.

3-A-28 A fire within an area is not expected to affect the operability of any systems or components that are independent (both physically and electrically) of the area. Conversely, a fire that occurs outside of an area is not expected to affect the operability of equipment located within the area.

Basis: NRC Generic Letter 86-10, Enclosure I, Interpretations of Appendix R, Section 4

3-A-29 Cold shutdown repairs will be made using only onsite capabilities which may include fuse replacement, cable splicing and replacement, lifting cable leads, component and equipment replacement, etc.

Basis: 10 CFR 50, Appendix R, Introduction and Scope; NRC Generic Letter 86-10, Interpretations of Appendix R, Section 2

3-A-30 Both trains of equipment necessary for mitigation of consequences following design basis accidents may be damaged by a single exposure fire.

Basis: 10 CFR 50, Appendix R, Introduction and Scope

3-A-31 Shutdown systems installed to ensure post fire safe shutdown capability need not be safety related except where required for other reasons.

Basis: 10 CFR 50, Appendix R, Specific Requirements III.L.6; NEI 00-01, Rev. 2, Paragraph 3.1.1.8.

3-A-32 Internal jumpers are not considered as cables for this evaluation however, fire effects on internal jumpers are evaluated as part of an enclosure fire.

Basis: Enclosures (panels, MCCs, Boards, etc.) that contain internal jumpers are evaluated.

Therefore, internal jumpers required for PFSSD are included in the PFSSD design.

3-A-33 Wolf Creek's electrical breaker protection design provides for electrical breaker coordination. A cable fault will be isolated at the lowest possible breaker or fuse.

Basis: USAR section 8.1.4; USAR section 8.3.1.1.2; WCNOC-76

3-A-34 Instruments (e.g., resistance temperature detectors, thermocouples, pressure transmitters, and flow transmitters) are assumed to fail upscale, midscale, or downscale as a result of fire damage, whichever is worse. An instrument performing a control function is assumed to provide an undesired signal to the control circuit.

Basis: NEI 00-01, Rev. 2, Section 333.2.1.5

**Note: In general, the plant initial conditions assumed for a fire are those that require maximum times for the control of the functions (reactivity control, reactor makeup, decay heat removal) to achieve hot standby and subsequent cold shutdown. The probability of maintenance-affected items during a fire is assumed to be comparable to those of an accident where more stringent criteria are applied (single failure, environmental phenomenon, etc.). The plant is normally at 100% power operation and in a normal plant alignment. Non-electrically powered mechanical components are generally in wet piping systems and therefore require significant heat and duration to become incapable of performing their passive functions (check valve remain closed, normally open and closed valves remaining in their normal alignment positions).

3.B. Design Inputs

3-B-1 Design:

3-B-1.1 Design documents utilized in this analysis are summarized below. For a detailed listing see the References.

Calculation AN-96-062, "Retran Analysis of Plant Shutdown Capability Following a Postulated Fire in Fire Area A-18"

System Descriptions (E-00/E-10, M-00/M-10)

E-15000, Electrical Cable and Raceway List

Piping and Instrumentation Diagrams (P&IDs) (M-02/M-12)

One-Line and Elementary Electrical Diagrams (E-01/E-11)

Schematic Diagrams (E-03/E-13)

Raceway Drawings (E-0R/E-1R)

Fire Area Delineation Drawings (A-08/A-18)

3-B-2 Technical References:

Bechtel Electrical Fire Hazards Analysis, Doc Type 117.01

10 CFR 50, Appendix R, Sections III.G and III.L

Generic Letter 81-12, Fire Protection Rule – Appendix R, February 20, 1981

Clarification of Generic Letter 81-12, Fire Protection Rule – Appendix R, March 22, 1982

Generic Letter 86-10, Implementation of Fire Protection Requirements, May 15, 1986

Information Notice IN 85-09, Isolation Transfer Switches and Post-Fire Shutdown Capability

Generic Letter 83-33, NRC Positions On Certain Requirement Of Appendix R To 10 CFR 50, October 19, 1983

Information Notice IN 92-18, Potential For Loss Of Remote Shutdown Capability During A Control Room Fire, February 28, 1992

Information Notice IN 97-07, Problems Identified during Generic Letter 89-10 Closeout Inspections, March 6, 1997

Information Notice IN 99-17, Problems Associated with Post-Fire Safe Shutdown Circuit Analyses

3-B-3 Licensing Bases:

Wolf Creek Generating Station, Unit No. 1, Facility Operating License, paragraph 2.C.5

Wolf Creek Nuclear Generating Station USAR Section 9.5

Wolf Creek Nuclear Generating Station USAR Appendix 9.5B

NUREG 0800, Standard Review Plan, 9.5.1 Fire Protection Program

NUREG 0881, Safety Evaluation Report, April 1982

NUREG 0881, Safety Evaluation Report, Supplement No. 3, August 1983

NUREG 0881, Safety Evaluation Report, Supplement No. 5, March 1985

SNUPPS Letter SLNRC 82-046, Fire Protection Review, November 15, 1982

SNUPPS Letter SLNRC 84-0106, Fire Protection Review, August 10, 1984

E-1F9915, Design Basis Document for OFN RP-017, Control Room Evacuation

Cermak Fletcher Associates, Inc. Letter CFA 92-097, Control Room Fire Phase A Actions / Timing, October 13,1992

3-B-4 Procedures:

Wolf Creek Nuclear Generating Station OFN RP-014, Hot Standby To Cold Shutdown From Outside The Control Room

Wolf Creek Nuclear Generating Station OFN RP-017, Control Room Evacuation

4. Methodology, Nomenclature and Computations

4-A Methodology

PFSSD is the ability to bring the plant from full power to a cold shutdown condition after a fire occurs in any area of the plant. This safe shutdown capability is achieved by meeting applicable criteria or by providing a PFSSD type evaluation of specific fire area conditions such that the intent of the criteria is met.

The criteria are set forth in 10 CFR 50 Appendix R III.G “Fire Protection of Safe Shutdown Capability” and III.L “Alternative and Dedicated Shutdown Capability”. Section III.G.1 requires that:

Fire protection features shall be provided for structures, systems, and components important to safe shutdown. Fire protection features shall be capable of limiting fire damage so that:

One train of systems (equipment) necessary to achieve and maintain hot standby from either the control room or emergency control station(s) is free of fire damage.

Systems necessary to achieve and maintain cold shutdown from either the control room or emergency control station(s) can be repaired (made operable) within 72 hours. [Both trains (systems / equipment) may be damaged by a single fire, including an exposure fire, but damage must be limited so that at least one train / system is repaired within 72 hours using onsite capability.] Where alternate shutdown is required, cold shutdown conditions must be achieved within 72 hours.

Section III.G.2 requires that: Except as provided for in III.G.3 of this section (alternative or dedicated shutdown capability), where cables or equipment, including associated non-safety circuits that could prevent operation or cause mal-operation (improper) due to hot shorts, open circuits, or shorts to ground, of redundant trains of systems necessary to achieve and maintain hot standby conditions are located within the same fire area outside of primary containment, one of the following means of ensuring that one of the redundant trains is free of fire damage shall be provided:

(<u>3-hour Fire Barrier</u>): Separation of cables and equipment and associated non-safety circuits of redundant trains by a fire barrier having a 3-hour fire rating. Structural steel forming a part of or supporting such fire barriers shall be protected to provide fire resistance equivalent to that required of the barrier.

(<u>Horizontal Separation with detection and automatic suppression</u>): Separation of cables and equipment and associated non-safety circuits of redundant trains by a horizontal distance of more than 20 feet with no intervening combustible or fire hazards. In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area, or

(<u>1-hour enclosure with detection and automatic suppression</u>): Enclosure of cable and equipment and associated non-safety circuits of one redundant train in a fire barrier having a 1-hour rating. In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area;

Inside non-inerted containments one of the fire protection means specified above or one of the following fire protection means shall be provided:

a. Separation of cables and equipment and associated non-safety circuits of redundant trains by a horizontal distance of more than 20 feet with no intervening combustible or fire hazards;

b. Installation of fire detectors and an automatic fire suppression system in the fire area; or

c. Separation of cables and equipment and associated non-safety circuits of redundant trains by a noncombustible radiant energy shield.

Section III.G.3 requires that alternative or dedicated shutdown capability and its associated circuits, independent of cables, systems, or components in the area, room, or zone under consideration, shall be provided:

a. Where the protection of systems whose function is required for hot standby does not satisfy the requirement of paragraph III.G.2; or

b. Where redundant trains of systems required for hot shutdown (standby) located in the same fire area may be subject to damage from fire suppression activities or from the rupture or inadvertent operation of fire suppression systems.

In addition, fire detection and a fixed fire suppression system shall be installed in the area, room, or zone under consideration.

Satisfying the criteria provides reasonable assurance that plant conditions can be controlled through the functions of reactivity control, decay heat removal, RCS and feedwater makeup, process monitoring and support systems to achieve PFSSD.

In bringing the plant down from full power to cold shutdown multiple operational stages are traversed: full power; hot standby; hot shutdown and cold shutdown. The term " post fire safe shutdown" (PFSSD) refers to the conditions and events occurring after the reactor trip through cold shutdown accomplishment. Accomplishing PFSSD involves controlling the above listed functions while traversing the different stages. At WCGS the two stages analyzed are Hot Standby and Cold Shutdown. The reason for this is because of the immediate actions required for PFSSD, which renders the plant in an immediate return to power condition or in a repair condition, which requires cold shutdown.

Post fire safe shutdown methodology consists of identifying the systems, components, indication, and support systems required to control the PFSSD functions. This includes:

1. Defining the functions required for achieving and maintaining hot standby and cold shutdown conditions after a fire has occurred in a safety-related area of the plant.
2. Development of logic diagrams to validate/verify the process by which PFSSD is achieved.
3. Analyzing the as-built conditions of PFSSD components / systems and the redundant components / systems cable routing, and component locations.

PFSSD methodology is based on criteria set forth in 10 CFR 50 Appendix R., Section III.G and L supplemented by GL 81-12 and GL 86-10.

PFSSD achievement and maintenance functions and their codes are:

1. Reactivity Control (R) – Required for achieving and maintaining cold shutdown reactivity conditions.
2. Reactor Coolant Makeup (M) – Required for maintaining the reactor coolant level within the level indication in the pressurizer.
3. Decay Heat Removal (H) – Required for achieving and maintaining decay heat removal.
4. Process Monitoring (Temperature, Pressure, and Level) – Included with above functions.
5. Support Systems (S) – Required for providing the process cooling, lubrication, etc., necessary to permit the operation of the equipment used for post fire safe shutdown functions.

These PFSSD functions apply to both hot standby and cold shutdown conditions. However, the systems utilized to achieve post-fire cold shutdown are slightly different. For example, during hot standby the decay heat removal function is provided by auxiliary feedwater and steam generators whereas, during cold shutdown the decay heat removal function is provided by RHR and CCW.

The application of these functions establishes the systems and components required for PFSSD. The components required for PFSSD are listed in Appendix 3 to this analysis.

For a fire in the control room, a method is provided for achieving PFSSD conditions from outside the control room. This method is known as “Alternative Shutdown Capability”. Alternative shutdown capability includes the use of isolation switches installed to isolate post fire safe shutdown required circuits from potential control room fire damage. For example, the motor driven auxiliary feedwater pump “B” has an isolation switch on RP118B to isolate its circuits from the control room, allowing operation from the auxiliary shutdown panel (ASP) RP118B.

Alternative shutdown capability can be provided by rerouting, relocating, or modifying existing systems or by providing implementation of procedures specifying “alternative” methods of operation such as local manual operations and/or shutdown from the ASP.

4-A-1 PFSSD System Applicability Selection:

PFSSD system selection was accomplished by reviewing licensing, design, and operating documents and applying the PFSSD function requirements.

4-A-1.1 Licensing Documentation Review:

Licensing documents were reviewed for commitments related to the ability to achieve and maintain PFSSD conditions. Searches on existing correspondence, analyses, calculations, and USAR sections were made to determine restrictions, limitations, or impacts on plant operation, design, or special condition. Such documents include: the WCGS operating license, SLNRC 84-0106 and 84-0109; SSER 3 and 5; USAR Section 9.5B and USAR Table 9.5E-1.

4-A-1.2 Design Documentation Review:

System Descriptions provide general manufacturing, design, and operational information of WCGS systems, components, and equipment.

Drawings reviewed include the following:

- P&IDs (M-02/M-12) – Provides the as-built piping and instrument layout utilized in determining the components / equipment of a system that is required to achieve and / or maintain the PFSSD functions.
- One-Line Diagrams (E-01/E-11) – Provides information on plant power supply and distribution systems. These are used to determine the on-site and off-site bus ties and power feeds to different PFSSD related equipment.
- Electrical Schematic Drawings (E-03/E-13) – Provides the as-built wiring configuration utilized in determining the cables and circuits of the components / equipment required to achieve and / or maintain the safe shutdown functions.
- System Design Basis Documents (system descriptions, loop/logic diagrams, etc.) – Provides the operating philosophy of the system and its components.
- Raceway Drawings (E-0R/E-1R) – Provides the as-built routing configuration utilized in determining the cable raceways and routings.
- SETROUTE Database (E-15000) – Provides cable, raceway and termination information related to power block components, raceway and cables.

4-A-1.3 System Operating Procedure Review:

The following documentation was reviewed during the post fire safe shutdown system selection:

- General Operating Procedures
- System Operating Procedures
- Off Normal Procedures
- Emergency Operating Procedures

4-A-2 PFSSD Functions:

PFSSD functions are terms describing control activities. The functions are: (1) reactivity control; (2) reactor coolant makeup; (3) decay heat removal; (4) process monitoring and (5) support systems. The functions must be achieved under post-fire conditions to prevent severe damage to the reactor core. The systems, components and design features affecting the operation of components has to be determined and factored into the post fire safe shutdown analyses for both hot standby and cold shutdown for fires in the control room and outside the control room. The PFSSD component list (Appendix 3) and PFSSD relay list (Appendix 4) contain the list of components and relays necessary to achieve the PFSSD functions.

4-A-2.1 Reactivity Control:

Reactivity control is required to ensure that the reactor is sub-critical. This can be accomplished by inserting the control rods and / or adding sufficient quantities of boron to the RCS. When the plant has to be shutdown immediately, due to a fire, the control rods are inserted by “reactor trip” in the control room. This brings the plant to a Hot Standby condition. For a fire in the control room, the plant may be maintained in hot standby until the transition to cold shutdown is initiated. Adding boron to the RCS will be required to achieve cold shutdown. The following systems are required to achieve and maintain post-fire reactivity control:

- Main Steam (AB) – Isolate to Control Cooldown
- Main Turbine (AC) – Isolate to Control Cooldown
- Reactor Coolant (BB) – Borate
- Chemical and Volume Control (BG) – Borate
- Steam Generator Blowdown (BM) – Isolate to Control Cooldown
- Borated Refueling Water Storage (BN) – Borate
- High Pressure Coolant Injection (EM) – Prevent Spurious Operation, save RWST inventory
- Containment Spray (EN) – Prevent Spurious Operation, save RWST inventory
- Auxiliary Steam (FB) – Isolate to Control Cooldown
- Auxiliary Turbines (FC) – Isolate to Control Cooldown
- Miscellaneous Control Panels (RP) – Control Room Isolation
- Reactor Protection (SB) – Insert Negative Reactivity
- Ex- Core Neutron Monitoring (SE) – Provide Reactivity Status

Reactivity control is maintained from the initiating trip to cold shutdown conditions. Positive reactivity increases resulting from xenon decay and reactor coolant temperature decreases is compensated for by the addition of boron via the charging pumps taking suction from the Refueling Water Storage Tank (RWST).

The cooldown transition from hot standby to cold shutdown requires additional boration to maintain the required margin of shutdown reactivity. This additional boration compensates for the negative moderator coefficient and xenon decay.

4-A-2.2 Reactor Coolant Makeup:

Reactor coolant makeup is required to ensure that the reactor core is covered with borated water for maintaining a negative reactivity condition and for circulation to remove latent and decay heat. The following PFSSD systems are required to achieve and maintain post-fire reactor coolant makeup:

- Main Steam (AB) – Isolate to Control Cooldown and Loss of Pressurizer Level
- Reactor Coolant (BB) – Control Inventory, Provide Indication
- Chemical and Volume Control (BG) – Add Inventory
- Steam Generator Blowdown (BM) – Isolate to Control Cooldown and Loss of Pressurizer Level)
- Borated Refueling Water Storage (BN) – Provide Inventory
- Residual Heat Removal (EJ) – Isolate to Control Inventory
- High Pressure Coolant Injection (EM) – Prevent Spurious Operation, save RWST inventory
- Containment Spray (EN) – Prevent Spurious Operation, save RWST inventory)
- Miscellaneous Control Panels (RP) – Control Room Isolation

Reactor coolant inventory control is required to ensure that sufficient makeup inventory is provided to compensate for RCS fluid shrinkage during cooldown and losses by leakage from the system. Satisfactory performance of this function is achieved by maintaining pressurizer level within the level indication in the pressurizer. Reactor coolant system pressure control is required to ensure that RCS pressure is high enough to prevent boiling of the coolant. As T_{avg} decreases the required RCS pressure decreases to a point where the RHR system can be utilized to cool down and maintain cold shutdown conditions. The following systems are required to achieve and maintain post fire reactor coolant system pressure control:

Main Steam (AB) – Isolate to Control Cooldown and Loss of Pressurizer Level

Reactor Coolant System (BB) – Control Inventory, Provide Indication

Chemical and Volume Control (BG) – Add inventory
Reactor Instrumentation (SC) – Control pressurizer pressure and level.

Reactor coolant system pressure control must be maintained to ensure that RCS pressure is:

Maintained within the Technical Specification limits for RCS pressure/temperature requirements.
Controlled to prevent peak RCS pressure from exceeding system design pressure.
Maintained to ensure an adequate sub-cooling margin to preclude void formation within the reactor vessel during decay heat removal by natural circulation.

4-A-2.3 Decay Heat Removal:

There are two phases of decay heat removal: (1) Hot Standby and (2) Cold Shutdown. Hot standby is the phase from a full power reactor trip to the point where RCS T_{avg} is at or above 350°F. Cold shutdown is when the RCS temperature is less than 200°F. The following systems are required to achieve and maintain post fire decay heat removal:

- Main Steam (AB) – Isolate to Control Cooldown
- Main Turbine (AC) – Isolate to Control Cooldown
- Feedwater (AE) – Isolate to Control Cooldown, Provide Steam Generator Level Indication
- Auxiliary Feedwater (AL) – Remove Heat
- Condensate Storage and Transfer (AP) – Supply to Auxiliary Feedwater (AFW)
- Reactor Coolant (BB) – Isolate, Cooldown RCS, RCS Pressure and Temperature
- Steam Generator Blowdown (BM) – Isolate to Control Cooldown
- Borated Refueling Water Storage (BN) – Isolate RWST
- Essential Service Water (EF) – Remove Heat
- Residual Heat Removal (EJ) – Remove Heat
- Accumulator Safety Injection (EP) – Isolate Safety Injection (SI)
- Auxiliary Steam (FB) – Isolate to Control Cooldown
- Auxiliary Turbines (FC) – Isolate to Control Cooldown
- Lower Medium Voltage – 4.16KV (Non- Class 1E Power) (PB) – Isolate to Control Cooldown
- Miscellaneous Control Panels (RP) – Control Room Isolation

Decay heat removal is required to remove both decay and latent energy from the reactor core and primary system at a rate such that overall system temperature can be maintained within acceptable limits. For alternative shutdown areas, this function is to achieve cold shutdown conditions within 72-hours and maintain cold shutdown thereafter. For non-alternative shutdown areas, only the capability to restore/repair equipment to achieve and maintain cold shutdown conditions must be feasible within 72-hours.

4-A-2.4 Process Monitoring:

Process monitoring is required to assure the ability to determine the temperature, pressure, level and other parameters of PFSSD systems, including indication of certain components that are required for accomplishing PFSSD conditions. The following systems are required to achieve and maintain the post fire process monitoring function:

Main Steam (AB)

- Steam Generator Pressure

Feedwater (AE)

- Steam Generator Wide Range Level
- Steam Generator Narrow Range Level

Auxiliary Feedwater (AL)

- Auxiliary Feedwater Flow Diagnostic Instrumentation
- Condensate Storage Tank Level

Reactor Coolant (BB)

- RCS Pressure
- Pressurizer Level
- Pressurizer Pressure
- Reactor Coolant Wide Range Hot Leg Temperature
- Reactor Coolant Wide Range Cold Leg Temperature

Borated Refueling Water Storage (BN)

- RWST Level Indicators

Residual Heat Removal (EJ)

- RHR System Flow Diagnostic Instrumentation

Auxiliary Turbines (FC)

- Auxiliary Feedwater Pump (AFWP) Turbine Speed Indication

Ex-Core Neutron Monitoring (SE)

- Source Range Monitors

Process monitoring is required to identify the status of key process variables in order to modify system alignments and/or control post fire safe shutdown equipment. Process monitoring instrumentation includes remote indication in the control room or at the Auxiliary Shutdown Panel (ASP) and local tank level, system temperature, system pressure, and system flow instruments necessary for the operators to perform and/or control post fire safe shutdown functions. Process monitoring is included with the functions/systems required for PFSSD.

4-A-2.5 Support Systems:

Support is the ability to provide system components with operating environments: power, lubrication, and cooling that are necessary for accomplishing PFSSD functions. In addition, support systems provide preventive measures in support of the reactivity control, reactor coolant makeup, or heat removal functions. The following support systems are required to accomplish the support function:

- Main Steam (AB) – SI Initiator
- Reactor Coolant (BB) – SI Initiator
- Chemical and Volume Control (BG) – Isolate Excess Letdown Heat Exchanger
- Essential Service Water (EF) – Remove Heat
- Component Cooling Water (EG) – Remove Heat
- Essential Service Water Pumphouse HVAC (GD) – Provide HVAC
- Miscellaneous Buildings HVAC (GF) – Provide HVAC
- Control Building HVAC (GK) – Provide HVAC
- Auxiliary Building HVAC (GL) – Provide HVAC
- Diesel Building HVAC (GM) – Provide HVAC, Combustion Air
- Containment Cooling (GN) – Provide Cooling
- Emergency Fuel Oil (JE) – Emergency Diesel Generator (EDG) Fuel Oil, Indication
- Instrument Air (KA) - Provide motive force for air operated components.
- Fire Protection (KC) – ESF Switchgear AC
- Service Gas (KH) - Provide nitrogen to air operated components.
- Standby Diesel Engine (KJ) – Provide Power
- Main Generation (MA) – Transformer Protection
- Startup Transformer (MR) – Provide Power
- Lower Medium Voltage – 4.16KV (Class 1E Power) (NB) – Provide Power
- Standby Generation (NE) – Provide Power
- Load Shedding & Emergency Load Sequencing (NF) – Automatic Actuation Initiator
- Lower Voltage – 480V (Class 1E Power) (NG) – Provide Power
- 125V DC (Class 1E Power) (NK) – Provide Power
- Instrument AC Power – 120V (Class 1E Power) (NN) – Provide Power
- Higher Medium Voltage – 13.8 KV (PA) – Provide Power
- Lower Medium Voltage – 4.16V (Non-Class 1E Power) (PB) – Provide Power
- Low Voltage – 480V (Non-Class 1E Power) (PG) – Provide Power
- 125V DC (Non-Class 1E Power) (PK) – Provide Power

- Local Instrument Panels (PL) - Provide power and control.
- Instrument AC (Non-Class Power) (PN) – Provide Power
- Standby AC Lighting (QB) - Provide lighting.
- Emergency Lighting DC (QD) – Control Room Lighting
- Main Control Board (RL) – Control Circuits
- Miscellaneous Control Panels (RP) – Control Circuits
- Engineered Safety Features Actuation (SA) – Automatic Actuation Initiator, Status
- Reactor Protection (SB) – Automatic/Manual Actuation Initiators/Cabinets
- Reactor Instrumentation (SC) - Diagnostic Instrumentation
- Switchyard (SY) - Provide Power
- Supervisory System (UU) - Provide Supervision/Control of Auxiliaries

Systems and equipment used to achieve the PFSSD functions require miscellaneous supporting functions, such as electric power, process cooling, lubrication, HVAC, communications, and emergency lighting. These supporting functions are provided by auxiliary equipment that ensures acceptable performance of the post fire safe shutdown components.

4-A-3 PFSSD Logic Diagrams:

Logic Diagrams provide the information necessary to perform post fire safe shutdown. The diagrams show the logic and components used to achieve the post fire safe shutdown functions. The methodology used to prepare the logic diagrams is described below:

- The initiating demand for each system is shown in a condition block.
- The P&IDs and standard logic symbols are used to model the components in the flow path to achieve the post fire safe shutdown functions. Essential mechanical/environmental support and essential electrical support are also identified. Components are modeled using logic symbols with component identification along with their specific desired operational status, if applicable.
- Oval shaped symbols summarize the conditions achieved and identify system sub-functions accomplished.
- AND, OR, and NAND gates depict the paths required to achieve conditions or functions.
- Components that require interfacing support (HVAC system, cooling system, electrical, etc.) are shown with the system required support block, as necessary.
- Essential instrumentation required for system process monitoring are depicted as necessary.
- The LOGIC DIAGRAMs were reviewed to ensure that all components in Appendix 3 are depicted on the logic diagrams and that all depicted components are in Appendix 3.
- If a system requires water from another system to function, a hard tie is shown on the LOGIC DIAGRAM for the system requiring the fluid. Soft ties (HVAC and electrical interlocks) are normally not shown unless the tie is absolutely required to adequately represent the system.

- Power supplies are identified for all LOGIC DIAGRAM components that require power to achieve their desired state. Power supplies are not shown for electrically operated components that will automatically fail to the desired state on loss of electrical power.

4-A-4 <u>Component Selection</u>:

Once the required systems and existing function codes were identified, the P&IDs and other design documentation were reviewed to identify all components in these systems that are necessary to support post fire safe shutdown.

Components in the flow paths that require operation/repositioning to allow the system to function, and components that could spuriously operate and impair post fire safe shutdown were verified/identified. Components (manual valves, heat exchangers, check valves, flow orifices etc.) in the flow path were also identified as described below. The following guidelines were used to determine what components should to be included in Appendix 3:

- Valves/dampers constituting system boundaries (including manual valves and dampers, and check valves) included. Associated valve operators included.

- Manual drain and vent valves depicted on the P&IDs as emptying to a closed or open drain system not included.

- Valves/dampers in the flow path (including manual valves/dampers) included in the list. These components should be included whether or not they are required to change position during post fire safe shut shutdown. Note: Check valves and back draft dampers in the flow path that allow flow in the desired direction not included. Check valves and back draft dampers in auxiliary flow paths that provide flow path integrity included.

- Safety relief valves provided for equipment and piping protection not included. However, relief valves providing an active post fire safe shutdown function such as the Pressurizer PORVs included.

- Instrument root valves for instruments not credited for post fire safe shutdown not included since their position does not impact post fire safe shutdown capability.

- Loops or bypasses within a system where spurious actuation would not result in a loss of flow or inadequate flow to post fire safe shutdown success paths not included.

- For tanks, all outlet lines are evaluated for their functional requirements and isolation. For lines not required to be functional a means of isolation is included when necessary to prevent unnecessary draw down of the tank.

- For equipment availability concerns, filters, heat exchangers, tanks, etc. in post fire safe shutdown flow paths generally included based on their function. Temporary equipment, such as startup strainers and spool pieces, not included.

- Interlock circuitry, as identified by dashed lines on P&IDs, between post fire safe shutdown components and post fire safe shutdown/non-post fire safe shutdown components, reviewed to determine additional components for inclusion.

- Power supplies for post fire safe shutdown components that require power to achieve their post fire safe shutdown function, are identified as PFSSD components.

The following information is entered in Appendix 3 for each PFSSD component.

- Component ID: Component ID number from the P&IDs and/or E-15000.

- S/G: Separation Group is identified based on the division of the power source.
- Description: Description of the component is from E-15000. If the component meets the definition of high/low pressure interface, it will be identified as a high/low pressure interface component in the notes field.
- Room: The room where the post fire safe shutdown component is located. This was determined from the fire delineation drawings (A-08/A-18) and the raceway drawings (E-0R/E-1R).
- Fire Area: The fire area where the room/component is located. The fire area/room number correlation was determined from the fire delineation drawings and USAR Appendix 9.5B.
- Instrument Location: The panel on which the instrument is located.
- SSD Fun: An alphabetic identifier that relates the post fire safe shutdown component to its function (R, H, M, or S). Function codes assigned during the logic diagram development.
- Sprtd Fun: An alphabetic identifier that relates the support function identifier (S) of the PFSSD component to its corresponding function (R, H, M).
- Hot Stdby: An X in this field identifies the component is required for Hot Standby.
- Cold Shdwn: An X in this field identifies the component is required for Cold Shutdown.
- Normal Shdwn: An X in this field identifies the component is required for Normal Shutdown from the control room.
- Alt Shdwn: An X in this field identifies the component is required for Alternate Shutdown from outside of the control room.
- P&ID: M-02/M-12s associated to the component. Reference drawings were current when revision 0 of this calculation was created. Changes to these references are not necessary unless the component information is being revised for other reasons. Wolf Creek’s configuration management system identifies the correct drawing where a listed drawing has been superseded.
- Schematic / One Line: E-03/E-13s and/or E-01/E-11s associated to the component. Reference drawings were current when revision 0 of this calculation was created. Changes to these references are not necessary unless the component information is being revised for other reasons. Wolf Creek’s configuration management system identifies the correct drawing where a listed drawing has been superseded.
- Other Drawings: Additional reference drawings associated to the component that do not fall into the preceding drawing categories. Reference drawings were current when revision 0 of this calculation was created. Changes to these references are not necessary unless the component information is being revised for other reasons. Wolf Creek’s configuration management system identifies the correct drawing where a listed drawing has been superseded.
- Power Source: The power source(s) associated with the post fire safe shutdown component. Determined from applicable electrical design documents (E-03/E-13, E-01/E-11, etc.).
- Notes: Necessary comments or notes as required.

4-A-5 PFSSD Cable Selection:

All electrically operated components highlighted on the P&IDs were identified. The electrical schematic diagrams (E-03/E-13) for all PFSSD components were reviewed to determine the cables necessary for PFSSD. Only cables necessary to make the component function properly were selected as PFSSD cables. In some cases, position indication/status cables were selected so the operator would have indication of component status if no other method were available.

4-A-6 Process Monitoring:

For the process monitoring function the guidance provided in IN 84-09 were used to identify the minimum set of instruments required for PFSSD.

4-A-7 E-15000/SETROUTE:

The following codes are used in E-15000 to identify components/cables required for PFSSD and/or LOOP.

S. Component/cable is required for post fire safe shutdown.

O. Cable has potential of initiating a loss of off-site power and is associated to one of the ESF busses.

D. Cable has potential of initiating a loss of off-site power and is associated to one of the emergency diesel generators.

4-A-8 Separation Analysis:

A separation analysis was performed on the new post fire safe shutdown cables to verify compliance with PFSSD separation requirements.

4-B Nomenclature

See Attachment 1

4-C Computations

4-C-1 SCOPE

This analysis is the Wolf Creek Post Fire Safe Shutdown Analysis. It identifies systems, components, and cables required to achieve and maintain safe shutdown following a fire in any fire area in the plant.

5. References

1. 10 CFR 50 Appendix R
2. 10 CFR 50.109 (Backfit Rule)
3. CKL BB-110, Reactor Coolant System Lineup
4. CKL EJ-120, RHR Normal System Lineup
5. CKL EP-120, Accumulator Safety Injection
6. Drawings Identified in Appendix 3 and Appendix 4
7. E-1F9915, Design Basis Document for OFN RP-017, Control Room Evacuation
8. M-712-00068, Westinghouse Instruction Book 209 Reactor Coolant Pump Model W11012A1 (93A1) page 103
9. M-747-00025-W40, Precautions, Limitations And Setpoints For Nuclear Steam Supply Systems Westinghouse Electric Corporation
10. NRC Generic Letter 86-10, Appendix R Question & Answers
11. NRC Information Notice 84-09, Lessons Learned from NRC Inspections of Fire Protection Safe Shutdown Systems (10 CFR 50, Appendix R)
12. NUREG 0881 Supplement No. 5, Safety Evaluation Report related to the operation of Wolf Creek Generating Station. Unit 1, Dated March 1985
13. OFN KC-016, Fire Response
14. OFN RP-014, Hot Standby To Cold Shutdown From Outside The Control Room
15. OFN RP-017, Control Room Evacuation
16. Deleted
17. STS BG-004, Rev. 10, CVCS Seal Injection and Return Flow Balance
18. WCNOC-76, Design Guide, Voltage/Overcurrent Protection and Coordination
19. WCRE-03, Tank Information Document
20. Wolf Creek Technical Specification B 3.7.6
21. Wolf Creek Technical Specification Surveillance Requirements, SR 3.5.4.2
22. Wolf Creek Technical Specification Surveillance Requirements, SR 3.5.4.3
23. Wolf Creek USAR Section 7.4.3.2
24. Wolf Creek USAR Section 7.4.3.3
25. Wolf Creek USAR Table 9.5B-2, Equipment Required For Shutdown Following A Fire
26. XX-M-052, Wolf Creek Tank Document Verification
27. Westinghouse Technical Bulletin TB-04-22, Rev. 1
28. NRC IE Notice 2005-14
29. NEI-00-01, Revision 2 – Guidance for Post-Fire Safe Shutdown Analysis
30. NUREG-1852, October 2007 – Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to a Fire
31. Westinghouse WCAP-17541-P, Implementation Guide for the Westinghouse Reactor Coolant Pump SHIELD® Passive Thermal Shutdown Seal, Revision 0 dated March, 2012.

REACTIVITY CONTROL FUNCTION

The reactivity control function requires control rod insertion (reactor trip) and control of two reactor coolant system (RCS) parameters (RCS temperature and boron concentration). Reactor trip is performed manually from the control room. RCS temperature control is maintained by preventing uncontrolled cooldown of the steam generators. RCS boron concentration is controlled by borating the RCS to cold shutdown reactivity conditions. The following pages discuss reactor reactivity control issues related to prevention of uncontrolled RCS cooldown and increasing RCS boron concentration to cold shutdown boron concentration.

CONTROL ROD INSERTION

Control rods can be inserted by manual rod insertion, automatic reactor trip and manual reactor trip. Manual rod insertion is not used because the time to manually insert all control rods delays entry into hot shutdown. Although an automatic reactor trip may occur, manual reactor trip is used in the post fire safe shutdown (PFSSD) design.

Manual reactor trip is initiated by operating SBHS0001, on main control board (MCB) RL003, or SBHS0042, on main control board RL006. Either SBHS0001 or SBHS0042 will actuate the reactor trip switchgear and initiate control rod insertion into the reactor core. The reactor is in hot standby when the control rods are inserted.

Fire Area A-27 is the Rod Drive MG Set room and contains both trains of reactor trip switchgear. If a fire occurs in this area, the reactor may not trip using SBHS0001 or SBHS0042. De-energizing rod drive motor generators SF001 and SF002 will initiate control rod insertion. Breakers PA0106 and PA0207 are opened using control room hand switches PGHIS0002 and PGHIS0003 to de-energize load centers PG19 and PG20 in order to cause a loss of power to SF001 and SF002. Lower level breakers are not used because a fire in area A-27 could prevent operation of these breakers. See E-1F9910, Fire Area A-27 for additional information.

UNCONTROLLED COOLDOWN REACTIVITY CONTROL ISSUES

CRITERIA

Uncontrolled RCS cooldown must be prevented to mitigate positive reactivity addition by the reactor’s moderator negative temperature coefficient.

1.a <u>Main Steam Isolation Valve (MSIV) & MSIV Bypass Valve Closure</u>

Wolf Creek’s method for preventing uncontrolled RCS cooldown via the main steam system requires controlling the steam generator atmospheric power operated relief valves and shutting the MSIVs.

Each MSIV is designed to utilize system fluid (main steam) as the motive force to open and close. The valve actuation (open or close) is accomplished through positioning a series of six electric solenoid pilot valves to either direct the system fluid to the Upper Piston Chamber (UPC) and/or the Lower Piston Chamber (LPC), or vent either or both piston chambers. The six solenoid pilot valves are divided into two trains (3 per train) that are independently powered and controlled. Either train can independently perform the PFSSD function to close the valves and isolate main steam. This is done by actuating either all close hand switch ABHS0079 (separation group 4) or ABHS0080 (separation group 1) to de-energize the associated solenoid valves.

Bypass valves are normally closed at power. If the valves spuriously open, they can be closed by removing power from one of two solenoids. Hand switch ABHS0079 and ABHS0080 operation closes all four bypass valves (ABHV0012, ABHV0015, ABHV0018 and ABHV0021) by deenergizing associated auxiliary relays which opens a contact and deenergizes the associated Train solenoid valve (ABHY0012A&B, ABHY0015A&B, ABHY0018A&B and ABHY0021A&B). In the event of a fire in the main control room, the MSIVs are closed by disconnecting either the Train A or Train B bulkhead connector located in fire area A-23 to deenergize the solenoids and close the valves. The bypass valves are closed by removing fuse block 46 in RP209 in room 1320 (Fire Area A-8) to deenergize the Train A solenoids and fail the valves closed. This process is proceduralized in OFN RP-017. Limit switches on the MSIV bypass valves are not included in the PFSSD design. The basis for not including these limit switches in the design is as follows:

a. Limit switches ABZS0012B, ABZS0015B, ABZS0018B and ABZS021B are used for status indication only. This is not required to achieve post fire safe shutdown.

b. Limit switches ABZS0012A, ABZS0015A, ABZS0018A and ABZS0021A are used as inputs to MSIV bypass valve indication lights that are not required to achieve post fire safe shutdown.

Because these limit switches only provide indication they are not included in the design.

Main steam line pressure transmitters provide a steam line pressure input signal to the safety injection circuits. Safety injection complicates control of the reactivity control function (excessive cooldown inserts positive reactivity), reactor makeup function (pressurizer level may not be maintained within indicating range) and decay heat removal (excessive cooldown rate). Safety injection is controlled by either preventing safety injection (SI) actuation (protecting SI input signals) and/or opening safety injection pump breakers to prevent safety injection pumps from running. The steam line pressure transmitters included in the post fire safe shutdown design are identified in Appendix 3.

NRC guidance (Generic Letter 86-10, Appendix R Questions & Answers, Response to Question 3.8.4, Control Room Fire Considerations) states:

> "Note that the only manual action in the control room prior to evacuation usually given credit for is the reactor trip. For any additional control room actions deemed necessary prior to evacuation, a demonstration of the capability of performing such actions would have to be provided. Additionally, assurance would have to be provided that such actions could not be negated by subsequent spurious actuation signals resulting from the postulated fire."

The MSIV all close switches (ABHS0079 and ABHS0080) are located in close proximity to the reactor manual trip switch on main control board panel RL006. When actuated, the MSIV all close switches close all four MSIVs and the MSIV bypass valves. Because the reactor trip and MSIV all close switches are very near each other, a single operator can operate the manual reactor trip and the MSIV all close switches consecutively without imposing a significant delay in control room evacuation. Therefore, MSIV and MSIV bypass valve switch will be placed in the "close" position as the control room is evacuated and operators are directed by OFN RP-017 to verify locally that they are closed or close them if they did not close.

1.b <u>Isolation of MSIV Downstream Components</u>

For a fire in area A-15, both all close hand switches ABHS0079 and ABHS0080 could be affected by the fire. For a fire in fire area A-23, the MSIVs and their associated cables are subject to fire damage and access to the MSIVs will not be feasible. Therefore, for a fire in fire areas A-15 and A-23, turbine trip and closure of the steam dumps and isolation of other components downstream of the MSIVs will be used to isolate steam flow through the main steam lines. These components are identified in the post fire safe shutdown component list (Appendix 3) and the MSIV and Redundant Cable Analysis (Appendix 5).

The main turbine stop valves are closed by simultaneously pushing main turbine trip push buttons ACHS0002A and ACHS0002B. This energizes 125 VDC relays ETM1A, ETM1B, ETM1C, ETM1D, OAM1A, OAM1B, OAM1C and OAM1D in AC119D (See drawing M-855A-00015). Relays ETM1D and OAM1D are used for status indication and are not associated with the trip function. Relays ETM1A, ETM1B and ETM1C control power to 125 VDC solenoid valves ACFZ0001A, ACFZ0002A and ACFZ0003A, respectively. Relays OAM1A, OAM1B and OAM1C control power to 24 VDC solenoid valves ACFZ0001B, ACFZ0002B and ACFZ0003B, respectively. Energizing the ETM and OAM relays opens a normally closed contact on the solenoid valve power supply circuits and de-energizes the solenoids. De-energizing two out of three 125 VDC solenoid valves ACFZ0001A, ACFZ0002A and ACFZ0003A or two out of three 24 VDC solenoid valves ACFZ0001B, ACFZ0002B and ACFZ0003B dumps control oil and trips the main turbine stop valves.

For PFSSD, it is only necessary to credit one of the two trip circuits. It was decided to credit the 125 VDC solenoids and the ETM relays because the ETM relays are powered from PK4114 and PK41 is currently credited for PFSSD. Therefore, the hand switch circuit associated with the ETM relays (15ACQ15BA) is credited for PFSSD whereas the hand switch circuit associated with the OAM relays (16ACQ15AA) is not. Solenoid valves ACFZ0001A, ACFZ0002A and ACFZ0003A are powered from PK0314, PK0414 and PK4114, respectively. Since the desired PFSSD condition of the solenoids is de-energized, the power supplies, solenoids and associated circuits are not included in the PFSSD equipment list.

The steam generator feed pumps are tripped by closing high pressure stop valves FCFV0005 and FCFV0105. This is done by simultaneously actuating master trip pushbuttons FCHS0018A and FCHS0018B to close FCFV0005 and simultaneously actuating master trip pushbuttons FCHS0118A and FCHS00118B to close FCFV0105. Actuating FCHS0018A and FCHS0018B energizes trip relays K04, K05 and K06 in panel FC169C. Actuating FCHS0118A and FCHS0118B energizes trip relays K04, K05 and K06 in panel FC170C. Energizing trip relays K04, K05 and K06 opens normally closed contacts in series with normally energized TDM solenoids FCFZ0001A, FCFZ0001B and FCFZ0001C, associated with valve FCFV0005, and FCFZ0002A, FCFZ0002B and FCFZ0002C, associated with valve FCFV0105. This, in turn, de-energizes the solenoids, opens the valves and dumps oil from the high pressure stop valves, causing them to close.

Power to energize trip relays K04, K05 and K06 originates from redundant and diverse sources. The primary source of power to FC169A/C is from 120 VAC distribution panel PN009A, which also serves as a backup source of power to FC170A/C. The primary source of power to FC170A/C is from 120 VAC distribution panel PN010A, which also serves as a backup source of power to FC169A/C. Only the primary source of power to each panel is required for PFSSD.

Distribution panels PN009A and PN010A are also powered from redundant and diverse sources. Panel PN009A is powered from inverter PN09 which is powered from 120 VAC non-Class 1E distribution panel PN07 (PN0712) and 125 VDC non-Class 1E distribution switchboard PK33 (PK3303). Panel PN010A is powered from inverter PN10 which is powered from 120 VAC non-Class 1E distribution panel PN08 (PN0806) and 125 VDC non-Class 1E distribution switchboard PK33 (PK3303). Only one source of power to inverters PN09 and PN10 are required to be credited for PFSSD. The power source chosen is the 120 VAC source from PN0712 and PN0806.

The desired PFSSD state of TDM solenoids FCFZ0001A, FCFZ0001B, FCFZ0001C, FCFZ0002A, FCFZ0002B and FCFZ0002C is de-energized. Therefore, the power supplies, solenoids and associated circuits are not included in the PFSSD equipment/cable list.

2. <u>Steam Generator Atmospheric Relief Valves</u>

The alternate shutdown design includes air and nitrogen supply valves KAV1364, KAV1366, KAV1435 and KAV1445 for isolation of steam generator loops 1 and 3 atmospheric relief valves (ABPV0001 and ABPV0003). The alternate shutdown design also includes manual isolation valves ABV0018 and ABV0029 for isolation of steam generator loops 1 and 3 atmospheric relief valves (ABPV0001 and ABPV0003, respectively). This capability is included in the alternate shutdown design because ABPV0001 and ABPV0003 control circuits are not provided with the capability for isolation from the control room. Consequently, ABPV0001 and ABPV0003 are subject to spurious operation during a control room fire. ABPV0002 and ABPV0004 do not require a similar isolation capability for alternate shutdown because they can be isolated from the control room and are not subject to control room fire induced spurious operation. Consequently, ABPV0002 and ABPV0004 manual isolation valves ABV0007 and ABV0040 are not included in the design.

The redundant shutdown design utilizes any available combination of auxiliary feedwater supplies and steam generator atmospheric relief valves (SGARVs) to control cooldown. In some areas, one or more SGARV could spuriously open, potentially causing uncontrolled cooldown. Calculation WCNOC-CP-002 shows that up to three failed open SGARVs will not adversely impact PFSSD. However, operators may want to isolate the failed open ARVs to regain control of the plant. Therefore, the air and nitrogen supply valves to ARV ABPV0004 (KAV1365 and KAV1429) are included in the PFSSD design, in addition to the air and nitrogen supply valves for ARVs ABPV0001 and ABPV0003 which are included in the alternate shutdown design discussed in the previous paragraph. Air and nitrogen supply valves for ARV ABPV0002 are not included in the PFSSD design because local controller ABFHC0002, which can be used to locally control or close ABPV0002, is included in the PFSSD design.

Atmospheric relief valve position switches ABZS0001, ABZS0002, ABZS003 and ABZS0004, atmospheric relief valve main control board RL006 position indication lights ABZL0001A, ABZL0002A, ABZL0003A and ABZL004A and atmospheric relief valve auxiliary shutdown panel position indication lights, ABZL0001B, ABZL0002B, ABZL0003B and ABZL0004B are not included in the post fire safe shutdown design. These components were excluded from the design because instrumentation is available to determine the effect of atmospheric relief valve position changes. The proper operation of the atmospheric relief valves can be determined from the steam generator pressure and level indication.

3. <u>Turbine Driven Auxiliary Feedwater Pump Steam Supply Valves</u>

Main steam supply to the turbine driven auxiliary feedwater pump (TDAFWP) valves ABHV0005 and ABHV0006 must be controlled for reactivity control. The desired reactivity control function position for these valves is closed, however, for the decay heat removal function, the valves are required to be open for the TDAFWP to operate. ABHV0048 and ABHV0049, bypass valves for ABHV0005 and ABHV0006, are normally open to keep the TDAFWP steam supply lines warm. This flow path is isolated by normally shut FCHV0312, TDAFWP mechanical trip and throttle valve. A one-inch drain line to the low-pressure condenser cannot be isolated; however, the small size (one inch) drain line will not cause unacceptable RCS cooldown. The basis for accepting the one-inch open drain line is because the steam generator atmospheric relief valves are available and used to control reactor cooldown rate. Adjusting the throttled position of the steam generator atmospheric relief valves mitigates the cooldown via the one-inch open drain line.

ABHV0005 and ABHV0006 are required for post fire safe shutdown from the control room and for alternate shutdown outside the control room. Lockout relays 86XRP2 and 86XRP3 isolate ABHV0005 and ABHV0006 controls from the control room to allow control of the valves from RP118B.

Because the positions (either open or closed) of ABHV0048 and ABHV0049 have essentially no effect on post fire safe shutdown, ABHV0048 and ABHV0049 are not included in the post fire safe shutdown design.

4. <u>Steam Generator Blowdown</u>

Steam generator blowdown is isolated to prevent RCS cooldown via the steam generator blowdown path. Closing BMHV0001, BMHV0002, BMHV0003 and BMHV0004 isolates steam generator blowdown. The valves are closed by de-energizing solenoid valves supplying air to isolation valve operators. Three solenoid valves are associated with each valve. The A and C solenoid valves are operated by hand switches or automatic signals and the B solenoid valves are operated by automatic signals only. BMHY0001A, BMHY0002A, BMHY0003A and BMHY0004A are included in the post fire safe shutdown design because they can be manually positioned from the control room using MCB RL024 hand switches, BMHIS0001A, BMHIS0002A, BMHIS0003A and BMHIS0004A. BMHY0001C, BMHY0002C, BMHY0003C and BMHY0004C are included in the post fire safe shutdown design because they can be manually positioned locally using hand switches BMHIS0001C, BMHIS0002C, BMHIS0003C and BMHIS0004C at the blowdown control panel BM157. Power to the solenoid valves is controlled by auxiliary relays. These auxiliary relays are identified in Appendix 4. The solenoids may also be de-energized by opening their associated breakers.

Solenoid valves BMHY0001B, BMHY0002B, BMHY0003B, BMHY0004B are operated only by the steam generator blowdown and sample isolation signal (SGBSIS). These solenoid valves are not manually controlled and do not provide a redundant capability to isolate blowdown from outside the control room. Consequently, they are not included in the post fire safe shutdown design.

Steam generator surface blowdown isolation is not included in the post fire safe shutdown methodology. The justification for excluding the surface blowdown path is based on the surface blowdown piping discharging to the bottom blowdown path that is isolated as described above.

Both the surface and bottom blowdown piping may discharge to the nuclear sampling system. This path is not included/isolated because the path uses 3/8-inch pipe/tubing and the blowdown sample flow rate is throttled at a set value (not to exceed 44,000 lb_m/hr) on each steam generator. The 44,000 lb_m/hr is specified on WCNOC drawing M-11BM01.

The following steam generator blowdown sample rate approximation demonstrates that the maximum total steam generator blowdown monitor flow is less than 16 gpm:

- Steam generator blowdown flow rate per M-11BM01 is 176,000 lb_m/hour at 535°F and 925 psia.
- Chemistry Department personnel adjust steam generator blowdown flow rate to less than 176,000 lb_m/hour.
- 176,000 lb_m/hour ÷ 60 min/hour ≈ 2,933 lb_m/minute
- Specific volume of water at 535°F and 925 psia = 0.21315 ft^3/lb_m
- 0.21315 ft^3/lb_m X 7.48 gal/ft^3 ≈ 0.1594362 gal/lb_m
- 2,933 lb_m/minute X 0.1594362 gal/lb_m ≈ 468 gal/min
- 468 gal/min ÷ 4 S/G ≈ 117 gpm per S/G
- Blowdown sample monitor piping/tubing diameter = 0.375 in
- Piping to steam generator blowdown flash tank diameter = 4 in
- Area of the blowdown sample monitor piping/tubing ∝ tubing $(radius)^2 = (0.375/2)^2$
- Area of the piping to steam generator blowdown flash tank ∝ piping $(radius)^2 = (4/2)^2$
- Flow to blowdown sample monitor ∝ $\{(0.375/2)^2 \div [(4/2)^2 + (0.375/2)^2]\}$ X 117 gpm per S/G ≈ 4 gpm
- Total steam generator blowdown monitor flow ≈ 4 gpm X 4 ≈ 16 gpm

Adjusting steam generator atmospheric relief valves will compensate for possible cooldown via the blowdown sample path.

Limit switches BMZS0001A, 2A, 3A, 4A and BMZS0001B, 2B, 3B, 4B are included in the design to provide steam generator blowdown valve isolation indication at RL024 and BM157, respectively.

BORON INJECTION PATH REACTIVITY CONTROL ISSUES

Refueling Water Storage Tank, Charging and Letdown

Refueling water storage tank (RWST) level transmitters BNLT0930, BNLT0931, BNLT0932 and BNLT0933 and their associated level indicators BNLI0930, BNLI0931, BNLI0932 and BNLI0933 are required for the reactivity control function. In addition, these transmitters are required for valve actuation circuits described in the decay heat removal function.

RWST level indication is required to allow operators the ability to diagnose a spurious draindown condition. In some fire areas the possibility exists for the RWST to drain to the containment sump due to the spurious opening of the containment sump isolation valves. In all areas where this can occur, operators can mitigate the draindown using hand switches in the control room, but level indication is required to diagnose the draindown.

In areas where spurious draindown is not a concern, RWST level indication is not necessarily required. The justification for not requiring the RWST level indication in these cases is based on Technical Specification controls on the volume of borated water contained in the RWST and the volume of RWST water required to achieve cold shutdown. The following data demonstrates sufficient water is contained in the RWST to achieve cold shutdown conditions without having to makeup to the RWST:

- Wolf Creek Technical Specification Surveillance Requirements, SR 3.5.4.2, states, "Verify RWST borated water volume is ≥ 394,000 gallons." This surveillance is performed on a seven-day frequency to ensure that a minimum volume of water is maintained in the RWST.

- Wolf Creek Technical Specification Surveillance Requirements, SR 3.5.4.3, states, "Verify RWST boron concentration is ≥ 2400 ppm and ≤ 2500 ppm. This surveillance is performed on a seven-day frequency to ensure that a minimum boron concentration exists in the RWST water.

- Wolf Creek USAR Section 7.4.3.3, Cold Shutdown Discussion, states in part "A typical volume of water to be charged and letdown from hot full power at the beginning of a fuel cycle at peak xenon conditions is 33,500 gallons and the end of a fuel cycle water volume requirement from full power is 83,754 gallons, where the RWST is the source of the borated water." 83,754 gallons of RWST water is the maximum volume of RWST borated water required to be charged into the RCS to achieve cold shutdown conditions. The 83,754 gallons is required if letdown is used. The post fire safe shutdown design does not provide letdown for hot standby conditions. The volume of water charged into the RCS will be less than 83,754 gallons.

Given the Technical Specification requirements (394,000 gallon minimum RWST volume) minus the volume of water below the top of the outlet pipe (28,083 gallons) and the USAR maximum required volume (83,754 gallons) to achieve cold shutdown conditions, greater than 4 times the volume of borated RWST water is available. Therefore, RWST level indication is not required to achieve cold shutdown conditions. Note that Appendix R requires cold shutdown to be accomplished in 72 hours. If seal injection is performed for the entire 72 hour period at a rate of 32 gpm (8 gpm per seal) then the total quantity of water required in the RWST is:

32 gpm x 72 hrs x 60 min/hr = 138,240 gallons

Therefore, a sufficient quantity of water is contained in the RWST to achieve cold shutdown conditions.

If cable damage and spurious operation occurs such that either EJHV8811A or EJHV8811B spuriously open and either BNHV8812A or BNHV8812B, respectively, cannot be closed, the RWST could drain to the containment sump. The following calculation demonstrates the amount of time available to complete manual actions to ensure the RWST does not drain to a level below that required for cold shutdown.

Minimum Tech Spec. Volume of RWST (506.2" level): 394,000 gallons (BN-20)

"EMPTY" water level in RWST (53" level): @ 41,500 gallons (9,361 gal/ft per BN-20)

Volume of water between Tech. Spec. and Empty: 352,500 gallons

Maximum Volume Needed to Achieve Cold PFSSD:

32 gpm (seal injection @ 8 gpm/seal) x 72 hrs (Per Appendix R) x 60 min/hr

= 138,240 gallons

Allowable volume lost to sump: 352,500 gal – 138,240 gal = 214,260 gallons

Based on Calculation BN-21, the equivalent pipe length from the RWST to the CCP B pump takeoff is:

L_{eq} from RWST to CCP B takeoff = <u>441.2'</u> of 0.375" nom wall pipe (id = 23.25")

Based on Calculation BN-21, the equivalent pipe length from the CCP B takeoff to the containment sump is determined as follows:

L_{eq} from CCP B takeoff to RHR B takeoff = <u>48.3'</u> of 0.375" nom wall pipe (id = 23.25")

L_{eq} from RHR B takeoff to BNHV8812B = <u>139.7'</u> of 0.375" nom wall pipe (id = 13.25")

L_{eq} from BNHV8812B to Tee = <u>255.3'</u> of sch 40 pipe (id = 13.12")

L_{eq} from Tee to EJHV8811B = <u>139.6'</u> of sch 40 pipe (id = 13.12")

L_{eq} from BNHV8812B to Tee = <u>112.6'</u> of 0.375" nom wall pipe (id = 13.25")

The water elevation in the RWST is approximately 2045'-0". The elevation of the top of the sump is 2000'-0", at which point water will overflow onto the containment floor. Therefore, the total head from the tank to the sump is 2045'-0" - 2000'-0" = 45.0 feet or 19.5 psi, which is the maximum pressure loss from the RWST to the sump. It is conservatively assumed that water level remains constant in the tank and sump. 32 gpm flows to the CCP and the remaining flows to the sump.

The Hazen and Williams equation is used to estimate flow from the RWST and is given below.

$$\Delta p = \frac{\left(4.52 \times Q^{1.85} \times L\right)}{\left(C^{1.85} \times d^{4.87}\right)}$$

where:

Δp = pressure difference (psi)
Q = flow (gpm)
L = pipe equivalent length (feet)
C = pipe coefficient (130)
d = pipe inside diameter (in)

With the help of a spreadsheet, the above equation was solved multiple times to determine the flow that produces a pressure drop of 19.5 psi across the pipe network. The flows were determined as follows:

Q from RWST to CCP B takeoff = <u>7,515 gpm</u>

Q from CCP B takeoff to sump = <u>7,483 gpm</u>

Therefore, with the CCP charging to the RCP seals and one flow path to the containment sump open, the maximum flow from the RWST is 7,515 gpm.

The maximum time allowed to isolate containment sump valve before the RWST drops to a level below that required for cold shutdown is:

214,260 gal / 7,515 gpm = 28.5 minutes

BGLCV0112B and BGLCV0112C, Volume Control Tank (VCT) outlet valves, are controlled to prevent a loss of BG pump suction that could occur with a low level in the VCT. The following table describes the controls associated with these valves:

COMPONENT	DESCRIPTION
BGHIS0112B	VCT Isolation Valve from Charging Pump Suction Hand Indicating Switch
BGHIS0112C	VCT Isolation Valve from Charging Pump Suction Hand Indicating Switch
K647	VCT LOLO Level Relay – Closes BGLCV0112B on a LOLO level in the VCT
K647	VCT LOLO Level Relay – Closes BGLCV0112C on a LOLO level in the VCT

In fire area A-8, the possibility exists that BGLCV0112B and BGLCV0112C cannot be closed and that letdown could isolate. In addition, circuits associated with automatic swapover to the RWST could be damaged such that swapover may not occur when the VCT reaches Low-Low level. With continued operation of the charging pump in this scenario, draindown of the VCT could occur and hydrogen could be introduced into the pump suction, damaging the pump. Alternatively, if one of the valves fail closed prior to lining up the RWST, suction to the pump would be lost resulting in pump damage. Under normal operating conditions (Assumption 3-A-22), the NCP would be operating and damage would be limited to the NCP, and both safety related charging pumps would be available. A fire in area A-8 could render Train A CCP inoperable due to damage to it's power and control cables. In order to provide additional time margin to VCT draindown, valve KHV0096 is included in the PFSSD design to isolate hydrogen makeup supply to the VCT and reduce the cover gas pressure. Calculation BG-M-025 shows that if the hydrogen supply to the VCT were isolated within 10 minutes, there would be significant time before the water level in the VCT dropped to the level of the CCP suction.

The possibility exists of causing a boron dilution event in the case of a loss of letdown because the make-up pumps start automatically on low level in the VCT. This is not a concern for post fire safe shutdown as shown in the next paragraph.

There are two scenarios where fire can cause loss of letdown. In the first scenario, the fire causes a loss of off site power, and valves BGLCV0459 and 0460 close due to the fail close design. In this scenario, the make-up pumps would not start because they also have no power, and the automatic transfer would occur. If the automatic transfer does not occur, the operators can manually make the transfer. In the second scenario, the fire causes damage to the cables of the BGLCV0459 and 0460 valves such that one or both close. In this case, the make-up pumps may start and provide unborated water to the VCT, causing a slow RCS dilution. This is not a concern because, when entering post fire safe shutdown a plant trip is assumed. PFSSD analysis has shown that the operator would have SRM indication in the event of fire in any area of the plant. If needed, the RWST valves can be lined up from the control room or locally.

The following table identifies how the RWST discharge (drain/suction) paths are isolated (controlled) to ensure adequate RWST volume is maintained available to achieve cold shutdown reactivity conditions:

COMPONENTS	DESCRIPTION	RESOLUTION
BNHV8806A BNHV8806B	Safety Injection Pump Suction	Safety injection pumps have to operate to cause a loss of RWST volume. Safety Injection Pump Motors (DPEM01A & DPEM01B) are controlled (off) by OFN RP-017 and OFN KC-016
BNV8717	RHR Pumps crosstie to RWST manual isolation	Normally shut manual valve/ Locked closed

COMPONENTS	DESCRIPTION	RESOLUTION
BNHV8812A BNHV8812B	RHR Pump Suction	BNHV8812A and BNHV8812B controlled (shut) by OFN RP-017 and OFN KC-016. BNHV8812A breaker is placed to off and BNHV8812B LOCAL/ISO Hand Switch, BNHS8812B, is placed to ISO
BNLCV0112D BNLCV0112E	Centrifugal Charging Pump Suction	This flow path is used to achieve cold shutdown reactivity conditions in the reactor
BNHV0003 BNHV0004	Containment Spray Pump Suction	Containment spray pumps have to operate to cause a loss of RWST volume. Check valves ENV0002 and ENV0008 prevent draindown of the RWST into the containment sump if valves ENHV0001 or ENHV0007 spuriously open. Containment Spray Pump Motors (DPEN01A & DPEN01B) are controlled (off) by OFN RP-017 if a fire occurs in the control room and ENHIS0003 and ENHIS0009 can be used to lock-out the containment spray pumps if the fire occurs outside the control room.
BNV0013 BNV0014	Spray Additive Eductor Suction	Normally shut manual valves
BNHCV8800A BNHCV8800B	Fuel Pool Cleanup Suction	BNHCV8800A and BNHCV8800B are normally closed fail closed valves. If both valves were spuriously opened, then normally closed manual valves and check valves (ECV0112, ECV0083, ECV0009, ECV0037, ECV0004, ECV0091 and ECV7138) prevent loss of RWST volume. If both valves spuriously open with the fuel pool cleanup pumps in operation, a maximum of 18,000 gallons per hour will be lost from the RWST from this path. At 18,000 gallons per hour, over 17 hours will elapse before the volume of water in the RWST in excess of volume required to achieve cold shutdown would be depleted. This is acceptable because cold shutdown conditions should be achieved in less than 12 hours.
EJHV8811A EJHV8811B	Containment Sump Isolation Valves	Valves are redundant to BNHV8812A and BNHV8812B and are closed to prevent draindown of the RWST into the containment sump.

Control of the containment spray and safety injection pumps is accomplished with local and remote hand indicating switches. These switches are identified in Appendix 3.

DPBG05A and DPBG05B, centrifugal charging pump motors are included in the post fire safe shutdown design. The pumps inject borated water from the RWST and discharge to the RCS via the reactor coolant pump (RCP) seals or the boron injection tank (BIT).

BGHCV0182, Charging Header Flow Control Valve, is not included as a post fire safe shutdown component because valves BGHV8105 and BGHV8106 are included in the PFSSD design to isolate this flow path in the event of a fire outside the control room. In addition, manual isolation valve BG8402B, installed upstream of BGHCV0182, is shut in accordance with OFN RP-017 if the fire occurs in the control room. In addition, BGHCV0182 manual bypass valve BGV0017 is verified closed in OFN RP-017. With BG8402B and BGV0017 shut, or either BGHV8105 or BGHV8106 shut, charging flow (boration flow) is directed through the RCP seals.

BGHIS8105 and BGHIS8106 are included in the design to provide the capability to isolate the BGHCV0182 flow path from the control room.

In the event of a fire requiring control room evacuation, Wolf Creek's post fire safe shutdown methodology (OFN RP-017) specifies to not restore seal injection, due to the possibility of seal damage if seal injection is not restored promptly. Boration is accomplished using the B Train Centrifugal Charging Pump (CCP) and injecting through the Boron Injection Tank (BIT) flow path using BIT inlet valve EMHV8803B and outlet valve EMHV8801B. Seal injection is isolated using BGV0101 and BGV0105.

BGHV8357A and BGHV8357B and their associated hand switches are included in the post fire safe shutdown design for use during non-alternate shutdown.

Except for a fire in area A-16S, BGHV8100 and BGHV8112 and their respective hand switches, BGHIS8100 and BGHIS8112, are not credited in the post fire safe shutdown design. BGHV8100 and BGHV8112 may be open or shut and safe shutdown capability is assured, except in the case of a fire in A-16S. In the event of a fire in area A-16S, valve BGHV8112 and hand switch BGHIS8112 are credited to isolate the seal leakoff line to prevent potentially elevated temperature RCS fluid from entering the CCP suction and damaging the pump. This is postulated because a fire in area A-16S could cause a loss of CCW flow to the seal water heat exchanger. In this case, it may be necessary to isolate seal leakoff flow and operate the CCP at minimum flow as described in OFN EG-004, CCW System Malfunctions.

In the event of a fire in other areas, the following two sections provide justification for not including these valves in the PFSSD design.

Justification of Seal Water Leak off Loss

Closing BGHV8100 and/or BGHV8112 will lift relief valve BGV8121 and pass the seal leak off water to the pressurizer relief tank (PRT), and/or bypass the seal leak off water through valves BGHV8143, BGHCV0123 and one or both valves BBHV8157A and B (failed open as a result of the fire) to the PRT. This would result in a maximum loss of water from the primary system of up to 84 gpm (based on a maximum of 21 gpm per pump as noted in WCAP-10541). Angle valve BGV0202 is throttled to provide an acceptable backpressure on the RCP seals at 12 gpm leak off during normal operation. (Reference STS BG-004) As noted earlier, 138,240 gallons of borated water from the RWST is the maximum Appendix R volume needed to achieve cold shutdown conditions. The RWST is required by Technical Specifications to contain at least 394,000 gallons. The unusable volume of water in the tank is 28,083 gallons. Therefore, a margin exists of more than 227,000 gallons.

At 84 gpm, there is a loss of 5,040 gallons from the RWST each hour due to the potential leakage to the PRT through the above paths. At that rate, it would take 1.8 days to deplete the margin of 227,000 gallons. Cold Shutdown can be achieved in less than twenty-four hours. At that time, valve BGV0202 can be manually closed to isolate the leak off flow path.

According to calculation XX-M-052, the volume of the PRT is greater than 13,000 gallons. If desired, valve BGV0202 can be closed within 2 hours to avoid spilling water onto the containment floor.

Justification for leaving seal leakoff line open

Westinghouse report, WCAP-10541, and subsequent letter, OG-00-009, discuss the seal performance in the case of a complete loss of cooling to the RCP seals. In both documents, the context is mainly in the case of a station blackout. WCAP-10541 reports on the analysis and tests performed, and assumes that the seal leakoff line will pressurize to the lift point of the pipe safety valve, maintaining backpressure on the #1 seal. The seal leakoff would be directed to the Pressure Relief Tank (PRT). Letter OG-00-009 continues with that assumption because that was the way the tests were run. In the case of a station blackout, valves BGHV8100 and BGHV8112 should be closed so the leakoff water isn't directed to the VCT where it could overflow and cause a small LOCA outside the containment. However, in the case of a fire at any location in the Wolf Creek Plant there is no station blackout. At least one CCP will be available and one VCT outlet valve will be closed. Valves BGHV8100 and BGHV8112 may be left open. Once seal injection is restored, the leakoff water will be contained and reused. A locked throttled manual valve (BGV0202) in the seal return line will assure sufficient backpressure on the seal.

System Interfaces

Limit switches BNZS8812AA and BNZS8812BA are not included in the reactivity control function post fire safe shutdown design. However, these limit switches are required for residual heat removal (RHR) valve interlocks and; therefore, the limit switches are included in the decay heat removal function post fire safe shutdown design.

Interlock circuits for EJHV8811A and EJHV8811B are not required for the reactor makeup function. These circuits are discussed under the decay heat removal function.

BNHIS8812AA and BNHIS8812BA are not included in the post fire safe shutdown design. These hand switches are test indicating switches for verifying circuit integrity. The hand switches are not required to achieve post fire safe shutdown in the event of a fire outside the control room. BNHIS8812BA is isolated in the event of a control room fire to permit local operation of BNHV8812B.

Component cooling water (CCW) and essential service water (ESW) are required for BG pump operation. These systems are addressed under the support function.

Safety injection switches SBHS0027 and SBHS0028 are included in the post fire safe shutdown design. These switches are included in the design because a safety injection is not desired. If a safety injection should occur, NB0103 and NB0203 are opened to stop the train A and B safety injection pumps.

Alternate Boration Path

Except in areas where seal injection is lost, the BIT flowpath is not required to achieve reactivity control.

Boration to cold shutdown reactivity conditions is normally accomplished through the RCP seal injection path. However, in fire areas where seal injection is lost, the BIT flowpath is used. Wolf Creek Technical Specification Boration Injection System – Shutdown TR B 3.1.10, reads in part:

“The boron solution volume limit of the RWST ensures 83,754 gallons are available to inject the required cold shutdown boron weight in MODE 4 and 14071 gallons are available to inject the required cold shutdown boron weight in MODES 5 and 6.”

Seal injection is maintained between 4 and 8 gallons per minute per pump. Therefore injection into the RCS via the seals will be between 16 and 32 gallons per minute. It will take approximately 87 hours to inject 83,754 gallons at 16 gpm and approximately 47 hours to inject 83,754 gallons at 32 gallons per minute. Consequently cold shutdown reactivity conditions will be achieved between 47 hours and 87 hours following reactor trip and boration via the RCP seals.

If charging flow through the BIT flow path occurs, then the time to achieve cold shutdown reactivity conditions will be reduced to less than the minimum injection time (47 hours) via the RCP seals. Charging via the BIT for makeup during the transition to cold shutdown reduces the time to achieve cold shutdown reactivity conditions.

Procedure OFN RP-017A uses the boric acid batching tanks and pumps for long term boration to maintain cold shutdown reactivity conditions. Valve BGHV8104 is included in the PFSSD cold shutdown design to provide a suction path from the boric acid transfer pumps to the charging pumps.

DCP 13130 installed heat tracing to maintain the emergency borate line and other lines fluid above the solidification temperature in the Train A SI pump room. Both safety trains can power the heat tracing; an automatic transfer switch (QJS0001) switches from Train A (primary source) to Train B (alternate source) on loss of A Train. The emergency borate line and valve BGHV8104 are only credited after a control room fire. Components of the heat tracing system that are credited for alternate PFSSD after a control room fire are NG02ACR115, QJS0001, QJTS6251, NG100B, and QJTE6244A. These components are unaffected by a fire in the control room and the automatic transfer to Train B power source will not be affected by a fire in the control room.

SOURCE RANGE NEUTRON MONITORING CAPABILITY

Regulatory Requirements and Considerations

10 CFR 50 Appendix R specifies that "One train of equipment necessary to achieve hot shutdown from either the control room or emergency control station(s) must be free of fire damage by a single fire, including an exposure fire."

Additionally, 10 CFR 50 Appendix R specifies, "The reactivity control function shall be capable of achieving and maintaining cold shutdown reactivity conditions."

NRC Information Notice IN 84-09 included source range flux monitor on the list of the minimum monitoring capability the NRC staff considers necessary to achieve post fire safe shutdown. In Generic Letter 86-10, the NRC reiterated that Information Notice 84-09 provides the listing of instrumentation acceptable to and preferred by the staff to demonstrate compliance with the process monitoring function. Generic Letter 86-10 also addresses the acceptability of boron concentration indication as an alternative to source range monitors.

Although NRC IN 84-09 specifies that a source range flux monitor is only necessary for alternative shutdown, post fire safe shutdown capability using redundant trains must be demonstrated for fires in all areas of the plant. Consequently, it is appropriate to provide source range monitor capability for all fire areas to confirm cold shutdown reactivity conditions following a fire.

Source Range Instrumentation

Four source range flux monitor circuits are available to provide indication of cold shutdown reactivity conditions:

- Source Range Channel N31 (SENE0031) (Separation Group 1)
- Source Range Channel N32 (SENE0032) (Separation Group 2)
- Post Accident Source Range (Gamma Metrics) Channel SENY0060A & B (Separation Group 1)
- Post Accident Source Range (Gamma Metrics) Channel SENY0061A & B (Separation Group 4)

Source range monitoring capability for three limiting fire areas has been evaluated. The evaluation is contained in Appendix 6, Source Range Monitor Evaluation. The results of the evaluation are summarized below:

a. Control Room – Fire Area C-27

The Control Room is provided alternate shutdown capability. Source range monitoring capability (via SENI0061X) at the alternative shutdown panel (RP118B) is available in the event that the Control Room must be evacuated in response to a Control Room fire. Because SENI0061X can be isolated from the Control Room it will be free of Control Room fire damage.

b. Reactor Building – Fire Area RB-1

SENE0031 or SENE0032 are available to provide source range indication in the event of a fire in reactor building fire area RB-1. SENE0031 or SENE0032 analysis demonstrated that either one or the other of these instruments will be available following a fire in fire area RB-1 (See Appendix 6).

c. Auxiliary Building – Fire Area A-16

In the event of fire in fire area A-16 all source range monitoring instruments except SENY0061A will be lost. Because SENY0061A is independent of fire area A-16, SENY0061A will be available to verify cold shutdown reactivity conditions if a fire occurs in fire area A-16.

Summary

- In the event of a Control Room fire requiring Control Room evacuation, cold shutdown reactivity conditions are verified using the source range indication (SENI0061X) installed on the auxiliary shutdown panel.
- In the event of a fire in fire area RB-1, cold shutdown reactivity conditions are verified using either SENE0031 or SENE0032.
- In the event of a fire in fire area A-16, cold shutdown reactivity conditions are verified using SENY0061A.

STATUS-MONITORING PANEL ANALYSIS

Discussion:

Status-monitoring panels are installed in the control circuits of some post fire safe shutdown components. The cables to these status-monitoring panels are associated circuits that are subject to failures that may compromise the post fire safe shutdown component. The following analysis describes how reactivity control function components may be affected by status panel associated circuits.

Analysis:

The following table identifies the reactivity control function post fire safe shutdown components that have status panels installed in their control circuits.

COMPONENT	STATUS PANEL SCHEMATIC	STATUS PANEL CABLE	NOTES
ABHV0005	E-13SA16	12SAZ16AA	A, B, C, D
ABHV0006	E-13SA16	12SAZ16AA	A, B, C, D
ABHY0012A	E13SA15	11SAZ15MA	A, C, D, E
ABHY0015A	E13SA15	11SAZ15MA	A, C, D, E
ABHY0018A	E13SA15	11SAZ15MA	A, C, D, E
ABHY0021A	E13SA15	11SAZ15MA	A, C, D, E
ABHY0012B	E-13SA16	14SAZ16MA	A, C, D, E

COMPONENT	STATUS PANEL SCHEMATIC	STATUS PANEL CABLE	NOTES
ABHY0015B	E-13SA16	14SAZ16MA	A, C, D, E
ABHY0018B	E-13SA16	14SAZ16MA	A, C, D, E
ABHY0021B	E-13SA16	14SAZ16MA	A, C, D, E
BMHV0001	E-13SA16	14SAZ16HA	A, C, D, F
BMHV0002	E-13SA16	14SAZ16HA	A, C, D, F
BMHV0003	E-13SA16	14SAZ16HA	A, C, D, F
BMHV0004	E-13SA16	14SAZ16HA	A, C, D, F

NOTES:

A. The status-monitoring panel is installed in parallel with the control circuit power supply and the control circuit. If the status-monitoring panel cables open circuit, there will be no effect on either the control circuit power supply or the control circuit.

B. If the status-monitoring panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The valve will open, but a downstream valve (FCHV0312) is closed. Consequently there will be no adverse reactivity control function consequence from this failure.

C. If one status-monitoring panel cable shorts to ground, there will be no effect on the component or post fire safe shutdown because the control circuit power supply is an ungrounded DC system. If both positive and negative status-monitoring panel cables short to ground, then the control circuit power supply will fail as a result of excessive current through the short circuit. The valve solenoid will be de-energized upon the failure of the control circuit power supply (fuse failure from overcurrent). When the valve solenoid is de-energized, the valve repositions to the desired post fire safe shutdown position.

D. A positive hot short to the status-monitoring panel positive cable or a negative hot short to the status-monitoring panel negative cable will have no effect on the control circuit power because normal control power will continue to exist. However, if a negative hot short occurs on the status-monitoring panel positive cable, or a positive hot short occurs on the status-monitoring panel negative cable, then excessive current may cause a control power fuse failure. The valve solenoid will be de-energized upon the failure of the control circuit power supply (fuse failure from overcurrent). When the valve solenoid is de-energized, the valve repositions to the desired post fire safe shutdown position.

E. If the status-monitoring panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The MSIV bypass valve solenoids will be de-energized and the valves will close, their post fire safe shutdown design position.

F. If the status-monitoring panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The blowdown valve will close (post fire safe shutdown required position). Consequently there will be no adverse consequence from this failure mode.

RCP SEAL COOLING

The Wolf Creek plant design utilizes two independent methods to ensure proper seal cooling; seal injection and thermal barrier cooling. During normal plant operation, both seal injection, utilizing the Chemical and Volume Control System (CVCS), and thermal barrier cooling, utilizing the Component Cooling Water System (CCW) are operating. Upon loss of only one seal cooling method, Wolf Creek operating procedures allow the continued operation of the RCP's.

Wolf Creek replaced the number one seal insert with the Westinghouse SHIELD® Passive Thermal Shutdown Seal (SDS) on all four reactor coolant pumps (RCPs). The SDS restricts reactor coolant system (RCS) leakage for plant events that result in a loss of all seal cooling. The benefit of the new SDS from a post-fire safe shutdown (PFSSD) perspective is that the maximum leakage from each seal is 19 gpm following a loss of all seal cooling with no operator response to trip the RCPs. Conversely, if the RCPs are tripped with adequate time margin to allow the RCP shaft to substantially slow down or stop rotating before the SDS activates, the maximum RCS leakage is 1 gpm per pump. If the SDS activates while the RCP shaft is still rotating, the SDS will be damaged and the resultant leakage will be 19 gpm per pump, or 76 gpm total per WCAP-17541-P (Reference 30). This leakage is below the 21 gpm per pump (84 gpm total) assumed leakage in the current PFSSD thermal hydraulic analysis (SA-08-006 and WCNOC-CP-002). Based on WCAP-17541-P, Table 4-1, the operator response margin for the Model 93A-1 RCPs is 8.3 minutes.

In the event of a loss of all seal cooling, operators need the capability to diagnose the condition. This is done by any of the methods described below:

- RCP Seal Flow indication (BGFI0215A, BGFI0215B) – Determines if the charging pump is operating and injecting into the RCP seal injection header.
- CCW flow to the RCP Thermal Barrier Heat Exchangers (EGFI0128, EGFI0129)– Determines total CCW flow to the RCPs

In any fire area where a fire causes loss of all seal cooling, the RCPs are stopped and a natural circulation cooldown is performed in accordance with Westinghouse guidance and WCNOC procedures. CCW thermal barrier cooling is not restored if it is lost in conjunction with loss of RCP seal injection. In addition, CCW thermal barrier cooling is isolated anytime all seal cooling is lost. This is to protect the thermal barrier heat exchanger, pump internals and the CCW system from thermal shock upon re-start of the CCW pump.

REACTOR MAKEUP FUNCTION

The reactor makeup (inventory control) function performance goal requires that reactor vessel level be maintained within the level indication in the pressurizer. Maintaining level indication within the pressurizer requires control of potential RCS inventory loss paths, RCS pressure and makeup to the RCS. Isolating RCS potential high/low pressure interfaces controls loss of RCS coolant. Pressurizer spray and pressurizer power operated relief valves (PORVs) are isolated to prevent RCS pressure reduction. RCS cooldown (RCS cooldown is addressed in the decay heat removal function discussion) is controlled to limit RCS pressure reduction. RCS makeup is accomplished by charging through the RCP seals and/or the BIT. The following paragraphs discuss the issues identified above.

RCS HIGH/LOW PRESSURE INTERFACE ISOLATION

BACKGROUND

In Generic Letter 81-12 the NRC required that each high/low pressure interface that uses redundant electrically controlled devices (such as two series motor operated valves) to isolate or preclude rupture of any primary coolant boundary be identified.

In Generic Letter 85-01 the NRC provided the following guidance: “The safe shutdown capability should not be adversely affected by a fire in any plant area which results in simultaneous spurious actuation of all valves in high/low pressure interface lines.”

In Generic Letter 86-10 the NRC provided the following guidance: “For three-phase AC circuits, the probability of getting a hot short on all three phases in the proper sequence to cause spurious operation of a motor is considered sufficiently low as to not require evaluation except for any cases involving Hi/Lo pressure interfaces. For ungrounded DC circuits, if it can be shown that only two hot shorts of the proper polarity without grounding could cause spurious operation, no further evaluation is necessary except for any cases involving Hi/Lo pressure interfaces.”

In SLNRC 84-0109, the SNUPPS submittal containing the basis for the Wolf Creek post fire safe shutdown methodology described in the Wolf Creek SER, RCS pressure boundary leakage is discussed. Specifically, the submittal included in part: “Other pressure boundary valves (RCS head vent and excess letdown) would result in a relatively small loss of RCS inventory if multiple failures occurred involving at least two valves in series on one line.”

Given the above background information, the following potential RCS high/low pressure interfaces are considered in the PFSSD analysis:

1. RHR suction and discharge interface with the RCS
2. Normal letdown interface
3. Excess letdown interface
4. Reactor head vent interface
5. Reactor coolant pump seal interface
6. RCS sample interface

No other RCS high/low pressure interfaces exist at Wolf Creek.

The following discussion provides the justification/methods for including and controlling the various high/low pressure interfaces at Wolf Creek.

1. <u>RHR Suction and Discharge High/Low Pressure Interface</u>: The RHR discharge to the RCS contains check valves BB8949B and BB8949C. These check valves provide isolation for the high/low pressure interface. The RHR suction valves from RCS, BBPV8702A and BBPV8702B, are administratively controlled. The valves are maintained closed with their respective motor operator circuit breakers (NG02BCF2 and NG02BBF3) LOCKED

OFF when RHR is placed in STANDBY (Reference CKL BB-110, Page 28). The circuit breakers for these valves are locked off to preclude inadvertent operation (opening) of these valves during normal operation. If these valves were opened with the reactor coolant system pressure at normal operating pressure, the low-pressure residual heat removal system piping could be over-pressurized and a loss of coolant accident (LOCA) outside containment would occur. The closed suction valves provide isolation for the RHR suction path high/low pressure interface.

Two limit switches (BBZS8702AA and BBZS8702AB) are installed on BBPV8702A. BBZS8702AA provides an interlock input to EJHV8804A (See decay heat removal function discussion). BBZS8702AB provides an input to the RWST level test circuitry and is not required for post fire safe shutdown.

Interlock and instrument signals are provided as inputs to the control circuits for BBPV8702A and BBPV8702B. Because these valves are administratively controlled, these circuits are effectively isolated for reactor makeup function purposes. These circuits are required for the decay heat removal function (transition to cold shutdown) (See decay heat removal function discussion).

EJHV8701A and EJHV8701B, RHR loops 1 and 4 hot leg suction valves, are administratively controlled in the closed position. The valves are maintained closed with their respective motor operator circuit breakers (NG01BEF2 and NG01BDF3) LOCKED OFF when RHR is placed in STANDBY (Reference CKL EJ-120, Page 25). The closed suction valves provide redundant isolation for the low pressure RHR piping. EJHIS8701A and EJHIS8701B are included in the design because they are in the control circuits for EJHV8701A and EJHV8701B. All of these components are required for cold shutdown heat removal (See decay heat removal function).

2. Normal Letdown High/Low Pressure Interface: Maximum normal letdown flow is 120 gpm. This flow rate is within the capacity of a centrifugal charging pump, but this flow path discharges to the VCT (the VCT is isolated during performance of OFN RP-017). Consequently, if the letdown flow remains unisolated, it would be feasible to have a small break LOCA (120 gpm) outside containment. Therefore, the normal letdown path must be isolated to prevent a possible LOCA through the VCT. BGLCV0459 and BGLCV0460 are shut to isolate this high/low pressure interface.

The following components are used for isolating the normal letdown high/low pressure interface:

COMPONENT	DESCRIPTION	COMMENT
BGHV8149A	Letdown Orifice Isolation Valve Limit Switch	Only Limit Switch is Used
BGHV8149B	Letdown Orifice Isolation Valve Limit Switch	Only Limit Switch is Used
BGHV8149C	Letdown Orifice Isolation Valve Limit Switch	Only Limit Switch is Used
BGHIS0459	Letdown Isolation Valve (BGLCV0459) Hand Switch	N/A
BGHIS0459A	Letdown Isolation Valve (BGLCV0459) Hand Switch	N/A
BGHIS0460	Letdown Isolation Valve (BGLCV0460) Hand Switch	N/A
BGHIS0460A	Letdown Isolation Valve (BGLCV0460) Hand Switch	N/A
BGHY0459	Letdown Isolation Valve (BGLCV0459) Solenoid Valve	N/A
BGHY0460	Letdown Isolation Valve (BGLCV0460) Solenoid Valve	N/A
BGLCV0459	Letdown Isolation Valve	N/A

COMPONENT	DESCRIPTION	COMMENT
BGLCV0460	Letdown Isolation Valve	N/A
KAFV0029	Instrument Air Containment Isolation Valve	Isolates instrument air to fail BGLCV0459 and BGLCV0460 closed.
KAHIS0029	Instrument Air Containment Isolation Valve (KAFV0029) Hand Switch	Isolates instrument air to fail BGLCV0459 and BGLCV0460 closed.
KAV0201	Instrument Air Isolation Manual Valve	Isolates instrument air to fail BGLCV0459 and BGLCV0460 closed. Used where KAFV0029 is affected by the fire.

3. Excess Letdown High/Low Pressure Interface: Excess letdown design flow rate is 20 gpm. Excess letdown could possibly be diverted to the reactor coolant drain tank. If this should occur, approximately 20 gpm would be lost from the RCS. Although this RCS coolant loss is within the capacity of the charging pumps, this interface should be isolated. OFN RP-017 includes actions to fail BGHV8153A, BGHV8153B, BGHV8154A and BGHV8154B closed by opening the control power circuit breakers for the valves. This action maintains the excess letdown high/low pressure interface isolated from the RCS.

   BGHV8153A, BGHV8153B, BGHV8154A and BGHV8154B and their hand switches, BGHIS8153A, BGHIS8153B, BGHIS8154A and BGHIS8154B are included in the design to provide the capability to shut the valves from the control room in the event of a fire outside the control room. Limit switches BGZS8153A, BGZS8153B, BGZS8154A and BGZS8154B are not included in the design because the limit switches are used for indication and not required for post fire safe shutdown.

   BBHV8157A and BBHV8157B, excess letdown path to PRT isolation valves, are not included in the hot standby PFSSD design. The basis for not including these components is that this path is isolated by the closure of BGHV8153A, BGHV8153B, BGHV8154A and BGHV8154B described above. Valves BBHV8157A and BBHV8157B are credited in the PFSSD design for cold shutdown because of the need for letdown during cold shutdown.

4. Reactor Head Vent High/Low Pressure Interface: A 3/8" orifice limits flow through the reactor head vent line. Although the potential flow rate through the reactor vessel head vent high/low pressure interface is within the charging pump capacity, OFN RP-017 provides actions to isolate the reactor head vent high/low pressure interface. Specifically, power is removed from head vent valves (BBHV8001A, BBHV8001B, BBHV8002A and BBHV8002B) to fail the valves closed.

   The reactor head vent valves BBHV8001A, BBHV8001B, BBHV8002A and BBHV8002B and their hand switches BBHIS8001A, BBHIS8001B, BBHIS8002A and BBHIS8002B are included in the design. This provides the capability to close these valves in the event of a fire outside the control room. Limit switches BBZS8001A, BBZS8001B, BBZS8002A and BBZS8002B are not included in the design. The basis for not including these limit switches is that the limit switches are for indication and are not required to close the valves.

5. Reactor Coolant Pump Seal High/Low Pressure Interface: Maintaining the RCP seals intact controls the reactor coolant pump seal high/low pressure interface. The RCP seals are maintained intact by restoring, or not restoring, RCP seal injection flow. At Wolf Creek, seal injection is only restored if thermal barrier cooling remains operable during the event. If both thermal barrier cooling and seal injection are lost in a single fire, then the RCP's are tripped and natural circulation cooldown is used. Procedure OFN RP-017 does not restore seal cooling if a fire occurs in the control room. The reactivity control function discussion provides additional discussion on RCP seal injection concerns.

6. RCS Sample Interface: The RCS sample flow path includes normally closed manual isolation valves. Consequently, the RCS sample interface is controlled and not subject to fire induced spurious operations. The RCS sample interface is included for discussion purposes only and is not included in the design.

The above discussion provides the justification/methods for including and controlling the various high/low pressure interfaces at Wolf Creek.

RCS PRESSURE CONTROL

RCS pressure control is required to maintain reactor level within the pressurizer level indication. Two RCS pressure control issues exist, high pressure and low pressure. Reactor high pressure control is a concern because RCS rupture could occur if RCS overpressure is not limited. Reactor low pressure is a concern because, in a low pressure condition, pressurizer level indication is inaccurate when boiling occurs in the reactor vessel. Under low RCS pressure conditions a steam bubble forms in the reactor vessel head and the steam bubble in the pressurizer is collapsed as RCS inventory is forced from the reactor into the pressurizer. This is the basis for the NRC requirement to maintain pressurizer level indication.

Reactor overpressure protection is provided by the RCS code safety valves, BBV8010A, BBV8010B and BBV8010C. The RCS code safety valves are passive mechanical components controlled by Technical Specifications. Because the RCS code safety valves are not subject to fire induced spurious operation and they are assured (controlled by Technical Specifications) to be available in the event of fire, the RCS code safety valves are not included in the PFSSDA.

RCS low-pressure control includes pressurizer spray, pressurizer PORVs and RCS cooldown rate. These three RCS pressure control issues are contained in the following discussion:

1. Pressurizer PORV Control: Uncontrolled RCS pressure reduction by the pressurizer PORVs spurious operation is mitigated by operator action specified in OFN RP-017 in the event of a control room fire and OFN KC-016 for fires outside the control room.

   The pressurizer PORV interface consists of two parallel paths. Each of these paths contains a pressurizer PORV and its associated block valve [(BBPCV0455A and BBHV8000A) and (BBPCV0456A and BBHV8000B)]. OFN RP-017 provides operator action to open 125VDC control power circuit breakers for BBPCV0455A and BBPCV0456A. Removing control power from these valves closes the valves and assures that hot shorts in the pressurizer PORV control circuits located in the control room cannot fail the pressurizer PORVs open. Hot shorts in the pressurizer PORV control circuits caused by a fire in other areas of the plant could fail the PORV's open. Failed open pressurizer PORVs can be isolated by either re-closing the PORVs using the control room hand switches or closing the block valves.

   The control circuits for BBPCV0455A, BBPCV0456A, BBHV8000A and BBHV8000B contain auxiliary relays that are required for isolation of the pressurizer PORV/block valve high/low pressure interface. These auxiliary relays control contactors that apply power to the PORVs. The relays and contactor panels are described in the following table:

RELAY	DESCRIPTION	COMMENT	
62XBB01	Pressurizer PORV Block Valve BBHV8000A Auxiliary Relay	Relay must be energized to close BBHV8000A	
62XBB02	Pressurizer PORV Block Valve BBHV8000B Auxiliary Relay	Relay must be energized to close BBHV8000B	

RELAY	DESCRIPTION	COMMENT
62XBB03	Pressurizer PORV Block Valve BBHV8000A Auxiliary Relay	If relay energized, BBHV8000A will open
62XBB04	Pressurizer PORV Block Valve BBHV8000B Auxiliary Relay	If relay energized, BBHV8000B will open
K713	Pressurizer High Pressure Train A	If relay energized, BBPCV0455A will open
K713	Pressurizer High Pressure Train B	If relay energized, BBPCV0456A will open
BB007	Pressurizer PORV BBPCV0455A Contactor Panel	Two Auxiliary relay contacts in series must be closed to initiate closing four contacts in series to open BBPCV0455A
BB008	Pressurizer PORV BBPCV0456A Contactor Panel	Two Auxiliary relay contacts in series must be closed to initiate closing four contacts in series to open BBPCV0456A

The following components and signals are related to cold overpressure protection and not required for post fire safe shutdown: BBHS8000A, BBHS8000B, BBZA8000, BBZA8000A, BBZA0455A, BBZS0455A, BBZS0456A, BBPB0403C, BBPV0405C, BBPB0455E and BBPB0456E.

The pressurizer pressure relief signals from the solid state protection system (SSPS) are included in the post fire safe shutdown design. The reason for including these signals is that inadvertant operation of the pressure control system could complicate PFSSD by causing the pressurizer PORVs and spray valves to operate, thus causing a rapid decrease in RCS pressure which could lead to boiling in the core.

Four pressurizer pressure transmitters feed signals to the pressurizer pressure and level control system as well as the reactor protection system (RPS). The signals from the pressure transmitters perform the following functions applicable to PFSSD:

- Trips the reactor on 2 of 4 high pressure at 2385 psig
- Closes PORV block valves on 2 of 4 low pressure at 2185 psig
- Trips the reactor on 2 of 4 low pressure at 1940 psig
- Safety injection on 2 of 4 low pressure at 1830 psig
- Opens PORV BBPCV0455A on signal from the pressurizer pressure master controller (BBPK0455A). The nominal open setpoint is 2335 psig from either BBPT0455 or BBPT0457, depending on the position of the pressure channel selector switch (BBPS0455F). The normal switch position is with BBPT0455 selected.
- Opens PORV BBPCV0456A on signal from pressurizer pressure control system through a bistable set at 2335 psig from either BBPT0456 or BBPT0458, depending on the position of the pressure channel selector switch (BBPS0455F). The normal switch position is with BBPT0456 selected.

The reactor trip signals and block valve close signals are not specifically discussed in the fire area analyses because, with the reactor tripped and the block valves closed, the desired PFSSD condition is achieved. A spurious safety injection signal (SIS) complicates PFSSD so the fire area analysis document (E-1F9910) addresses areas where spurious low pressurizer pressure SIS can occur. Spurious signals from the pressurizer pressure control system could cause one or both pressurizer PORVs to open, which is not desired for PFSSD. Therefore, these pressure signals are evaluated in the fire area analysis document (E-1F9910).

2. RCS Cooldown Rate Control: RCS cooldown rate control includes prevention of uncontrolled RCS cooldown and controlling RCS cooldown rate during decay heat removal.

   a. Uncontrolled RCS Cooldown: Main steam components that could initiate uncontrolled RCS cooldown are controlled (isolated). Control of these main steam components (steam generator atmospheric relief valves, MSIVs and MSIV bypass valves) is described in the reactivity control function discussion.

   b. Control of RCS Cooldown Rate: Main steam components (steam generator atmospheric relief valves) used to control RCS cooldown are described in the decay heat removal function discussion.

   Main steam line pressure transmitters provide a steam line pressure input signal to the safety injection circuits. Safety injection complicates control of the reactivity control function (excessive cooldown inserts positive reactivity), reactor makeup function (pressurizer level may not be maintained within indicating range) and decay heat removal (excessive cooldown rate). Safety injection is controlled by either preventing safety injection actuation (protecting SI input signals and/or opening safety injection pump breakers to prevent safety injection pumps from running). Consequently, the following steam line pressure transmitters are included in the post fire safe shutdown design:

COMPONENT	DESCRIPTION
ABPT0514	Steam Generator A Steamline Pressure Transmitter
ABPT0515	Steam Generator A Steamline Pressure Transmitter
ABPT0516	Steam Generator A Steamline Pressure Transmitter
ABPT0524	Steam Generator B Steamline Pressure Transmitter
ABPT0525	Steam Generator B Steamline Pressure Transmitter
ABPT0526	Steam Generator B Steamline Pressure Transmitter
ABPT0534	Steam Generator C Steamline Pressure Transmitter
ABPT0535	Steam Generator C Steamline Pressure Transmitter
ABPT0536	Steam Generator C Steamline Pressure Transmitter
ABPT0544	Steam Generator D Steamline Pressure Transmitter
ABPT0545	Steam Generator D Steamline Pressure Transmitter
ABPT0546	Steam Generator D Steamline Pressure Transmitter

3. Normal and Auxiliary Pressurizer Spray: Another element required to assure RCS pressure control functions are available is control of normal and auxiliary pressurizer spray. Because normal pressurizer spray relies upon the pressure differential between the surge line connection in the Loop 4 hot leg and the spray line connection in the Loops 1 and 2 cold leg, normal pressurizer spray is controlled (stopped) if the RCPs are not running. If less than four RCPs are operating, the pressurizer spray flow will be reduced if the D RCP is not operating because the static pressure in the surge line loop will be nearly equal to the spray source loop. The normal pressurizer spray valves are air operated. Isolation of instrument air to containment will fail the valves closed. OFN RP-017 provides actions to stop the RCPs within the first seven minutes following control room evacuation in the event of a control room fire. In the event of a fire outside the control room, operators can mitigate spurious operation of the pressurizer spray valves by either stopping the RCPs and using natural circulation cooldown or isolating instrument air to containment to fail the valves closed. Valve KAFV0029 and hand switch KAHIS0029 are included in the PFSSD design to isolate instrument air to containment. Valve KAV0201 is also included in the PFSSD design in the event KAFV0029 is affected by the fire. Therefore, pressurizer normal spray valves BBPCV0455B and BBPCV0455C and associated cables and components are included in the PFSSDA to evaluate whether the spray valves will spuriously open

The pressurizer normal spray valves (BBPCV0455B and BBPCV0455C) operate off a signal from the pressurizer pressure control system. The pressurizer pressure master controller (BBPK0455A) receives a signal from either BBPT0455 or BBPT0457, depending on the position of the pressure channel selector switch (BBPS0455F). The normal position of the switch has BBPT0455 selected. Switch BBPS0455F is connected to relay cards in panel RP047. Loss of power to the relay cards will cause the switch to revert to the BBPT0455/BBPT0456 position. If BBPT0455 is affected by the fire, operators can switch to BBPT0457 only if power to the relay cards is available. Therefore, power to RP047 is included in the PFSSD analysis.

Upon increasing pressure in the pressurizer as determined by the master controller, the spray valves open to compensate for the pressure increase. At Wolf Creek, one set of pressurizer backup heaters is normally maintained energized. This causes the master controller output to increase as pressure goes up. This output results in the pressurizer spray valves opening to compensate for the heat input to the pressurizer. The end result is RCS fluid from the spray lines continually mixing in the pressurizer, maintaining the boric acid and chemical concentrations equal to the RCS.

Pressurizer auxiliary spray valve BGHV8145 is not included in the post fire safe shutdown design because alternative and redundant means are available to prevent auxiliary spray. The pressurizer auxiliary spray tap is on the charging line downstream of the regenerative heat exchanger. Therefore, isolation of the normal charging line will prevent auxiliary pressurizer spray. In OFN RP-017, normal charging is isolated by closing BG8402B. For fires outside the control room, normal charging is isolated by closing either BGHV8105 or BGHV8106. However, in one fire area (A-24), it may not be possible to close valves BGHV8105 and BGHV8106 because these valves are located in fire area A-24 and a fire could damage the power cables. See fire area A-24 analysis in E-1F9910 for further discussion about this configuration.

4. Pressurizer Heaters: Pressurizer heaters are not credited in the redundant post fire safe shutdown design (10 CFR 50, Appendix R, Section III.G.2 areas). Calculation WCNOC-CP-002 is a thermal hydraulic transient analysis for the Wolf Creek plant for various fire scenarios. The pressurizer heaters were modeled on or off for each scenario to determine worse case effect. Based on the results, operation or maloperation of the pressurizer heaters had no adverse impact on PFSSD. Any minimal impact could be offset by available PFSSD equipment. Therefore, the pressurizer heaters are not included in the PFSSD analysis.

   The backup group B pressurizer heaters are credited in the alternative post fire safe shutdown design (10 CFR 50, Appendix R, Section III.G.3 areas). Procedure OFN RP-017 has operators maintain pressurizer pressure within acceptable parameters. This is done by cycling the backup group B heaters on and off as necessary. Calculation SA-08-006 assumes the pressurizer backup group B heaters are controlled in OFN RP-017 within 11.5 minutes following reactor trip. The backup group B heaters are isolated from the control room using RPHIS0003 on panel RP118B. Hand switch BBHIS0052B controls the position of incoming PG22 feeder breaker PG2201 from auxiliary shutdown panel RP118B. Bus PG22 is the power distribution bus for the backup group B heaters. Bus PG22 is fed from NB0208. These components are included in the alternative PFSSD design.

5. Pressurizer Pressure Indication: Pressurizer pressure indication is included in the PFSSD design to provide operators with a way of diagnosing an open PORV/block valve flow path or spurious pressurizer spray. The following pressurizer pressure indicators are included.

COMPONENT	DESCRIPTION
BBPI0455A	Pressurizer Pressure Indicator
BBPI0456	Pressurizer Pressure Indicator
BBPI0457	Pressurizer Pressure Indicator
BBPI0458	Pressurizer Pressure Indicator

REACTOR COOLANT SYSTEM MAKEUP

Reactor coolant system makeup is accomplished by charging to the RCS via the RCP seals and/or via the BIT. Approximately 16 to 32 gpm is charged via the RCP seals. The RCP seal injection path is described in the reactivity control function discussion. Appropriate components identified for reactivity control are incorporated into the reactor makeup function logic diagram. These components include borated water source (RWST), centrifugal charging pumps and valves associated with the centrifugal charging pumps and the RCP seal injection path.

Because RCP seal injection is limited to a maximum of 8 gpm per RCP, an additional RCS charging path is required for adequate RCS makeup during plant transition from hot standby to cold shutdown. The BIT injection path was selected because it is used in OFN RP-017.

EMHV8803A, EMHV8803B, EMHIS8803A and EMHIS8803B, charging pump discharge header to BIT isolation valves and hand switches, are included in the reactor makeup function design. The valve on the operating CCP Train must be open to achieve post fire safe shutdown. EMHV8801A, EMHV8801B, EMHIS8801A and EMHIS8801B, BIT isolation valves and hand switches, are included in the reactor makeup function design. At least one of these redundant parallel path valves must be open to achieve post fire safe shutdown.

EMHV8801A, EMHV8801B, EMHV8803A and EMHV8803B control circuits have a safety injection signal (SIS) input. The SIS circuit opens the valves if an SI signal occurs. If the valves are full open, RCS makeup may be excessive; therefore, these relays are included in the post fire safe shutdown design. The following table identifies the SI relays and their respective valves:

COMPONENT	DESCRIPTION	RELAY	DESCRIPTION
EMHV8801A	BIT Outlet Isolation Valve	K603	Safety Injection Signal
EMHV8801B	BIT Outlet Isolation Valve	K603	Safety Injection Signal
EMHV8803A	Charging Pump Discharge Header to BIT Isolation Valve	K608	Safety Injection Signal
EMHV8803B	Charging Pump Discharge Header to BIT Isolation Valve	K608	Safety Injection Signal

EMHV8843 and EMHV8882, SIS test line isolation valves, are included in the design because these valves provide a path to divert BIT injection flow. Both valves must remain closed. EMHV8843 and EMHV8882 were included in the original WCNOC post fire safe shutdown design described in SLNRC 84-0109 submitted to the NRC.

EMHY8843, EMHY8882, EMHIS8843, EMHS8843, EMHIS8882 and EMHS8882 are included in the design. Solenoid valves EMHY8843 and EMHY8882 are required to vent air to close EMHV8843 and EMHV8882. EMHIS8843 and EMHIS8882 are included to allow closing EMHV8843 and EMHV8882 in the event of fire outside the control room. EMHS8843 and EMHS8882 are included to allow closing EMHV8843 and EMHV8882 in the event of fire in the control room. EMHY8871, EMHY8964, EMHIS8871, EMHIS8964 are included in the design to allow closing EMHV8871 and EMHV8964 for redundant isolation capability for a fire outside the control room.

Pressurizer level indication is provided to verify that reactor level is maintained within the pressurizer level indication. BBLT0459 and BBLT0460 are included in the design to provide redundant pressurizer level indication in the control room. BBLT0460 is included because this transmitter supplies BBLI0460A in the control room and BBLI0460B on RP118B. BBLI0460B is independent of the control room. BBLT0461 and BBLI0461 were excluded from the design because circuitry associated with BBLT0461 may not be adequately separated from BBLT0460 and redundant pressurizer level indication is provided by BBLT0459 and BBLI0459A.

Because pressurizer level and pressure are maintained within the required limits, safety injection is prevented. The following RCS pressure instruments are included in the post fire safe shutdown design to ensure that associated circuits do not initiate a safety injection:

COMPONENT	JUSTIFICATION
BBPT0455	Safety injection must be prevented
BBPT0456	Safety injection must be prevented
BBPT0457	Safety injection must be prevented
BBPT0458	Safety injection must be prevented

MAKEUP CONTROL FUNCTION STATUS PANEL RESOLUTION

Discussion

Status panels are installed in the control circuits of some post fire safe shutdown components. The cables to these status panels are associated circuits that are subject to failures that may compromise the post fire safe shutdown component. The following analysis describes how reactor makeup function components may be affected by status panel associated circuits.

Analysis

The following table identifies the reactor makeup function post fire safe shutdown components that have status panels installed in their control circuits:

COMPONENT	STATUS PANEL SCHEMATIC	STATUS PANEL CABLE	NOTES
ABHV0005	E-13SA16	12SAZ16AA	A, B, C, D
ABHV0006	E-13SA16	12SAZ16AA	A, B, C, D
ABHY0012A	E13SA15	11SAZ15MA	A, B, C, E
ABHY0015A	E13SA15	11SAZ15MA	A, B, C, E
ABHY0018A	E13SA15	11SAZ15MA	A, B, C, E
ABHY0021A	E13SA15	11SAZ15MA	A, B, C, E
ABHY0012B	E-13SA16	14SAZ16MA	A, B, C, E
ABHY0015B	E-13SA16	14SAZ16MA	A, B, C, E
ABHY0018B	E-13SA16	14SAZ16MA	A, B, C, E
ABHY0021B	E-13SA16	14SAZ16MA	A, B, C, E
BMHV0001	E-13SA16	14SAZ16HA	A, C, D, F
BMHV0002	E-13SA16	14SAZ16HA	A, C, D, F
BMHV0003	E-13SA16	14SAZ16HA	A, C, D, F
BMHV0004	E-13SA16	14SAZ16HA	A, C, D, F
EMHV8843	E-13SA16	14SAZ16SA	A, C, D, E

NOTES:

A. The status-monitoring panel cable is installed in parallel with the control circuit power supply and the control circuit. If the status-monitoring panel cables open circuit, there will be no effect on either the control circuit power supply or the control circuit.

B. If the status-monitoring panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The valve will open, but a downstream valve FCHV0312 is closed. Consequently there will be no adverse secondary side injection from TDAFWP.

C. If one status-monitoring panel cable shorts to ground, there will be no effect on the component or post fire safe shutdown because the control circuit power supply is an ungrounded DC system. If both positive and negative status-monitoring panel cables short to ground, then the control circuit power supply will fail as a result of excessive current through the short circuit. The valve solenoid will be de-energized upon the failure of the control circuit power supply (fuse failure from overcurrent). When the valve solenoid is de-energized, the valve repositions to the desired post fire safe shutdown position.

D. A positive hot short to the status-monitoring panel positive cable or a negative hot short to the status-monitoring panel negative cable will have no effect on the control circuit power because normal control power will continue to exist. However, if a negative hot short occurs on the status-monitoring panel positive cable, or a positive hot short occurs on the status-monitoring panel negative cable, then excessive current may cause a control power fuse failure. The valve solenoid will be de-energized upon the failure of the control circuit power supply (fuse failure from overcurrent). When the valve solenoid is de-energized, the valve repositions to the desired post fire safe shutdown position.

E. If the status-monitoring panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The valve solenoids will be de-energized and the valves will close, their post fire safe shutdown design position.

F. If the status-monitoring panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The blowdown valve will close (post fire safe shutdown required position). Consequently there will be no adverse consequence from this failure mode.

DECAY HEAT REMOVAL FUNCTION

The decay heat removal function performance goal for PFSSD is to remove residual heat remaining in the RCS (reactor's core) to prevent overheating of the fuel elements and a release of radioactive material. The decay heat removal function includes two phases: (1) removal of heat in the RCS immediately after a reactor trip (Hot Standby to Cold Shutdown); and (2) long-term removal of reactor heat (Cold Shutdown).

The goal requires that decay heat removal be achieved and maintained under post fire conditions with a loss of off-site power. Therefore, post fire decay heat removal is accomplished through the use of the RCS in natural circulation; the main steam system and auxiliary feedwater system are used to remove decay heat during hot standby while other systems such as main feedwater are isolated to ensure control of the decay heat removal activity.

The following discussion applies to a control room fire. The discussion would change slightly for fires in other plant areas.

For hot standby, decay heat removal begins with a reactor trip initiated in response to a fire in the plant. The RCPs are not available (loss of off-site power assumption). Natural circulation is accomplished by establishing a temperature differential in the RCS (higher temperature in the core, lower temperature in the steam generators). This is achieved by opening the steam generator atmospheric relief valves (ARV) and releasing steam to the atmosphere. Maintaining decay heat removal requires auxiliary feedwater system operation to provide feedwater to the steam generators.

Decay heat removal is maintained during hot standby by controlling the steam released via the ARVs and providing makeup feedwater via the auxiliary feedwater system. To ensure control of the cooldown rate the main steam, main feedwater and steam generator blowdown systems are isolated.

Decay heat removal requires both achieving and maintaining hot standby as well as the transition to and maintenance of cold shutdown. Cycling the steam generator atmospheric relief valves controls cooldown to cold shutdown. The cooldown rate is coordinated with other PFSSD functions, reactivity control and reactor makeup, to maintain reactor shutdown margin and RCS level within the pressurizer level indication.

The transition to cold shutdown requires that cooldown be transferred to the RHR system. This includes isolating the safety injection accumulator tanks when RCS pressure is reduced to less than 1000 psig and reducing the RCS pressure to less than 360 psig prior to initiating RHR.

Instrumentation supporting decay heat removal includes:

- Steam generator wide range level indication
- RCS wide range T_H
- T_C and RCS pressure.

Decay heat removal control includes the following considerations:

- Main steam isolation
- Steam generator atmospheric relief operation
- Steam generator blowdown isolation
- Main feedwater isolation
- Auxiliary feedwater
- Essential service water operation
- RCS accumulator isolation
- RHR operation
- Instrumentation
- Time to initiate RCS cooldown

Discussion:

The following paragraphs describe the capabilities identified above and justify the selection or non-selection of specific components. Where components or capabilities have been discussed under the reactivity control or reactor makeup function, additional discussion is provided only if required.

MAIN STEAM ISOLATION

Main steam isolation is required to prevent an uncontrolled RCS cooldown in a PFSSD condition. The Wolf Creek decay heat removal methodology provides for controlling the cooldown using steam generator atmospheric relief valves.

1. MSIV & MSIV Bypass Valve Closure

   Main steam isolation valve (MSIV) and MSIV bypass valve isolation is described in the reactivity control function discussion. The reactivity control function discussion of MSIV and MSIV bypass valve isolation is directly applicable to decay heat removal.

2. Main Steam Line Drain Valves

   Main steam line drain valves (ABLV0007, ABLV0008, ABLV0009 and ABLV0010) are air operated one-inch valves. Individually the valves do not present an uncontrolled RCS cooldown rate. Each downstream discharge line also contains a flow orifice. However, if one or more of the valves were to spuriously open, release of steam via this path can be mitigated by either closing the drain line isolation valves (ABV0052, 0062, 0072, or 0082) or compensating for the loss through the control of the steam generator atmospheric relief valve's operation. The manually operated inlet and outlet isolation valves may be used to isolate a stuck open main steam line drain valve. Consequently, the main steam line drain valves are not identified as required for PFSSD.

STEAM GENERATOR ATMOSPHERIC RELIEF OPERATION

Steam generator relief valve isolation is described in the reactivity control function discussion. The reactivity control function discussion of steam generator atmospheric relief valve operation is directly applicable to decay heat removal, except the steam generator atmospheric relief valves are cycled open to remove heat rather than being maintained closed to prevent uncontrolled cooldown.

The decay heat removal function ensures sufficient heat removal capability to achieve and maintain hot standby and ensure the plant can be in cold shutdown in 72 hours (alternate shutdown requirement only). Hot standby is defined as $T_{AVG} \geq 350°F$ and cold shutdown is defined as $T_{AVG} \leq 200°F$. Calculation AN-96-062 shows that with a single steam generator ARV available, hot standby can be achieved in 94 hours. If a second ARV is placed in service in 60 hours after plant shutdown, hot standby can then be achieved within 1 hour after placing the second ARV in service. Cold shutdown can then be achieved within 72 hours using RHR while not exceeding a cooldown rate of 50°F per hour. Therefore, based on Calculation AN-96-062, as long as two steam generator ARVs are available, cold shutdown can be achieved in 72 hours.

Calculation WCNOC-CP-002 analyzed scenarios where one or more steam generator ARV fails open or closed. The calculation analyzed up to three ARVs failed open for the entire event, in addition to other failures, and the results showed no adverse impact on PFSSD. Also, the calculation analyzed all four ARVs failed closed and the results showed no adverse impact because the mechanical safety relief valves operated to remove excess heat and maintain stable hot standby conditions.

The following table describes the steam generator atmospheric relief valves and their associated components included in the PFSSD design:

RELIEF VALVE	ASSOCIATED COMPONENT	DESCRIPTION
ABPV0001		Steam Generator A Atmospheric Relief Valve
	ABPT0001	Steam Generator A Pressure Transmitter
	ABPIC0001A	Steam Generator A Atmospheric Steam Dump Pressure Controller at RL006
	ABPIC0001B	Steam Generator A Atmospheric Steam Dump Pressure Controller at RP118A
	ABHS0001	ABPV0001 Hand Switch at RP118A
	ABPY0001	ABPV0001 I/P Signal Converter
	ABV0018	ABPV0001 Manual Isolation Valve
	KAV1364	ABPV0001 Nitrogen Supply Valve
	KAV1435	ABPV0001 Air Supply Valve
ABPV0002		Steam Generator B Atmospheric Relief Valve
	ABPT0002	Steam Generator B Pressure Transmitter
	ABPIC0002A	Steam Generator B Atmospheric Steam Dump Pressure Controller at RL006
	ABPIC0002B	Steam Generator B Atmospheric Steam Dump Pressure Controller at RP118B
	ABHS0002	ABPV0002 Hand Switch at RP118B
	ABPY0002	ABPV0002 I/P Signal Converter
	ABFHC0002	ABPV0002 Local Manual Controller
ABPV0003		Steam Generator C Atmospheric Relief Valve
	ABPT0003	Steam Generator C Pressure Transmitter
	ABPIC0003A	Steam Generator C Atmospheric Steam Dump Pressure Controller at RL006
	ABPIC0003B	Steam Generator C Atmospheric Steam Dump Pressure Controller at RP118A
	ABHS0003	ABPV0003 Hand Switch at RP118A
	ABPY0003	ABPV0003 I/P Signal Converter
	ABFHC0003	ABPV0003 Local Manual Controller
	ABV0029	ABPV0003 Manual Isolation Valve
	KAV1366	ABPV0003 Nitrogen Supply Valve
	KAV1445	ABPV0003 Air Supply Valve
ABPV0004		Steam Generator D Atmospheric Relief Valve
	ABPT0004	Steam Generator D Pressure Transmitter
	ABPIC0004A	Steam Generator D Atmospheric Steam Dump Pressure Controller at RL006
	ABPIC0004B	Steam Generator D Atmospheric Steam Dump Pressure Controller at RP118B
	ABHS0004	ABPV0004 Hand Switch at RP118B
	ABPY0004	ABPV0004 I/P Signal Converter
	KAV1365	ABPV0004 Nitrogen Supply Valve
	KAV1429	ABPV0004 Air Supply Valve

ABPV0001, 0002, 0003 and 0004 are steam generator (SG) A, B, C and D air operated atmospheric relief valves, respectively. ABPIC0001A&B, 0002A&B, 0003A&B and 0004A&B are pressure indicating controllers used to set the pressure to be maintained in the steam generators. Hand switches ABHS0001, ABHS0002, ABHS0003 and ABHS0004 are used to select the effective controller. Current to pneumatic (I/P) converters are used to convert electrical signals to pneumatic signals to control the position of the steam generator atmospheric relief valves. Steam generator pressure transmitters ABPT0001, APPT0002, ABPT0003 and ABPT0004 provide the electrical signals.

ABFHC0002 and 0003 are local manual controllers for ABPV0002 and 0003. They are used to control the RCS cooldown via the release of steam through ABPV0002 and 0003 in the event that remote control of ABPV0002 and 0003 is not feasible.

The alternate shutdown design includes air and nitrogen supply valves KAV1364, KAV1366, KAV1435 and KAV1445 for isolation of steam generator loops 1 and 3 atmospheric relief valves (ABPV0001 and ABPV0003). The alternate shutdown design also includes manual isolation valves ABV0018 and ABV0029 for isolation of steam generator loops 1 and 3 atmospheric relief valves (ABPV0001 and ABPV0003). This capability is included in the alternate shutdown design because ABPV0001 and ABPV0003 control circuits are not provided capability for isolation from the control room. Therefore, ABPV0001 and 0003 are subject to spurious operation during a control room fire. ABPV0002 and 0004 do not require a similar isolation capability because they can be isolated from the control room and are not subject to control room fire induced spurious operation. Consequently, ABPV0002 and 0004 manual isolation valves ABV0007 and ABV0040 are not included in the design.

The redundant shutdown design utilizes any available combination of auxiliary feedwater supplies and steam generator atmospheric relief valves (SGARVs) to control cooldown. In some areas, one or more SGARV could spuriously open, potentially causing uncontrolled cooldown. Calculation WCNOC-CP-002 shows that up to three failed open SGARVs will not adversely impact PFSSD. However, operators may want to isolate the failed open ARVs to regain control of the plant. Therefore, the air and nitrogen supply valves to ARV ABPV0004 (KAV1365 and KAV1429) are included in the PFSSD design, in addition to the air and nitrogen supply valves for ARVs ABPV0001 and ABPV0003 which are included in the alternate shutdown design discussed in the previous paragraph. Air and nitrogen supply valves for ARV ABPV0002 are not included in the PFSSD design because local controller ABFHC0002, which can be used to locally control or close ABPV0002, is included in the PFSSD design.

Atmospheric relief valve position switches ABZS0001, ABZS0002, ABZS0003 and ABZS0004, atmospheric relief valve main control board RL006 position indication lights ABZL0001A, ABZL0002A, ABZL0003A and ABZL0004A and atmospheric relief valve auxiliary shutdown panel position indication lights, ABZL0001B, ABZL0002B, ABZL0003B and ABZL004B are not included in the post fire safe shutdown design. The proper operation of the atmospheric relief valves can be determined by assessing the steam generator pressure and level indication.

STEAM GENERATOR BLOWDOWN ISOLATION

Steam generator blowdown is isolated to prevent RCS cooldown via the steam generator blowdown path. Closing BMHV0001, BMHV0002, BMHV0003 and BMHV0004 isolates steam generator blowdown. The valves are closed by de-energizing solenoid valves supplying air to isolation valve operators. Three solenoid valves are associated with each valve. The A and C solenoid valves are operated by hand switches or automatic signals and the B solenoid valves are operated by automatic signals only. BMHY0001A, BMHY0002A, BMHY0003A and BMHY0004A are included in the post fire safe shutdown design because they can be manually positioned from the control room using MCB RL024 hand switches, BMHIS0001A, BMHIS0002A, BMHIS0003A and BMHIS0004A. BMHY0001C, BMHY0002C, BMHY0003C, BMHY0004C are included in the post fire safe shutdown design because they can be manually positioned locally using hand switches BMHIS0001C, BMHIS0002C, BMHIS0003C and BMHIS0004C at the blowdown control panel BM157. Power to the solenoid valves is controlled by auxiliary relays. These auxiliary relays are identified in Appendix 4.

Solenoid valves BMHY0001B, BMHY0002B, BMHY0003B, BMHY0004B are operated only by the steam generator blowdown and sample isolation signal (SGBSIS). These solenoid valves are not manually controlled and do not provide a redundant capability to isolate blowdown from outside the control room. Consequently, they are not included in the PFSSD design.

Limit switches BMZS0001A, 2A, 3A, 4A and BMZS0001B, 2B, 3B, 4B are included in the design to provide steam generator blowdown valve isolation indication at RL024 and BM157, respectively.

The steam generator blowdown components required for PFSSD are identified in Appendix 3.

Steam generator surface blowdown isolation is not included in the post fire safe shutdown methodology. The justification for excluding the surface blowdown path is included in the discussion of the reactivity control function above.

MAIN FEEDWATER ISOLATION

Three pumps, PAE01A, PAE01B and PAE02 supply main feedwater. Turbines (KFC01A and KFC01B) supplied by main steam, drive PAE01A and PAE01B and the motor for PAE02 is powered from PB0406.

Main feedwater must be isolated to prevent:

1. Excessive cooldown rates caused by overfeeding the steam generators and
2. Filling the steam generators and main steam piping with water.

Pumps PAE01A and PAE01B stop when the MSIVs are closed following reactor trip. Alternatively, the pumps stop when high pressure stop valves FCFV0005 and FCFV0105, respectively, close, thereby preventing high pressure steam flow to the pump turbines. Low pressure stop valves FCFV0009 and FCFV0109 are not included in the PFSSD design because main steam flow to moisture separator reheater (MSR) B is isolated by closing ABHV0032, thereby isolating low pressure steam flow to the pump turbines.

Pump PAE02 is prevented from starting by de-energizing the motor using AEHIS0104 at RL027 or PB0406HIS in the turbine building.

Feedwater isolation valves AEFV0039, AEFV0040, AEFV0041 and AEFV0042 are included in the decay heat removal design to isolate main feedwater flow to the steam generators.

With the main feedwater pumps stopped and the auxiliary feedwater system operating, flow diversion is prevented by the closure of feedwater check valves AEV0420, AEV0421, AEV0422 and AEV0423, which are installed on the feedwater line upstream of the auxiliary feedwater tap.

Closing the main feedwater isolation valves (MFIVs) prevents steam generator over-filling if the fire prevents stopping the main feedwater pumps . The MFIVs can be closed using one of two all-close hand switches (AEHS0080 and AEHS0081) located in the control room.

AUXILIARY FEEDWATER

The auxiliary feedwater system provides feedwater to the steam generators. The Wolf Creek post fire safe shutdown design for auxiliary feedwater includes the following categories:

a. Water supply
b. Auxiliary feedwater pumps
c. Steam generator level control

Water Supply:

Two water supplies are provided as suction sources for the auxiliary feedwater pumps:

1. Condensate storage tank (TAP01)
2. Essential service water (ESW)

Technical Specification B 3.7.6, Condensate Storage Tank (CST), states:

> “The CST contains sufficient inventory to provide water to the steam generators via the AFW System for four hours at hot standby conditions followed by a plant cooldown to RHR initiation conditions. However, the CST is not the safety related source of water to the AFW pumps. The safety related source is provided by the Essential Service Water (ESW) System.”

Although the CST is not the safety related source of water to the AFW pumps, it is the preferred source of water and will be used until the CST supply is depleted.

An automatic transfer from the CST to ESW occurs on a loss of AFW pump suction pressure (LSP) coinciding with AFW actuation. The LSP signal is developed from three pressure transmitters (ALPT0037, ALPT0038 and ALPT0039) installed on the CST outlet header and signal converters (ALPY0037A, ALPY0038A and ALPY0039A) in the balance of plant instrumentation panels in the control room. Two out of three coincidence logic is applied in the development of the LSP. Because the LSP is processed in reactor protection cabinets located in the control room, this method for selection of the AFW water source may not be available in the event of a fire in the control room.

The redundant CST level indication is manually calculated from AFW pump suction pressure. AFW pump suction pressure is available as identified in the following table:

INDICATOR	LOCATION	DESCRIPTION
ALPI0024A	RL005	Motor Driven AFW Pump PAL01B Suction Pressure
ALPI0024B	RP118B	Motor Driven AFW Pump PAL01B Suction Pressure
ALPI0025A	RL005	Motor Driven AFW Pump PAL01A Suction Pressure
ALPI0026A	RL005	Turbine Driven AFW Pump PAL02 Suction Pressure
ALPI0026B	RP118B	Turbine Driven AFW Pump PAL02 Suction Pressure

CST level is determined by converting the indicated suction pressure to height and subtracting the elevation difference between the suction AFW pump suction tap on the CST and the AFW pump suction. The resulting height corresponds to CST level. This height is then converted to inches and CST level (gallons) is determined from the CST curve (Reference WCRE-03). This method requires manual operation of motor operated valves.

The decay heat removal function design includes both methods for determining CST level (tank level indication and AFW pump suction pressure) and the motor operated valves that may be operated automatically or manually.

The alternative shutdown design incorporates the existing methodology (OFN RP-017) and SER requirements. Specifically, alternative shutdown relies on using both CST and ESW supplies, manually positioning motor operated valves and manual determination of CST level.

Auxiliary Feedwater Pumps:

Three auxiliary feedwater pumps are incorporated in the design, two motor driven auxiliary feedwater pumps (MDAFWPs) and the turbine driven auxiliary feedwater pump. For shutdown from the control room two redundant motor driven feedwater pumps, PAL01A and PAL01B, are provided. Turbine driven AFW pump, PAL02, is redundant to the motor driven auxiliary feedwater pumps.

The alternative shutdown design utilizes motor driven AFW pump B to supply steam generator D and the turbine driven AFW pump to supply steam generator B. This methodology is consistent with previous Wolf Creek NRC submittals, the Wolf Creek SER and OFN RP-017.

The auxiliary feedwater components required for PFSSD are identified in Appendix 3.

Auxiliary relay (86XRP7), actuated by RPHIS0002 on RP118B, is used to isolate DPAL01B controls from the control room if alternate shutdown is required.

1. Turbine Driven AFW Pump Steam Supply Valves

   Main steam supply valves, ABHV0005 and ABHV0006, to the turbine driven auxiliary feedwater pump must be open for the turbine driven AFW pump turbine (KFC02) to operate. ABHV0048 and ABHV0049, bypass valves for ABHV0005 and ABHV0006, are normally open to keep KFC02 steam supply lines warm. This flow path to the TDAFWP turbine is isolated by normally shut FCHV0312. Because the positions (either open or closed) of ABHV0048 and ABHV0049 have essentially no effect on post fire safe shutdown, ABHV0048 and ABHV0049 are not included in the post fire safe shutdown design.

   Closing FCFV0310 using FCHIS0310 to open solenoid valve FCFY0310 isolates a one-inch drain line to the low pressure condenser. When FCFY0310 opens, air is vented from FCFV0310 valve operator to allow FCFV0310 to fail closed.

   Lockout relay (86XRP1) is used to isolate FCHV0312 from the control room. This allows control of FCHV0312 from RP118B if the control room must be evacuated for alternate shutdown capability.

2. Turbine Driven Auxiliary Feedwater Pump

   The turbine driven auxiliary feedwater pump (PAL02) turbine (KFC02) is supplied steam by either ABHV0005 or ABHV0006.

   Two valves control steam supplied to the turbine:

   - Auxiliary feedwater pump mechanical trip/throttle valve (FCHV0312)
   - Auxiliary feedwater pump turbine speed governing valve (FCFV0313)

   A brief description of the electrical components and signals associated with the valves follows:

3. Auxiliary Feedwater Pump Mechanical Trip/Throttle Valve

   a. ASTS – The auxiliary shutdown transfer signal (ASTS) is initiated at RP118B by RPHIS0001 which transfers control to the auxiliary shutdown panel while isolating the main control board controls and indication (ASTS is included in the alternative shutdown design)

b. AFAS (To Start) – This is an automatic signal [auxiliary feedwater actuation signal (AFAS)] used to start the TDAFWP (AFAS (to start) is not included in the design because manual start of the TDAFWP is used).

c. FCHIS0312A – This hand indicating switch is used to manually start the TDAFWP at MCB RL005. FCHIS0312A is included in the design to manually start the TDAFWP in the event of fire outside the control room.

d. FCHIS0312B – This hand indicating switch is used to manually start the TDAFWP at auxiliary shutdown panel RP118B. FCHIS0312B is included in the design because it is required to start the TDAFWP for alternative shutdown.

e. FCZS0312C – This limit switch provides valve position indication at FC219. FCZS0312C and its associated indication lights are not included in the design because they do not provide control functions.

f. FCZS0312D – This is the mechanical over speed trip switch. The switch supplies indicator and annunciator lights and contacts in FCHV0312 open circuit. When FCZS0312D is reset, FCHV0312 open circuit interlock is closed to allow FCHV0312 to be opened. This interlock ensures that over speed protection is available when the TDAFWP is in operation. This circuit is not included in the design because a fundamental assumption of the design is that components free of fire damage will perform their designed function. If the TDAFWP is not available due to fire, then the redundant MDAFWPs will be available.

g. FCHS0332A – This push-button is used to trip FCHV0312 at FC219. The design assumes that FCHV0312 is open at the time of fire and remains open. Damage to this push-button due to a fire could trip valve FCHV0312. Therefore, it is included in the PFSSD design.

4. <u>Auxiliary Feedwater Pump Turbine Speed Governing Valve</u>

a. FCHIS0313A – This hand indicating switch is located in the main control room on MCB RL005 and is used to manually raise and lower the speed of the TDAFP. Since the switch is used to manually control the speed of the TDAFP, it is required for PFSSD.

b. FCHIS0313B – This hand indicating switch is located at the auxiliary shutdown panel RP118B and is used to manually raise and lower the speed of the TDAFP when evacuation of the control room is required. Since the switch is used to manually control the speed of the TDAFP in the event of a fire in the control room, it is required for PFSSD.

c. FCSC0313 – This is the Dresser-Rand 505 Turbine Speed Control System. Failure of this system could cause FCHV0312 to trip as well as cause a loss of control of speed governing valve FCFV0313. Therefore this device is required for PFSSD.

d. FCSE0313A – This speed element monitors AFP Turbine speed and provides an input to the 505 Turbine Speed Control System. FCSE0313A is included in the PFSSD design because turbine speed is required to be controlled, and an overspeed signal from this element will trip the turbine. The 505 system, using data from FCSE0313A, outputs the speed data to indicators located in the main control room and the auxiliary shutdown panel. Redundant speed element FCSE0313B is not included in the PFSSD design because only one speed element is required for operation of the TDAFP.

e. FCSI0313A – This is the AFP turbine speed and setpoint indicator located on MCB RL005. Since the speed indicator provides indication that the TDAFP is operating, it is included in the PFSSD design.

f. FCSI0313B – This is the AFP turbine speed and setpoint indicator located at the auxiliary shutdown panel, RP118B. Since the speed indicator provides indication that the TDAFP is operating, it is included in the PFSSD design.

g. FCZC0313 – This is the FCFV0313 valve positioner. Damage to the positioner could prevent operation of valve FCFV0313. Also, a failure of FCZC0313 drops power to relay CR2 on FCHV0312 control circuit and energizes the trip contactor, causing FCHV0312 to trip. Therefore, the positioner is included in the PFSSD design.

h. CR2 – This relay supplies an overspeed trip signal to FCHV0312. Damage to this relay due to a fire could cause a spurious trip of FCHV0312. Therefore, the relay is included in the PFSSD design.

i. FCHS0313 – This transfer switch, located on auxiliary shutdown panel RP118B, is used to select either FCHIS0313A or FCHIS0313B for TDAFWP speed control. This transfer switch is required for post fire safe shutdown; therefore FCHS0313 is included in the design.

Steam Generator Level Control

The SGs provide the means for removing heat from the RCS. The heat is circulated from the reactor core to the SG via RCS coolant where the heat is transferred to the SG lower temperature water. The heated water turns to steam and is released to the atmosphere. This release requires water be added to the SG for the cycle to continue. This process results in RCS natural circulation (water flowing based on a high temperature coolant seeking a lower temperature medium where its heat is released). Natural circulation must be maintained to prevent core damage from decay heat. The SG water provides the heat sink for the RCS. Therefore, the SG water level must be controlled to ensure: (1) that a proper heat sink is maintained for the RCS and (2) there is adequate decay heat removal capability prior to RHR initiation.

Steam generator water level is maintained by the release of steam and addition of auxiliary feedwater. The ARVs are operated to release steam to the atmosphere while maintaining a controlled RCS cooldown rate to lower RCS temperature and pressure.

Auxiliary feedwater control is accomplished by throttling AFW flow to the steam generators. The motor driven AFW pumps feed the steam generators via motor operated feed modulating valves. The turbine driven AFW pump feeds the steam generators via air operated feed valves.

The auxiliary feedwater components required for PFSSD are identified in Appendix 3.

The TDAFWP air operated feed valve position is controlled by hand operated controllers located at the control room MCB and the auxiliary shutdown panels.

The motor driven AFW pump motor operated feed modulating valve position is determined by hand operated controllers located at the control room MCB and the auxiliary shutdown panels or by signals developed from flow transmitters (ALFT0001, ALFT0007, ALFT0009 and ALFT0011) down stream of the feed modulating valves.

The TDAFWP and motor driven AFW pump suction valves close automatically when essential service water valves open automatically on an engineered safety feature actuation system (ESFAS) low suction pressure signal (LSP). The essential service water pumps also start on a LSP signal. These close and open signals are initiated by relays in the ESFAS cabinets. The following table identifies the valves and their associated LSP relay:

VALVE	DESCRIPTION	RELAY
ALHV0031	MDAFWP suction from the ESW system	K116
ALHV0032	TDAFW suction from the ESW system	K117
ALHV0035	MDAFWP suction from the condensate storage tank	K119
ALHV0036	TDAFWP suction from the condensate storage tank	K122
EFHV0023	ESW A/Service Water Cross Connect Valve	K140
EFHV0024	ESW B/Service Water Cross Connect Valve	K141
DPEF01A	ESW Pump A Motor	K142

VALVE	DESCRIPTION	RELAY
ALHV0030	ESW To Auxiliary Feed Pump B	K118
ALHV0033	TDAFWP suction from ESW B	K119
ALHV0034	CST To Auxiliary Feed Pump B	K121
EFHV0025	ESW A/Service Water Cross Connect Valve	K149
EFHV0026	ESW B/Service Water Cross Connect Valve	K150
DPEF01B	ESW Pump B Motor	K151

The flow transmitter signal is processed by FY and FC circuits located in instrument racks located in the control room or outside the control room. These FC and FY devices were not specifically identified as individual components in the post fire safe shutdown design. The basis for excluding these devices is that these are signal processing (amplification/isolation) devices rather than position changing devices. The position changing signal is developed either by hand controllers or flow transmitter output.

Alternative shutdown design provides for decay heat removal using the B and D steam generators. This methodology conforms to Wolf Creek NRC submittals, SER and OFN RP-017.

ESSENTIAL SERVICE WATER

Essential service water provides the safety related source of water to the AFW pumps. ESW is supplied to the AFW pumps via motor operated valves (ALHV0030 and 0031). Two redundant ESW trains are provided by the design. Each redundant train requires that the corresponding ESW pump is operating along with its associated traveling water screen and self-cleaning strainer and that service water is isolated from the ESW train. Local controls for ESW components are installed on ESW control panels, EF155 and EF156, located in the ESW facility.

Traveling Water Screen

Traveling water screen operation is required to ensure that the ESW pump suction is not blocked by debris. A traveling water screen supports post fire safe shutdown when the traveling water screen motor is energized and its traveling water screen spray valve is open. Both of these components and their associated hand switches are included in the PFSSD design as identified in Appendix 3.

Essential Service Water Pump

Each redundant ESW train has a motor driven ESW pump. The ESW pump motors, their associated hand switches and AFW pump loss of suction pressure (LSP) and loss of off site power (LOOP) circuits is included in the design. The LSP circuit is included because the LSP circuit is included in the AFW suction valve control discussed above. LOOP circuits are included because a LOOP may be initiated by fire. The ESW pump motors and controls included in the design are identified in Appendix 3.

ESW pump prelube storage tanks TEF01A (B) and associated ESW pump prelube components are not included in the post fire safe shutdown design. Exclusion of the prelube tanks and prelube components is justified by reason that the ESW pumps are self-lubricating after running, the pumps are maintained pre-lubricated prior to a fire by the head provided by the prelube tanks and the ESW pumps are designed to operate satisfactorily if they are started dry (Reference M-10EF, Page 6, Paragraph 3.2.5).

Self-Cleaning Strainer

ESW self-cleaning strainer operation is required to ensure that the ESW pump discharge flow will not be limited/blocked by a clogged strainer. The self-cleaning strainer is capable of supporting post fire safe shutdown if the self-cleaning strainer motor is running and self-cleaning strainer trash valve is open. The self-cleaning strainer motors and trash valves are incorporated in the post fire safe shutdown design.

Self-cleaning strainer operation is initiated manually by a hand switch and automatically by a differential pressure switch. The differential pressure switch actuates when flow is initiated through the strainer. This configuration automatically starts the self-cleaning strainer motor and opens the trash valve when the ESW pump motor starts. The self-cleaning strainer hand switch and differential pressure switch are included in the post fire safe shutdown design.
Self-cleaning strainer and associated components included in the PFSSD design are identified in Appendix 3.

<u>Service Water System Isolation</u>

The service water system is isolated from the ESW system to prevent diversion of the ESW flow to the service water system. Flow diversion is prevented by check valves EFV0470 (Train A) and EFV0471 (Train B). In the unlikely event the check valves fail, Service water can be isolated from the ESW system by closing two parallel motor operated valves (EFHV0023, 0024, 0025 and 0026) installed in the cross connect lines between the ESW and service water systems. These motor operated cross connect valves and their associated hand switches (EFHIS0023, 0024, 0025 and 0026) are included in the post fire safe shutdown design.

Alternative shutdown design uses the B ESW train. This design conforms to the Wolf Creek SER, NRC submittals and OFN RP-017.

SAFETY INJECTION ACCUMULATOR ISOLATION

During the transition to cold shutdown, the SI accumulators must be isolated to prevent introduction of nitrogen into the RCS when the RCS is de-pressurized. Each accumulator has a motor operated valve in the cold leg injection line. These valves are normally open with the circuit breakers OFF for the valve motor operators (Reference CKL EP-120, Pages 20 & 21). For post fire safe shutdown power is restored to the circuit breakers to shut the valves and then removed from the circuit breaker after the valves are shut. The valves are closed from the MCB for fires outside the control room and locally for a control room fire. Hand switches and interlock components, position switches and SI signal, are included as part of the design. These valves do not have to be closed until several hours (up to 72 hours) after entering PFSSD (for cold shutdown).

The alternative shutdown design requires that the circuit breakers for the motor operated accumulator isolation valves be manually operated at their corresponding motor control center (MCC). This methodology conforms to Wolf Creek’s SER, NRC submittals and OFN RP-017A.

The accumulator isolation components included in the PFSSD design are identified in Appendix 3.

RESIDUAL HEAT REMOVAL SYSTEM

The RHR system is placed in operation during the transition to cold shutdown when RCS temperature and pressure have been reduced to less than 350°F and 360 psig. When these conditions are met, the RHR suction valves are opened, the RHR pumps are started and RHR heat exchanger flow is controlled to maintain the RCS cooldown rate.

Two redundant RHR trains (A and B) are provided in the design for post fire safe shutdown from the control room and one train (B) for alternative shutdown from outside the control room.

RHR system components are addressed in the following categories:

1. RHR suction from the RCS
2. RHR pump operation
3. RHR heat exchanger operation
4. RHR discharge to the RCS

RHR Suction from the RCS

RHR suction from the RCS requires that normally closed valves in series BBPV8702A (B) and EJHV8701A (B) be opened and normally closed valves EJHV8811A (B) and BNHV8812A (B) be maintained closed. BBPV8702A (B) and EJHV8701A (B) provide the suction path from the RCS to the RHR pump suction. EJHV8811A (B) are maintained closed to prevent draining the RCS to the containment sump. BNZS8812AA (BA) provide interlocks with EJHV8811A (B) to prevent draining the RWST to the containment sump through EJHV8811A (B). BNHV8812A (B) are maintained closed to prevent makeup to the RCS via the RHR system (RCS makeup is discussed under the reactor makeup function). Additionally, BNHV8812A (B) are maintained closed to prevent draining the RWST to the containment sump.

Hand switches [EJHIS8701A (B), EJHIS8811A (B), BBHIS8702A (B) and BNHIS8812A (B)] and interlocks for these valves are included in the design to permit valve manipulations from the control room. Alternative shutdown design incorporates cold shutdown repairs to allow manipulations of these valves at their corresponding MCC; therefore, hand switch circuits are not included in the alternative shutdown design.

EJHV8811A (B) control circuit includes an open signal if an SIS occurs coincident with RWST (TBN01) Low-Low level on two of four RWST level transmitters (BNLT0930, BNLT0931, BNLT0932 and BNLT0933). This engineered safety feature (ESF) signal will initiate an automatic actuation [EJHV8811A (B) opening] adverse to post fire safe shutdown. The signal (circuit) is included in the post fire safe shutdown design to ensure that EJHV8811A (B) do not open.

EJHV8804A (B) are maintained closed to prevent diversion of RHR flow to the SI and charging pumps during cold shutdown evolution. Limit switch EJZS8804BA is used in the interlock circuit for safety injection miniflow isolation valves EMHV8814A (B). EJZS8804BA is not included in the post fire safe shutdown design because EMHV8814A (B) are not required for post fire safe shutdown.

RHR system suction valves included in the PFSSD design are identified in Appendix 3.

RHR Pump Operation

RHR pump operation requires the ability to start the RHR pump motors and maintain CCW cooling to the pump. RHR pump motors, DPEJ01A (B), may be controlled locally or remotely using their associated hand switches, EJHIS0001 (2), in the control room. CCW cooling is described under the support function.

Normally open motor operated valves EJFCV0610 (0611) provide minimum RHR pump flow protection. EJFCV0610 (0611) are controlled by EJHIS0610 (0611) or EJFIS0610 (0611). EJHIS0610 and 0611 are installed on MCB RL017. The differential pressure across flow elements installed in the RHR pump discharge path is used to automatically actuate EJFIS0610 (0611). The signal from EJFIS0610 (0611) provides automatic operation of EJFCV610 (0611). Automatic operation of EJFCV0610 (0611) is required; therefore, EJFIS0610 (0611) are included in the design. EJHIS0610 (0611) are used to manually open and close EJFCV0610 (0611) as required. EJHIS0610 (0611) are included in the design.

In case of a fire in the control room, the alternative shutdown design employs the B train pump. RHR pump motor hand switches are not included in the alternative shutdown design because the RHR pump motor will be started locally at the switchgear. EJFCV0611 can be manually positioned. EJFCV0611 is included in the alternative shutdown design. The design conforms to OFN RP-017. The alternative shutdown design conforms to OFN RP-017A.

RHR pump related components included in the PFSSD design are identified in Appendix 3.

RHR Heat Exchanger Operation

CCW cools the RHR flowing through the RHR heat exchangers. CCW is discussed under the support function.

Air operated heat exchanger outlet flow control valve EJHCV0606 (0607) is used to control flow through the RHR heat exchanger. Operators position EJHIC0606 (0607), located at MCB RL017, to adjust EJHY0606 (0607) and control the air supply to EJHCV0606 (0607). EJHCV0606 (0607), EJHIC0606 (0607) and EJHY0606 (0607) are included in the design for post fire safe shutdown from the control room.

In case of a fire in the control room the alternative shutdown design incorporates a cold shutdown repair to allow local manual operation of EJHCV0607. Specifically, EJHCV0607 is positioned using a signal generator connected to EJHCV0607 transducer. EJHCV0607 and the portable transducer are included in the alternative shutdown design. The design conforms to OFN RP-017A for alternative shutdown.

RHR heat exchanger related components included in the PFSSD design are identified in Appendix 3.

RHR Discharge to RCS

Normally open motor operated valves EJHV8809A (B) isolate RHR return flow to the RCS. EJHV8809A (B) must be opened for RHR operation. Hand switches EJHIS8809A (B), EJHIS8809AA and EJHIS8809BA are located on MCB RL017. EJHIS8809A (B) is used to open and close EJHV8809A (B). EJHIS8809AA and EJHIS8809BA are used to lockout power to EJHV8809A (B). In case of fire outside the control room EJHIS8809AA and EJHIS8809BA are used to restore power to EJHV8809A (B) and EJHIS8809A (B) are used to position EJHV8809A (B). The post fire safe shutdown design includes EJHIS8809A (B), EJHIS8809AA and EJHIS8809BA.

For post fire safe shutdown EJHV8840 must remain shut to direct RHR flow to the RCS cold legs. EJHIS8840 is used to close EJHV8840 from the control room. EJHIS8840A is used to unlock power for EJHIS8840 and is required for EJHV8840 operation. EJZS8840 is used for EJHV8840 position indication. EJZS8840 is not required for post fire safe shutdown because EJHV8840 position can be determined locally.

EJHV8804A (B) and their associated hand switches EJHIS8804A (B) are included in the design. EJHV8804A (B) are maintained closed to prevent diverting RHR flow to the charging pump and safety injection pump suction.

In the event of fire in the control room the alternative shutdown design includes EJHV8809B. Cold shutdown repairs will be employed to allow the operator to operate EJHV8809B at the MCC. The cold shutdown repairs and operator actions are described in OFN RP-017A.

RHR components included in the PFSSD design are identified in Appendix 3.

RHR valve interlock components are included in Appendix 3 to prevent adverse valve operation or to allow required valve positioning. The justification for valve position switches used in the RHR system valves is given below.

INITIATING VALVE LIMIT SWITCH	INTERLOCKED VALVE	JUSTIFICATION
BBPV8702A Open (BBZS8702AA)	EJHV8811A Close Permissive	RHR Suction from RCS Must Be Open To Prevent RHR Suction from Containment Sump; Prevent Draining RCS To Containment Sump
BBPV8702B Open (Rotor)	EJHV8811B Close Permissive	RHR Suction from RCS Must Be Open To Prevent RHR Suction from Containment Sump; Prevent Draining RCS To Containment Sump

INITIATING VALVE LIMIT SWITCH	INTERLOCKED VALVE	JUSTIFICATION
EJHV8701A Open (Rotor)	EJHV8811A Close Permissive	RHR Suction from RCS Must Be Open To Prevent RHR Suction from Containment Sump; Prevent Draining RCS To Containment Sump
EJHV8701B Open (EJZS8701BA)	EJHV8811B Close Permissive	RHR Suction from RCS Must Be Open To Prevent RHR Suction from Containment Sump; Prevent Draining RCS To Containment Sump
EJHV8804A Closed (EJZS8804A)	BBPV8702A Open Permissive	RHR Suction from RCS Must Be Open
EJZS8804A Closed (Rotor)	EJHV8701A Open Permissive	RHR Suction from RCS Must Be Open
EJHV8804B Closed (EJZS8804BB)	EJHV8701B Open Permissive	RHR Suction from RCS Must Be Open
EJHV8804B Closed (Rotor)	BBPV8702B Open Permissive	RHR Suction from RCS Must Be Open
EJHV8811A Closed (EJZS8811A)	BBPV8702A Open Permissive	RHR Suction from RCS Must Be Open
EJHV8811A Closed (Rotor)	EJHV8701A Open Permissive	RHR Suction from RCS Must Be Open
EJHV8811B Closed (EJZS8811B)	EJHV8701B Open Permissive	RHR Suction from RCS Must Be Open
EJHV8811B Closed (Rotor)	BBPV8702B Open Permissive	RHR Suction from RCS Must Be Open
BNHV8812A Closed (BNZS8812AA)	BBPV8702A Open Permissive	RHR Suction from RCS Must Be Open; Prevent Draining RWST To Containment Sump
BNHV8812A Closed (Rotor)	EJHV8701A Open Permissive	RHR Suction from RCS Must Be Open; Prevent Draining RWST To Containment Sump
BNHV8812A Closed (Rotor)	EJHV8811A Close Permissive	RHR Suction from RCS Must Be Open; Prevent Draining RWST To Containment Sump
BNHV8812B Closed (BNZS8812BA)	EJHV8701B Open Permissive	RHR Suction from RCS Must Be Open; Prevent Draining RWST To Containment Sump
BNHV8812B Closed (Rotor)	BBPV8702B Open Permissive	RHR Suction from RCS Must Be Open; Prevent Draining RWST To Containment Sump
BNHV8812B Closed (Rotor)	EJHV8811B Close Permissive	RHR Suction from RCS Must Be Open; Prevent Draining RWST To Containment Sump

For normal shutdown from the control room, limit switches associated with EJHV8804A (B) cannot result in opening the valves. Therefore, the limit switch valve open interlocks are not included in the PFSSD design.

Solid state protection system relays initiate automatic positioning and interlocks for some residual heat removal system valves. Spurious operation of these relays could drain the RWST or RCS to the containment sump or isolate residual heat removal pump suction from the RCS during transition to cold shutdown. Valve interlocks and separation group redundancy prevent RWST and RCS from draining to the containment sumps. These relays and their related valve functions are identified in the following table:

COMPONENT	DESCRIPTION	RELAY	DESCRIPTION
EJHV8701A	RHR Shutdown Suction Line Isolation Loop A	K734	Residual Heat Removal RCS HI1 Pressure Open Interlock
EJHV8701B	RHR Shutdown Suction Line Isolation Loop B	K734	Residual Heat Removal RCS HI1 Pressure Open Interlock
BBPV8702A	RCS Hot Leg 1 to RHR Pump A Suction Isolation valve	K734	Residual Heat Removal RCS HI1 Pressure Open Interlock
BBPV8702B	RCS Hot Leg 4 to RHR Pump B Suction Isolation Valve	K734	Residual Heat Removal RCS HI1 Pressure Open Interlock
EJHV8811A	Containment Recirculation Sump Isolation Valve (Encapsulated)	K740	Safety Injection Signal Open Interlock
EJHV8811A	Containment Recirculation Sump Isolation Valve (Encapsulated)	K741	Residual Heat Removal RCS HI1 Pressure RWST Lo-Lo Level Open Interlock
EJHV8811B	Containment Recirculation Sump Isolation Valve (Encapsulated)	K740	Safety Injection Signal Open Interlock
EJHV8811B	Containment Recirculation Sump Isolation Valve (Encapsulated)	K741	Residual Heat Removal RCS HI1 Pressure RWST Lo-Lo Level Open Interlock

INSTRUMENTATION

Decay heat removal function instrumentation includes indication for specific parameters and inputs to control circuits (interlocks). The following instrumentation is required for the decay heat removal function:

<u>Steamline Pressure Transmitters and Indicators</u>

Main steam line pressure transmitters provide a steam line pressure input signal to the safety injection circuits. Safety injection complicates control of the reactivity control function (excessive cooldown inserts positive reactivity), reactor makeup function (pressurizer level may not be maintained within indicating range) and decay heat removal function (excessive cooldown rate). Safety injection is controlled by either preventing safety injection actuation (protecting SI input signals and/or opening safety injection pump breakers to prevent safety injection pumps from running). Steam line pressure transmitters required for PFSSD are identified in Appendix 3.

Main steamline pressure indication is required for PFSSD to provide diagnostic indication of a stuck open ARV, diagnosis of a spurious SIS per EMG E-0 and verification of heat removal per EMG ES-04. The following table identifies the main steamline pressure indicators that are included in the PFSSD design:

COMPONENT	DESCRIPTION
ABPI0514A	Loop 1 Steamline Pressure Indicator
ABPI0515A	Loop 1 Steamline Pressure Indicator
ABPI0516A	Loop 1 Steamline Pressure Indicator
ABPI0524A	Loop 2 Steamline Pressure Indicator
ABPI0525A	Loop 2 Steamline Pressure Indicator
ABPI0526A	Loop 2 Steamline Pressure Indicator
ABPI0534A	Loop 3 Steamline Pressure Indicator
ABPI0535A	Loop 3 Steamline Pressure Indicator
ABPI0536A	Loop 3 Steamline Pressure Indicator
ABPI0544A	Loop 4 Steamline Pressure Indicator
ABPI0545A	Loop 4 Steamline Pressure Indicator
ABPI0546A	Loop 4 Steamline Pressure Indicator

Steam Generator Level Indication

Steam generator level indication is required for decay heat removal. The operators need the steam generator level indication to verify that steam generator AFW flow is acceptable. Narrow and wide range steam generator level indication is used in the design.

The narrow and wide range steam generator level transmitters and level indicators used for PFSSD are identified in Appendix 3.

RCS Temperature Indication

RCS temperature indication is required to verify that RCS decay heat removal by natural circulation has been established. RCS cooldown rate must be controlled to ensure that excessive RCS cooldown does not lead to reactor vessel level not within the pressurizer level indication. Wide range RCS temperature instruments are used because narrow range RCS temperature instruments do not cover the RCS temperature range from hot standby to cold shutdown conditions.

RCS temperature instruments required for PFSSD are identified in Appendix 3

Although BBTI0413X (RCS loop 1) is on RP118B, the instrument is not included in the PFSSD design. BBTI0423B (RCS loop 2) and BBTI0443A (RCS Loop 4) on RP118B are included in the PFSSD design. Alternate shutdown from RP118B utilizes RCS loops 2 and 4.

Narrow range RCS temperature instruments are not required for PFSSD because their operational range is not sufficient. These narrow range temperature instruments are listed in the following table with justification for not including the instruments in the PFSSD design:

INSTRUMENT	DESCRIPTION	JUSTIFICATION
BBTE0411A1	Loop 1 (NR) Hot Leg Temp	Wide Range BBTE0413A used
BBTE0411A2	Loop 1 (NR) Hot Leg Temp	Wide Range BBTE0413A used
BBTE0411A3	Loop 1 (NR) Hot Leg Temp	Wide Range BBTE0413A used
BBTE0411B	Loop 1 (NR) Cold Leg Temp	Wide Range BBTE0413B used
BBTE0421A1	Loop 2 (NR) Hot Leg Temp	Wide Range BBTE0423A used
BBTE0421A2	Loop 2 (NR) Hot Leg Temp	Wide Range BBTE0423A used
BBTE0421A3	Loop 2 (NR) Hot Leg Temp	Wide Range BBTE0423A used

INSTRUMENT	DESCRIPTION	JUSTIFICATION
BBTE0421B	Loop 2 (NR) Cold Leg Temp	Wide Range BBTE0423B used
BBTE0431A	Loop 3 (NR) Hot Leg Temp	Wide Range BBTE0433A used
BBTE0431B	Loop 3 (NR) Cold Leg Temp	Wide Range BBTE0433B used
BBTE0441A	Loop 4 (NR) Hot Leg Temp	Wide Range BBTE0443A used
BBTE0441B	Loop 4 (NR) Cold Leg Temp	Wide Range BBTE0443B used

RCS Pressure Indication

RCS wide range pressure indication is required to verify that adequate RCS subcooling margin is maintained during post fire safe shutdown and provides RCS pressure input to valve interlocks. Adequate subcooling margin is required to ensure that boiling does not occur within the reactor vessel. Boiling within the reactor vessel can possibly lead to loss of natural circulation cooldown and fuel becoming uncovered. RCS pressure is used in RHR suction valves [EJHV8801A (B) and BBPV8702A (B)] open control circuits (interlocks).

The following table identifies and justifies the RCS pressure indication instrumentation used for PFSSD:

RCS PRESSURE TRANSMITTER	RCS PRESSURE INDICATOR	JUSTIFICATION
BBPT0403	BBPB0403A	RHR valve interlock
BBPT0405	BBPI0405	RCS pressure indication at RL022
BBPT0405	BBPB0405A	RHR valve interlock
BBPT0406	BBPI0406	RCS pressure indication at RL022
BBPT0406	BBPI0406X	RCS pressure indication at RP118B
BBPT0455	N/A	Safety injection must be prevented
BBPT0456	N/A	Safety injection must be prevented
BBPT0457	N/A	Safety injection must be prevented
BBPT0458	N/A	Safety injection must be prevented

Condensate Storage Tank Level Indication

Technical Specification B 3.7.6, Condensate Storage Tank (CST), states:

> “The CST contains sufficient inventory to provide water to the steam generators via the AFW System for four hours at hot standby conditions followed by a plant cooldown to RHR initiation conditions. However, the CST is not the safety related source of water to the AFW pumps. The safety related source is provided by the Essential Service Water (ESW) System.”

The CST provides a passive flow of water, by gravity, to the AFW pump suction. Motor operated valves are installed in the suction path to isolate the CST from the AFW pump suction on a low suction pressure (LSP) signal. When a LSP (CST low level) occurs, motor operated AFW pump suction valves automatically open to the safety grade ESW system to ensure a supply of AFW to the AFW pump suction. This method ensures a suction source for the AFW pumps provided that the LSP circuits are free of fire damage. The LSP circuits consist of ALPT0037, ALPT0038 and ALPT0039. Because these pressure transmitters provide the capability to automatically transfer to the ESW supply on low CST level (LSP), this capability is equivalent to manually transferring to ESW when the CST level instruments indicate a low level in the CST coincides with AFW signal. Thus the LSP transfer to ESW is equivalent to one train of CST level indication.

The CST level indication redundant to the LSP circuits is the safety-related indication provided by converting auxiliary feedwater pump suction pressure to available tank level. This capability is credited in M-10AL. This indication is obtained from level indicators supplied by pressure transmitters ALPT0024, ALPT0025 and ALPT0026.

A description of methodology for manual calculation of CST level is included in the auxiliary feedwater discussion above. AFW pump suction valves must be manually positioned on a low CST level indication using this method.

Although the two redundant CST level indication capabilities identified above do not provide a direct indication of CST level, they support transfer to ESW in the event of CST low level. Therefore these equivalent CST level indications are acceptable and the design does not require introduction of direct reading non-safety related CST level instruments into the decay heat removal function design.

The following table identifies the pressure instruments used to determine CST level:

PRESSURE TRANSMITTER	PRESSURE INDICATOR	DESCRIPTION
ALPT0024	ALPI0024A at RL005 ALPI0024B at RP118B	Motor Driven Auxiliary Feedwater Pump B Suction Pressure
ALPT0025	ALPI0025A at RL005	Motor Driven Auxiliary Feedwater Pump A Suction Pressure
ALPT0026	ALPI0026A at RL005 ALPI0026B at RP118B	Turbine Driven Auxiliary Feedwater Pump Suction Pressure
ALPT0037		AFW Condensate Storage Tank Suction Header Pressure
ALPT0038		AFW Condensate Storage Tank Suction Header Pressure
ALPT0039		AFW Condensate Storage Tank Suction Header Pressure

TIME TO INITIATE RCS COOLDOWN

The time to initiate RCS cooldown is related to decay heat removal and RCS volume control. Decay heat removal is initiated by steam generator atmospheric relief valve operation following reactor trip. The length of time that the plant is maintained in hot standby is limited by the post fire safe shutdown performance goal to maintain pressurizer level within the pressurizer level indication.

Reactivity and makeup control require RCS makeup from the RWST through the RCP seals or through the BIT. Assuming the worst case where seal injection is running, and letdown is not available, a possible case in Wolf Creek post fire safe shutdown design, then the time that the plant is maintained in hot standby before initiating a transition to cold shutdown is limited. The following approximation was used to estimate the maximum time available before plant cooldown is required.

1. Calculate total steam volume available at 0% power (hot standby)

   - At 100% power, pressurizer steam volume is 720 cubic feet (Reference M-10BB)
   - At 100% power, pressurizer level is programmed at 57% ± 5% (Reference M-747-00025-W40, Page 37)
   - Therefore, at 100% power, pressurizer steam volume is 43% ± 5% (100% - 57%)
   - Total volume monitored by the wide range level instrument is: $720\ ft^3 \div 38\% = 1674\ ft^3$
   - At 0% power, pressurizer level is programmed at 27% ± 5% (Reference M-747-00025-W40, Page 37)
   - Therefore, at 0% power, pressurizer steam volume is 73% ± 5% (100% - 27% ± 5%)
   - If a worst case condition is assumed, then at 0% power, pressurizer steam volume is only 68%

- 68% X 1674 $ft^3 \approx$ 1138 ft^3 steam volume available for charging without letdown before pressurizer level goes out of the indication range

2. Calculate expansion of water from coldest assumed RWST temperature to 557°F

- Using a conversion of 1 $ft^3 \approx$ 7.48 gal, then 1138 ft^3 X 7.48 gal/$ft^3 \approx$ 8512 gal available to be charged before pressurizer level indication is lost

- Specific volume of water at 50°F ≈ 1.0018 $cm^3/g \approx$ 0.0010018 m^3/kg
  Or
  0.0010018 m^3/kg X 119.826427(gal/m^3)(kg/ lb_m) ≈ 0.12 gal/lb_m

- Specific volume of water at 557°F ≈ 0.1657.8 ft^3/lb_m ÷ 0.133680556 (ft^3/gal) ≈ 1.24 gal/lb_m

- Therefore 1 gal at 50°F will be (1.24 gal/ lb_m ÷ 0.12 gal/ lb_m) ≈ 10.33 gal when heated to 557°F

3. Calculate the time available before plant cooldown is required

- Seal injection is maintained at ≈ 5 gpm per pump at 50°F. This is equivalent to 51.65 gpm at 557°F (5 gpm X 10.33)

- There are four RCPs. 51.65 gpm X 4 = 206.6 equivalent gallons per minute seal injection to the primary system.

- 8512 gallons ÷ 206.6 = 41.2 minutes

The above approximation demonstrates that pressurizer level will remain in the indication range provided that either letdown is restored, injection is stopped or plant cooldown is initiated within 41.2 minutes following reactor trip. This assumes 8 gpm is charged into each RCP and 3 gpm are returned through the seal leakoff line.

DECAY HEAT REMOVAL FUNCTION STATUS PANEL RESOLUTION

<u>Discussion</u>

Status panels are installed in the control circuits of some post fire safe shutdown components. The cables to these status panels are associated circuits subject to failures that may compromise the post fire safe shutdown component. The following analysis describes how decay heat removal function components may be affected by status panel associated circuits.

<u>Analysis</u>

The following table identifies the decay heat removal function post fire safe shutdown components that have status panels installed in their control circuits:

COMPONENT	STATUS PANEL SCHEMATIC	STATUS PANEL CABLE	NOTES
ABHV0005	E-13SA16	12SAZ16AA	1, 2, 3, 4
ABHV0006	E-13SA16	12SAZ16AA	1, 2, 3, 4
ABHY0012A	E13SA15	14SAZ15MA	1, 4, 5, 6
ABHY0015A	E13SA15	11SAZ15MA	1, 4, 5, 6
ABHY0018A	E13SA15	11SAZ15MA	1, 4, 5, 6
ABHY0021A	E13SA15	11SAZ15MA	1, 4, 5, 6
ABHY0012B	E-13SA16	14SAZ16MA	1, 4, 5, 6
ABHY0015B	E-13SA16	14SAZ16MA	1, 4, 5, 6
ABHY0018B	E-13SA16	14SAZ16MA	1, 4, 5, 6
ABHY0021B	E-13SA16	14SAZ16MA	1, 4, 5, 6

NOTES:

1. If the cables to the status panel open, there will be no effect on the component and post fire safe shutdown.

2. If the status panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The valve will open, but a downstream valve FCHV0312 is closed. Consequently there will be no adverse decay heat function consequence from this failure.

3. If one status panel cable shorts to ground, there will be no effect on the component or post fire safe shutdown because the control circuit power supply is an ungrounded DC system. If both status panel cables short to ground, then the effect will be the same as short circuit described in note 2.

4. A hot short(s) on the status panel cables has no effect on the control circuit or the post fire safe shutdown component.

5. If the status panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The MSIV bypass valve solenoids will be de-energized and the valves will close, their post fire safe shutdown design position.

6. If one status panel cable shorts to ground, there will be no effect on the component or post fire safe shutdown because the control circuit power supply is an ungrounded DC system. If both status panel cables short to ground, then the effect will be the same as short circuit described in note 5.

POST FIRE SAFE SHUTDOWN SUPPORT FUNCTION

The post fire safe shutdown support function provides the necessary cooling, ventilation and electrical power required by the reactivity control, reactor makeup, decay heat removal and instrumentation functions. The support function literally supports all the other post fire safe shutdown functions.

The post fire safe shutdown support function systems are grouped into the following categories:

- Cooling Water
- Ventilation
- Diesel Generator
- Electrical

COOLING WATER

The essential service water (ESW) and component cooling water (CCW) systems supply cooling water for post fire safe shutdown components.

Essential Service Water

The essential service water pumps (DPEF01A and DPEF01B) supply water from the ultimate heat sink to PFSSD components. After cooling the PFSSD equipment, the heated water is returned to the ultimate heat sink. The ESW pumps are controlled with hand switches (EFHIS0055A and EFHIS0056A) installed on the main control board (RL019) or locally with hand switches (EFHIS0055B and EFHIS0056B) installed on the ESW control panels (EF155 and EF156) located in the essential service water pump house. Additionally, DPEF01B can also be started using a local hand switch on NB0215. When an ESW pump starts, the associated traveling water screen starts if in AUTO.

Self-cleaning strainers (FEF02A and FEF02B) filter the essential service water before it is supplied to the PFSSD components. High differential pressure caused by accumulated debris on the strainer element is corrected automatically by back-washing the element to the ultimate heat sink. The automatic flushing is initiated by a signal from differential pressure switches (EFPDS0019A or EFPDS0020A) to open drain valves (EFPDV0019 or EFPDV020) to flush the strainer.

The essential service water system flow path is from the ultimate heat sink, through the traveling water screens (DFEF01A and DFEF01B), to the essential service water pumps (DPEF01A and DPEF01B). Self-cleaning strainers (FEF02A and FEF02B) installed in the ESW pump discharge headers filter essential service water supplied to various load. When the ESW pump is started, the traveling water screen motors start and EFHV0097 and EFHV0098 open for fifteen seconds to vent air from the ESW pump discharge. The self-cleaning strainers are flushed automatically when the differential pressure across the strainer exceeds the setpoint on differential pressure switches EFPDS0019A and EFPDS0020A. When EFPDS0019A and EFPDS0020A actuate, the self-cleaning strainer trash valves (EFPDV0019 and EFPDV0020) open to flush the self-cleaning strainers to the ultimate heat sink. Auxiliary relays are used in the control circuits for the trash valves. Trash valve auxiliary relays included in the PFSSD design are identified in the following table:

RELAY	DESCRIPTION
62TDDEF19	Essential Service Water Self Cleaning Strainer FEF02A Auxiliary Relay
62TDDEF20	Essential Service Water Self Cleaning Strainer FEF02B Auxiliary Relay

The prelube storage tank supplying water to the ESW pump line shaft bearings and stuffing box is not included in the PFSSD design. The ESW pump is designed to start and continue to run satisfactorily with dry bearings (Reference M-10EF, Page 6, Paragraph 3.2.5). The use of a pre-lube merely extends bearing life and reduces wear.

The traveling water screens (DFEF01A and DFEF01B) automatically start on the same signal that starts the ESW pump. The screens protect the ESW pumps from large debris. Water from the ESW pump discharge is sprayed on the screens. The traveling water screen spray valves (EFHV0091 and EFHV0092) are opened by the same signal that starts the ESW pump. Auxiliary relays are used in the control circuits for the screen wash valves. Screen wash auxiliary relays included in the PFSSD design are identified in the following table:

RELAY	DESCRIPTION
3XEF55	Screen Wash Water Valve EFHV0091 Open Auxiliary Relay
3XEF56	Screen Wash Water Valve EFHV0092 Open Auxiliary Relay
3XEF57	Screen Wash Water Valve EFHV0091 Close Auxiliary Relay
3XEF58	Screen Wash Water Valve EFHV0092 Close Auxiliary Relay

Load shed and load sequencing relays are used in the control circuits for various essential service water components. These components and their associated load shed and load sequencing relays are identified in the following table:

COMPONENT	DESCRIPTION	RELAY
DPEF01A	ESW Pump A Motor	K1102
DPEF01A	ESW Pump A Motor	K1121
DPEF01A	ESW Pump A Motor	K1117
EFHV0042	ESW Train B To Service Water System Isolation Valve	K1117
DPEF01B	ESW Pump B Motor	K4102
DPEF01B	ESW Pump B Motor	K4122
DPEF01B	ESW Pump B Motor	K4117
EFHV0040	ESW Train B To Service Water System Isolation Valve	K4117
EFHV0051	ESW A To CCW Heat Exchanger A Isolation Valve	K1137
EFHV0039	ESW Train A To Service Water System Isolation Valve	K4136
EFHV0037	ESW A To Ultimate Heat Sink Isolation Valve	K1138
EFHV0052	ESW B To CCW Heat Exchanger B Isolation Valve	K4137
EFHV0038	ESW B To Ultimate Heat Sink Isolation Valve	K4138
EFHV0023	ESW A Service Water Cross Connect Valve	K1116
EFHV0024	ESW B Service Water Cross Connect Valve	K1135
EFHV0025	ESW A Service Water Cross Connect Valve	K4116
EFHV0026	ESW B Service Water Cross Connect Valve	K4135
EFHV0041	ESW A To Service Water Isolation Valve	K1136
EFHV0059	ESW A Return From CCW HX A Isolation Valve	K1118
EFHV0060	ESW B Return From CCW HX B Isolation Valve	K4118

Freeze protection is provided by warming lines from each ESW discharge line to prevent ice forming on the traveling water screens. Some of the flow returning to the ultimate heat sink is diverted to the pump intake area via the warming line. Manually adjusted valves preset warming line flow; consequently, warming line valves are not included in the PFSSD design.

During normal operations ESW loads are supplied by service water; however, for PFSSD, service water is not available. Consequently, the service water system is isolated from the ESW system to prevent diversion of the ESW flow to service water loads. Flow diversion is prevented by check valves EFV0470 (Train A) and EFV0471 (Train B). In the unlikely event the check valves fail, EFHV0023, EFHV0024, EFHV0025 and EFHV0026 can be closed to isolate the service water system from the ESW system. These valves are closed locally or from the control room using hand switches EFHIS0023, EFHIS0024, EFHIS0025 and EFHIS0026. The following table identifies the components supplied by ESW:

COMPONENT	DESCRIPTION	ISOLATION VALVE	HAND SWITCH
EEG01A	Component Cooling Water Heat Exchanger	EFHV0051	EFHIS0051
EEG01A	Component Cooling Water Heat Exchanger	EFHV0059	EFHIS0059
EEG01B	Component Cooling Water Heat Exchanger	EFHV0052	EFHIS0052
EEG01B	Component Cooling Water Heat Exchanger	EFHV0060	EFHIS0060
EKJ03A, B	Intercooler Heat Exchangers	---	---
EKJ04A, B	Lube Oil Coolers	---	---
EKJ06A, B	Jacket Water Heat Exchangers	---	---
SGN01A & C	Containment Air Cooler	EFHV0031	EFHIS0031
SGN01A & C	Containment Air Cooler	EFHV0033	EFHIS0033
SGN01A & C	Containment Air Cooler	EFHV0045	EFHIS0045
SGN01A & C	Containment Air Cooler	EFHV0049	EFHIS0049
SGN01B & D	Containment Air Cooler	EFHV0032	EFHIS0032
SGN01B & D	Containment Air Cooler	EFHV0034	EFHIS0034
SGN01B & D	Containment Air Cooler	EFHV0046	EFHIS0046
SGN01B & D	Containment Air Cooler	EFHV0050	EFHIS0050
SGL11A	Component Cooling Water Pump Room Cooler	---	---
SGL11B	Component Cooling Water Pump Room Cooler	---	---
SGL12A	Centrifugal Charging Pump room Cooler	---	---
SGL12B	Centrifugal Charging Pump room Cooler	---	---
SGF02A	Auxiliary Feedwater Pump Room Cooler	---	---
SGF02B	Auxiliary Feedwater Pump Room Cooler	---	---
SGL10A	RHR pump Room Cooler	---	---
SGL10B	RHR pump Room Cooler	---	---
SGL15A	Penetration Room Cooler	---	---
SGL15B	Penetration Room Cooler	---	---
SGK04A	Control Room Air Conditioning Unit	---	---
SGK04B	Control Room Air Conditioning Unit	---	---
SGK05A	Class 1E Switchgear Air Conditioning Unit	---	---
SGK05B	Class 1E Switchgear Air Conditioning Unit	---	---
PAL01A	Auxiliary Feedwater System Motor Driven Pump	ALHV0031	ALHIS0031A
PAL01B	Auxiliary Feedwater System Motor Driven Pump	ALHV0030	ALHIS0030A, B
PAL02	Auxiliary Feedwater System Turbine Driven Pump	ALHV0032	ALHIS0032A
PAL02	Auxiliary Feedwater System Turbine Driven Pump	ALHV0033	ALHIS0033A, B

Upon exiting from the ESW loads the flow is directed back to the ultimate heat sink via EFHV0037 and EFHV0038. Isolating the return flow path to the service water system by closing EFHV0039, EFHV0040, EFHV0041 and EFHV0042 ensures ESW discharge to the ultimate heat sink. These valves may be operated locally or from the control room using hand switches EFHIS0037, EFHIS0038, EFHIS0039, EFHIS0040, EFHIS0041 and EFHIS0042.

EFV0058 and EFV0090 are installed as bypass valves on the CCW heat exchanger outlet valves (EFHV0059 and EFHV0060). EFV0058 and EFV0090 are locked in a throttled position to provide the minimum design basis accident and LOOP essential service water flow. To ensure proper flow balance in the ESW system, valves EFHV0059 or EFHV0060 are required to remain closed when operating the associated ESW Train. Failure to maintain either EFHV0059 or EFHV0060 closed on the operating train could result in flow diversion from essential PFSSD components on that Train.

Essential service water diagnostic instrumentation included in the PFSSD design for shutdown from the control room is identified in the following table:

TRANSMITTER	DESCRIPTION	INDICATOR	INDICATOR LOCATION
EFFI0053	Essential Service Water Flow To Power Block Flow Transmitter (Separation Group 1)	EFFI0053	RL019
EFFI0054	Essential Service Water Flow To Power Block Flow Transmitter (Separation Group 4)	EFFI0054	RL019

The ESW PFSSD components required for PFSSD are identified in Appendix 3.

The ESW PFSSD relays are identified in Appendix 4.

<u>Component Cooling Water</u>

For PFSSD, the component cooling water (CCW) system is used to provide cooling to the centrifugal charging pump (CCP) oil cooler, seal water heat exchanger, the RHR heat exchangers and the RHR pump seal coolers. In addition, the CCW system provides cooling to the RCP thermal barriers and is credited as a backup to RCP seal injection to maintain RCP seal cooling. Only one train of CCW is operating at a time and the operating train is swapped periodically depending on the plant lineup.

The component cooling water system is a closed loop system that acts as an intermediate barrier between the essential service water system and actual or potentially radioactive systems in order to minimize the possibility of an uncontrolled release of radioactivity.

The PFSSD CCW components consist of the four CCW pumps (DPEG01A, DPEG01B, DPEG01C and DPEG01D), two heat exchangers (EEG01A and EEG01B), two surge tanks (TEG01A and TEG01B) and associated valves.

The CCW surge tanks allow for expansion of the system inventory and provide a head tank and suction source for the CCW pumps. The CCW suction lines are connected to the CCW return header by common return header valves. These valves and their hand switches are identified in the following table:

VALVE	DESCRIPTION	HAND SWITCH
EGHV0015	CCW Train A Common Header Return Isolation Valve	EGHS0015
EGHV0016	CCW Train B Common Header Return Isolation Valve	EGHS0016

The CCW heat exchangers are equipped with a bypass line and valve (EGTV0029 and EGTV0030) to regulate the supply temperature to the components cooled by CCW. For post fire safe shutdown, these valves are closed to ensure CCW supply temperature is not too high during warm weather. Additionally, maintaining the valves closed simplifies the post fire safe shutdown design by not having to protect automatic temperature control circuits.

The following table identifies the components supplied by CCW:

COMPONENT	DESCRIPTION	ISOLATION VALVE	HAND SWITCH
EEJ01A	Train A RHR Heat Exchanger	EGHV0101	EGHIS0101
PBG05A	Train A Centrifugal Charging Pump Oil Cooler	---	---
PEJ01A	Train A RHR Pump Seal Cooler	---	---
EEJ01B	Train B RHR Heat Exchanger	EGHV0102	EGHIS0102
PBG05B	Train B Centrifugal Charging Pump Oil Cooler	---	---
PEJ01B	Train B RHR Pump Seal Cooler	---	---
EBG03	Seal Water Heat Exchanger	See below	See below

The centrifugal charging pump oil coolers and RHR pump seal coolers do not have electrically operated isolation valves. CCW is supplied to these components when the respective CCW train is in operation. CCW flow to the RHR heat exchangers (EEJ01A and EEJ01B) is required during the transition to cold shutdown and for maintaining cold shutdown conditions. EGHIS0101 and EGHIS0102 are included in the design to allow operation of EGHV0101 and EGHV0102 from the control room.

The seal water heat exchanger (EBG03) is required for PFSSD to maintain charging pump suction temperatures below acceptable limits. The seal water heat exchanger cools the water returning from the reactor coolant pump seals prior to the seal return water entering the CCP suction header. In addition, the seal water heat exchanger cools the recirculating water from the CCP discharge when the CCPs are operating on minimum flow. If CCW flow to EBG03 is unavailable, then the operating CCP could cavitate, resulting in damage to the pump. The CCW tap to EBG03 is located on the service loop. Therefore, valves EGHV0015 and EGHV0053 or EGHV0016 and EGHV0054 need to be open, depending on the credited CCW train.

Some CCW components have auxiliary relays in their control circuits. These auxiliary relays are required for the component to operate. The auxiliary relays included in the CCW PFSSD design are identified in Appendix 4.

Auxiliary relays 3XEG01, 3XEG03, 3XEG05 and 3XEG07 have contacts in the CCW pump load shed circuit and CCW pump motor circuit breaker close circuit. These relays are included in the PFSSD design.

63TDEEG02, 63TDEEG04, 63TDEEG06 and 63TDEEG08 are installed in the component cooling water pump control circuits. The TDE auxiliary relays provide a four second time delay to prevent CCW pumps A and C and CCW pumps B and D from starting at the same time. These auxiliary relays are included in the PFSSD design.

All four CCW pump motors are included in the PFSSD design. All four CCW pumps are capable of supporting shutdown from the control room. However, only CCW pump B is provided for alternate shutdown from outside the control room. If necessary, the CCW pump motors may be started locally at the switchgear. The CCW pump motors start automatically on low discharge header pressure. EGPT0077 and EGPSL0077 provide a start signal to DPEG01A and DPEG01C. EGPT0078 and EGPSL0078 provide a start signal to DPEG01B and DPEG01D.

The CCW pump motors and their associated main control board hand switches are identified in Appendix 3.

The CCW heat exchanger bypass valves EGTV0029 and EGTV0030 are air-operated valves. These valves are maintained closed for post fire safe shutdown. Failing the solenoid operator’s open to remove air from the valves and shutting the valves can be done from the control room or locally. CCW heat exchanger bypass valves and their associated components are identified in the following table:

COMPONENT	DESCRIPTION	HAND SWITCH
EGTV0029	CCW Heat Exchanger A Temperature Control Valve	EGHIS0029
EGTV0030	CCW Heat Exchanger B Temperature Control Valve	EGHIS0030
EGTY0029A	CCW Heat Exchanger A Bypass Valve Isolation Valve Temperature Controller	Local Operator
EGTY0030A	CCW Heat Exchanger B Bypass Valve Isolation Valve Temperature Controller	Local Operator

CCW is supplied to the centrifugal charging pump oil coolers and RHR pump seal coolers via manual isolation valves. Consequently, CCW supply to these components is not subject to fire induced cable damage.

The RHR heat exchangers are supplied CCW via motor operated valves (EGHV0101 and EGHV0102). These valves are normally closed and the operating RHR train valve is required to be open only for cold shutdown. They can be operated from the control room using main control board hand switches or locally by hand. The A train or B train RHR cooler may be used for shutdown from the control room; however, the B train RHR cooler is used for shutdown from outside the control room. During hot standby the valve on the operating CCW train is required to be closed to ensure adequate CCW flow to the credited PFSSD components.

The CCW pumps have two valves installed in each pump suction header. These valves, EGHV0011 and EGHV0013 for DPEG01A and EGHV0012 and EGHV0014 for DPEG01B, provide a supply of makeup water to the CCW pumps from essential service water. If required, the valves can be operated locally using manual operators. The CCW system is a closed system. The CCW system operating history has demonstrated that leakage from the CCW system is negligible. Consequently, these valves are not required for PFSSD.

Surge tanks (TEG01A and TEG01B) are connected to the CCW pump suction header to provide a positive suction head for the pumps and to accommodate CCW system volume changes. These have remote reading level instruments and local reading level gages (sight glasses). The remote level indication is not included in the PFSSD design because CCW surge tank level should remain relatively constant. The local level gages are included in the PFSSD design to allow operators to monitor CCW surge tank level to evaluate CCW system operation. The CCW surge tanks and level gages are listed in the following table:

COMPONENT	DESCRIPTION	LEVEL GAGE
TEG01A	Train A Component Cooling Water Surge Tank	EGLG0007
TEG01B	Train B Component Cooling Water Surge Tank	EGLG0008

CCW provides cooling water to the RCP thermal barrier cooling coil to help keep the RCP seals cool and functioning properly. If all seal cooling is lost, the stagnant water in the CCW side of the thermal barrier cooling coil will heat up and possibly flash since it is at lower pressure than the RCP. Prior to restarting the CCW pump, the CCW flow from the thermal barrier cooling coil must be isolated to avoid sweeping the hot water and/or voids into the CCW return line where thermal gradients or void collapse may damage the CCW piping or hangers. Closing EGHV0071 and EGHV0126 or EGHV0058 and EGHV0127 isolates the common header inlet from CCW to the RCP thermal barrier cooling coils. Closing EGHV0061 and EGHV0133 or EGHV0062 and EGHV0132 isolates the common header outlet to CCW from RCP thermal barrier cooling coils. These valves are operated remotely using hand switches on the main control boards in the control room or locally using the manual valve operators. The following table identifies the CCW containment isolation valves and their hand switches.

COMPONENT	DESCRIPTION	HAND SWITCH
EGHV0058	CCW TO RCS Outer Containment Isolation Valve	EGHIS0058
EGHV0061	CCW Return From RCS Thermal Barrier Outer Containment Isolation Valve	EGHIS0061

COMPONENT	DESCRIPTION	HAND SWITCH
EGHV0062	CCW Return From RCS Thermal Barrier Inner Containment Isolation Valve	EGHIS0062
EGHV0071	CCW TO RCS Outer Containment Isolation Valve	EGHIS0071
EGHV0126	CCW To RCS HV58 & HV71 Bypass Valve	EGHIS0126 EGHIS0126A
EGHV0127	CCW To RCS HV58 & HV71 Bypass Valve	EGHIS0127 EGHIS0127A
EGHV0132	CCW Return From RCS EGHV0062 Bypass Valve	EGHIS0132 EGHIS0132A
EGHV0133	CCW Return From RCS EGHV0061 Bypass Valve	EGHIS0133 EGHIS0133A

Flow transmitter EGFT0062, and associated cable, is included in the PFSSD design because a spurious high flow signal will automatically close valve EGHV0062. If this occurs, flow to the RCP thermal barriers will be disrupted. Therefore, in order to fully evaluate the availability of RCP thermal barrier cooling, this flow transmitter and cable need to be analyzed.

Alternatively, if only seal injection is lost, RCP thermal barrier cooling is sufficient to maintain seal cooling until seal injection can be restored, as discussed in the Reactivity Control section. To ensure thermal barrier cooling is maintained, either the main valves or the bypass valves on the inlet or outlet flow path to the thermal barrier listed in the above table need to be open. In addition, the following components are included in the PFSSD design to ensure an available CCW to thermal barrier heat exchanger flow path:

VALVE	DESCRIPTION	HAND SWITCH
BBFT0017	RCP A Thermal Barrier Cooler Flow Transmitter	N/A
BBFT0018	RCP B Thermal Barrier Cooler Flow Transmitter	N/A
BBFT0019	RCP C Thermal Barrier Cooler Flow Transmitter	N/A
BBFT0020	RCP D Thermal Barrier Cooler Flow Transmitter	N/A
BBHV0013	RCP A Thermal Barrier Cooler Isolation Valve	BBHIS0013
BBHV0014	RCP B Thermal Barrier Cooler Isolation Valve	BBHIS0014
BBHV0015	RCP C Thermal Barrier Cooler Isolation Valve	BBHIS0015
BBHV0016	RCP D Thermal Barrier Cooler Isolation Valve	BBHIS0016
EGHV0053	CCW Train A Common Header Return Isolation Valve	EGHS0015
EGHV0054	CCW Train B Common Header Return Isolation Valve	EGHS0016

Note that hand switch EGHS0015 is common to valves EGHV0015 and EGHV0053 and hand switch EGHS0016 is common to valves EGHV0016 and EGHV0054.

Valves BBHV0013, BBHV0014, BBHV0015 and BBHV0016 and hand switches BBHIS0013, BBHIS0014, BBHIS0015 and BBHIS0016 are included in the PFSSD design because spurious closure of these valves will disrupt CCW flow to the associated RCP thermal barrier. Flow transmitters BBFT0017, BBFT0018, BBFT0019 and BBFT0020 are included in the PFSSD design because the flow transmitters automatically close the associated valve upon high flow in the CCW line. A spurious high flow signal will close the associated valve and disrupt flow to the thermal barrier. Therefore, these components are included to evaluate the availability of thermal barrier cooling.

Valves EGHV0069A/B and EGHV0070A/B are not included in the PFSSD design. The normal proceduralized method of shutting down is with all CCW loops in service. The RHR heat exchanger is in service and all radwaste loads are supported. Therefore all heat loads are supported. (USAR table 9.2.10 shows the shutdown heat loads and table 9.2.12 shows the capability of the heat exchanger) The function of valves EGHV0069A/B, 70A/B is to isolate the non-seismic portion of the CCW system following a design basis accident. In the case of a design basis fire, no other accident needs to be postulated. Therefore, the position of the valves is irrelevant to PFSSD analysis.

Fuel Pool Cooling

Fuel pool cooling is required to prevent a release of radioactivity; however, fuel pool cooling is not required to achieve post fire safe shutdown.

VENTILATION

Support function PFSSD ventilation systems provide cooling for the control room, containment, essential service water pump rooms, component cooling water pump rooms, residual heat removal pump rooms, centrifugal charging pump rooms, auxiliary feedwater pump rooms, penetration rooms, class 1E electrical equipment rooms and diesel generator rooms.

Control Room

Control room HVAC operation is required to support PFSSD from the control room. The control room air conditioning units cool and dehumidify the control room atmosphere.

Two trains of control room ventilation are included in the PFSSD design. Each train has a control room air conditioning unit (SGK04A and SGK04B) cooled by essential service water. The control room air conditioning units are controlled by hand switches located on the balance of plant (BOP) miscellaneous panel (RP068). SGK04B can also be started locally using local control GKHS0040. Control room ventilation components included in the PFSSD design are identified in the following table:

COMPONENT	DESCRIPTION	HAND SWITCH
SGK04A	Train A Control Room Air Conditioning Unit	GKHIS0029
SGK04B	Train B Control Room Air Conditioning Unit	GKHIS0040 GKHS0040
GKHZ0029A	Train A Control Room Air Conditioning Unit Inlet Damper	GKHIS0029
GKHZ0029B	Train A Control Room Air Conditioning Unit Outlet Damper	GKHIS0029
GKHZ0040A	Train B Control Room Air Conditioning Unit Inlet Damper	GKHIS0040 GKHS0040
GKHZ0040B	Train B Control Room Air Conditioning Unit Outlet Damper	GKHIS0040 GKHS0040

Dampers GKHZ0029A, GKHZ0029B, GKHZ0040A and GKHZ0040B are used to align control room air flow in and out of the control room air conditioning units.

Containment

Containment cooling is required to maintain the containment environment within PFSSD component environmental qualification limits. Although a design basis LOCA is not postulated to occur with fire, pressurizer PORV operation may lead to pressurizer relief tank rupture disk operation and introduction of reactor coolant into the containment. Additionally, containment entry may be required to perform local operations inside containment.

Two trains of containment cooling are provided for PFSSD. Train A uses containment coolers SGN01A and SGN01C. Train B uses containment coolers SGN01B and SGN01D. All four coolers can be operated from main control board RL020 in the control room. Train B containment coolers SGN01B and SGN01D can be isolated from the control room and operated locally.

The essential service water supply to the containment coolers is discussed under the essential service water discussion.

Containment cooling components included in the PFSSD design are identified in the following table:

COMPONENT	DESCRIPTION
DSGN01A	Train A Containment Cooler Motor
GNHIS0005	Containment Cooler Fan A Main Control Board Hand Indicating Switch
GNHIS0005A	Containment Cooler Fan A Local Hand Indicating Switch
GNHS0005	Containment Cooler Fan A Speed Selector Switch
DSGN01C	Train A Containment Cooler Motor
GNHIS0013	Containment Cooler Fan C Main Control Board Hand Indicating Switch
GNHIS0013A	Containment Cooler Fan C Local Hand Indicating Switch
GNHS0013	Containment Cooler Fan C Speed Selector Switch
DSGN01B	Train B Containment Cooler Motor
GNHIS0009	Containment Cooler Fan B Main Control Board Hand Indicating Switch
GNHIS0009A	Containment Cooler Fan B Local Hand Indicating Switch
GNHS0009	Containment Cooler Fan B Speed Selector Switch
GNHS0009A	Containment Cooler Fan B Run/Isolate Hand Switch
DSGN01D	Train B Containment Cooler Motor
GNHIS0017	Containment Cooler Fan D Main Control Board Hand Indicating Switch
GNHIS0017A	Containment Cooler Fan D Local Hand Indicating Switch
GNHS0017	Containment Cooler Fan D Speed Selector Switch
GNHS00017A	Containment Cooler Fan D Run/Isolate Hand Switch

Essential Service Water Pump Room

Essential service water pump room cooling is required for PFSSD because the essential service water pumps must be cooled while providing cooling water for PFSSD systems and equipment.

Essential service water pump room cooler fan motors DCGD01A and DCGD01B start when the respective ESW pump starts. The cooler fans also have hand switches to permit local and remote control of the fans. Additionally, train B motor DCGD01B has a local control station, GDHS0011, to allow remote operation of the train B cooler for alternate shutdown from outside the control room.

Each pump room has an inlet damper supplying outside air to the cooler fan, an outlet damper to exhaust pump room air to the outside environment, and a recirculation damper to recirculate air within the room. The outlet dampers automatically open when the associated fan starts. The inlet and recirculation dampers modulate based on room temperature. Low temperature switches GDTSL0001 and GDTSL0011 are included in the design because the switches are required for automatic fan start when the ESW pump starts. ESW pump room temperature elements GDTE0001 (Train A) and GDTE0011 (Train B) are included in the design because they feed room temperature data to bistable contacts (GDTSL0001 (Train A), located in RP053B in the control room, and GDTSL0011 (Train B)), located in RP147B in the Train B ESF switchgear room. The bistables are part of the control circuitry for associated ESW pump room supply fan, and are included as PFSSD components. Low pump room temperature will open the contact on the bistable and prevent automatic operation of ESW pump room supply fans. Damage to room temperature elements or associated circuits could cause a false low room temperature and prevent operation of the fans, which could cause operability concerns for the running ESW pump. Temperature controllers GDTC0001 and GDTC0011 control the position of the outside air intake damper and the recirculation damper to maintain room temperature within operational limits. These controllers are required to function for PFSSD but are not specifically listed as PFSSD components because these controllers are integral to panels RP053B and RP0147B, respectively.

Each pump room also has a recirculation damper actuator, GDTZ0001B and GDTZ0011B, used to maintain room temperature within a temperature band. These damper actuators are included in the PFSSD design because recirculation of the pump room air is required for PFSSD to maintain room temperature within operational limits.

ESW fan operation requires auxiliary relay operation for the fans to start. The auxiliary relays included in the PFSSD design are identified in Appendix 4.

The ESW pump room ventilation components included in the PFSSD design are identified in Appendix 3.

Component Cooling Water Pump Room

The component cooling water pump room coolers provide cooling for the component cooling water pumps. Train A and train B essential service water cool the component cooling water pump room coolers.

Train A cooler motor, DSGL11A, starts when either train A component cooling water pump starts. Train B cooler motor, DSGL11B, starts when either train B component cooling water pump starts. When the CCW pump motor breaker closes, a start signal (circuit breaker auxiliary contact closes) is sent to the control circuit for the respective fan cooler motor.

Local hand switches, GLHIS0002 and GLHIS0023, are included in the design because these switches are integral to the automatic start circuit when the CCW pump starts.

Train A CCW pump room cooler SGL11A has two exhaust dampers (GLHZ0080 and GLHZ0081) directing air flow to cool the train A CCW pumps. These dampers open when the train A CCW pumps start. These dampers are included in the PFSSD design.

The CCW pump room ventilation components included in the PFSSD design are identified in Appendix 3.

Residual Heat Removal Pump Room

The residual heat removal pump room coolers provide cooling for the residual heat removal pumps. Train A and train B essential service water cool the residual heat removal pump room coolers.

Train A cooler motor, DSGL10A, starts when train A residual heat removal pump starts. Train B cooler motor, DSGL11B, starts when train B residual heat removal pump starts. When the residual heat removal pump motor breaker closes, a start signal (circuit breaker auxiliary contact closes) is sent to the control circuit for the respective fan cooler motor. The fan motor also may be started locally by push button at the MCCs supplying the fan motors.

No dampers are installed in the residual heat removal pump room cooling system.

Centrifugal Charging Pump Room

The centrifugal charging pump room coolers provide cooling for the centrifugal charging pumps. Train A and train B essential service water cool the centrifugal charging pump room coolers.

Train A cooler motor, DSGL12A, starts when train A centrifugal charging pump starts. Train B cooler motor, DSGL12B, starts when train B centrifugal charging pump starts. When the centrifugal charging pump motor breaker closes, a start signal (circuit breaker auxiliary contact closes) is sent to the control circuit for the respective fan cooler motor. The fan motor also may be started locally by push button at the MCCs supplying the fan motors.

No dampers are installed in the centrifugal charging pump room cooling system.

Auxiliary Feedwater Pump Room

The auxiliary feedwater pump room coolers provide cooling for motor driven auxiliary feedwater pumps. Train A and train B essential service water cool the motor driven auxiliary feedwater pump room coolers.

Train A cooler motor, DSGF02A, starts when train A motor driven auxiliary feedwater pump starts. Train B cooler motor, DSGF02B, starts when train B motor driven auxiliary feedwater pump starts. When the motor driven auxiliary feedwater pump motor breaker closes, a start signal (circuit breaker auxiliary contact closes) is sent to the control circuit for the respective fan cooler motor and starts the fan motor.

Local hand indicating switches GFHIS0015 (train A) and GFHIS0016 (train B) are included in the PFSSD design. These switches must be in AUTO for automatic fan cooler motor start to occur when the motor driven auxiliary feedwater pump circuit breaker closes.

Room air is drawn through the cooling coils by the fan and discharges into the room; therefore, no dampers are installed in the auxiliary feedwater pump room cooling system.

Penetration Room

The penetration room coolers provide cooling for post fire safe shutdown equipment and components installed in the electrical penetration rooms. Train A and train B essential service water provide cooling for the penetration room coolers. The penetration room coolers may not be required for normal shutdown (non-LOCA) but have been presently included in the PFSSD design

The penetration room cooler motor (DSGL15A and DSGL15B) automatic start feature is initiated by a safety injection signal. Because safety injection is not included in the PFSSD design, the penetration room coolers must be manually started for PFSSD. Depressing the start push-button at the motor's MCC performs the local manual start. Train B cooler motor control circuit has a control room isolate hand switch (GLHS0035) to switch in redundant control power fuses in the event of a control room fire damaging the normal control power fuses. GLHS0035 is installed on NG02BAF2.

No dampers are installed in the penetration room cooling system.

Class 1E Electrical Equipment Room

The class 1E electrical equipment room air conditioning units provide cooling for post fire safe shutdown equipment and components installed in the class 1E electrical equipment rooms. Train A and train B essential service water cools the class 1E electrical equipment room air-conditioning units.

The load sequencer automatically starts the class 1E electrical equipment room air conditioning units (SGK05A and SGK05B). Because the load sequencer is not included in the PFSSD design, the class 1E electrical equipment room air conditioners must be manually started for PFSSD. The air conditioning units are started from the control room using hand switches (GKHIS0100 and GKHIS0103). Train B air conditioning unit has a control room isolate hand switch (GKHS0103) to locally start the air conditioning unit. In the event cable damage occurs, causing a false fire signal, both Train A and B have NORM-BYPASS switches (GKHS0101 and GKHS0104) to bypass the fire signal from the fire isolation relays (95XGK07 and 95XGK08) and allow the units to be started from the control room.

Fire isolation relays (95XGK07 and 95XGK08) are included in the PFSSD design. These relays are included because the relays have contacts in the start circuit for the air conditioning units.

No dampers are installed in the class 1E electrical equipment room cooling system.

Diesel Generator Room

The diesel generator building ventilation system supplies combustion air for the diesel generators and ensures proper room temperature for operation of the equipment. The exhaust flow path of the ventilation system is provided with a damper (GMHZ0009 or GMHZ0019) designed to fail in the open position. With the exhaust damper open the maximum quantity of combustion air required by the diesel is provided.

The exhaust damper opens automatically on a diesel start when the diesel ASR relay is energized or when the associated supply fan starts. When the diesel ASR relay energizes or when the supply fan starts, the damper solenoid valve (GMHY0009 or GMHY0019) is de-energized to vent air from the damper and allow it to fail open.

The control room hand switches (GMHIS0009A and GMHIS0019A) are included in the PFSSD design. If these switches are in the closed position, then the exhaust dampers will not open when the diesel starts. The PFSSD design requires that these switches be in either the OPEN or NORMAL position but not the CLOSE position.

In the event of a control room fire requiring control room evacuation locally operated hand switch GMHS0019B is used to isolate control room hand switch GMHIS0019A and fail the train B diesel generator room exhaust damper open.

Diesel generator room supply fans CGM01A and CGM01B are required for PFSSD because they provide temperature control for the diesel generator rooms.

In addition to the exhaust dampers described above, each diesel generator room has an inlet damper that supplies outside air to the supply fan, and a recirculation damper to recirculate air within the room. The inlet and recirculation dampers modulate to control room temperature. Low temperature switches GMTSL0001 and GMTSL0011 provide a signal to start the associated supply fan when the low temperature setpoint is not met. Diesel generator room temperature elements GMTE0001 (Train A) and GMTE0011 (Train B) are included in the PFSSD design because they feed room temperature data to bistable contacts (GMTSL0001 (Train A), located in RP053B in the control room, and GMTSL0011 (Train B)), located in RP147B in the Train B ESF switchgear room. The bistables are part of the control circuitry for the associated diesel generator room supply fan, and are also included as PFSSD components. Low pump room temperature will open the contact on the bistable and prevent operation of the associated diesel generator room supply fan. Damage to room temperature elements or associated circuits could cause a false low room temperature and prevent operation of the fans, which could cause operability concerns for the running diesel generator.

Hand switch GMHS0011B is required for alternative shutdown in the event of a fire in the control room. The hand switch isolates the control room and starts Train B diesel generator room supply fan CGM01B.

Each diesel generator room has a recirculation damper actuator, GMTZ0001B and GMTZ0011B, used to maintain room temperature within a temperature band. These damper actuators are included in the PFSSD design because recirculation of the diesel generator room air is required for PFSSD to maintain room temperature within operational limits.

DIESEL GENERATOR

Two standby diesel generators, KKJ01A and KKJ01B, are incorporated into the PFSSD design. The standby diesel engine system in conjunction with the standby generators provides an alternate and ultimate source of electrical power that is required to shutdown the reactor and to maintain the reactor in a safe shutdown condition in the event of a loss of off-site power.

Each standby diesel engine system includes the following:

a. Fuel oil storage and transfer system
b. Cooling water system
c. Starting air system
d. Lubricating system
e. Intake and exhaust system
f. Safeguards and controls
g. Diesel engine

The fuel oil storage and transfer system is required for PFSSD. It is discussed below.

The cooling water system is required for post fire safe shutdown. However, only the jacket water expansion tank (TKJ01A and TKJ01B) and the expansion tank level glass (KJLG0070 and KJLG0170) are included in the PFSSD design. The cooling water pump is attached to and driven by the diesel engine. Therefore, the cooling water pump is considered to be part of the diesel engine.

The starting air system is required for PFSSD. It is discussed below.

The lubricating system is an integral part of the diesel engine. The lubricating oil pump is attached to and driven by the diesel engine. An independent keep-warm pump not attached to the diesel engine is required to keep the diesel warm prior to operation. However, the keep-warm pump is not required after the engine-driven pump is running. The keep-warm pump supplies flow through the lube oil filter so for long term health of the engine it is needed. The pump remains running even after the engine starts. Therefore, the lubricating system is considered to be part of the diesel engine and is not addressed as a separate part of the PFSSD design.

The diesel engine intake and exhaust system consists of air intake filters and silencers, turbocharger and intercooler and exhaust silencer. These components are integral to the diesel engine skid. Consequently, these components are not included in the PFSSD design. Combustion air for the diesel is provided through the diesel engine room exhaust damper. Operation of the diesel engine exhaust damper is discussed under the ventilation system above.

The diesel engine safeguards and controls are included in the PFSSD design. Because the PFSSD design criteria provides for excluding non-fire induced failures, none of the diesel engine protection signals and lockouts are included in the PFSSD design. However, the loss of off site power automatic start is included in the design because fire can induce a loss of off-site power. Diesel engine controls are distributed between the control room and the respective diesel engine room. Diesel engine gauge and control panels (KJ121 and KJ122) and diesel generator control and relay panels (NE106 and NE107) are located in the diesel generator rooms. These control panels are included in the PFSSD design.

The diesel engines (KKJ01A and KKJ01B) are included in the PFSSD design. The diesel engines are skid-mounted machines with required auxiliary equipment attached to the engine proper or mounted on the diesel engine skid.

Safeguards and Controls

Diesel engine gauge and control panels, KJ121 and KJ122, have local controls for the diesel engines and supporting system. These panels also provide termination points for diesel engine cables.

Diesel generator control and relay panels, NE106 and NE107, have local controls for the diesel generators. These controls are identified in the following table:

COMPONENT	PANEL	DESCRIPTION
KJHS0001C	NE107	Diesel Generator A Start Hand Switch
KJHS0001D	NE107	Diesel Generator A Emergency Start Hand Switch
KJHS0008B	NE107	Diesel Generator A Stop Hand Switch
KJHS0009	NE107	Diesel Generator A Master Transfer Switch
KJHS0007B	NE107	Diesel Generator A Governor Speed Control Switch
TS2	NE107	Emergency Diesel Generator A Test Switch
RNM	NE107	Diesel Generator A Regulator Null Meter
NEHS0011B	NE107	Diesel Generator A Voltage Regulator Selector Switch
NEHS0013B	NE107	Diesel Generator A Auto Voltage Regulator Switch
NEHS0015B	NE107	Diesel Generator A Manual Voltage Regulator Switch
NEHS0021	NE107	Diesel Generator A Exciter Shutdown Hand Switch
NEHS0023	NE107	Diesel Generator A Exciter Reset hand Switch
KJHS0101C	NE106	Diesel Generator B Start Hand Switch
KJHS0101D	NE106	Diesel Generator B Emergency Start Hand Switch
KJHS0107B	NE106	Diesel Generator B Governor Speed Control Switch
KJHS0108B	NE106	Diesel Generator B Stop Hand Switch
KJHS0109	NE106	Diesel Generator B Master Transfer Switch
TS2	NE106	Emergency Diesel Generator B Test Switch
RNM	NE106	Diesel Generator B Regulator Null Meter
NEHS0012B	NE106	Diesel Generator B Voltage Regulator Selector Switch
NEHS0014B	NE106	Diesel Generator B Auto Voltage Regulator Switch
NEHS0016B	NE106	Diesel Generator B Manual Voltage Regulator Switch
NEHS0022	NE106	Diesel Generator B Exciter Shutdown Hand Switch
NEHS0024	NE106	Diesel Generator B Exciter Reset Hand Switch

The NE106 and NE107 controls identified above are used for PFSSD locally.

Standby diesel generator start is accomplished locally using hand switches (KJHS0001C or KJHS0001D at NE107 and KJHS00101C or KJHS0101D at NE106), remotely in the control room using main control board hand switches (KJHS0008A for diesel generator A and KJHS0108A for diesel generator B) and automatically by K1173 for diesel generator A and K4173 for diesel generator B. The automatic start signal is developed from a loss of off-site power. Undervoltage relays (127-1/DG, 127-2/DG, 127-3/DG and 127-4/DG for diesel generators A and B) are processed through load shed/sequencing panels NF039A, NF039B and NF039C. All three methods for standby diesel start are included in the PFSSD design.

When the diesel engine fuel rack shutdown solenoid valves (KJPV0008 and KJPV0108) are energized, the diesel generators stop. The shutdown solenoids are energized remotely using control room hand switches (KJHS0008A or KJHS0108A) or locally using KJHS0008B on NE107 or KJHS0108B on NE106. For PFSSD, KJPV0008 and KJPV0108 must remain de-energized.

Standby diesel generator voltage control is controlled remotely from the control room (RL015) or locally in the standby diesel generator rooms on NE106 or NE107. Exciter and voltage regulator controls required for PFSSD are identified in the following table:

COMPONENT	LOCATION	DESCRIPTION
NEHS0013A	RL015	Diesel generator A auto voltage regulator switch
NEHS0013B	NE107	Diesel generator A auto voltage regulator switch
NEHS0014A	RL015	Diesel generator B auto voltage regulator switch
NEHS0014B	NE106	Diesel generator B auto voltage regulator switch
NEHS0015A	RL015	Diesel generator A manual voltage regulator hand switch
NEHS0015B	NE107	Diesel generator A manual voltage regulator hand switch
NEHS0016A	RL015	Diesel generator B manual voltage regulator hand switch
NEHS0016B	NE106	Diesel generator B manual voltage regulator hand switch
NEII0005	RL015	Diesel generator A null meter
NEHS0011A	RL015	Diesel generator A voltage regulator selector switch
NEHS0011B	NE107	Diesel generator A voltage regulator selector switch
NEHS0005	RL0015	Diesel generator A unit parallel switch
NEHS0027	RL015	Diesel generator A synchronizing transfer switch
NEHS0012A	RL015	Diesel generator B voltage regulator selector switch
NEHS0012B	NE106	Diesel generator B voltage regulator selector switch
NEHS0006	RL015	Diesel generator B unit parallel switch
NEHS0028	RL015	Diesel generator B synchronizing transfer switch
NEHS0021	NE107	Diesel generator A exciter shutdown hand switch
NEHS0022	NE106	Diesel generator B exciter shutdown hand switch
NEHS0023	NE107	Diesel generator A exciter reset hand switch
NEHS0024	NE106	Diesel generator B exciter reset hand switch

Standby diesel generator speed/frequency is adjusted using a hydraulic actuator controlled remotely from the control room (RL015) or locally in the standby diesel generator rooms on NE106 or NE107. Speed/frequency controls required for PFSSD are identified in the following table:

COMPONENT	LOCATION	DESCRIPTION
KJHS0009	NE107	Diesel generator A master transfer hand switch
KJHS0001D	NE107	Diesel generator A emergency start hand switch
NEHS0005	RL015	Diesel generator A unit parallel hand switch
KJHS0007A	RL015	Diesel generator A raise/lower hand switch
KJHS0007B	NE107	Diesel generator A raise/lower hand switch
KJHS0109	NE106	Diesel generator B master transfer hand switch
KJHS0101D	NE106	Diesel generator B emergency start hand switch
NEHS0006	RL015	Diesel generator B unit parallel hand switch
KJHS0107A	NE106	Diesel generator B raise/lower hand switch
KJHS0107B	NE106	Diesel generator B raise/lower hand switch

Standby diesel generator control circuits required for PFSSD include various control and protective relays. These relays are identified in Appendix 4.

Starting Air System

The diesel generator starting air components required for PFSSD include the starting air tanks (TKJ02A and TKJ02B for diesel generator A and TKJ02C and TKJ02D for diesel generator B) and diesel generator starting air inlet isolation valves (KJPV0001A and KJPV0001B for diesel generator A and KJPV0101A and KJPV0101B for diesel generator B). The starting air tanks provide the volume of air directed to the diesel generator cylinders when the starting air valves open. No other starting air components are required for PFSSD.

Cooling Water System

The diesel generator cooling water system requires essential service water to provide cooling water to the jacket water, intercooler and lube oil heat exchangers. The jacket water, intercooler water and lube oil pumps are attached and driven by the diesel engine. Jacket water expansion tanks, TKJ01A and TKJ01B and their level gauges, KJLG0070 and KJLG0170, are required for post fire safe shutdown. A level switch normally controls makeup water to the tank. The expansion tanks are required to maintain net positive suction head on the jacket water pump and the level gauges are required to determine expansion tank level. No other diesel generator cooling water components are included in the PFSSD design.

Fuel Oil Storage and Transfer System

The emergency fuel oil system provides onsite storage and delivery of fuel oil to the diesel generators. Each diesel generator has an emergency fuel oil storage tank (TJE01A and TJE01B) buried near the diesel generator buildings. Each emergency fuel oil storage tank is sized to provide sufficient fuel to operate its associated diesel generator.

A submersible fuel oil transfer pump (DPJE01A and DPJE01B) is installed inside each emergency fuel oil storage tank. The fuel oil transfer pumps start when its associated diesel engine starts. The fuel oil transfer pumps discharge to the emergency fuel oil day tanks (TJE02A and TJE02B). Fuel oil transfer pump hand switches (JEHIS0001A and JEHIS0021A on RL024; JEHS0001B on KJ121; JEHS0021B on KJ122; and JEHS0021C on NG04DDF3) are normally aligned for automatic pump start. In the event of a control room fire that disables the fuel oil transfer pumps, Operators can manually start the B Train fuel oil transfer pump (DPJE01B) by placing control room isolation switch JEHS0021C in ISO position and turning JEHS0021B to the RUN position. To stop the pump, Operators can turn JEHS0021B to the STOP position while maintaining JEHS0021C in the ISO position.

The emergency fuel oil day tanks have a capacity of approximately 1 1/2 hours of operation for the associated diesel generator at rated loads (Reference M-10JE, Page 4, Paragraph 3.1.4). Each emergency fuel oil day tank has a level gauge (JELG0009 and JELG0029) that may be used to locally determine emergency fuel oil day tank level. The emergency fuel oil day tanks also have level transmitters (JELT0001 and JELT0021) for automatically starting and stopping the fuel oil transfer pumps. Limit switches (JELSL0001C and JELSL0021C) control the fuel oil transfer pump start and stop. The emergency fuel oil day tanks are installed above the diesel generators to provide positive feed of fuel oil to the diesel engine by gravity flow.

The fuel oil storage and transfer system components included in the PFSSD design are identified in the following table:

COMPONENT	DESCRIPTION
DPJE01A	Train A emergency fuel oil transfer pump motor
DPJE01B	Train B emergency fuel oil transfer pump motor
JEHIS0001A	Train A emergency fuel oil transfer pump DPJE01A hand indicating switch
JEHIS0021A	Train B emergency fuel oil transfer pump DPJE01B hand indicating switch
JEHS0001B	Train A emergency fuel oil transfer pump DPJE01A hand switch

COMPONENT	DESCRIPTION
JEHS0021B	Train B emergency fuel oil transfer pump DPJE01B hand switch
JEHS0021C	Isolation Handswitch for DPJE01B
JELG0009	Emergency fuel oil day tank TJE02A level gauge
JELG0029	Emergency fuel oil day tank TJE02B level gauge
JELSH0001B	Emergency Fuel Oil Day A Low Level Switch
JELSL0001C	Emergency Fuel Oil Day A High Level Switch
JELSH0021B	Emergency Fuel Oil Day B Low Level Switch
JELSL0021C	Emergency Fuel Oil Day B High Level Switch
JELT0001	Emergency Fuel Oil Day A Level Transmitter
JELT0021	Emergency Fuel Oil Day b Level Transmitter
TJE01A	Train A emergency fuel oil storage tank
TJE01B	Train B emergency fuel oil storage tank
TJE02A	Train A emergency fuel oil day tank
TJE02B	Train B emergency fuel oil day tank

Standby diesel generator components required for post fire safe shutdown are identified in Appendix 3.

ELECTRICAL

The PFSSD electrical distribution system includes portions of the13.8KV, 4.16KV, 480V, 125VDC and 120VAC systems.

<u>Lower Medium Voltage System – 4.16KV and Higher Medium Voltage System – 13.8KV</u>

Load group 1 is supplied by 4.16KV bus NB01 and load group 2 is supplied by 4.16KV bus NB02. ESF transformer XNB01 is connected to a 13.8KV supply in the switchyard. ESF transformer XNB02 is connected to one 13.8KV winding of the startup transformer. This configuration provides two sources of preferred (off-site) power to the Class 1E busses.

Each 4.16KV bus can be supplied from its associated transformer or from its respective diesel generator if off-site power is unavailable. The following circuit breakers and power sources supply power to 4.16KV busses NB01 and NB02:

CIRCUIT BREAKER	DESCRIPTION
NB0109	NB01 Feeder from XNB02
NB0111	NB01 Feeder from emergency diesel generator NE01
NB0112	NB01 Feeder from XNB01
XNB01	13.8KV To 4.16KV ESF transformer feeding NB01
NB0209	NB02 Feeder from XNB02
NB0211	NB02 Feeder from emergency diesel generator NE02
NB0212	NB02 Feeder from XNB01
XNB02	13.8KV To 4.16KV ESF transformer feeding NB02
PA0201	XNB02 13.8KV Feeder from startup transformer XMR01
13-21	XNB01 13.8KV feeder from switchyard
13-23	XNB01 13.8KV feeder from switchyard

PA0210 is included in the PFSSD design because PA0210 control section provides control power for PA02. No PFSSD loads other than PA02 control power are supplied by PA0210.

Off-site power availability requires that off-site power cables and cables associated with XNB01 and XNB02 protective relays remain free of fire damage. The power cables are associated with the circuit breakers in the preceding table. Off-site protective relays and potential transformers required for PFSSD are identified in Appendix 4 and Appendix 3.

The above discussion addresses safety-related power required for post fire safe shutdown. A limited number of components derive their power from non-safety related busses (PA01 and PA02). The non-safety related power is normally supplied from the unit auxiliary transformer (XMR02). On a failure of XMR02 or the power to XMR02, a fast bus transfer to the start-up transformer (XMR01) occurs. The power path from XMR02 is not included in the PFSSD design because the XMR01 power path is in the PFSSD design. Other than 480V MCCs, there are no other non-safety related PFSSD loads powered from PA01 and PA02. Controls required for off-site and on-site power are identified in Appendix 3.

Forced cooling of ESF transformers XNB01 and XNB02 is not required for PFSSD. Each transformer has a self-cooled rating of 12 MVA and a forced air cooled rating of 16 MVA. The maximum design basis accident (DBA) load is approximately 6 MW which equates to 6 MVA assuming a power factor of 1 (actual power factor is between 0.8 and 1.0). Therefore, there is a 100% margin for the DBA loading for the self-cooled rating. PFSSD loading would be equal to or less than the DBA rating since some of the DBA loads are not credited for PFSSD (e.g. containment spray pumps and safety injection pumps). Therefore, there is adequate justification for not including ESF transformer cooling in the PFSSD analysis.

Lower medium voltage – 4.16KV components and relays required for PFSSD are identified in Appendix 4 and Appendix 3.

An evaluation of the potential for a fire-induced loss of off-site power is contained in Appendix 2. This evaluation identified the plant locations where a fire initiated loss of off-site power (loss of non-safety related power) could occur.

<u>Low Voltage System – 480V</u>

The low voltage system is divided into two load groups that are redundant and independent, load group 1 and load group 2. Either one of the associated load groups is capable of achieving PFSSD.

The Class 1E 480V system consists of load center unit substations and motor control centers. Supplied from the 4.16KV buses (NB01 and NB02), the load centers transform power from 4.16KV to 480V. The load centers supply power at 480V directly to motors above 50 hp and less than 250 hp. Motors 50 hp and below, two-speed or reversible motors and motors subject to repeated cycling are supplied from motor control centers.

Post-fire safe shutdown components powered by non-safety related power were evaluated to determine the components that required power (power required to reposition the component) for post fire safe shutdown. The review determined that some of the components used to isolate steam flow downstream of the MSIVs require power to isolate steam flow. Appendix 5 determined that these components were only required for a fire in fire areas A-15 and A-23. None of the preferred power cables are routed in fire areas A-15 and A-23. Therefore, the non-safety related power would be available when required.

Transformers employed in the PFSSD design to transform 4.16KV to 480V are identified in Appendix 3.

480V load center and motor control center components used in the PFSSD design are identified in Appendix 3.

The 4.16KV to 480V transformers and their incoming feeder breakers have protective relays that are included in the PFSSD design. These relays are included in the design because, if the relays actuate, MCCs that supply PFSSD components will be lost. The relays are identified in Appendix 4.

<u>125VDC System</u>

The PFSSD 125VDC system includes four Class 1E 125VDC buses (NK01, NK02, NK03 and NK04) and two non-class 1E 125VDC buses (PK01 and PK02). 125VDC batteries (NK11, NK12, NK13, NK14, PK11 and PK12) and/or 125VDC battery chargers (NK21, NK22, NK23, NK24, NK25, NK26, PK21 and PK22) supply power to the 125VDC buses. Swing 125VDC battery chargers (NK25 and NK26) are included in the design because these chargers may be in service instead of a normal charger. The battery chargers are connected to the 125VDC buses by output transfer switches (NK71, NK72, NK73, NK74, NK75 and NK76). The swing battery chargers also have AC transfer switches (NK77 and NK78).

The 125VDC components included in the PFSSD design are identified in Appendix 3.

<u>Instrument AC Power System – 120VAC</u>

The PFSSD 120VAC system includes four Class 1E 120VAC distribution panels (NN01, NN02, NN03 and NN04) and two Non-class 1E 120VAC distribution panels (PN07 and PN08). Inverters (NN11, NN12, NN13 and NN14) supply 120VAC power to NN01, NN02, NN03 and NN04. Swing inverter NN15 can be lined up to supply 120 VAC power to NN01 or NN03 through manual transfer switch NK79. Swing inverter NN16 can be lined up to supply 120 VAC power to NN02 or NN04 through manual transfer switch NK80. 480/120V regulating transformers XPN07A and XPN08A supply power to PN07 and PN08 respectively. Alternate source of power to PN07 and PN08 is from 480/120V regulating transformers XPN07D and XPN08D.

Manual transfer switches NK79 and NK80 are powered by 120 VAC for switching and local indication. The power supply and associated cables are not included in the PFSSD analysis because loss of power will not prevent operation of the switches.

The 120VAC components included in the PFSSD design are identified in Appendix 3.

SAFETY INJECTION AND CONTAINMENT SPRAY

A spurious safety injection signal (SIS) and spurious containment spray actuation signal (CSAS) complicate PFSSD because of the various automatic actuations that occur. A SIS trips the reactor, trips the turbine, starts both emergency diesel generators, actuates the LOCA sequencer and starts a number of pumps, causes a number of valves to re-position and sheds certain non-safety loads. A CSAS actuates the LOCA sequencer, starts the containment spray pumps and opens the containment spray valves.

Most of the automatic actuations that accompany a SIS are beneficial to PFSSD. However, a fire-induced SIS coincident with other fire induced spurious actuations or mal-operations could cause damage to credited PFSSD equipment. Document E-1F9910 analyzes whether a fire-induced SIS or CSAS could occur due to a fire in each area and evaluates the potential PFSSD impact if it does occur simultaneously with other postulated fire-induced failures. A LOCA is not postulated to occur simultaneously with the fire.

The following multiple spurious scenarios are analyzed in E-1F9910.

1. SIS with loss of pump suction
2. SIS with loss of discharge or recirculation flow
3. SIS causing overfill of steam generators
4. SIS causing overfill of pressurizer
5. CSAS causing RWST depletion

If the SI and RHR pumps start without an actual LOCA present, the pumps will dead head against normal RCS pressure until RCS pressure is decreased below the shutoff pressure of the pumps. Under certain conditions, the SI pumps could become damaged. Since the SI pumps are not credited for PFSSD, this is only a commercial concern.

If the RHR pumps are operating, taking suction from the RWST, the water would circulate through the RHR heat exchanger, which is being cooled by CCW, and back to the pump suction through the flow control valve. Therefore, no damage will occur to the RHR pump provided these components are unaffected by the fire. A spurious low level in the RWST will open the containment sump isolation valve and isolate the RWST from the RHR pump. If this occurs coincident with a SIS, then damage to the RHR pump could occur due to loss of suction source. One train of RHR is required for PFSSD cold shutdown.

A SIS also causes the charging pumps to start and opens the BIT flowpath. If this occurs absent an actual LOCA, the pressurizer could go solid. Procedure EMG-E-0 is entered on a SIS. Within the first 8 minutes following a SIS operators are required to determine if the signal is spurious and terminate the SIS if it is spurious. This will prevent pressurizer overfill. Also, if the charging pumps start on a spurious SIS and if the fire also causes other components to mal-operate, pump damage could occur. For example, a spurious pump start coincident with the RWST valves failing to open and the VCT outlet valves closing would result in loss of suction and pump damage.

The CCW system is a closed loop system and spurious start of the pumps on the standby train will not result in immediate damage to the pumps. Normally open manual valves in the suction and discharge piping will ensure sufficient flow in the system to keep the pumps cool until operators terminate the spurious signal. The associated ESW train needs to be unaffected to ensure proper cooling of the CCW flow.

Auxiliary feedwater (AFW) pumps will start on a spurious SIS. The AFW pumps normally take suction from the condensate storage tank (CST) and swap to the ESW system on low suction pressure (LSP) from the CST. Recirculation flow is taken back to the CST. There are no electrically operated valves in the recirculation lines. Normally open, electrically operated valves are located in the suction lines. Spurious closure of these valves coincident with a SIS will result in damage to the AFW pumps. A spurious start of the AFW pumps with damage to the flow control valves could cause an overfill on the steam generators as well as excess cooldown.

A spurious CSAS could impact PFSSD because operation of containment spray will deplete the inventory in the RWST. Based on the RWST to containment sump draindown calculation provided in the Reactivity Control Section, the volume of water that can be lost from the RWST and still have sufficient volume to achieve cold shutdown is 214,260 gallons. The containment spray pumps deliver 3,165 gpm each based on M-10EN. With a single pump operating, it would take about 67 minutes to lose 214,260 gallons from the RWST. If both pumps operate, it would take about 33 minutes to lose 214,260 gallons from the RWST. Therefore, Operators have a limited amount of time to mitigate a CSAS before draining the RWST to a level below that required for cold shutdown.

Safety injection (SI) is initiated automatically by any of the following conditions:

1. Two out of three high containment pressures on pressure transmitters GNPT0934, GNPT0935 and GNPT0936.
2. Two out of four low pressurizer pressures on pressure transmitters BBPT0455, BBPT0456, BBPT0457 and BBPT0458.
3. Two out of three low steam line pressures on any steam generator on ABPT0514, ABPT0515 and ABPT0516 on SG A; ABPT0524, ABPT0525 and ABPT0526 on SG B; ABPT0534, ABPT0535 and ABPT0536 on SG C; and, ABPT0544, ABPT0545 and ABPT0546 on SG D. Two out of three logic must be satisfied on a single steam generator line. Low pressure on a single pressure transmitter co-incident with low pressure on another pressure transmitter on a different steam generator line will not initiate SIS.

Containment spray (CS) is initiated automatically by two out of four high containment pressures on pressure transmitters GNPT0934, GNPT0935, GNPT0936 and GNPT0937.

The SI and CS initiators are included in the PFSSD design to evaluate the potential for a spurious SI or CS. Document E-1F9910 includes the detailed evaluation of the impact on PFSSD in the event of a spurious SI or CS. The following table lists additional components not listed above that are included in the PFSSD design for analysis of spurious SI.

COMPONENT	DESCRIPTION
SBHS0027	Safety Injection Hand Switch
SBHS0028	Safety Injection Hand Switch
K501	Safety Injection Master Relay
K521	Safety Injection Master Relay
K525	Safety Injection Master Relay
K526	Safety Injection Master Relay

A spurious SI is diagnosed by entering procedure EMG E-0. The following parameters are used in EMG E-0 to determine if the SI is required:

- RCS pressure is currently or has been - LESS THAN OR EQUAL TO 1830 PSIG
- Any S/G pressure is currently or has been - LESS THAN OR EQUAL TO 615 PSIG
- Containment pressure is currently or has been - GREATER THAN OR EQUAL TO 3.5 PSIG
- RCS subcooling is currently or has been - LESS THAN 30°F [45°F]
- PZR level is currently or has been - LESS THAN 6% [33%]

RCS pressure indicators BBPI0405 and BBPI0406 are included in the PFSSD design.

All three steam generator pressure indicators on each loop (12 total) are included in the PFSSD design.

Containment pressure indicators GNPI0934, GNPI0935, GNPI0936 and GNPI0937 are included in the PFSSD design.

Pressurizer level indicators BBLI459A and BBLI460A are included in the PFSSD design.

RCS subcooling monitoring is not included in the PFSSD design. The indication described above is sufficient to determine if the SI is required or if it spuriously actuated because of a fire.

MISCELLANEOUS SUPPORT FUNCTION PANELS

The post fire safe shutdown design includes various control panels (control boards), instrument racks and relay panels. These panels are identified in Appendix 3.

CONTROL ROOM ISOLATION

In the event of a fire in the control room requiring control room evacuation and alternate shutdown from the auxiliary shutdown panel (RP118B), various control circuits must be isolated from control room fire damage. Control room isolation is accomplished by performing local operations at various operating stations in the plant and by lockout relays.

Auxiliary shutdown transfer signal (ASTS) is initiated at RP118B by RPHIS0001, RPHIS0002 and RPHIS0003, which transfer control to the auxiliary shutdown panel while isolating the main control board controls and indications from RP118B. The components isolated by ASTS and included in PFSSD alternative shutdown design are identified in the following table:

TRANSFER SWITCH	LOCKOUT RELAY	RELAY LOCATION	ISOLATED COMPONENT	DESCRIPTION
RPHIS0001	86XRP1	RP334	FCHV0312	Turbine Driven Auxiliary Feedwater Pump Trip and Throttle Valve
RPHIS0001	86XRP2	RP334	ABHV0006	Main Steam Supply Valve To Turbine Driven Auxiliary Feedwater Pump
RPHIS0001	86XRP3	RP334	ABHV0005	Main Steam Supply Valve To Turbine Driven Auxiliary Feedwater Pump
RPHIS0001	86XRP3	RP334	FCHV0312	Turbine Driven Auxiliary Feedwater Pump Trip and Throttle Valve
RPHIS0002	86XRP5	RP335	ALHV0034	Motor Driven Auxiliary Feedwater Pump B Supply from condensate Storage Tank
RPHIS0002	86XRP6	RP335	ALHV0033	Turbine Driven Auxiliary Feedwater Pump Supply from ESW
RPHIS0002	86XRP7	RP335	DPAL01B	Motor Driven Auxiliary Feedwater Pump B
RPHIS0002	86XRP5	RP335	ALHV0030	Motor Driven Auxiliary Feedwater Pump B Supply from Essential Service Water System
RPHIS0003	86XRP9	RP334	PG2201	Pressurizer Heater Backup Group B

The components isolated by ASTS that are not included in the PFSSD design are identified in the following table:

TRANSFER SWITCH	LOCKOUT RELAY	RELAY LOCATION	ISOLATED COMPONENT	DESCRIPTION/JUSTIFICATION
RPHIS0001	86XRP2	RP334	FCFV0313 Position Indication	Turbine Driven Auxiliary Feedwater Pump Governor Valve position can be verified locally or by monitoring steam generator level trend
RPHIS0001	86XRP3	RP334	ABPV0002 Position Indication	Steam Generator 2 Atmospheric Relief Valve position can be verified by controlling the ARV at the ASP and monitoring RCS temperature
RPHIS0002	86XRP4	RP335	BGHV8152	Letdown Line Isolation Valve – Letdown isolation valves BGLCV0459 and BGLCV0460 are used for letdown line isolation
RPHIS0002	86XRP4	RP335	NB0208	This isolation function is not credited for alternate shutdown. NB0208 is manually controlled in OFN RP-017
RPHIS0002	86XRP6	RP335	ABPV0004 Position Indication	Steam Generator D Atmospheric Relief Valve position can be verified by controlling the ARV at the ASP and monitoring RCS temperature

SUPPORT FUNCTION STATUS PANEL RESOLUTION

Discussion

Status panels are installed in the control circuits of some post fire safe shutdown components. The cables to these status panels are associated circuits subject to failures that may compromise the post fire safe shutdown component. The following analysis describes how support function components may be affected by status panel associated circuits.

Analysis

The following table identifies the support function post fire safe shutdown components that have status panels installed in their control circuits:

COMPONENT	STATUS PANEL SCHEMATIC	STATUS PANEL CABLE	NOTES
EGTV0029	E13SA15	11SAZ15AA	1, 2, 3, 4
EGTV0030	E-13SA16	14SAZ16AA	1, 2, 3, 4
SGK04A	E13SA19	11SAZ19JA	1, 4, 5, 6
SGK04B	E13SA20	14SAZ20GA	1, 4, 5, 6
GKHZ0029A	E13SA19	11SAZ19EA	1, 7, 8, 9
GKHZ0029B	E13SA19	11SAZ19EA	1, 7, 8, 9
GKHZ0040A	E03SA20	14SAZ20EA	1, 7, 8, 9
GKHZ0040B	E03SA20	14SAZ20EA	1, 7, 8, 9
SGK05A	E13SA19	11SAZ19KA	1, 4, 5, 6
SGK05B	E13SA20	14SAZ20HA	1, 4, 5, 6
GLHZ0080	E13SA19	11SAZ19FA	1, 4, 7, 8
GLHZ0081	E13SA19	11SAZ19FA	1, 4, 7, 8
GMHZ0009	E13SA19	11SAZ19AA	1, 4, 10, 11
GMHZ0019	E13SA20	14SAZ20AA	1, 4, 10, 11

NOTES:

1. If the cables to the status panel open, there will be no effect on the component and post fire safe shutdown.
2. If the status panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The valve will close, the desired PFSSD position. Consequently there will be no adverse support function consequence from this failure.
3. If one status panel cable shorts to ground, there will be no effect on the component or post fire safe shutdown because the control circuit power supply is an ungrounded DC system. If both status panel cables short to ground, then the effect will be the same as short circuit described in note 2.
4. A hot short(s) on the status panel cables has no effect on the control circuit or the post fire safe shutdown component.
5. If the status panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. When the control circuit is de-energized, the control room air conditioning unit fan stops.
6. If the status panel cable connected to terminal 30 shorts to ground, the effect will be the same as the short circuit described in note 5. If the status panel cable connected to terminal 15 shorts to ground, there will be no effect on post fire safe shutdown.

7. If the status panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The damper motors will be de-energized and the dampers will fail as is.

8. If the grounded status panel cable shorts to ground, there will be no effect on the component or post fire safe shutdown. If the ungrounded status panel cable shorts to ground, then the effect will be the same as short circuit described in note 7.

9. A hot short(s) on the status panel cables has no effect on the control circuit or the post fire safe shutdown component.

10. If the status panel cables short together, the control circuit power supply will be lost as a result of excessive current through the short circuit. The damper will open, the desired PFSSD position. Consequently there will be no adverse support function consequence from this failure.

11. If one status panel cable shorts to ground, there will be no effect on the component or post fire safe shutdown because the control circuit power supply is an ungrounded DC system. If both status panel cables short to ground, then the effect will be the same as short circuit described in note 10.

FIRE INDUCED LOSS OF OFF-SITE POWER

BACKGROUND:

Post fire safe shutdown capability is provided by two different capabilities: 1) Alternate post fire safe shutdown and 2) Normal post fire safe shutdown.

- Alternate post fire safe shutdown capability is performed when the control room must be evacuated to perform safe shutdown operations. In this case fire damage precludes continued operations from the control room. Alternate post fire safe shutdown is controlled from alternate shutdown panel RP118B. Alternate shutdown must be capable of achieving safe shutdown with or without off-site power available.

- Normal post fire safe shutdown capability, using redundant post fire safe shutdown trains (divisions) is performed when the control room remains occupied during a fire. In this case fire damage does not preclude continued operations from the control room. During normal shutdown from the control room, a loss of off-site power is not assumed. Off-site power remains available except for fires that damage off-site power equipment (cables, switchgear, transformers, etc.).

This evaluation is performed to identify the fire areas where a loss of off-site power may be initiated by fire damage.

ASSUMPTIONS:

- A fire induced loss of off-site power may be initiated by open circuits, shorts to ground or hot shorts (10 CFR Appendix R Sections III.G.2 and III.L.7).
- Fire induced circuit failures occur one at a time and not simultaneously (Generic Letter 86-10, Question 5.3.10).
- Three phase hot shorts are not analyzed because three phase hot shorts are only postulated for high/low pressure interface components (Generic Letter 86-10, Question 5.3.1).
- Switchyard cables are not analyzed.
- A fire induced loss of off-site power is not initiated by cables embedded or buried in the fire area of concern.
- The Wolf Creek electrical distribution system is coordinated; consequently, fire induced common bus failure does not occur.

CABLE SELECTION:

The Post fire Safe Shutdown Analysis logic diagrams (E-1F9420 series drawings) identify the off-site power components. Schematic diagrams (E-13 series drawings) identify the cables for the off-site power components. The minimum set of off-site power cables is presented in Table A.

The minimum set of off-site power cables includes the following types of cables:

- Power feeder cables in the off-site power paths to the redundant engineered safety features (ESF) busses (NB01 and NB02)

- Control cables for components in the off-site power paths to the redundant ESF busses (NB01 and NB02)

- Protective relay cables for relays controlling components in the off-site power paths to the redundant ESF busses (NB01 and NB02)

NOTE: If fire initiated damage to a cable would not initiate a loss off off-site power, the cable is not included in the minimum set of cables. For example: If a protective relay has to actuate to initiate a loss of off-site power, a cable providing control power to the relay would not be included in the minimum list of cables because failure of the cable does not actuate the protective relay.

Cables associated with the unit auxiliary transformer (XMA02) are not included in the evaluation. In the event of a loss of the unit auxiliary transformer or power to the unit auxiliary transformer an immediate transfer to the startup transformer (XMR01) occurs (Reference E-00PA). Cables associated with XMR01 are included in the evaluation. Therefore, a loss of XMA02 is incorporated into the evaluation by analysis of the XMR01 cables.

CABLE ROUTING:

The routing (by fire area) of the off-site power cables identified in Table A is presented in Table B. The routing of these cables was obtained from E-15000.

RESULTS:

Fire areas containing off-site power cables are identified in Table C. In the event of fire in these fire areas, it should be assumed that a partial or complete loss of off-site power would occur during the fire. For fires in other fire areas, excluding fire areas provided alternate shutdown capability; off-site power will remain available (i.e. fire damage will not initiate a partial or complete loss of off-site power). It should be noted that this loss of off-site power evaluation only considers cables that could directly cause a loss of off-site power or loss of diesel generators, and not cables that are indirectly associated with these functions. Associated circuits that could indirectly affect these functions are evaluated in E-1F9910.

- In the event of fire in fire area C-27, post fire safe shutdown will be performed using alternate shutdown capability with power supplied by the train B emergency diesel generator (EDG).

- In the event of fire in fire areas C-22, C-30, and C-33, post fire safe shutdown will be performed with equipment powered from NB01. Off-site power and the train A emergency diesel generator are available to supply power to NB01. NB02 will be de-energized.

- In the event of fire in fire areas C-10, C-11, C-17 and C-23, post fire safe shutdown will be performed with equipment powered from NB01. The train A emergency diesel generator will supply power to NB01. NB02 will be de-energized.

- In the event of fire in fire areas A-16 North and A-21, post fire safe shutdown will be performed with equipment powered from NB01 and/or NB02. Off-site power and the train A emergency diesel generator will supply power to NB01. Off-site power will supply power to NB02.

- In the event of fire in fire area A-16 South, post fire safe shutdown will be performed with equipment powered from NB01 via off-site power and the train A emergency diesel generator. Off-site power to NB02 could be lost but the train B emergency diesel generator is available.

- In the event of a fire in area C-6, post fire safe shutdown will be performed with equipment powered from NB01 and/or NB02. The train A emergency diesel generator will supply power to NB01. The train B emergency diesel generator will supply power to NB02.

- In the event of fire in fire area C-15, post fire safe shutdown will be performed with equipment powered from NB01 and/or NB02. The train A emergency diesel generator will supply power to NB01. Off-site power will supply power to NB02.

- In the event of fire in fire areas A-27, C-5, CC-1, T-2, TURB, and YARD, post fire safe shutdown will be performed with equipment powered from NB01 and/or NB02. The train A emergency diesel generator will supply power to NB01. The train B emergency diesel generator will supply power to NB02.

- In the event of fire in fire areas A-8, C-12, C-18, C-21, and C-24, post fire safe shutdown will be performed with equipment powered from NB02. Off-site power will supply power to NB02. NB01 will be de-energized.

- In the event of fire in fire area C-9, post fire safe shutdown will be performed with equipment powered from NB02. The train B emergency diesel generator will supply power to NB02. NB01 will be de-energized.

- In the event of fire in fire area C-16, post fire safe shutdown will be performed with equipment powered from NB01 and/or NB02. Off-site power will supply NB01. Off-site power will supply NB02.

- In the event of a fire in area D-1, post fire safe shutdown will be performed with equipment powered from NB02. While off-site power cables for NB01 do not run in area D-1, a fire in area D-1 could cause an open in the diesel generator output current transformer circuit and cause a secondary fire inside NB01, thereby rendering NB01 unavailable. This was discovered during the current transformer assessment in condition report 46637.

- In the event of a fire in area D-2, post fire safe shutdown will be performed with equipment powered from NB01. While off-site power cables for NB02 do not run in area D-2, a fire in area D-2 could cause an open in the diesel generator output current transformer circuit and cause a secondary fire inside NB02, thereby rendering NB02 unavailable. This was discovered during the current transformer assessment in condition report 46637.

- In the event of fire in all other fire areas, post fire safe shutdown will be performed with equipment powered from NB01 and/or NB02. Off-site power will supply NB01 and NB02. Additionally, the train A and train B emergency diesel generators will also be available to supply NB01 and NB02.

There are some post fire safe shutdown components powered by non-safety related power (off-site power). These components and the mitigation of a loss of off-site power is summarized in the following table:

COMPONENT (S)	MITIGATION
Components downstream of the MSIVs used to isolate steam flow through the MSIVs	Some of these components fail closed on a loss of power, and some require power to close. In those cases where the components require power to be positioned to the desired post fire safe shutdown position, the MSIVs remain available to be closed to isolate steam flow.
Blowdown isolation valves	These valves fail closed on a loss of power. Closed is the required post fire safe shutdown position.
Letdown isolation valves	These valves fail closed on a loss of power. Closed is the required post fire safe shutdown position.

COMPONENT (S)	MITIGATION
RHR heat exchanger discharge control valves	These valves are positioned during the transition to and during cold shutdown. If required, these valves will be locally positioned.
Boron injection downstream test line isolation valve	This valve fails closed on a loss of power. Closed is the required post fire safe shutdown position.

Therefore, in the event of a loss of off-site power, those components powered by non-safety related (off-site) power will either fail to the desired post fire safe shutdown position or other components (MSIVs) remain available to isolate steam flow.

CONCLUSION:

In the event of fire in any fire area, post fire safe shutdown can be achieved using electrical power supplied from off-site power or the emergency diesel generators.

TABLE A

OFF-SITE POWER AND EMERGENCY DIESEL GENERATOR CABLES

CABLE	ASSOCIATED BUS / DIESEL GENERATOR				DESCRIPTION
	NB01	DG A	NB02	DG B	
11JEG01AA		X			DG A Fuel Oil Transfer Pump
11JEG01AB		X			DG A Fuel Oil Transfer Pump
11JEG01AC		X			DG A Fuel Oil Transfer Pump
11JEG01AE		X			DG A Fuel Oil Transfer Pump
11JEG01AG		X			DG A Fuel Oil Transfer Pump
11JEG01AH		X			DG A Fuel Oil Transfer Pump
11JEG01AJ		X			DG A Fuel Oil Transfer Pump
11JEI04AA		X			DG A Fuel Oil Day Tank Level
11KJK01AA		X			Emergency Diesel A
11KJK01AC		X			Emergency Diesel A
11KJK01AD		X			Emergency Diesel A
11KJK01AE		X			Emergency Diesel A
11KJK01AF		X			Emergency Diesel A
11KJK01AH		X			Emergency Diesel A
11KJK01AK		X			Emergency Diesel A
11KJK01AM		X			Emergency Diesel A
11KJK06AC		X			Emergency Diesel A
11KJK06AD		X			Emergency Diesel A
11KJK06AE		X			Emergency Diesel A
11NBB01AB		X			NB01 Synchroscope Selector Switch NBHS0010
11NBB01AF		X			NB01 Synchroscope Selector Switch NBHS0010
11NBB12AA	X				NB0112 Hand Indicating Switch NBHIS0002

TABLE A

OFF-SITE POWER AND EMERGENCY DIESEL GENERATOR CABLES

CABLE	ASSOCIATED BUS / DIESEL GENERATOR				DESCRIPTION
	NB01	DG A	NB02	DG B	
11NBB12AB	X				NB0112 LSELS Output Relay K1102 NB0112 LSELS Output Relay K1148
11NBB12AD	X				NB0112 RCP Start UV Trip Block
11NBB12AE	X				NB0112 SIS Relay K617
11NBB12AF	X				NB0112 Hand Indicating Switch NBHIS0002
11NBK13AA	X	X			NB01 Control Power
11NBK13AB	X	X			NB01 Control Power
11NEB01AA		X			Emergency Diesel Generator A
11NEB01AB		X			Emergency Diesel Generator A
11NEB01AC		X			Emergency Diesel Generator A
11NEB01AD		X			Emergency Diesel Generator A
11NEB01AE		X			Emergency Diesel Generator A
11NEB01AF		X			Emergency Diesel Generator A
11NEB01AG		X			Emergency Diesel Generator A
11NEB01AH		X			Emergency Diesel Generator A
11NEB01AJ		X			Emergency Diesel Generator A
11NEB01AK		X			Emergency Diesel Generator A
11NEB01AL		X			Emergency Diesel Generator A
11NEB01AP		X			Emergency Diesel Generator A
11NEB01AQ		X			Emergency Diesel Generator A
11NEB01AR		X			Emergency Diesel Generator A
11NEB01AS		X			Emergency Diesel Generator A
11NEB01AT		X			Emergency Diesel Generator A
11NEB01AU		X			Emergency Diesel Generator A
11NEB01AV		X			Emergency Diesel Generator A
11NEB10AA		X			Emergency Diesel Generator A
11NEB10AB		X			Emergency Diesel Generator A
11NEB10AC		X			Emergency Diesel Generator A
11NEB10AD		X			Emergency Diesel Generator A
11NEB10AF		X			Emergency Diesel Generator A
11NEB10AG		X			Emergency Diesel Generator A
11NEB10AJ		X			Emergency Diesel Generator A
11NEK12AA		X			Emergency Diesel Generator A
11NEK12AD		X			Emergency Diesel Generator A
11NEK12AE		X			Emergency Diesel Generator A
11NEK12AF		X			Emergency Diesel Generator A
11NEK12AH		X			Emergency Diesel Generator A
11NEK12AJ		X			Emergency Diesel Generator A
14JEG01BA				X	DG B Fuel Oil Transfer Pump
14JEG01BB				X	DG B Fuel Oil Transfer Pump
14JEG01BC				X	DG B Fuel Oil Transfer Pump
14JEG01BD				X	DG B Fuel Oil Transfer Pump

TABLE A

OFF-SITE POWER AND EMERGENCY DIESEL GENERATOR CABLES

CABLE	ASSOCIATED BUS / DIESEL GENERATOR				DESCRIPTION
	NB01	DG A	NB02	DG B	
14JEG01BE				X	DG B Fuel Oil Transfer Pump
14JEG01BG				X	DG B Fuel Oil Transfer Pump
14JEG01BH				X	DG B Fuel Oil Transfer Pump
14JEG01BJ				X	DG B Fuel Oil Transfer Pump
14JEI04BA				X	DG B Fuel Oil Day Tank Level
14KJK03AA				X	Emergency Diesel B
14KJK03AC				X	Emergency Diesel B
14KJK03AD				X	Emergency Diesel B
14KJK03AE				X	Emergency Diesel B
14KJK03AF				X	Emergency Diesel B
14KJK03AH				X	Emergency Diesel B
14KJK03AK				X	Emergency Diesel B
14KJK03AM				X	Emergency Diesel B
14KJK07AC				X	Emergency Diesel B
14KJK07AD				X	Emergency Diesel B
14KJK07AE				X	Emergency Diesel B
14NBB04AB				X	NB02 Synchroscope Selector Switch NBHS0011
14NBB04AF				X	NB02 Synchroscope Selector Switch NBHS0011
14NBB14AA			X		NB0209 Hand Indicating Switch NBHIS0004 NB0209 Synchronizing Transfer Switch NBHS0008
14NBB14AB			X		NB0209 LSELS Output Relay K4101 NB0209 LSELS Output Relay K4149
14NBB14AD			X		NB0209 LSELS Output Relay K4101 NB0209 LSELS Output Relay K4149
14NBB14AE			X		NB0209 LSELS Output Relay K4101 NB0209 LSELS Output Relay K4149
14NBB14AF			X		NB0209 Hand Indicating Switch NBHIS0004
14NBB15AA			X		NB0212 Hand Indicating Switch NBHIS0005 NB0212 Synchronizing Transfer Switch NBHS0009
14NBK15AA			X	X	Bus NB02 Breaker Control Power
14NBK15AB			X	X	Bus NB02 Breaker Control Power
14NEB02AA				X	Emergency Diesel Generator B
14NEB02AB				X	Emergency Diesel Generator B
14NEB02AC				X	Emergency Diesel Generator B
14NEB02AD				X	Emergency Diesel Generator B
14NEB02AE				X	Emergency Diesel Generator B
14NEB02AF				X	Emergency Diesel Generator B
14NEB02AG				X	Emergency Diesel Generator B

TABLE A

OFF-SITE POWER AND EMERGENCY DIESEL GENERATOR CABLES

CABLE	ASSOCIATED BUS / DIESEL GENERATOR				DESCRIPTION
	NB01	DG A	NB02	DG B	
14NEB02AH				X	Emergency Diesel Generator B
14NEB02AJ				X	Emergency Diesel Generator B
14NEB02AL				X	Emergency Diesel Generator B
14NEB02AM				X	Emergency Diesel Generator B
14NEB02AN				X	Emergency Diesel Generator B
14NEB02AP				X	Emergency Diesel Generator B
14NEB02AQ				X	Emergency Diesel Generator B
14NEB02AR				X	Emergency Diesel Generator B
14NEB02AS				X	Emergency Diesel Generator B
14NEB02AU				X	Emergency Diesel Generator B
14NEB02AV				X	Emergency Diesel Generator B
14NEB11AA				X	Emergency Diesel Generator B
14NEB11AB				X	Emergency Diesel Generator B
14NEB11AC				X	Emergency Diesel Generator B
14NEB11AD				X	Emergency Diesel Generator B
14NEB11AF				X	Emergency Diesel Generator B
14NEB11AG				X	Emergency Diesel Generator B
14NEB11AJ				X	Emergency Diesel Generator B
14NEK13AA				X	Emergency Diesel Generator B
14NEK13AD				X	Emergency Diesel Generator B
14NEK13AE				X	Emergency Diesel Generator B
14NEK13AH				X	Emergency Diesel Generator B
14NEK13AJ				X	Emergency Diesel Generator B
15MRK10AA			X		XMR01 fault pressure switch 463-1/T2 XMR01 fault pressure switch 463-2/T2 XMR01 fault pressure relay 463X-1/T2 XMR01 fault pressure relay 463X-2/T2
15MRK10AE			X		XMR01 Deluge Relay AR7
15MRK10AF			X		XMR01 Trip On PA0201 Phase Overcurrent
15MRM11AA			X		XMR01 Transformer Cooling
15MRM11AC			X		XMR01 Lockout Relay Cooling and Oil Level Trips
15MRX01AG			X		XMR01 Phase Differential Relay 487/T1
15MRX01AL			X		XMR01 Neutral Ground Relay 251N-1/T1 XMR01 Neutral Ground Relay 251N-2/T1
15MRX01AN			X		XMR01 Feeder to PA0110
15NBA10AA	X				NB0112 Lockout Relay 286-1/T1 NB0212 Lockout Relay 286-2/T1
15NBA10AC	X				XNB01 Fault Pressure Switch 263-1/T1 XNB01 Fault Pressure Relay 263X-1/T1 XNB01 Fault Pressure Switch 263-2/T1 XNB01 Fault Pressure Relay 263X-2/T1

TABLE A

OFF-SITE POWER AND EMERGENCY DIESEL GENERATOR CABLES

CABLE	ASSOCIATED BUS / DIESEL GENERATOR				DESCRIPTION
	NB01	DG A	NB02	DG B	
15NBA10AD	X				NB0112 Input to Switchyard Trip Relay Panel MA152A
15NBB03AA	X				XNB01 Phase A Feeder to NB0112
15NBB03AC	X				XNB01 Phase B Feeder to NB0112
15NBB03AE	X				XNB01 Phase C Feeder to NB0112
15NBB03AH	X				XNB01 Neutral/Ground Over Current Relay 151N/T1
15NBB03AJ	X				XNB01 Phase Differential Relay 287/T1
15NBB03AL	X				XNB01 Phase Differential Relay 287/T1
15NBB06AA	X				XNB01 Phase A Feeder To NB0212
15NBB06AB	X				XNB01 Phase B Feeder To NB0212
15NBB06AC	X				XNB01 Phase C Feeder To NB0212
15PGG01AL	X				PG13R Feeder
15PGG01AM	X				PG13R Feeder
16MRM11AA			X		XMR01 Transformer Cooling
16MRX01AG			X		XMR01 Phase Differential Relay 487/T1
16MRX01AH			X		XMR01 Phase Differential Relay 487/T1
16MRX01AJ			X		XMR01 Phase Differential Relay 487/T1
16MRX01AN			X		XMR01 Phase Overcurrent Relay 450-451 G/T1
16MRX01AP			X		XMR01 Neutral Ground Relay 251N-3/T1 XMR01 Neutral Ground Relay 251N-4/T1
16MRX01AT			X		XMR01 Feeder To PA0201
16NBA11AA			X		XNB02 Fault Pressure Switch 263-1/T2 XNB02 Fault Pressure Switch 263-2/T2 XNB02 Fault Pressure Relay 263X-1/T2 XNB02 Fault Pressure Relay 263X-2/T2
16NBA11AB			X		PA0201 Hand Indicating Switch NBHIS0001
16NBA11AC			X		PA0201 Hand Indicating Switch NBHIS0001 XNB02 Lockout Relay 286-1/T2
16NBA11AD			X		XMR01 Lockout Relay 486/T1 XMR01 Lockout Relay 286/T1
16NBB02AA			X		XNB02 Phase A feeder to NB0109
16NBB02AB			X		XNB02 Phase B feeder to NB0109
16NBB02AC			X		XNB02 Phase C feeder to NB0109
16NBB03AB	X				XNB01 Phase Differential Relay 287/T1
16NBB05AA			X		XNB02 Phase A Feeder To NB0209
16NBB05AB			X		XNB02 Phase B Feeder To NB0209
16NBB05AC			X		XNB02 Phase C Feeder To NB0209
16NBB05AD			X		XNB02 Phase Differential Relay 287/T2
16NBB05AG			X		XNB02 Phase A Feeder From PA0201
16NBB05AH			X		XNB02 Phase B Feeder From PA0201

TABLE A

OFF-SITE POWER AND EMERGENCY DIESEL GENERATOR CABLES

CABLE	ASSOCIATED BUS / DIESEL GENERATOR				DESCRIPTION
	NB01	DG A	NB02	DG B	
16NBB05AJ			X		XNB02 Phase C Feeder From PA0201
16NBB05AK			X		XNB02 Neutral Ground Over Current Relay 151N/T2
16NBB05AL			X		XNB02 Phase Differential Relay 287/T2
16PAK14AA			X		Bus PA02 Breaker Control Power
16PAK14AB			X		Bus PA02 Breaker Control Power

APPENDIX 2
LOSS OF OFF-SITE POWER EVALUATION

TABLE B
OFF-SITE POWER CABLE ROUTING

CABLE	D			A				C																	CC1	T-2	TURB	YARD
	1	2	8	16N	16S	21	27	5	6	9	10	11	12	15	16	17	18	21	22	23	24	27	30	33				
11JEG01AA	X																											
11JEG01AB	X																	X				X						
11JEG01AC	X																											
11JEG01AE	X																											
11JEG01AG	X																											
11JEG01AH	X																											
11JEG01AJ	X																											
11JEI04AA	X																	X				X						
11KJK01AA	X									X			X		X		X											
11KJK01AC	X																											
11KJK01AD	X																											
11KJK01AE	X																											
11KJK01AF	X																											
11KJK01AH	X																	X				X						
11KJK01AK	X																	X				X						
11KJK01AM	X																											
11KJK06AC	X																											
11KJK06AD	X																											
11KJK06AE	X																	X				X						
11NBB01AB										X			X				X	X				X						
11NBB01AF	X																	X				X						
11NBB12AA										X			X				X	X			X	X						
11NBB12AB										X			X				X	X			X	X						
11NBB12AD			X							X			X				X											
11NBB12AE										X			X				X	X			X	X						
11NBB12AF										X			X				X	X			X	X						
11NBK13AA										X			X		X		X				X	X						
11NBK13AB										X			X		X		X				X							
11NEB01AA	X		X							X																		
11NEB01AB	X																											
11NEB01AC	X		X							X																		
11NEB01AD	X																											
11NEB01AE	X		X							X																		
11NEB01AF	X																											
11NEB01AG	X																	X				X						
11NEB01AH	X																											
11NEB01AJ	X																											
11NEB01AK	X																	X										

APPENDIX 2
LOSS OF OFF-SITE POWER EVALUATION

TABLE B
OFF-SITE POWER CABLE ROUTING

CABLE	D			A				C																	CC1	T-2	TURB	YARD
	1	2	8	16N	16S	21	27	5	6	9	10	11	12	15	16	17	18	21	22	23	24	27	30	33				
11NEB01AL	X																	X										
11NEB01AP	X																											
11NEB01AQ	X																											
11NEB01AR	X																											
11NEB01AS	X																											
11NEB01AT	X																											
11NEB01AU	X																											
11NEB01AV	X																	X										
11NEB10AA										X			X				X	X			X	X						
11NEB10AB	X									X								X										
11NEB10AC	X									X								X										
11NEB10AD										X			X				X	X			X	X						
11NEB10AF	X																											
11NEB10AG	X									X								X										
11NEB10AJ	X									X								X										
11NEK12AA	X									X			X		X		X											
11NEK12AD	X																	X				X						
11NEK12AE	X																											
11NEK12AF	X																	X				X						
11NEK12AH	X																											
11NEK12AJ	X																	X				X						
14JEG01BA		X																										
14JEG01BB		X									X	X				X			X			X	X	X				
14JEG01BC		X																										
14JEG01BD		X		X		X					X	X								X			X					
14JEG01BE		X									X	X				X			X			X	X	X				
14JEG01BG		X																										
14JEG01BH		X																										
14JEG01BJ		X																										
14JEI04BA		X									X	X				X			X			X	X	X				
14KJK03AA		X									X	X		X		X												
14KJK03AC		X																										
14KJK03AD		X																										
14KJK03AE		X																										
14KJK03AF		X																										
14KJK03AH		X									X	X				X			X			X	X	X				
14KJK03AK		X									X	X				X			X			X	X	X				
14KJK03AM		X																										

TABLE B

OFF-SITE POWER CABLE ROUTING

CABLE	D			A				C																	CC1	T-2	TURB	YARD
	1	2	8	16N	16S	21	27	5	6	9	10	11	12	15	16	17	18	21	22	23	24	27	30	33				
14KJK07AC		X																										
14KJK07AD		X																										
14KJK07AE		X									X	X				X			X			X	X	X				
14NBB04AB											X	X				X			X	X		X	X	X				
14NBB04AF											X	X				X			X			X	X	X				
14NBB14AA											X	X				X			X	X		X	X	X				
14NBB14AB											X	X				X			X	X		X	X	X				
14NBB14AD					X						X	X				X				X								
14NBB14AE											X	X				X			X	X		X	X	X				
14NBB14AF											X	X				X			X	X		X	X	X				
14NBB15AA											X	X				X			X	X		X	X	X				
14NBK15AA											X	X		X		X												
14NBK15AB											X	X		X		X												
14NEB02AA		X									X																	
14NEB02AB		X									X																	
14NEB02AC		X									X																	
14NEB02AD		X																										
14NEB02AE		X																										
14NEB02AF		X																										
14NEB02AG		X																										
14NEB02AH		X																										
14NEB02AJ		X																										
14NEB02AL		X									X	X				X			X			X	X	X				
14NEB02AM		X									X																	
14NEB02AN		X																										
14NEB02AP		X									X																	
14NEB02AQ		X																										
14NEB02AR		X																										
14NEB02AS		X																										
14NEB02AU		X																										
14NEB02AV		X									X																	
14NEB11AA											X	X				X			X			X	X	X				
14NEB11AB		X									X																	
14NEB11AC		X									X																	
14NEB11AD											X	X				X			X			X	X	X				
14NEB11AF		X																										
14NEB11AG		X									X																	
14NEB11AJ		X									X																	

APPENDIX 2
LOSS OF OFF-SITE POWER EVALUATION

TABLE B
OFF-SITE POWER CABLE ROUTING

CABLE	D			A				C																	CC1	T-2	TURB	YARD
	1	2	8	16N	16S	21	27	5	6	9	10	11	12	15	16	17	18	21	22	23	24	27	30	33				
14NEK13AA		X									X	X		X		X												
14NEK13AD		X									X	X				X			X			X	X	X				
14NEK13AE		X																										
14NEK13AH		X																										
14NEK13AJ		X									X	X				X			X			X	X	X				
15MRK10AA																											X	
15MRK10AE																											X	
15MRK10AF																										X	X	
15MRM11AA																											X	X
15MRM11AC																											X	X
15MRX01AG																											X	
15MRX01AL																											X	
15MRX01AN																												X
15NBA10AA							X			X			X				X				X				X	X	X	
15NBA10AC																										X	X	X
15NBA10AD										X			X	X			X	X			X				X		X	
15NBB03AA								X		X															X			X
15NBB03AC								X		X															X			X
15NBB03AE								X		X															X			X
15NBB03AH																										X	X	X
15NBB03AJ							X			X			X				X				X				X	X	X	
15NBB03AL																										X	X	X
15NBB06AA								X	X		X														X			X
15NBB06AB								X	X		X														X			X
15NBB06AC								X	X		X														X			X
15PGG01AL																											X	
15PGG01AM																											X	
16MRM11AA																											X	X
16MRX01AG																											X	
16MRX01AH																										X		
16MRX01AJ																											X	X
16MRX01AN																											X	X
16MRX01AP																											X	X
16MRX01AT																												X
16NBA11AA																										X	X	X
16NBA11AB																			X			X			X	X		
16NBA11AC							X				X	X				X				X					X	X		
16NBA11AD																										X		

TABLE B

OFF-SITE POWER CABLE ROUTING

CABLE	D			A				C																	CC1	T-2	TURB	YARD
	1	2	8	16N	16S	21	27	5	6	9	10	11	12	15	16	17	18	21	22	23	24	27	30	33				
16NBB02AA								X	X	X															X			X
16NBB02AB								X	X	X															X			X
16NBB02AC								X	X	X															X			X
16NBB03AB							X				X	X				X				X					X	X		
16NBB05AA								X	X		X														X			X
16NBB05AB								X	X		X														X			X
16NBB05AC								X	X		X														X			X
16NBB05AD							X				X	X				X				X					X	X		
16NBB05AG																											X	X
16NBB05AH																											X	X
16NBB05AJ																											X	X
16NBB05AK																											X	X
16NBB05AL							X			X	X	X				X				X					X	X		
16PAK14AA																										X	X	
16PAK14AB																										X	X	
16PGG04AA																											X	
16PGG04AS																											X	
16PGG04AT																											X	

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APPENDIX 2 LOSS OF OFF-SITE POWER EVALUATION	CALCULATION NO. XX-E-013 REVISION NO. 4 Page 15

TABLE C

Summary of Available Power Sources by Fire Area

FIRE AREA	TRAIN A (NB01)	TRAIN B (NB02)
A-8		DG B
A-16 North	DG A	
A-16 South	DG A	DG B
A-21	DG A	
A-27	DG A	DG B
C-5	DG A	DG B
C-6	DG A	DG B
C-9		DG B
C-10	DG A	
C-11	DG A	
C-12		DG B
C-15	DG A	
C-16		DG B
C-17	DG A	
C-18		DG B
C-21		DG B
C-22	DG A	
C-23	DG A	
C-24		DG B
C-27		DG B (1)
C-30	DG A	
C-33	DG A	
CC-1	DG A	DG B
D-1		DG B
D-2	DG A	
T-2	DG A	DG B
TURB	DG A	DG B
YARD	DG A	DG B

LEGEND:

(hatched box) Off-site power available for the identified train.

(empty box) Post fire safe shutdown off-site power cables exist, therefore off-site power not available for the identified train.

DG A Emergency diesel generator available for the identified train

(1) Emergency diesel generator B is used for alternate shutdown

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

MSIV AND REDUNDANT CABLE ANALYSIS

BACKGROUND:

Post-fire safe shutdown reactivity control and decay heat removal functions require that uncontrolled RCS cooldown be prevented. This is accomplished by isolating/controlling steam flow from the steam generators and controlling feed flow to the steam generators. Feed flow to the steam generators and steam flow via the steam generator atmospheric relief valves are not included in this evaluation, which analyzes steam flow through the main steam lines.

Closing the MSIVs and their associated bypass valves or the components downstream of the MSIVs and bypass valves isolates steam flow through the main steam lines.

ASSUMPTIONS:

- Alternate shutdown capability is provided in the event of a fire in the main control room
- Post-fire safe shutdown components operate as designed, provided they remain free of fire damage

REFERENCES:

1. 10 CFR 50, Appendix R
2. E-11NG01/09
3. E-11NG02/08
4. E-11PK01/05
5. E-11PK02/10
6. E-13AB02A/02
7. E-13AB02B/02
8. E-13AB04/01
9. E-13AB08/02
10. E-13AB11A/01
11. E-13AB11B/02
12. E-13AB11C/02
13. E-13AB12/02
14. E-13AB18/00
15. E-13AB22/00
16. E-13AB23A/02
17. E-13AB23B/01
18. E-13AB26/03
19. E-13AB27/03
20. E-13AB28/05
21. E-13AB29/04
22. E-13AB30/01
23. E-13AB31/01
24. E-13AC07/02
25. WIP-E-1307A-000-A-1
26. WIP-E-13AC15-002-B-1/02
27. WIP-E-13AC16-002-A-1/00
28. E-13FB12/00
29. E-13MR01/03
30. E-13MR10/07

31. E-13PA10/04
32. E-13PA11/02
33. E-13PA12/02
34. E-13PA13/03
35. E-13PA14/05
36. E-13PG01/00
37. E-13PG02/00
38. E-13PG03/01
39. E-13PG04/01
40. E-13PK10/00
41. E-13PK11/00
42. E-13RL07/04
43. E-15000/65
44. E-1F9101/01
45. E-1F9102/02
46. E-1F9103/03
47. KD-7496/30
48. M-12AB02/10
49. M-12AB03/18
50. M-12AC01/21
51. M-12AD01/05
52. M-12FB01/17
53. M-12FC03/11
54. M-12FC04/11
55. OFN RP-017 Control Room Evacuation
56. E-1F9910 - Post Fire Safe Shutdown Area Analysis
57. E-13FC29A/00
58. E-13FC29B/00
59. E-13FC35/00

EVALUATION:

The MSIVs, their bypass valves and associated cables are identified in Table A. The MSIVs and bypass valves are provided redundant (Train A and Train B) cables to ensure valve closure when required. The valves close if either a Train A or Train B close signal is initiated.

- Train A MSIV cables are routed independently of Train B MSIV cables in fire areas A-8, A-13, A-14, A-16, A-21, A-27, C-15, C-16, C-17, C-18, C-21, C-22, C-23, C-24, C-30 and C-33. In the event of fire in these fire areas, steam flow through the main steam lines is isolated by closing the MSIVs and bypass valves using the hand switch identified in Table C.

- Train A MSIV cables are not routed independently of Train B MSIV cables in fire areas A-6, A-15, A-23 and C-27. In the event of a fire in the main control room (fire area C-27), the MSIVs and bypass valves are closed when the alternate shutdown capability is implemented in accordance with OFN RP-017. In the event of a fire in areas A-15 and A-23, main steam valves located downstream of the MSIVs and bypass valves are closed using appropriate hand switches in the main control room. Cables for components downstream of the MSIVs and the MSIV bypass valves are identified in Table B. None of these cables are routed in fire areas A-15 and A-23. Consequently, in the event of fire in fire areas A-15 and A-23, the components downstream of the MSIVs and MSIV bypass valves will be available to isolate steam flow through the main steam lines. In fire area A-6, Train A cables associated with all four MSIVs and bypass valves are installed in cable tray that has been wrapped with a 3-hour qualified fire barrier. Consequently, Train A capability exists to close the MSIVs and bypass valves.

- Fire areas not mentioned above do not contain either Train A or Train B cables associated with the MSIVs and bypass valves. Consequently, a fire in any other area can use either Train A or Train B hand switch to close the MSIVs and bypass valves.

CONCLUSION:

In the event of a fire in any fire area, closing either the MSIVs or components downstream of the MSIVs prevents uncontrolled RCS cooldown from steam flow through the main steam lines. Table C identifies how steam flow through the main steam lines is isolated in the event of fire in fire areas containing MSIV cables or cables for components downstream of the MSIVs. In all other fire areas that do not contain cables for either the MSIVs or components downstream of the MSIVs, the MSIVs are used to isolate steam flow through the main steam lines.

TABLE A - MSIV AND MSIV BYPASS VALVE CABLE ROUTING

CABLE	TRAIN	COMPONENT	FIRE AREA																			NOTES
			A									C										
			6	8	13	14	15	16	21	23	27	15	16	17	18	21	22	23	24	27	30	33	
11ABK23AA	A	ABHY0012A	X	X		X				X													Cable wrapped in fire area A-6
11ABK23AB	A	ABHY0015A	X	X		X				X													Cable wrapped in fire area A-6
11ABK23AC	A	ABHY0018A	X	X		X	X			X													Cable wrapped in fire area A-6
11ABK23AD	A	ABHY0021A	X	X		X	X			X													Cable wrapped in fire area A-6
11ABK23AE	A	ABHY0012A, 15A, 18A, 21A		X											X	X			X	X			
11ABK23AF	A	ABHY0012A, 15A, 18A, 21A		X											X	X			X	X			
11ABK26AB	A	ABHV0011, 14, 17, 20														X				X			
11ABK28AE	A	ABHV0014								X													
11ABK28AH	A	ABHV0014	X	X		X				X					X	X			X	X			Cable wrapped in fire area A-6
11ABK28BE	A	ABHV0020								X													
11ABK28BH	A	ABHV0020	X	X		X	X			X					X	X			X	X			Cable wrapped in fire area A-6
11ABK29AH	A	ABHV0017	X	X		X	X			X					X	X			X	X			Cable wrapped in fire area A-6
11ABK29BH	A	ABHV0011	X	X		X				X					X	X			X	X			Cable wrapped in fire area A-6
11ABK30BB	A	ABHV0011, 14, 17, 20											X		X	X			X	X			125 VDC power to SA075A. Loss of power will fail the MSIVs and bypass valves closed.
14ABK23FA	B	ABHY0012B	X					X	X	X	X							X			X		To prevent MSIV bypass valve closure, cable to cable hot short has to occur in both divisions
14ABK23FB	B	ABHY0015B	X					X	X	X	X							X			X		To prevent MSIV bypass valve closure, cable to cable hot short has to occur in both divisions
14ABK23FC	B	ABHY0018B	X		X		X	X	X	X	X							X			X		To prevent MSIV bypass valve closure, cable to cable hot short has to occur in both divisions
14ABK23FD	B	ABHY0021B	X		X		X	X	X	X	X							X			X		To prevent MSIV bypass valve closure, cable to cable hot short has to occur in both divisions
14ABK23FE	B	ABHY0012A, 15A, 18A, 21A						X			X						X	X		X	X	X	
14ABK23FF	B	ABHY0012A, 15A, 18A, 21A						X			X						X	X		X	X	X	

TABLE A - MSIV AND MSIV BYPASS VALVE CABLE ROUTING

CABLE	TRAIN	COMPONENT	FIRE AREA																				NOTES
			A									C											
			6	8	13	14	15	16	21	23	27	15	16	17	18	21	22	23	24	27	30	33	
14ABK27AB	B	ABHV0011, 14, 17, 20															X			X			
14ABK28AE	B	ABHV0017								X													
14ABK28AH	B	ABHV0017	X		X		X	X	X	X							X			X	X	X	
14ABK28BE	B	ABHV0011								X													
14ABK28BH	B	ABHV0011	X					X	X	X							X			X	X	X	
14ABK29AH	B	ABHV0014	X					X	X	X							X			X	X	X	
14ABK29BH	B	ABHV0020	X		X		X	X	X	X							X			X	X	X	
14ABK30BB	B	ABHV0011, 14, 17, 20										X		X			X	X		X	X	X	125 VDC power to SA075B. Loss of power will fail the MSIVs and bypass valves closed.

APPENDIX 5
MSIV & REDUNDANT CABLE ANALYSIS

TABLE B - CABLE ROUTING FOR COMPONENTS DOWNSTREAM OF MSIVS AND MSIV BYPASS VALVES

CABLE	SYS. (Note)	COMP.	A						C															CC1	TURB	T		NOTES
			8	16	19	21	22	27	9	10	11	15	16	17	18	21	22	23	24	27	30	31	33			1	2	
14ABK08DA	1	ABUY0034B			X		X									X			X	X		X		X		X		
14ABK08DB	1	ABUY0034B														X				X								
14ABK08FA	1	ABUY0041B		X	X	X	X										X			X	X		X	X		X		
14ABK08FB	1	ABUY0041B															X			X								
14ABK08EA	1	ABUY0045B		X	X	X	X										X			X	X		X	X		X		
14ABK08EB	1	ABUY0045B															X			X								
14ABK11AA	1	ABUY0037B		X	X	X	X										X			X	X		X	X		X		
14ABK11AB	1	ABUY0037B															X			X								
14ABK11BA	1	ABUY0038B		X	X	X	X										X			X	X		X	X		X		
14ABK11BB	1	ABUY0038B															X			X								
14ABK11CA	1	ABUY0039B		X	X	X	X										X			X	X		X	X		X		
14ABK11CB	1	ABUY0039B															X			X								
14ABK11DA	1	ABUY0040B		X	X	X	X										X			X	X		X	X		X		
14ABK11DB	1	ABUY0040B															X			X								
14ABK11EA	1	ABUY0036B		X	X	X	X										X			X	X		X	X		X		
14ABK11EB	1	ABUY0036B															X			X								
14ABK11FA	1	ABUY0042B		X	X	X	X										X			X	X		X	X		X		
14ABK11FB	1	ABUY0042B															X			X								
14ABK11GA	1	ABUY0043B		X	X	X	X										X			X	X		X	X		X		
14ABK11GB	1	ABUY0043B															X			X								
14ABK11HA	1	ABUY0044B		X	X	X	X										X			X	X		X	X		X		
14ABK11HB	1	ABUY0044B															X			X								
14ABK11JA	1	ABUY0035B		X	X		X										X			X	X		X	X		X		
14ABK11JB	1	ABUY0035B															X			X								
14ABY31BA	1	ABHS0064															X			X								
14PKK11AA	5	NG0409 RL015/RL016								X	X			X			X	X		X	X		X					FCHIS0118 FCHY0118A
15ABG02AA	2	ABHV0031																									X	
15ABG02AB	2	ABHV0031																									X	
15ABG02AC	2	ABHV0031														X			X	X				X			X	
15ABG02AD	2	ABHV0031																									X	

APPENDIX 5
MSIV & REDUNDANT CABLE ANALYSIS

TABLE B - CABLE ROUTING FOR COMPONENTS DOWNSTREAM OF MSIVS AND MSIV BYPASS VALVES

CABLE	SYS. (Note)	COMP.	A						C															CC1	TURB	T		NOTES
			8	16	19	21	22	27	9	10	11	15	16	17	18	21	22	23	24	27	30	31	33			1	2	
15ABY04AA	3	ABFY002 3/25/27/29 ABHIS002 3														X								X			X	
15ABY04AB	3	ABFY0023 ABHIS0023														X								X			X	
15ABY04AC	3	ABFY0025																									X	
15ABY04AD	3	ABFY0027																									X	
15ABY04AE	3	ABFY0029																									X	
15ABY18BA	3	ABLY0051 ABHIS0051														X				X				X			X	
15ABY18BB	3	ABLSH0051 ABHIS0051														X								X	X			
15ABY18DA	3	ABLY0053 ABHIS0053														X				X				X			X	
15ABY18DB	3	ABLSH0053 ABHIS0053														X								X	X			
15ACK07AB	4	AC119D ACFCV0043 ACFCV0044 ACFCV0045 ACFCV0046																							X		X	125 VDC Power for Turbine Manual Trip Circuit
15ACQ15BA	4	ACHS0002A ACHS0002B ACFCV0043 ACFCV0044 ACFCV0045 ACFCV0046														X				X				X			X	Turbine Manual Trip Pushbuttons
15FCQ29AE	5	FCHS0018A FCHS0018B														X				X				X	X		X	
15FCY08AA	3	FCHV0003 RL023														X				X					X		X	FCHY0003 FCHIS0003
15FCY08AB	3	FCLSH0003 RL023														X				X					X		X	FCHY0003 FCHIS0003
15FCY35AA	5	PN009A FC169A							X				X		X	X			X					X	X		X	

TABLE B - CABLE ROUTING FOR COMPONENTS DOWNSTREAM OF MSIVS AND MSIV BYPASS VALVES

CABLE	SYS. (Note)	COMP.	A						C															CC1	TURB	T		NOTES
			8	16	19	21	22	27	9	10	11	15	16	17	18	21	22	23	24	27	30	31	33			1	2	
15MRK10AB	3	MA104E PK6106						X																X	X		X	ABLY0050 ABLY00 52
15MRK10AC	3	MA104E PK6106						X																X	X		X	ABLY0050 ABLY0052
15PAK14AA	2	PA0102 PK4103																							X		X	ABHV0031 ABHIS0032 ABHIS0051 ABHIS0053 FBHV0081 FBHS0082
15PAK14AB	2	PA0102 PK4103																							X		X	ABHV0031 ABHIS0032 ABHIS0051 ABHIS0053 FBHV0081 FBHS0082
15PGG01AA	2	PA0105 PG1300																							X			ABHV0031 ABHIS0032 FBHV0081 FBHS0082
15PGG01AB	2	PG1300 PG1100																							X			ABHV0031 ABHIS0032 FBHV0081 FBHS0082
15PGG01AD	2	PG1106 PG11JFF1																							X			ABHV0031 ABHIS0032
15PGG01AE	2	PG1106 PG11JFF1																							X			ABHV0031 ABHIS0032
15PGG01AF	7	PG1107 PG11KAF5																							X			FBHV0081 FBHS0082
15PGG01AG	7	PG1107 PG11KAF5																							X			FBHV0081 FBHS0082
15PGG02AA	3	PA0106 PG1500																							X			ABLV0051 ABLV0053 ABFY0023 ABFY0025 ABFY0027 ABFY0029

TABLE B - CABLE ROUTING FOR COMPONENTS DOWNSTREAM OF MSIVS AND MSIV BYPASS VALVES

CABLE	SYS. (Note)	COMP.	A						C															CC1	TURB	T		NOTES
			8	16	19	21	22	27	9	10	11	15	16	17	18	21	22	23	24	27	30	31	33			1	2	
15PGG02AB	3	PG1500 PG1900	X																					X				ABLV0051 ABLV0053 ABFY0023 ABFY0025 ABFY0027 ABFY0029
15PGG02AF	3	PG1907 PG19GAF8	X																									ABLV0051 ABLV0053 ABFY0023 ABFY0025 ABFY0027 ABFY0029
15PGG02AX	3	PG1907 PG19GAF8	X																									ABLV0051 ABLV0053 ABFY0023 ABFY0025 ABFY0027 ABFY0029
15RLY01HA	3	PG19GCR217 RL023/RL024						X								X			X	X								ABFY0023 ABFY0025 ABFY0027 ABFY0029 ABLY0051 ABLY0053 FCHY0003
15RPY10AA	5	PN0712 PN009							X				X															
15RPY10AB	5	PN009 PN009A							X																			
16ABG02BA	2	ABHV0032																									X	
16ABG02BB	2	ABHV0032																									X	
16ABG02BC	2	ABHV0032															X			X				X			X	
16ABG02BD	2	ABHV0032																									X	
16ABG22AA	6	ABHV0046																									X	
16ABG22AB	6	ABHV0046																									X	
16ABG22AC	6	ABHIS0046															X			X				X			X	
16ABY18AA	3	ABSH0050 ABHIS0050															X			X				X				

APPENDIX 5
MSIV & REDUNDANT CABLE ANALYSIS

TABLE B - CABLE ROUTING FOR COMPONENTS DOWNSTREAM OF MSIVS AND MSIV BYPASS VALVES

CABLE	SYS. (Note)	COMP.	A						C															CC1	TURB	T		NOTES
			8	16	19	21	22	27	9	10	11	15	16	17	18	21	22	23	24	27	30	31	33			1	2	
16ABY18AB	3	ABLY0050 ABHIS0050															X							X	X		X	
16ABY18CA	3	ABLY0052 ABHIS0052															X			X				X			X	
16ABY18CB	3	ABSH0052 ABHIS0052															X							X	X		X	
16FBG12BA	7	FBHV0080																									X	
16FBG12BB	7	FBHV0080																									X	
16FBG12BC	7	FBHV0080															X			X				X			X	
16FCQ29AE	6	FCHS0118A FCHS0118B															X			X				X	X		X	
16FCY08CA	3	FCHV0103 RL023															X			X					X		X	FCHY0103 FCHIS0103
16FCY08CB	3	FCLSH0103 RL023															X			X					X		X	FCHY0103 FCHIS0103
16FCY35AA	6	PN010A FC170A						X		X	X			X				X						X	X		X	
16MRK10AA	3	PK6216 MA104D																							X			ABLY0050 ABLY0052
16MRK10AD	3	PK6216 MA104D																							X			ABLY0050 ABLY0052
16PAK14AA	2, 3, 6, 7	PK6204 PA0210																							X		X	ABLV0050 ABLV0052 ABHIS0050 ABHIS0052 ABHV0032 ABHIS0032 ABHV0046 FBHV0080 FBHS0082 ABHIS0046

APPENDIX 5
MSIV & REDUNDANT CABLE ANALYSIS

TABLE B - CABLE ROUTING FOR COMPONENTS DOWNSTREAM OF MSIVS AND MSIV BYPASS VALVES

CABLE	SYS. (Note)	COMP.	A						C															CC1	TURB	T		NOTES
			8	16	19	21	22	27	9	10	11	15	16	17	18	21	22	23	24	27	30	31	33			1	2	
16PAK14AB	2, 3, 6, 7	PK6204 PA0210																							X		X	ABLV0050 ABLV0052 ABHIS0050 ABHIS0052 ABHV0032 ABHIS0032 ABHV0046 FBHV0080 FBHS0082 ABHIS0046
16PGG03AA	2, 6, 7	PA0206 PG1600																							X			ABHIS0032 ABHV0032 ABHV0046 FBHS0082 FBHV0080
16PGG03AB	2, 6, 7	PG1600 PG1200																							X			ABHIS0032 ABHV0032 ABHV0046 FBHS0082 FBHV0080
16PGG03AF	2, 6, 7	PG1207 PG12KAF6																							X			ABHIS0032 ABHV0032 ABHV0046 FBHS0082 FBHV0080
16PGG03AG	2, 6, 7	PG1207 PG12KAF6																							X			ABHIS0032 ABHV0032 ABHV0046 FBHS0082 FBHV0080
16PGG04AA	3	PA0207 PG1400																							X			ABLY0050 ABLY0052
16PGG04AB	3	PG1400 PG2400						X																X				ABLY0050 ABLY0052
16PGG04AC	3	PG2400 PG2000						X																				ABLY0050 ABLY0052
16PGG04AQ	3	PG2008 PG20GAF1		X				X																				ABLY0050 ABLY0052

APPENDIX 5
MSIV & REDUNDANT CABLE ANALYSIS

TABLE B - CABLE ROUTING FOR COMPONENTS DOWNSTREAM OF MSIVS AND MSIV BYPASS VALVES

CABLE	SYS. (Note)	COMP.	A						C															CC1	TURB	T		NOTES
			8	16	19	21	22	27	9	10	11	15	16	17	18	21	22	23	24	27	30	31	33			1	2	
16PGG04AR	3	PG2008 PG20GAF1		X				X																				ABLY0050 ABLY0052
16PKK02AL	5, 7	PK0206 PK6200																							X			ABLV0050 ABLV0052 ABHIS0050 ABHIS0052 ABHV0032 ABHIS0032 ABHV0046 FBHV0080 FBHS0082 ABHIS0046
16PKK02AW	5, 7	PK0206 PK6200																							X			ABLV0050 ABLV0052 ABHIS0050 ABHIS0052 ABHV0032 ABHIS0032 ABHV0046 FBHV0080 FBHS0082 ABHIS0046
16RLY01GA	3	PG20GBR217 RL023						X									X	X		X	X		X					ABLY0050 ABLY0052 FCHY0103
16RPY10AA	6	PN0806 PN010								X	X	X		X														
16RPY10AB	6	PN010 PN010A								X																		
15FBG12AA	7	FBHV0081																							X		X	
15FBG12AB	7	FBHV0081																							X		X	
15FBG12AC	7	FBHV0081														X				X				X	X		X	
16FCK09BB	5	FC168 FCHIS0118															X			X				X	X		X	

Notes:

1. Cooldown Condenser Dump Valve
2. Moisture Separator Reheater
3. Steam Trap Bypass Valve
4. Main Stop Valve
5. Main Feedwater Pump
6. Main Steam Seals
7. Auxiliary Steam Reboiler

MAIN STEAM LINE STEAM FLOW ISOLATION

TABLE C - MAIN STEAM LINE STEAM FLOW ISOLATION			
FIRE AREA	Components used for Main Steam Line Flow Isolation		
	MSIV and BYPASS VALVES		DOWNSTREAM COMPONENTS
	ABHS0079 (Train B)	ABHS0080 (Train A)	
A-6		X	
A-8	X		
A-13		X	
A-14	X		
A-15			X
A-16		X	
A-19 (See Note)	X	X	
A-21		X	
A-22 (See Note)	X	X	
A-23			X
A-27		X	
C-9 (See Note)	X	X	
C-15		X	
C-16	X		
C-17		X	
C-18	X		
C-21	X		
C-22		X	
C-23		X	
C-24	X		
C-27 (See Note)	X	X	
C-30		X	
C-31 (See Note)	X	X	
C-33		X	
CC-1 (See Note)	X	X	
T-1 (See Note)	X	X	
T-2 (See Note)	X	X	
TURB (See Note)	X	X	

Note: Either hand switch ABHS0079 or ABHS0080 can be used in the event of a fire in this area.

POST FIRE SAFE SHUTDOWN
SOURCE RANGE NEUTRON MONITORING CAPABILITY

Purpose

During the WCNOC Post Fire Safe Shutdown (PFSSD) Revalidation Project, a preliminary determination was made that all source range indication would be lost in the event of fire in fire areas RB-1 or A-16. This evaluation was performed to verify that cold shutdown reactivity control could be monitored following a fire in the control room, the reactor building or auxiliary building fire area A-16.

Discussion

10 CFR 50 Appendix R specifies that “One train of equipment necessary to achieve hot shutdown from either the control room or emergency control station(s) must be free of fire damage by a single fire, including an exposure fire.”

Appendix R specifies, “The reactivity control function shall be capable of achieving and maintaining cold shutdown reactivity conditions.”

There are four source range flux monitor circuits available to provide indication of cold shutdown reactivity conditions:

1. Source Range Channel N31 (SENE0031) (Separation Group 1)
2. Source Range Channel N32 (SENE0032) (Separation Group 2)
3. Post-Accident Source Range (Gamma-Metrics) Channel SENY0060A & B (Separation Group 1)
4. Post-Accident Source Range (Gamma-Metrics) Channel SENY0061A & B (Separation Group 4)

NRC Information Notice 84-09 included source range flux monitors on the list of the minimum monitoring capability the NRC staff considers necessary to achieve post fire safe shutdown. In NRC Generic Letter 86-10, the NRC reiterated that IN 84-09 provides the listing of instrumentation acceptable to and preferred by the staff to demonstrate compliance with the process monitoring function. Generic Letter 86-10 also addresses the acceptability of boron concentration indication as an alternative to source range monitors.

Although NRC IN 84-09 specifies that a source range monitor (SRM) is only necessary for alternative shutdown, safe shutdown capability using redundant trains must be demonstrated for fires in all areas of the plant. Consequently, it is appropriate to provide source range monitor capability for all fire areas.

This evaluation addresses the source range monitors and post-accident source range (Gamma-Metrics) nuclear instruments identified above.

Control Room

The control room is provided alternative shutdown capability. Source range monitoring capability (via SENI0061X) at the alternative shutdown panel (ASP) is available in the event that the control room must be evacuated in response to a control room fire. Because SENI0061X can be isolated from the control room it will be free of control room fire damage.

Reactor Building

The following discussion demonstrates that at least one source range instrument will be available to confirm cold shutdown reactivity conditions following a fire in the reactor building.

SENE0031 or SENE0032 have greater than twenty feet of horizontal separation free of intervening combustibles in fire area RB-1. Although detection and automatic suppression are not installed in fire area RB-1, the only significant fire loading in fire area RB-1 is the lubrication oil for the reactor coolant pumps (RCPs) and leaks of this oil are captured by the RCP oil collection system. A hot gas layer is unlikely to form in fire area RB-1 that can damage cables in conduit (the source range instrument cables are routed in conduit in fire area RB-1). Additionally, transient combustibles and ignition sources are controlled in fire area RB-1. (Generic Letter 86-10 Question 3.6.1 provides justification for accepting the Wolf Creek configuration.)

Given the above justification and as tabulated below, either SENE0031 or SENE0032 will be available to verify that the reactor is shutdown following a fire in fire area RB-1.

FIRE LOCATION	SURVIVING SOURCE RANGE INSTRUMENT
Vicinity of Loops 1 & 4	SENE0031
Vicinity of Loop 1	SENE0031
Vicinity of Loops 1 & 2	SENE0032
Vicinity of Loop 2	SENE0032
Vicinity of Loops 2 & 3	SENE0032
Vicinity of Loop 3	SENE0032
Vicinity of Loops 3 & 4	SENE0032
Vicinity Loop 4	SENE0031

Elev. 2000’

SENE0031 circuits exit fire area RB-1 through the north “secondary shield wall” at el. 2019’-0” to junction box 1JJ003 in fire area RB-2. They continue to junction box 1JJ004 at el. 2023’-5”. They exit 1JJ004 via conduit 1J2005 to junction box 1JJ005. They exit 1JJ005 via conduit 1J2006 to containment penetration ZNI295 in fire area RB-3 (el. 2026’-0”), which is protected by manually initiated suppression operated locally (from the south piping penetration room) or remotely (from the control room).

The only combustibles and propagation path(s) in fire area RB-2 is cable tray 1U2A which traverses fire area RB-2 from azimuth 333 degrees to about 245 degrees at el. 2010’-4”. SENE0031 circuits, in conduit 1J2005 (el. 2023’-5”), cross 13’ above the tray at azimuth 325 degree. A fire stop (9” to 12” silicone foam) is installed in tray 1U2A44 approximately 16’ from the point of crossing. Additionally, tray 1U2A sections 43, 44, 45 and 46, located below the conduit containing SENE0031 circuits, are provided with solid metal covers.

The redundant SRM, SENE0032, circuits enter fire area RB-2 through the southwest portion of the secondary shield wall at azimuth 242 degrees into junction box 2JJ004 at el. 2018’-6”. They exit 2JJ004 via conduit 2J2005 (el. 2023’-7”) crossing above tray 4U2A37 (el. 2013’-0”) to junction box 2JJ005 (el. 2023’-7”). A fire stop (9” to 12” silicone foam) is installed in the south end of tray 4U2A37. A fire stop is also installed in tray 4U2A41. Because conduit 2J005 passes between the two fire stops, the fire stops provide reasonable assurance that a fire will not propagate through fire area RB-2 and impact both SRMs. Conduit 2J2006 traverses up from junction box 2JJ005 to penetration ZSI258 in fire area RB-4, which is protected by manually initiated suppression operated locally (from the south piping penetration room) or remotely (from the control room).

Elev. 2026'

The reactor building at el. 2026'-0" consists of fire areas RB-3, RB-7 and RB-4. The circuits for SRM SENI0031 traverse in conduit through fire area RB-3 to containment penetration ZNI295. The redundant SRM, SENI0032, circuits are routed in conduit through fire area RB-4 to penetration ZSI258. The penetrations are protected by manually initiated suppression operated locally (from the south piping penetration room) or remotely (from the control room).

Cable tray 5U2A exits fire area RB-1 and traverses fire areas RB-4 and RB-7 to RB-3. This tray provides a potential fire propagation path between redundant SRM circuits. The tray enters fire area RB-4 at el. 2026'-4" rising to el. 2033'-0". It is provided with a fire stop (9" to 12" silicone foam) and a solid metal cover at about azimuth 236 degrees.

The tray exits fire area RB-4 into fire area RB-7 at el. 2033'-0" where it continues along the inner circumference of the reactor building's outer wall to fire area RB-3. Upon entry into fire area RB-3, a fire stop (9" to 12" silicone foam) is installed and protected by manually initiated suppression operated locally (from the south piping penetration room) or remotely (from the control room). Tray 5U2A ends at about azimuth 321 degrees, approximately 12' from penetration ZNI295 that contains the SRM SENI0031 circuits.

Based on evaluation of the design and installation configuration it is concluded that a fire in fire areas RB-2, RB-3, RB-4 or RB-7 will not propagate to the redundant SRM circuits due to separation, manual suppression, low combustible load and fire stop installation. (NOTE: The fire stops installed at WCNOC are a 9" to 12" depth of fire resistant silicone foam such as Dow Corning 3-6548 Silicone RTV Foam with a weight of 14 to 20 pounds per cubic foot). Therefore, the ability to achieve and maintain post fire safe shutdown conditions in these areas will be maintained.

Auxiliary Building Fire Area A-16

Fire area A-16 is comprised of rooms 1401, 1402, 1406 and 1408. Circuits for source range nuclear instruments SENE0031, SENE0032 and SENY0060 are routed in this area. The circuit routings were reviewed and the results are tabulated below: (YES means circuits for the component are routed in the room and NO means circuits for the component are not routed in the room)

COMPONENT	ROOM 1401	ROOM 1402	ROOM 1406	ROOM 1408
SENE0032	NO	NO	YES	YES
SENE0031	NO	NO	YES	YES
SENY0060A	NO	NO	YES	YES
SENY0061A	NO	NO	NO	NO

In the event of fire in fire area A-16 all source range monitoring instruments except SENY0061A will be lost. Because SENY0061A is independent of fire area A-16, SENY0061A will be available to verify cold shutdown reactivity conditions if a fire occurs in fire area A-16.

An indication circuit for SENY0061A at the ASP is routed through fire area A-16. The SENY0061A circuit to the ASP is isolated from the control room indication circuit. Consequently, if the SENY0061A to the ASP circuit is lost due to a fire in fire area A-16, SENY0061A control room indication will still be available.

Conclusion

1. In the event of a control room fire requiring control room evacuation, cold shutdown reactivity conditions are verified using the source range indication installed on the auxiliary shutdown panel.

2. In the event of a fire in fire area RB-1, cold shutdown reactivity conditions are verified using either SENE0031 or SENE0032.

3. In the event of a fire in fire area A-16, cold shutdown reactivity conditions are verified using SENY0061A.

APPENDIX 6
SOURCE RANGE MONITOR EVALUATION

TABLE 1 - CABLE ROUTING FOR SOURCE RANGE MONITORS

Cable ID	Associated Component	A									C														R				
		8	16	17	18	19	20	21	27	28	15	16	17	18	20	21	22	23	24	25	27	30	32	33	1	2	3	4	11
11SES01AA	SENE0031											X		X		X			X		X								
11SES01B4	SENE0031																								X				X
11SES01BB	SENE0031		X		X				X							X					X								
11SES01BC	SENE0031		X		X				X							X					X								
11SES01BG	SENE0031				X																								
11SES01BK	SENE0031																								X	X	X		
11SES07AA	SENY0060A/B																								X	X			X
11SES07AB	SENY0060A/B																								X	X	X		
11SES07AC	SENY0060A/B		X		X				X																				
11SES07AD	SENY0060A/B								X																				
11SES07AE	SENY0060A/B								X																				
11SES07BA	SENY0060A/B	X							X			X		X															
11SES07BB	SENY0060A/B	X							X					X		X			X		X								
11SES07CA	SENY0060A/B	X							X			X		X															
12SES02AA	SENE0032										X				X					X	X		X						
12SES02B4	SENE0032																								X				X
12SES02BB	SENE0032		X	X					X											X	X								
12SES02BC	SENE0032		X	X					X											X	X								
12SES02BG	SENE0032			X																									
12SES02BK	SENE0032																								X	X		X	
14SES07AA	SENY0061A/B																								X				X
14SES07AB	SENY0061A/B																								X	X		X	
14SES07AC	SENY0061A/B			X		X	X	X																					
14SES07AD	SENY0061A/B							X																					

APPENDIX 6
SOURCE RANGE MONITOR EVALUATION

TABLE 1 - CABLE ROUTING FOR SOURCE RANGE MONITORS

Cable ID	Associated Component	A									C														R				
		8	16	17	18	19	20	21	27	28	15	16	17	18	20	21	22	23	24	25	27	30	32	33	1	2	3	4	11
14SES07AE	SENY0061A/B							X																					
14SES07BA	SENY0061A/B							X			X		X					X				X							
14SES07BB	SENY0061A/B	X	X					X		X																			
14SES07BC	SENY0061A/B							X									X				X	X		X					
14SES07CA	SENY0061A/B							X			X		X					X				X							

DEFINITIONS

(Source: USAR, 10CFR50 Appendix R, NEI 00-01, and/or design drawings & procedures reference throughout XX-E-013)

Design Basis Fire: A design basis fire for the entire plant is not defined. A design basis fire for each fire area is defined for the individual fire area based on the post fire safe shutdown (PFSSD) components and PFSSD cables contained in the individual fire area.

Alternative Fire Area: A fire area, which does not comply with the specific separation criteria contained in 10 CFR 50 Appendix R, Section III.G.2 and lacks approved deviations needed to demonstrate an acceptable level of compliance. The requirements of Section III.L, therefore, are not limited to only those areas, which require control room evacuation. Any area provided an alternative method of achieving a particular post fire safe shutdown performance goal (because redundant components located within the area may be lost in a fire) is considered an alternative shutdown fire area.

Alternative Shutdown: The method of accomplishing a post fire safe shutdown function when separation criterion of 10 CFR 50 Appendix R, III.G.2 cannot be met: e.g. redundant cables are not separated by a 3-hour fire barrier; redundant cables are not enclosed in a 1-hour fire barrier and the area has fire detection and suppression; or redundant cables are not separated by 20 feet with no intervening combustibles and the area has fire detection and suppression. Alternative shutdown is governed by 10 CFR 50 Appendix R, Sections III.G.3 and III.L and generally involves one or both of the following conditions:

- Key shutdown activities are controlled/conducted outside of the control room (i.e., from the Alternate Shutdown Panels), or
- Plant systems are utilized in a manner that is diverse from their intended design function.

Alternative Shutdown Panel (ASP): The ASP (RP118B) serves as the command center for alternative shutdown in the event of control room evacuation due to fire. The ASP provides indication and control used to achieve PFSSD.

Associated Circuit: Circuits in a fire area that may be damaged by fire and ultimately compromise post fire safe shutdown capability. Associated circuits are those cables [safety related (class 1E) and non-safety related (non-class 1E)] that have a physical separation from the location of a postulated fire less than that required by 10 CFR 50 Appendix R, Section III.G.2 (3-hour fire rated barrier, separation of cables and equipment and associated non-safety circuits of redundant trains by a horizontal distance of more than 20' with no intervening combustible or fire hazards plus area fire detection and automatic fire suppression system; or enclosure of cable and equipment and associated non-safety circuits of one redundant train in a fire barrier having a 1 hour rating plus area fire detection and suppression) and have either:

- A SSD component having a circuit that has common power supply with redundant or alternative shutdown equipment and their power supplies are not electrically protected from the associated circuit of concern (common bus / common power supply:);
- A connection to circuits whose spurious operation would adversely affect the safe shutdown capability (spurious signal); or
- A common enclosure (raceway, conduit, panel, junction box, cable) with the redundant or alternative shutdown cables (common enclosure).

Cold Shutdown: The plant condition in which the reactor is at zero percent power, K_{eff} is less than 0.99, and the average reactor coolant temperature is less than 200°F.

Cold Shutdown Equipment: Equipment used during the transition from hot standby to cold shutdown conditions and to maintain the plant in a cold shutdown condition.

Cold Shutdown Repair: Repair of equipment required to commence cold shutdown within 72 hours using onsite capability. Cold shutdown repairs may include fuse replacement, cable splicing and replacement, lifting cable leads, component and equipment replacement, etc.

8-Hour Emergency Lighting: Emergency lighting units having at least an 8-hour battery power supply and are required for operating post fire safe shutdown equipment and in providing lighting for access and egress routes to the equipment.

Exposure Fire: Fire in a given area that involves either in situ or transient combustibles and is external to any structures, systems, or components located in or adjacent to that same area. Thus, a fire involving one train of post fire safe shutdown equipment may constitute an exposure fire for the redundant train located in the same area, and a fire involving combustibles other than either safe shutdown train may constitute an exposure fire to both post fire safe shutdown trains located in the same area.

Fire Area: Designated area consisting of rooms, general areas, or buildings established for the purpose of fire hazards analysis. The fire area is generally enclosed by barriers constructed of known fire resistive materials.

Suppression Effects: Where redundant trains of systems required for hot standby located in the same fire area may be subject to damage from fire suppression activities or from the rupture or inadvertent operation of fire suppression systems.

Fire Hazard Analysis (FHA): Fire area analyses including the fire hazards and the fire protection features within the fire areas.

PFSSD: Condition achieved after a fire occurs in the plant that will prevent the reactor from inadvertently returning to power and will prevent the release of unacceptable levels of radioactive materials.

High Impedance Fault: Circuit fault having a current magnitude just below the trip setpoint for the circuit protective device.

High/Low Pressure Interface Components: Components (valves) that isolate the reactor coolant system (RCS) from low-pressure systems.

Hot Standby Repair: Hot standby repairs include actions OTHER than manual actions to manipulate components or equipment. Actions characterized as hot standby repairs include:

- Fuse Pulling: Manually removing fuses from a circuit with a fuse puller (tool). (NOTE: Removing a fuse using a fusible switch [fuse block handle] is NOT a hot standby repair).
- Fuse Replacement: Installing a fuse removed by fuse pulling or replacing a fuse damaged by fire.
- Lifting Leads: Disconnecting conductors from terminals. Lifting leads typically requires a use of a tool such as a wrench or screwdriver.
- Cable Cutting: Mechanically opening a cable by cutting (using a cable cutter).
- Cable Splicing: Joining cable together by a mechanical connection.

- Component Replacement: Replacing a defective component.

For plants that do not meet 10 CFR 50 Appendix R, III.G.2 separation requirements, requires that the capability be available to achieve hot standby using alternative or dedicated systems with no repairs required.

Hot Standby: The plant condition in which the reactor is at zero percent power, K_{eff} is less than 0.99, and the average reactor coolant temperature is greater than or equal to 350°F.

Hot Standby (Shutdown) Equipment: That equipment employed to achieve and maintain hot standby conditions.

Local Control: Control activities at control stations outside the control room.

Manual Action/Manual Operation: Physical manipulation (human powered) or visual observation of a component (i.e., an action or operation that requires no power source, support components, or electrical circuits/cables), including specific control room actions to overcome fire-induced failures.

Switch Positioning: Placing a control switch in the ON, OFF, START, STOP, OPEN, CLOSE, etc. position.

Circuit Breaker Operation: Opening or closing a circuit breaker. Racking a circuit breaker in or out. Charging a circuit breaker operating spring.

Fusible Switch Operation: Opening a circuit by withdrawing a fusible switch (fuse block) from a circuit. Fusible switch operation is typically associated with removing control power. Fusible switch operation (pulling) is performed by pulling on an installed handle (a tool [fuse puller] is not required) to remove a fuse block.

Valve Positioning: Manipulating manual valve operators to change valve position.

Multiple High Impedance Faults (MHIFs): Two or more high impedance faults occurring simultaneously, such that the sum of the high impedance fault currents will exceed the trip set point for the main supply breaker supplying the high impedance fault circuits.

Multiple Spurious Operations: Spurious operations caused by spurious signals occurring at different times.

Performance Goals: A set of functional criteria which ensure that the plant will achieve hot standby condition, and subsequently be cooled to and maintained in cold shutdown condition. Performance goals for post fire safe shutdown functions include:

- Reactivity Control Function: The reactivity control function shall be capable of achieving and maintaining cold shutdown reactivity conditions.
- Reactor Makeup Function: The reactor makeup function shall be capable of maintaining the reactor coolant level within the level indication in the pressurizer.
- Decay Heat Removal Function: The decay heat removal function shall be capable of achieving and maintaining decay heat removal.
- Process Monitoring Function: The process monitoring function shall be capable of providing direct readings of the process variables necessary to perform and control the above functions, and are included with the above functions.
- Support Function: The supporting functions shall be capable of providing the process cooling, lubrication, etc., necessary to permit the operation of the equipment used for post fire safe shutdown functions.

Post-Fire: The time following discovery of a fire. It includes response time, mitigating activities, and plant recovery.

Safe Shutdown: The ability to take the plant from full power to "hot standby" then to cold shutdown conditions.

Safe Shutdown Analysis (SSA): Provides a written analysis for the impact of a fire in any area of the plant on the performance of necessary post fire safe shutdown functions.

Safe Shutdown Equipment: Equipment required for achieving and maintaining hot standby and / or cold shutdown conditions.

Safe Shutdown System: A plant system or a portion thereof that is used to achieve and maintain Post Fire Safe Shutdown performance goals.

Separation: Where cables or equipment of redundant trains of systems necessary to achieve and maintain hot standby conditions are located within the same fire area, an acceptable level of protection for one of the redundant trains of equipment may be achieved by one of the following means of separation:

- 3-Hour Fire Barrier: A fire barrier having a 3-hour rating provides separation of redundant cables and equipment and associated non-safety circuits.

- Horizontal Separation: A horizontal distance of 20 feet with no intervening combustibles provides separation of redundant cables, equipment and associated non-safety circuits. Additionally, fire detectors and an automatic fire suppression system must be installed in the area.

- 1-Hour Fire Barrier: Separation of redundant cables and equipment and associated non-safety circuits is achieved by enclosure in a fire barrier having a 1-hour rating. Additionally, fire detectors and an automatic fire suppression system must be installed in the area.

Simultaneous Spurious Operations: Any and all spurious operations taken one at a time. Simultaneous spurious operations include the following representative examples:

- Series Components:

  If cables for valves installed in series are subject to fire damage, the effects of the fire damage must be determined for each valve individually (one at a time).

  If at least one of the valves installed in series does not spuriously operate to an unacceptable position, then protection for simultaneous spurious operation is demonstrated.

  If all of the valves installed in series spuriously operate to an unacceptable position, then action must be taken (reposition at least one of the valves) to mitigate the unacceptable simultaneous spurious operation.

  Because the simultaneous spurious operations occur one at a time, the time limit to mitigate simultaneous spurious operations must be evaluated on a case by case basis.

- Parallel Components:

  If cables for valves installed in parallel are subject to fire damage, the effects of fire damage must be determined for each valve individually (one at a time).

If at least one of the valves does not remain open when at least one of the valves must remain open, then action must be taken (reposition at least one of the valves) to mitigate the unacceptable simultaneous spurious operation.

Because the simultaneous spurious operations occur one at a time, the time limit to mitigate simultaneous spurious operations must be evaluated on a case by case basis.

Spurious Operation: The undesired operation of plant equipment, which adversely affects post fire safe shutdown capability. Spurious operations are caused by fire initiated circuit failures. Fire-induced cable damage may cause either one or a combination of the following possible cable failure modes:

- Short Circuit: An individual conductor within a cable comes in electrical contact with another conductor, cable, circuit, etc.
- Short To Ground: An individual conductor comes in electrical contact with a grounded conducting device such as a cable tray, conduit, grounded conductor, grounded equipment, etc.
- Hot Shorts: An energized conductor within a cable comes in electrical contact with de-energized conductor(s) located within the same cable or in another cable.
- Open Circuit: An individual conductor within a cable loses electrical continuity.

Timeline: Graphic or verbal description of time limit(s) for completing required PFSSD actions.

Unrecoverable Condition: A point in the sequence of an event where no reasonable action is available to recover plant conditions consistent with defined performance goals.

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DOCUMENT TITLE: Post-Fire Safe Shutdown (PFSSD) Analysis

ORIGINATOR: Bill Wilkins

DESIGN VERIFIED:	SAFETY CLASSIFICATION:	VERIFICATION METHOD:
☐ PRELIMINARY	☐ SAFETY-RELATED	☒ DESIGN REVIEW
☐ FINAL	☒ SPECIAL SCOPE	☐ ALTERNATE CALCULATION
☐ REVISION	☐ NON-SAFETY RELATED	☐ TESTING

☒ **INDIVIDUAL VERIFICATION** **SIGNATURE:** Brian Masters/ Brian Masters **DATE:** 10/22/15

Print / Sign

QUALIFICATION REQUIRED: ES9280465 OR ES9280479

☐ **TEAM VERIFICATION**

Scope Verified:	SIGNATURE:	DATE:

TEAM LEADER SIGNATURE: **DATE:**

QUALIFICATION REQUIRED
ES9280465 OR ES9280479

PRINT / SIGN

*** Team leader signature certifies that adequate interfaces and overlaps have occurred.**

OVERVIEW (PURPOSE AND SCOPE):
The purpose is to verify changes made by Post-Fire Safe Shutdown (PFSSD) Analysis calculation XX-E-012 R/4. This analysis ensures the capability to achieve and maintain safe shutdown following a fire for any plant fire area. Revision 4 includes the following:

1. Incorporation of CCNs XX-E-013-003-CN002, XX-E-013-003-CN003, XX-E-013-003-CN004, XX-E-013-003-CN006, & XX-E-013-003-CN008.
2. Changes in support of and/or allow by License Amendment 214 (Reference Correspondence 15-00793, ET 13-0035):
   - 3-A-4 revised to take credit for automatic feedwater isolation signal (FWIS).
   - 3-B-3 revised to remove SNUPPS Letter SLNRC 84-0109 and add E-1F9915 as a licensing basis document.
   - Section 5 References revised add E-1F9915 and clarify SLNRC 84-0109 is superseded by E-1F9915.

CRUCIAL AREAS:

1. Verify contents of CCNs XX-E-013-003-CN002, XX-E-013-003-CN003, XX-E-013-003-CN004, XX-E-013-003-CN006, & XX-E-013-003-CN008 are accurately incorporated as identified in the CNNs in this revision.
2. Verify changes in support of and/or allowed by License Amendment 214 (Reference Correspondence 15-00793, ET 13-0035) have been accurately incorporated.
3. Review all changes for consistency with NRC regulations and information.
4. Assure consistency with PFSSD analysis methodology.
5. Impact on margins.
6. Compliance with applicable procedures.

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ALTERNATE OR INDEPENDENT ITEMS USED FOR VERIFICATION:

1. None

COMMENTS:	ORIGINATOR'S RESPONSE:
1. Procedure AP 05D-001 step 6.9.6.2 states: "The source of each attachment shall be indicated on the first page of the attachment. Attachment 1, 2 & 3 do not clearly identify the source of the attachments.	Corrected. Attachment 1 revised to note definitions are a compilation of terminology from review of USAR, 10 CFR 50 Appendix R, NEI 00-01and various design drawings procedures referenced throughout XX-E-013.
2. Based on the AP 05D-001 step 6.9.5 (Appendices) and step 6.9.6 (Attachments) Attachment 2 and 3 of this calculation say they are analysis and as such per the procedure these attachments should be an Appendix not an Attachment or included in the body of the calculation. Based on changes the Appendix 5 and 6 are verified to be acceptable with no changes required. The reference to these attachment in the calculation Appendix 1 has been verified to be changed to Appendix 5 & 6.	Corrected. Attachments 2 & 3 now referred to as Appendices 5 & 6, respectively
3. Step 6.11.2.2.b of AP 05D-001 requires any committed CCNs to be superseded by new commited CCN(s) issued against this new revision. In Curator CCN XX-E-013-CN005 and CCN XX-E-013-CN007 are identified as committed and as such need to be superseded with a new CCN created to this revision 4 calculation.	Commited CCNs are created against new XX-E-013 Revision 4.
4. Section 3-B-3 revision to add E-1F9915 as a Licensing Bases document to replace SNUPPS Letter SLNRC 84-0109 did not correctly identify the title of the document. The last part of the title ", Control Room Evacuation" was left off. Also the change includes in paratheses the following: "(Listed in USAR Appendix 9.5B per License Amendment 214.)". None of the other documents state this and the USAR Appendix 9.5B is already a reference, plus the reference to the License Amendment 214 is already made as a part of section 3-A-4 where it is applicable based on this it is recommended that the part in paratheses be deleted.	Corrected
5. Reference 7 added did not include ",Control Room Evacuation" and it needs to be added.	Corrected
6. On reference 16 since the reference has been superseded by E-1F9915 need to just show this reference as being deleted. Another option would be to change change reference 16 to what is identified as being added as reference 7.	Corrected
7. Recommend that instead of referencing the TMO 10-004-NE as identified by CCN-XX-E-013-003 that DCP 013095 be referenced or as a minimum put the DCP in parentheses after the TMO as the DCP per the CCN subject put the TMO in permanently and is not listed anywhere in R/4.	Corrected

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8. Validated that changes identified on CCN-XX-E-013-003-CN002 were done as identified on the CNN but in several cases as a result of other changes the page numbers have changed, which is acceptable: • change to delete NEII0006 from the table on page 58 was done but the table is now on page 62. • change to delete 14NEK13AF from Appendix 1 table A on page 6 was done but the changes are now on page 7. • Change to delete 14NEK13AF from Appendix 2 table B now on page 4. • Change to delete NEII0006 from the Appendix 3 list is validated as being done.	No issues.
9. Validated that changes identified on CCN-XX-E-013-003-CN003 were done as identified on the CNN but in some cases as a result of other changes the page numbers have changed, which is acceptable: • Wording changes to Appendix 1 “Instrument AC Power System – 120VAC” section made on page 66. • Appendix 3 component list updated to add NG01ACR3, NG02AFF3, NG01AGF3, NG01AGF4, NG02ABR1, NG02AFF1, NK0103, NK0203, NK0303, NK0403, NK79, NK80, NN15 and NN16 as well as to remove XNN05, XNN06, NN0102, NN0202, NN0302 and NN0402.	No issues.
10. Validated that changes identified on CCN-XX-E-013-003-CN004 were done as identified on the CNN but in some cases as a result of other changes the page numbers have changed, which is acceptable: a) Wording changes to Appendix 1 “Essential Service Water Pump Room” section page 56 have been made as identified in the CCN. b) Wording change to Appendix 1 “Diesel Generator Room” section pages 58 & 59 have been made as identified in the CCN. c) Appendix 3 and the component list on the cover sheet have been updated to include the following components on the list with applicable changes that are bolded on the CCN: GDTE0011, GDTSL0011, GDTZ0001B, GDTZ0011A, GDTZ0011B, DCGM01A, DCGM01B, GMHIS0001A, GMHIS0011A & GMHS0011B. d) Appendix 3 identifies that GDHS0011A is to be deleted and it is on Appendix 3 but the component was not deleted from the cover sheet list of components, which is correct? e) Components NG03DBF6 and NG04DBF6 are shown as being added but they have not been included in the list of components on the cover sheet like they should be. f) The following components were identified on the component list and shown in the CCN to be added to Appendix 3 and they were but they were not added in the “GM” section of the list and should be moved to make it easier to find them in Appendix 3: GMTE0001, GMTE0011, GMTSL0001, GMTSL0011, GMTZ0001A, GMTZ0001B, GMTZ0011A, GMTZ0011B	a), b), c) no issues. d) Corrected. GDHS0011A removed from cover sheet listing consistent with CCN-XX-E-013-003-CN004 change description and Appendix 3 markup. e) Consistent with other component listings, MCCs are listed in the cover sheet but individual cubicles are not. NG003D and NG004D are already identified in the component listing. f) GM components are added to Appendix 3 in the “GM” section. Spreadsheet was sorting for rev 4 changes only for convenience to the verifier. Removing the sort shows the GM components in the proper location.

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11. Validated that changes identified on CCN-XX-E-013-003-CN006 were done as identified on the CNN but in some cases as a result of other changes the page numbers have changed, which is acceptable: a) Wording change to Appendix 1 "Alternate Boration Path" section page 11 changed to show the different breaker number. b) Confirmed new paragraph to Appendix 1 "Lower Medium voltage System – 4.16KV and Higher Medium Voltage System – 13.8KV" section on page 64 has been added to provide the additional justification identified by the CCN. c) Confirmed changes to Appendix 2 "Results" section page 2 were changed as identified on the CCN. d) Appendix 2 Table A was confirmed to add cable 14JEG01BD and delete cables 15NBG16AA, 15NBG16AB, 16NBG16AA and 16NBG16AB. e) Appendix 2 Table B was confirmed to add cable 14JEG01BD and delete cables 15NBG16AA, 15NBG16AB, 16NBG16AA and 16NBG16AB as well as mark 14NBB14AD with an "X" in the 16S column. f) The changes identified to Appendix 2 Table C were made as identified but it was not clear if the "A-16 North fire area Train B (NB02) needed to be shaded or not also need to validate that is how A-21 fire area on the table is supposed to be? g) Confirmed that Appendix 3 "Component List" was updated as identified in the CCN to delete the following components: PG12KAF1, PG12KCF2, PG13, PG1301, PG1302, PG13Q, PG13QAF1, PG13QAR5, PG13QFR3 and XPG13. Change NG02ACR123 to NG02ACR115. h) Confirmed the changes to components on Appendix 3 "Component List" were updated as identified by the CCN for components: BBPCV0455A, B & C, BBPCV0456A, BBPY0455BA & CA, NG03DEF1, NG03DEF110, NG03DEF111, NG03DEF1, NG04DEF111 and NG04DEF112.	a), b), c), d), e) No issues f) Appendix 2,Table C is revised consistent with the results summary changes (fourth bulleted item) identified on CCN page 2. A-16 North Train B (NB02) is required to be shaded and is shaded on the CCN. A-21 is required to be and is shaded exactly the same as A-16 North. g), h) No issues
12. Validated that changes identified on CCN-XX-E-013-003-CN008 were done as identified on the CNN but in some cases as a result of other changes the page numbers have changed, which is acceptable: • The wording updates to Appendix 1 for the "Service Water System Isolation" page 36, "Essential Service Water" page 47 and "Component Cooling Water" page 51 sections have been properly updated as indentified in this CCN. • Confirmed the changes to components on Appendix 3 "Component List" were updated as identified by the CCN for components: AEV0022, AEV0023 and AEV0738 were deleted. AEV0420, 421, 422 & 423, EFV0470 and EFV471 were added.	No issues

CONCLUSIONS:

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All comments have been resolved to the satisfaction of the reviewer. All new information has been incorporated accurately and appropriately and in accordance with NRC regulations. No changes in methodologies were identified. Design Inputs were revised and clarified. All CCN's have been incorporated accurately. The CCNs that can be made final or are final have all been verified to be incorporated as identified on the CCN. This calculation revision is acceptable.

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TABLE A **(This table is required for change packages, or when required by a Supervisor.) If the answer to the question is yes, then provide a descriptive answer that explains why you came to this conclusion. If the question is not applicable, then provide a descriptive explanation detailing why it is not applicable.**

Design Verification Question	See Table Footnote
1. Were the design inputs correctly selected and incorporated into the design? Yes:☒ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. The purpose of this revision is to put in the wording approved by the NRC Generic Letter 86-10, Response to Question 3.8.4; NEI 00-01, Rev. 2, Paragraph 3.3.1.1.4.1; License Amendment 214. The design input section 3-B-3 for the licensing bases changes approved in the amendment were properly made to replace SLNRC 84-0109 with E-1F9915.	
2. Are assumptions, necessary to perform the design activity, documented, adequately described and reasonable? Yes:☒ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. The purpose of this revision is to put in the wording approved by the NRC Generic Letter 86-10, Response to Question 3.8.4; NEI 00-01, Rev. 2, Paragraph 3.3.1.1.4.1; License Amendment 214. The necessary evaluation of these changes are provided in the calculation referenced License Amendment. The CNN changes have been incorporated as previously verified to be acceptable.	
3. Are the appropriate quality and quality assurance requirements specified? Yes:☒ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. The purpose of this revision is to put in the wording approved by the NRC Generic Letter 86-10, Response to Question 3.8.4; NEI 00-01, Rev. 2, Paragraph 3.3.1.1.4.1; License Amendment 214. The necessary evaluation of these changes are provided in the calculation referenced License Amendment. The CNN changes have been incorporated as previously verified to be acceptable.	

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TABLE A (This table is required for change packages, or when required by a Supervisor.) If the answer to the question is yes, then provide a descriptive answer that explains why you came to this conclusion. If the question is not applicable, then provide a descriptive explanation detailing why it is not applicable.

Design Verification Question	See Table Footnote
4. Are the applicable codes, standards and regulatory requirements, including issue and addenda, properly identified and are their requirements for design met? Yes: ☒ No: ☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. No changes in any codes, standards and regulatory requirements other than those outlined in the approved calculation referenced License Amendment 214 have changed.	
5. Has applicable plant and industry construction and operating experience been considered? Yes: ☒ No: ☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. The approved calculation referenced License Amendment 214 letters provide all the applicable corresponds with the NRC for the subject calculation changes (Also reference CP 014986).	
6. Have the hardware interface design requirements been satisfied? Yes: ☒ No: ☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. No hardware interfaces occurred as a result of this calculation revision.	
7. Is the output reasonable compared to input? Yes: ☒ No: ☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. Te output is to incorporate the calculation referenced License Amendment 214 statement wording, so this is not applicable to this change.	

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TABLE A **(This table is required for change packages, or when required by a Supervisor.) If the answer to the question is yes, then provide a descriptive answer that explains why you came to this conclusion. If the question is not applicable, then provide a descriptive explanation detailing why it is not applicable.**

Design Verification Question	**See Table Footnote**
8. Are the specified parts, equipment and processes suitable for the required application? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
9. Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
10. Have adequate maintenance features and requirements been specified? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
11. Are accessibility and other design provisions adequate for performance of needed maintenance and repair? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	

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TABLE A **(This table is required for change packages, or when required by a Supervisor.) If the answer to the question is yes, then provide a descriptive answer that explains why you came to this conclusion. If the question is not applicable, then provide a descriptive explanation detailing why it is not applicable.**

Design Verification Question	See Table Footnote
12. Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
13. Has the design properly considered radiation exposure to the public and plant personnel? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
14. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
15. Does each document contain the required signatures and date? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. This is one of the questions that cannot be answered until the verification and supervisor have approved it, but it is an expectation to ensure the required signatures are provided before processing.	

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TABLE A **(This table is required for change packages, or when required by a Supervisor.) If the answer to the question is yes, then provide a descriptive answer that explains why you came to this conclusion. If the question is not applicable, then provide a descriptive explanation detailing why it is not applicable.**

Design Verification Question	See Table Footnote
16. If a computer program was used in the analysis, has the program been verified? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
17. If a component has been added, has a Safety Classification Analysis been completed? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
18. Were the commitments provided in the USAR and the Design Criteria documents correctly incorporated into the design documents? Yes:☒ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. The changes required are being done as a part of CP 014986 and do not need to be verified as a part of this calculation.	
19. Have the appropriate design documents been identified and/or updated? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	

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TABLE A (This table is required for change packages, or when required by a Supervisor.) If the answer to the question is yes, then provide a descriptive answer that explains why you came to this conclusion. If the question is not applicable, then provide a descriptive explanation detailing why it is not applicable.

Design Verification Question	See Table Footnote
20. Has warehouse stock been considered for modification or retirement? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
21. Are acceptance criteria for the changes adequately defined to enable verification that the changes meet existing design requirements? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	
22. Are all differences between previous and proposed configuration identified; Are reasons for acceptability of changes adequately documented; and does the evaluation adequately support authorization of the changes? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the “yes” or “no” box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	

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TABLE A **(This table is required for change packages, or when required by a Supervisor.) If the answer to the question is yes, then provide a descriptive answer that explains why you came to this conclusion. If the question is not applicable, then provide a descriptive explanation detailing why it is not applicable.**

Design Verification Question	See Table Footnote
23. Were existing design requirements, functions, failure mechanisms, failure modes and effects, and critical characteristics appropriately determined and applied to the evaluation of the changes? Yes:☒ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. The changes out lined in the calculation had approapriate design bases and justification for why the changes were need and appropriately associated the changes to the applicable change package.	
24. Does the change impact existing digital assets or add a new digital asset? If so, have AP 15D-008, Wolf Creek Cyber Security Program considerations been addressed? Yes:☐ No:☐ Design verifier must clearly define the basis upon which the "yes" or "no" box was checked. As identified above this section of the form is not required to be completed and thus only question considered to have some benefit have had an applicable statement added, this question is not being completed.	

DESIGN VERIFICATION REPORT	DOCUMENT NO. XX-E-013	REV. 4

TABLE A **(This table is required for change packages, or when required by a Supervisor.) If the answer to the question is yes, then provide a descriptive answer that explains why you came to this conclusion. If the question is not applicable, then provide a descriptive explanation detailing why it is not applicable.**

TABLE A FOOTNOTE:

The purpose of this column is to enable Wolf Creek to track and trend deficiencies discovered during package verification. IF the design verification question is answered "no," THEN he verifier shall mark this box with deficiency type as follows:

Type	**Description**
• MPR -	Missed procedural requirement. Use this designator if all or part of a process step was not performed.
• TEV -	Technical Error by Vendor. Use this designator if the discrepancy was caused by the actions of a Vendor. If the discrepancy was caused by misinformation supplied by Wolf Creek, use the next designator.
• TEWC -	Technical Error by Wolf Creek. Use this designator if the discrepancy was caused by Wolf Creek personnel.

IF the design verification question is answered "yes" but could be significantly enhanced by additional or altered information, THEN the verifier shall mark the box as:

- DE - Document enhancement opportunity