NEF-6.4A
(5/89)

CALCULATION ANALYSIS

Nuclear Engineering Department

REF 1
SECTION III

INSTRUMENTATION & CONTROLS SECTION

SHEET 1 OF 13

I.D. NO. 12-NI-05

PLANT COOK NUCLEAR UNIT 1

SAFETY RELATED YES ___ NO X

SYSTEM LTOPS

COMPANY I&M

TITLE LTOP SETPOINT CALC

CALCULATED BY: CHARLES SAVITSCUS 7-23-90
DATE

FILE LOCATION ECP 12-NI-05

CHECKED BY: D. Schmader 8/30/90
DATE

MICROFILM NO. ___

APPROVED BY: S K Fisher 8/30/90
DATE

PROBLEM DESCRIPTION:

UPDATE UNIT 1 LTOP SETPOINT USING 1990 CAPSULE DATA AND 1989 WESTINGHOUSE SETPOINT EVALUATION REPORT

DESIGN BASIS ~~OR REFERENCES:~~ USNRC REGULATORY GUIDE 1.99 REVISION 2 "RADIATION EMBRITTLEMENT OF REACTOR VESSEL MATERIALS" DATED MAY 1988

REFERENCES: SEE NEXT PAGE

METHOD OF VERIFICATION: ALT. CALC.

REVISIONS

| NO. | REASON FOR CHANGE | PREP'D BY | DATE | CKD. BY | DATE | APVD. BY | DATE |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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METHOD OF VERIFICATION: ___

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ECP 12-N1-05
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DATE 7/18/90 BY CCS CK 2nd
COMPANY I&M G.O.
PLANT COOK NUCLEAR PLANT U 1

SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

## REFERENCES

1) D. C. COOK UNIT 2 LOW TEMPERATURE OVERPRESSURE PROTECTION SYSTEM (LTOPS) SETPOINT EVALUATION JUNE - 1989 WESTINGHOUSE ELECTRIC CORPORATION

2) COOK NUCLEAR PLANT LTOPS SETPOINT EVALUATION REPORT MEMO FROM: A.E. SCHOERF DATED 1-4-90
TO R.C. CARRUTH

3) ANALYSIS OF CAPSULE U FROM THE AMERICAN ELECTRIC POWER COMPANY D. C. COOK UNIT 1 REACTOR VESSEL RADIATION SURVEILLANCE PROGRAM - WCAP-12483 JANUARY 1990

4) WESTINGHOUSE INSTRUCTION AND OPERATING BOOK CONTROLLED LEAKAGE SEAL REACTOR COOLANT PUMP (RP-095) MODEL WI-1100Y-B1

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PLANT COOK NUCLEAR PLANT U1

SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

## SUMMARY OF CONCLUSIONS

FOR 1-NRV-152 OR 1-NRV-153, A SINGLE PORV OPERATION THE PEAK PRESSURE WILL REMAIN BELOW THE APPENDIX "G" LIMIT AS FOLLOWS:

SETPOINT - 435 PSIG WITH REACTOR VESSEL EXPOSURES TO 23 EFPY AND PORV STROKE OPEN TIMES BELOW 6 SECONDS

SETPOINT - 435 PSIG WITH REACTOR VESSEL EXPOSURES TO 32 EFPY AND PORV STROKE OPEN TIMES BELOW 6 SECONDS

FOR UNIT 1 A MINIMUM SETPOINT LIMIT TO PROTECT THE REACTOR COOLANT PUMP (RCP) NUMBER 1 SEAL DOES NOT EXIST. WITH THE 4 SECOND PORV CLOSURE TIME, THERE IS NOT ENOUGH SEPARATION BETWEEN THE STEADY STATE PRESSURE-TEMPERATURE LIMIT AND THE MINIMUM RCS PRESSURE REQUIREMENTS FOR AN RCP START TO ENVELOPE THE PRESSURE SWING RESULTING FROM EITHER A HEAT INJECTION OR MASS INJECTION EVENT.

FOR UNIT 1 THE LTOP WILL BE ENABLED FOR TEMPERATURES BELOW 152°F

SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

## INTRODUCTION

USNRC Regulatory Guide 1.99 Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," dated May, 1988 became official with it's publication in the Federal Register on June 8, 1988. The guide revises the general procedures acceptable to the NRC staff for calculating the effects of neutron radiation embrittlement of the low alloy steels currently used for light water cooled reactor vessels.

Appendix G of 10 CFR Part 50 provides the fracture toughness requirements for reactor pressure vessels under certain conditions. To ensure that the Appendix G limits are not exceeded during any anticipated operational occurrence, technical specification pressure-temperature limits are provided during low temperature operations. The embrittlement algorithm specified by revision 2 of Regulatory Guide 1.99 is more conservative than revision 1, and requires that these limits be re-calculated.

The Low Temperature Overpressure Protection System (LTOPS) provides protection against exceeding the vessel ductility limits, as expressed by the Appendix G pressure-temperature limits, during cold shutdown, heatup, and cooldown operations. The limits resulting from implementation of the new revision to Regulatory Guide 1.99, requires that the LTOPS setpoints be re-evaluated.

## PURPOSE

THE PURPOSE OF THIS CALCULATION IS TO RE-EVALUATE THE UNIT 1 LTOP SETPOINT FOR 1-NRV-152 & 1-NRV-153.

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SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

LTOP CALCULATION 1 FOR UNIT 1

THE COOK NUCLEAR PLANT UNIT 2 LTOP SETPOINT EVALUATION (REF 1) WILL BE USED TO EVALUATE UNIT 1 (REF 2) USING: WCAP 12483 PRESSURE-TEMPERATURE LIMITS (APP G CURVES) (REF 3).

THE LTOP SETPOINT WILL BE BASED ON THE WOG REPORT METHODOLOGY. REF 1 PROVIDES A WESTINGHOUSE CORRELATION TO THE LOFTRAN BASE ANALYSIS SETPOINT. THE SETPOINT BASED ON THE WOG REPORT METHODOLOGY ENVELOPES THE SETPOINT DETERMINED BY THE WESTINGHOUSE CORRELATION TO THE LOFTRAN BASE ANALYSIS.

FOR UNIT 1 THE FOLLOWING CRITERIA APPLY: SINGLE PORV OPERATION, 1-NRV-152 OR 1-NRV-153 OPENING TIME $\geq$ 6 SECONDS; CLOSING TIME $\leq$ 4 SECONDS; 23 EFPY AND 32 EFPY STEADY STATE COOLDOWNS; AND

THE RCS IS CONSIDERED "WATER SOLID" WITH ISOTHERMAL (STEADY STATE) HEATUP AND ISOTHERMAL (STEADY STATE) COOLDOWN.

APPENDIX G LIMITS WITHOUT INSTRUMENTATION UNCERTAINTY ARE USED, JUSTIFIED ON THE BASIS OF THE LARGE AMOUNT OF CONSERVATISM (RECOGNIZED BY THE NRC) INHERENT IN THE DEVELOPMENT OF THE LIMITS."

THE LTOP'S DESIGN BASIS TRANSIENTS ARE: 1) THE MASS INPUT TRANSIENT CAUSED BY A NORMAL CHARGING/LETDOWN FLOW MISMATCH AFTER TERMINATION OF LETDOWN FLOW AND 2) THE HEAT INPUT TRANSIENT CAUSED BY THE RESTART OF A RCP WHEN THE RHRS IS NOT OPEN TO THE RCS.

THE SAME WOG METHODOLOGY AND MOST CONSERVATIVE (U1/U2) PLANT PARAMETERS (REF 2) HAVE BEEN USED FOR UNIT 2 LTOP SETPOINT EVALUATION. THE SETPOINT FOR U1 NEED ONLY TO BE FIT TO THE WCAP 12483 (REF 3). THUS TABLES 3.4,

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SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

3.5, & 3.6 OF REF 1 ARE APPLICABLE AND MUST FIT UNDER THE (WCAP 12483 REF 3) AEP COOLDOWN CURVES. REG GUIDE 1.99 REV 2 (NO MARGIN FOR INSTRUMENT UNCERTAINTY) FOR 23 EFPY AND 32 EFPY.

THE TABLES 3.4 3.5 & 3.6 ARE EVALUATED FOR SETPOINT PRESSURES OF BETWEEN 400-500 PSIG WITH A 6 SECOND PORV OPENING TIME FOR 23 EFPY AND 32 EFPY.

D THE INSTRUMENTATION TIME DELAYS, PRESSURIZER PORV FLOW CHARACTERISTICS AND PRESSURIZER PORV FULL FLOW $C_v$ ARE TO BE THE SAME AS IN REF 1.

CALCULATION INDEX

PART 1 CALCULATION OF LTOP SETPOINT

PART 2 EVALUATION OF UNDER PRESSURE SETPOINT FOR RCP #1 SEAL PROTECTION

PART 3 DETERMINATION OF LTOP ENABLE TEMPERATURE

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PLANT COOK NUCLEAR PLANT U1

SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

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TABLE 3.4

Max Overshoot/Undershoot Delta P Values vs PORV Opening Time Due to Mass Injection

D. C. Cook Unit 2 → ALSO APPLICABLE FOR UNIT 1

| Setpt Press. | Mass Inj. | Overshoot/Undershoot Values (psi) vs. PORV Opening Time (sec)* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.0 | | 2.0 | | 4.0 | | 6.0 | | 8.0 | | 10.0 | |
| (psig) | Rate (gpm) | Over | Under | Over | Under | Over | Under | Over | Under | Over | Under | Over | Under |
| 400.0 | 439.2 | 439.0 | 231.0 | 446.0 | 232.0 | 460.0 | 282.0 | 473.0 | 296.0 | 487.0 | 310.0 | 499.0 | 318.0 |
| 500.0 | 429.7 | 538.0 | 302.0 | 542.0 | 303.0 | 555.0 | 372.0 | 566.0 | 388.0 | 578.0 | 403.0 | 588.0 | 407.0 |
| 600.0 | 420.2 | 635.0 | 381.0 | 641.0 | 388.0 | 651.0 | 460.0 | 560.0 | 482.0 | 671.0 | 492.0 | 681.0 | 493.0 |
| 700.0 | 410.7 | 733.0 | 465.0 | 738.0 | 479.0 | 747.0 | 547.0 | 755.0 | 576.0 | 765.0 | 577.0 | 773.0 | 591.0 |

* PORV Closure time = 4.0 sec.

Notes: 1. Mass injection rate obtained from RCS pressure vs. single pump charging flow.

2. Overshoot obtained from max delta P overshoot vs. mass injection flow curve.

3. Undershoot obtained from max delta P undershoot vs. mass injection flow.

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SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

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TABLE 3.5

Max Overshoot/Undershoot Delta P Values vs PORV Opening Time Due to Heat Injection

D. C. Cook Unit 2 → ALSO APPLICABLE FOR UNIT 1

| Setpoint Pressure (psig) | Overshoot/Undershoot Values (psi) vs. PORV Opening Time (sec)* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.0 | | 2.0 | | 4.0 | | 6.0 | | 8.0 | | 10.0 | |
| | Over | Under | Over | Under | Over | Under | Over | Under | Over | Under | Over | Under |
| 400.0 | 418.0 | 265.0 | 420.0 | 266.0 | 423.0 | 289.0 | 427.0 | 311.0 | 431.0 | 323.0 | 435.0 | 330.0 |
| 500.0 | 517.0 | 329.0 | 518.0 | 335.0 | 521.0 | 372.0 | 525.0 | 400.0 | 528.0 | 416.0 | 531.0 | 426.0 |
| 600.0 | 617.0 | 422.0 | 618.0 | 426.0 | 621.0 | 463.0 | 624.0 | 496.0 | 627.0 | 513.0 | 629.0 | 523.0 |
| 700.0 | 716.0 | 502.0 | 717.0 | 510.0 | 720.0 | 557.0 | 723.0 | 593.0 | 726.0 | 610.0 | 728.0 | 621.0 |

3.22

* Valve Closure time = 4.0 sec.

RCS temperature = 85.0°F

S/G temperature = 135.0°F

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TABLE 3.6

Max Overshoot/Undershoot Delta P Values vs PORV Opening Time Due to Heat Injection

D. C. Cook Unit 2 → ALSO APPLICABLE FOR UNIT 1

| Setpoint Pressure (psig) | Overshoot/Undershoot Values (psi) vs. PORV Opening Time (sec)* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.0 | | 2.0 | | 4.0 | | 6.0 | | 8.0 | | 10.0 | |
| | Over | Under | Over | Under | Over | Under | Over | Under | Over | Under | Over | Under |
| 400.0 | 438.0 | 278.0 | 445.0 | 279.0 | 459.0 | 295.0 | 475.0 | 311.0 | 490.0 | 311.0 | 505.0 | 324.0 |
| 500.0 | 540.0 | 338.0 | 547.0 | 342.0 | 562.0 | 381.0 | 576.0 | 395.0 | 589.0 | 407.0 | 602.0 | 408.0 |
| 600.0 | 639.0 | 419.0 | 646.0 | 433.0 | 659.0 | 468.0 | 672.0 | 487.0 | 685.0 | 493.0 | 697.0 | 495.0 |
| 700.0 | 739.0 | 512.0 | 745.0 | 516.0 | 757.0 | 563.0 | 770.0 | 579.0 | 782.0 | 581.0 | 793.0 | 585.0 |

3.23

* Valve Closure time = 4.0 sec.

RCS temperature = 150.0°F

S/G temperature = 200.0°F

AEP COOLDOWN CURVES REG. GUIDE 1.99,REV.2 FOR UNIT 0 01/12/90

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 1 ( STEADY-STATE COOLDOWN )

IRRADIATION PERIOD = 23.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 524.39 | 17 | 165.000 | ~~677.90~~ | | 33 | 245.000 | 1161.74 |
| 2 | 90.000 | 529.65 | 18 | 170.000 | ~~698.96~~ | * | 34 | 250.000 | 1214.52 |
| 3 | 95.000 | 536.32 | 19 | 175.000 | ~~711.88~~ | | 35 | 255.000 | 1271.18 |
| 4 | 100.000 | 541.30 | 20 | 180.000 | ~~731.20~~ | | 36 | 260.000 | 1331.92 |
| 5 | 105.000 | 547.85 | 21 | 185.000 | 752.05 | | 37 | 265.000 | 1396.95 |
| 6 | 110.000 | 554.89 | 22 | 190.000 | 774.40 | | 38 | 270.000 | 1467.01 |
| 7 | 115.000 | 562.45 | 23 | 195.000 | 798.34 | | 39 | 275.000 | 1541.80 |
| 8 | 120.000 | 570.59 | 24 | 200.000 | 824.15 | | 40 | 280.000 | 1622.30 |
| 9 | 125.000 | 579.34 | 25 | 205.000 | 851.84 | | 41 | 285.000 | 1708.49 |
| 10 | 130.000 | 588.62 | 26 | 210.000 | 881.50 | | 42 | 290.000 | 1800.74 |
| 11 | 135.000 | 598.72 | 27 | 215.000 | 913.59 | | 43 | 295.000 | 1899.56 |
| 12 | 140.000 | 609.59 | 28 | 220.000 | 947.92 | | 44 | 300.000 | 2005.08 |
| 13 | 145.000 | ~~621.28~~ | 29 | 225.000 | 984.79 | | 45 | 305.000 | 2118.16 |
| 14 | 150.000 | ~~633.70~~ | 30 | 230.000 | 1024.38 | | 46 | 310.000 | 2238.95 |
| 15 | 155.000 | ~~647.10~~ | 31 | 235.000 | 1066.91 | | 47 | 315.000 | 2368.09 |
| 16 | 160.000 | ~~661.72~~ | 32 | 240.000 | 1112.62 | | | | |

Data Points for Heatup and Cooldown Curves for up to 23 EFPY and Without Margins for Instrumentation Error

* 621 PSI. FLANGE REQUIREMENT

AEP COOLDOWN CURVES REG. GUIDE 1.99,REV.2 FOR UNIT 1 01/12/90

THE FOLLOWING DATA WERE PLOTTED FOR COOLDOWN PROFILE 1 ( STEADY-STATE COOLDOWN )

IRRADIATION PERIOD = 32.000 EFP YEARS
FLAW DEPTH = AOWIN T

| | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) | | INDICATED TEMPERATURE (DEG.F) | INDICATED PRESSURE (PSI) |
|---|---|---|---|---|---|---|---|---|
| 1 | 85.000 | 514.83 | 18 | 170.000 | ~~681.72~~ | * | 34 | 250.000 | 1112.62 |
| 2 | 90.000 | 519.49 | 19 | 175.000 | ~~677.90~~ | | 35 | 255.000 | 1161.74 |
| 3 | 95.000 | 524.38 | 20 | 180.000 | ~~698.96~~ | | 36 | 260.000 | 1214.52 |
| 4 | 100.000 | 529.65 | 21 | 185.000 | 711.99 | | 37 | 265.000 | 1271.18 |
| 5 | 105.000 | 538.32 | 22 | 190.000 | 731.20 | | 38 | 270.000 | 1331.92 |
| 6 | 110.000 | 541.30 | 23 | 195.000 | 752.05 | | 39 | 275.000 | 1396.95 |
| 7 | 115.000 | 547.85 | 24 | 200.000 | 774.40 | | 40 | 280.000 | 1467.01 |
| 8 | 120.000 | 554.89 | 25 | 205.000 | 798.34 | | 41 | 285.000 | 1541.90 |
| 9 | 125.000 | 562.45 | 26 | 210.000 | 824.15 | | 42 | 290.000 | 1622.30 |
| 10 | 130.000 | 570.59 | 27 | 215.000 | 851.84 | | 43 | 295.000 | 1708.49 |
| 11 | 135.000 | 579.34 | 28 | 220.000 | 881.50 | | 44 | 300.000 | 1800.74 |
| 12 | 140.000 | 588.62 | 29 | 225.000 | 913.59 | | 45 | 305.000 | 1899.56 |
| 13 | 145.000 | 598.72 | 30 | 230.000 | 947.92 | | 46 | 310.000 | 2005.08 |
| 14 | 150.000 | 609.59 | 31 | 235.000 | 984.79 | | 47 | 315.000 | 2118.16 |
| 15 | 155.000 | ~~621.28~~ | 32 | 240.000 | 1024.38 | | 48 | 320.000 | 2238.95 |
| 16 | 160.000 | ~~633.70~~ | 33 | 245.000 | 1066.91 | | 49 | 325.000 | 2368.09 |
| 17 | 165.000 | ~~647.10~~ | | | | | | | |

Data Points for Heatup and Cooldown Curves for up to 32 EFPY and Without Margins for Instrumentation Error

* 621 PSI, FLANGE REQUIREMENT

SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

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SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

PART (1) CALCULATION OF LTOP SETPOINT

FOR 6 SECOND PORV OPENING TIME AND 23 EFPY

| SETPOINT PSIG | MASS INJECTION OVER SHOOT PSIG | RCS = 85°F HEAT INJECTION OVER SHOOT PSIG | 23 EFPY APPENDIX G PRESS PSIG AT 85°F | RCS = 150°F HEAT INJECTION OVERSHOOT PSIG | 23 EFPY APPENDIX G PRESS PSIG AT 150°F |
|---|---|---|---|---|---|
| 400 | 473 | 427 | 524.39 | 475 | 621 |
| * 435 | 505.55 | | 524.39 | | 621 |
| + 445 | 514.85 | | 524.39 | | 621 |
| ⊖ 455 | 524.15 | | 524.39 | | 621 |
| 500 | 566 | 525 | 524.39 | 576 | 621 |

FROM THE ABOVE TABLE IT IS EVIDENT THAT THE MOST LIMITING TEMPERATURE WITH RESPECT TO APPENDIX G CRITERIA IS AT 85°F AND THAT THE MASS INJECTION EVENTS DOMINATE. ONCE THE MOST LIMITING TEMP OF 85°F IS USED THEN THE COMPARISON OF MASS INJECTION OVER SHOOT TO HEAT INJECTION OVER SHOOT @ 85°F SHOWS THE MASS INJECTION OVER SHOOT TO BE GREATER, THAT IS, IT DOMINATES.

* 500 − 400 PSI SETPOINT = 35 PSI Δ SETPOINT

566 − 473 PSI MASS INJECTION = Δ MASS INJECTION OVERSHOOT (MIO)

Δ MIO = 32.55

MIO = 32.55 + 473 = 505.55

\+ 100 / 93 = 45 / Δ MIO

Δ MIO = 41.85

MIO = 41.85 + 473 = 514.85

⊖ 100 / 93 = 55 / Δ MIO

Δ MIO = 51.15

MIO = 51.15 + 473 = 524.15

SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT
PART (1) CALCULATION OF LTOP SETPOINT

FOR 6 SECOND PORV OPENING TIME AND 32 EFPY

| SETPOINT PSIG | MASS INJECTION OVERSHOOT PSIG | RCS=85°F HEAT INJECTION OVERSHOOT PSIG | 32 EFPY APPENDIX G PRESS PSIG AT 85°F | RCS=150°F HEAT INJECTION OVERSHOOT PSIG | 32 EFPY APPENDIX G PRESS PSIG AT 150°F |
|---|---|---|---|---|---|
| 400 | 473 | 427 | 514.93 | 475 | 609.59 |
| *435 | 505.55 | | 514.93 | | 609.59 |
| +445 | 514.185 | | 514.93 | | 609.59 |
| | | | 514.93 | | 609.59 |
| 500 | 566 | 525 | 514.93 | 576 | 609.59 |

FROM THE ABOVE TABLE IT IS EVIDENT THAT THE MOST LIMITING TEMPERATURE WITH RESPECT TO APPENDIX G CRITERIA IS AT 85°F AND THAT THE MASS INJECTION EVENTS DOMINATE. (SIMILAR TO 28 EFPY DISCUSSION, SHEET 10 OF 13)

* $\frac{500-400 \text{ PSI SETPOINT}}{566-473 \text{ PSI MASS INJECTION}} = \frac{35 \text{ PSI } \Delta \text{ SETPOINT}}{\Delta \text{ MASS INJECTION OVERSHOOT (MIO)}}$

$\Delta MIO = 32.55$

$MIO = 32.55 + 473 = 505.55$

\+ $\frac{100}{93} = \frac{45}{\Delta MIO}$

$\Delta MIO = 41.85$

$MIO = 41.85 + 473 = 514.85$

FOR UNIT 1 USE A LTOP SETPOINT OF 435 PSIG INCREASING FOR UP TO 32 EFPY PER REF 3

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SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

PART ② EVALUATION OF UNDER PRESSURE SETPOINT

FOR THE 4 SECOND PORV CLOSURE TIME TO PROTECT THE RCP NUMBER 1 SEAL THE UNDERSHOOT PRESSURE SHOULD REMAIN ABOVE 325 PSIG (REF 4).

SOLVING FOR THE MASS INJECTION UNDERSHOOT FROM A SETPOINT OF 435 PSIG @ OPENING TIME = 6 SECONDS

$$\frac{\text{PSI } 500 - 400}{\text{PSI } (388 - 296)^*} = \frac{35 \text{ PSI}}{\Delta \text{ MASS INJECTION UNDERSHOOT (MIU) PSI}}$$

* SEE TABLE 3.4 SHEET 7

$\Delta MIU = 32.2$ psi

$MIU = 32.2 + 296 = 328.2$ PSIG

SOLVING FOR THE HEAT INJECTION UNDERSHOOTS FROM A SETPOINT OF 435 PSIG

$$\frac{500 - 400}{(400 - 311)^*} = \frac{35}{\Delta MIU_{85°F}}$$

* SEE TABLE 3.5 SHEET 8

$\Delta MIU_{85°F} = 31.15$

$MIU_{85°F} = 342.15$ PSIG

$$\frac{500 - 400}{395 - 311} = \frac{35}{\Delta MIU_{150°F}}$$

$\Delta MIU_{150°F} = 29.4$

$MIU_{150°F} = 340.4$ PSIG

HOWEVER SINCE THE OPENING TIME IS EXPECTED TO BE LESS THAN* OR EQUAL TO 6 SECONDS THE UNDERSHOOT PRESSURES WILL TEND TO BE LESS THAN 325 PSIG (REF 4) AND SO A MINIMUM SETPOINT LIMIT TO PROTECT THE RCS NUMBER 1 SEAL DOES NOT EXIST.

* SEE PERFORMANCE TRENDS, APP III REF 3.

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SUBJECT LOW TEMPERATURE OVERPRESSURIZATION PROTECTION (LTOP) SETPOINT

PART (3) DETERMINATION OF LTOP ENABLE TEMPERATURE

BY INSPECTION THE 32 EFPY CURVE IS MORE LIMITING THAN THE 23 EFPY. FOR 32 EFPY THE APPENDIX G CURVE PRESSURE AT 152° IS ≈

$$\left(\frac{621.28 - 609.59}{155 - 150}\right)^{*} \frac{\text{psi}}{^\circ\text{F}} \approx \frac{\Delta \text{APP G PRESS}}{\Delta 2^\circ\text{F}}$$

* SEE DATA FOR 32 EFPY YEARS SHEET 9 OF THE APPENDIX G CURVE

$$4.676 \approx \Delta \text{APP G PRESS}$$

$$609.59 + 4.68 \approx \text{APP G PRESS}$$

$$614.27 \text{ psig} \approx \text{APP G PRESS}$$

FOR THE 435 PSIG LTOP SETPOINT THE MAXIMUM OVERSHOOT IS 505.55 PSIG WHICH IS LESS THAN THE ≈614.27 PSIG APP G PRESSURE AND THIS IS ACCEPTABLE. ALSO THERE WILL GENERALLY BE A STEAM BUBBLE IN THE PRESSURIZER WHEN THE REACTOR COOLANT TEMPERATURE IS ABOVE ABOUT 150°F DURING PLANT COOL DOWN SO THAT WATER SOLID CONDITIONS ARE LIMITED TO RELATIVELY LOW TEMPERATURE CONDITIONS.

THEREFORE THE LTOP ENABLE TEMPERATURE IS 152°F.

ATTACHMENT 2 TO AEP:NRC:0894Q

REFERENCE DOCUMENTS FOR THE CALCULATION TO SUPPORT

THE UNIT 1 LTOP SETPOINT CHANGE

TITLE: LTOP (Low Temp. Overpress. Prot.)

AMERICAN ELECTRIC POWER

Date January 4, 1990

Subject COOK NUCLEAR PLANT
Low Temperature Overpressure Protection System
Setpoint Evaluation Report

From P. G. Schoepf

To R. C. Carruth

Attached, for your use, is an approved copy of the Westinghouse Report, "D. C. Cook (Unit 2) Low Temperature Overpressure Protection System (LTOPS) Setpoint Evaluation." This report provides a Cook Plant specific application of the Westinghouse Owner's Group methodology for LTOPS setpoint determination, including a sensitivity study on PORV opening time.

Although the report title indicates "Unit 2", the evaluation was intentionally performed using the most conservative of Unit 1 and Unit 2 plant parameters. Therefore, the methodology described may be applied to either unit's isothermal heatup/cooldown curves to calculate that unit's LTOP setpoint. This report should be used to calculate future LTOPS setpoints based on the results of reactor vessel material surveillance program capsule analyses.

Please note that this report provides justification to retain the current Unit 2 LTOPS setpoint (T/S value) of 435 psig (provided PORV stroke open times remain below 6.5 seconds) when the heatup/cooldown curves developed per Regulatory Guide 1.99, Rev. 2 are instituted. These new curves were submitted to the NRC via AEP:NRC:0894L, and are scheduled for implementation during the 1990 Unit 2 refueling outage.

Attachment

cc: R. L. Shoberg/File: AEP:NRC:0894L
D. R. Hafer
J. D. Grier
T. R. Satyan-Sharma
T. P. Beilman - Bridgman
J. R. Sampson/T. R. Stephens - Bridgman

Intra-System