# APPENDIX 15E

## INITIAL CORE FOR SSES UNITS 1 AND 2

## NON-LIMITING EVENTS

TABLE 15E.0-1
RESULTS SUMMARY OF TRANSIENT EVENTS
UNITS 1 AND 2 NON-LIMITING EVENTS (VALUES ARE FOR THE INITIAL CORES ONLY)

| Section | Figure | Description | Maximum Neutron Flux | Maximum Dome Pressure psig | Maximum Vessel Pressure psig | Maximum Steam line Pressure psig | Maximum Core Average Surface Heat Flux % of Initial | ΔCPR(1) | Frequency Category* | Number of Valves - 1st Blowdown | Duration of Blowdown |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.1 | | DECREASE IN REACTOR COOLANT TEMPERATURE | | | | | | | | | |
| 15.1.1 | | Loss of Feedwater Heater | See Text and Appendices 15C and 15D for current cycle limits | | | | | | | | |
| 15.1.2 | | Feedwater Controller Failure | See Text and Appendices 15C and 15D for current cycle limits | | | | | | | | |
| 15.1.3 | | Pressure Regulator Failure - Open | See Text and Appendices 15C and 15D for current cycle limits | | | | | | | | |
| 15.1.4 | | Inadvertent Opening of Safety or Relief Valves | See Text | | | | | | | | |
| 15.1.6 | | RHR Shutdown Cooling Malfunction | See Text | | | | | | | | |
| 15.2 | | INCREASE IN REACTOR PRESSURE | | | | | | | | | |
| 15.2.1 | | Pressure Regulator Failure - Closed | See Text | | | | | | | | |
| 15.2.2 | 15E.2.2-1 | Generator Load Reject - Bypass On | 281.7 | 1154 | 1179 | 1153 | 109.7 | 0.11 | a | 16 | 9 sec |
| 15.2.2 | | Generator Load Reject- Bypass Off | See Text and Appendices 15C and 15D for current cycle limits | | | | | | | | |
| 15.2.3 | 15E.2.3-1 | Turbine Trip - Bypass On | 167.2 | 1143 | 1167 | 1132 | 101.4 | 0.09 | a | 16 | 8 sec |

TABLE 15E.0-1 (Cont'd)
RESULTS SUMMARY OF TRANSIENT EVENTS
UNITS 1 AND 2 NON-LIMITING EVENTS (VALUES ARE FOR THE INITIAL CORES ONLY EXCEPT AS NOTED)

| Section | Figure | Description | Maximum Neutron Flux | Maximum Dome Pressure psig | Maximum Vessel Pressure psig | Maximum Steam line Pressure psig | Maximum Core Average Surface Heat Flux % of Initial | $\Delta CPR^{(1)}$ | Frequency Category* | Number of Valves - 1st Blowdown | Duration of Blowdown |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.2.3 | | Turbine Trip - Bypass Off | See Text and Appendices 15C and 15D for current cycle limits | | | | | | | | |
| 15.2.4 | 15E.2.4-1 | Inadvertent MSIV Closure (3) | 144.3 | 1250 | 1281 | 12501 | 100.8 | 0.11 | a | 12 | 16 sec estimated |
| 15.2.5 | 15E.2.5-1 | Loss of Condenser Vacuum | 167.5 | 1140 | 1165 | 1131 | 101.3 | <0.09 | a | 13 | 20 sec |
| 15.2.6 | 15E.2.6-1 | Loss of Auxiliary Power Transformer | 104.5 | 1145 | 1160 | 1140 | 100.1 | ~0.0 | a | 16 | 16 sec |
| 15.2.6 | 15E.2.6-2 | Loss of All Grid Connections | 107.2 | 1140 | 1161 | 1130 | 100.1 | ~0.0 | a | 13 | 17 sec |
| 15.2.7 | 15E.2.7-1 | Loss of All Feedwater Flow (3) | 102.0 | 1040 | 1081 | 1029 | 102.0 | ~0.0 | a | 0 | 0 sec |
| 15.2.8 | | Feedwater Piping Break | See Section 15.6.6 | | | | | | | | |
| 15.2.9 | | Failure of RHR Shutdown Cooling | See Text | | | | | | | | |
| 15.3 | | DECREASE IN REACTOR COOLANT SYSTEM FLOW RATE | | | | | | | | | |
| 15.3.1 | 15E.3.1-1 | Trip of One Recirculation Pump Motor | 103.6 | 1015 | 1053 | 998 | 100.0 | ~0.0 | a | 0 | 0 sec |
| 15.3.2 | 15E.3.2-1 | Trip of Both Recirculation Pump Motors | 103.5 | 1113 | 1127 | 1109 | 100.1 | ~0.0 | a | 10 | 28 sec |
| 15.3.3 | | Seizure of One Recirculation Pump (Single Loop Operation) | See Text and Appendices 15C and 15D for current cycle limits | | | | | | c | | |
| 15.3.4 | | Recirculation Pump Shaft Break | See Text | | | | | | c | | |
| 15.4 | | REACTIVITY AND POWER ANOMALIES | | | | | | | | | |
| 15.4.1.1 | | RWE – Refueling | See Text | | | | | | b | | |

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TABLE 15E.0-1 (Cont'd)
RESULTS SUMMARY OF TRANSIENT EVENTS
UNIT 1 AND 2 NON-LIMITING EVENTS (VALUES ARE FOR THE INITIAL CORES ONLY)

| Section | Figure | Description | Maximum Neutron Flux | Maximum Dome Pressure psig | Maximum Vessel Pressure psig | Maximum Steam line Pressure psig | Maximum Core Average Surface Heat Flux % of Initial | ΔCPR(1) | Frequency Category* | Number of Valves - 1st Blowdown | Duration of Blowdown |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.4.1.2 | | RWE - Startup | See Text | | | | | | b | | |
| 15.4.2 | | RWE - At Power | See Text | | | | | | a | | |
| 15.4.3 | | Control Rod Maloperation | See Subsections 15.4.1 and 15.4.2 | | | | | | | | |
| 15.4.4 | 15E.4.4-1 | Startup of Idle Recirculation Loop | 323.4 | 973 | 988 | 967 | 134.9 | (2) | a | 0 | 0 |
| 15.4.5 | | Recirculation Flow Controller Failure | See Text and Appendices 15C and 15D for current cycle limits | | | | | | | | |
| 15.4.7 | | Misplaced Bundle Accident | See Text | | | | | | | | |
| 15.5 | | INCREASE IN REACTOR INVENTORY | | | | | | | | | |
| 15.5.1 | 15E.5.1-1 | Inadvertent HPCI Pump Start(3) | 112 | 1039 | 1079 | 1028 | 112 | 0.18 | a | 0 | 0 |
| 15.5.3 | | BWR Transients That Increase Reactor Coolant Inventory | See Sections 15.1 and 15.2 | | | | | | | | |

*Frequency
a = Moderate
b = Infrequent
c = Limiting Faults

Notes

1. ΔCPRs values in this Table are for the initial cores for Units 1 and 2 and are non-limiting. SEE TEXT.
2. Event initiated from low power levels - Initial core MCPR safety limit 1.06 is not violated
3. The event was re-analyzed for 3952 MWt rated power. The results show that the vent is non-limiting and is therefore reported in this Appendix.

TABLE 15E.0-2
INPUT PARAMETERS AND INITIAL CONDITIONS FOR TRANSIENTS
UNITS 1 AND 2 INITIAL CYCLES

| | | |
|---|---|---|
| 1. | Thermal Power Level, MWT<br>Rated Value (NBR)<br>Analysis Value (104.4% NBR) | <br>3293<br>3439 |
| 2. | Steam Flow, Mlbs/hr<br>Analysis Value (105% NBR) | <br>14.153 |
| 3. | Core Flow, Mlbs/hr | 100.0 |
| 4. | Feedwater Flow Rate, lbs/sec Analysis Value | 3921 |
| 5. | Feedwater Temperature,°F | 386.9 |
| 6. | Vessel Dome Pressure, psig | 1020.0 |
| 7. | Vessel Core Pressure, psig | 1030.0 |
| 8. | Turbine bypass Capacity, %NBR | 25% |
| 9. | Core Coolant Inlet Enthalpy, BTU/lb | 521.1 |
| 10. | Turbine Inlet Pressure, psig | 960.0 |
| 11. | Fuel Lattice | 8x8 |
| 12. | Core Average Gap Conductance, BTU/sec-ft$^2$-°F | 0.1744 |
| 13. | Core Leakage Flow,% | 9.85 |
| 14. | Required MCPR Operating Limit | Not Applicable to current cycles ΔCPRs are non-limiting |
| 15. | MCPR Safety Limit | 1.06 |
| 16. | Doppler Coefficient**<br>Nominal EOC-1 (-)cents/°F<br>Analysis Data | <br>0.2255<br>0.2142 |

TABLE 15E.0-2 (Cont'd)
INPUT PARAMETERS AND INITIAL CONDITIONS FOR TRANSIENTS
UNITS 1 AND 2 - INITIAL CYCLES

| | | |
|---|---|---|
| 17. | Void Coefficient**<br>Nominal EOC-1 (-)cents/°F<br>Analysis Data for Power Increase Events<br>Analysis Data for Power Decrease Events | <br>7.48<br><br>12.0<br><br>6.61 |
| 18. | Core Average Rated Void Fraction ** | 40.74 |
| 19. | Scram Reactivity Analysis Data | See Figure 15E.0-2 |
| 20. | Control Rod Drive Speed, Position Versus Time | See Figure 15E.0-2 |
| 21. | Jet Pump Ratio, M | 1.84 |
| 22. | Safety Relief Valve<br>Capacity, % NBR @ 1091 psig<br>Manufacturer<br>Number installed | <br>99.0<br>Crosby<br>16 |
| 23. | Relief Function Delay, sec | 0.4 |
| 24. | Relief Function Response, sec | <0.15 |
| 25. | Set Points for Safety/Relief Valves, psig | 2@1110 3@1140<br>4@1120 3@1150<br>4@1130 |
| 26. | Number of Valve Groups Simulated | 5 |
| 27. | High Flux Trip, %NBR Analysis set point | 125.3 |
| 28. | High Pressure Scram Set Point, psig | 1071 |
| 29. | Vessel Level Trips, Inches Above(+), Below (-) Dryer Skirt Bottom, Tech Spec settings | High Level (L8)≤ 58.7<br>(L4)≤ 30<br>Low Level (L3)≥ 12.5<br>Low Low Level (L2)≥ -38 |
| 30. | APRM Thermal Trip Set Point,%NBR | 125.0 |

TABLE 15E.0-2 (Cont'd)
INPUT PARAMETERS AND INITIAL CONDITIONS FOR TRANSIENTS
UNITS 1 AND 2 - INITIAL CYCLES

| | | |
|---|---|---|
| 31. | Recirculation Pump Trip Delay, sec | 0.175 |
| 32. | Recirculation Pump Trip Inertia time constant for Analysis*, sec | 4.5 |
| | *The inertia time constant is defined by the expression:<br>$t = (2\pi J_0 n)/gT_0$<br><br>Where: t = Inertia time constant, sec<br>$J_0$ = Pump Motor Inertia, lb-ft$^2$<br>n = Rated pump speed, rps<br>g = gravitational constant ft/sec$^2$<br>$T_0$ = Pump shaft torque, lb-ft | |
| ** | Parameters used in REDY only. ODYN values are calculated within the code for equilibrium cycle conditions. | |

TABLE 15E.1.1-1

OPERATOR ACTIONS WHEN REACTOR SCRAM IS INCURRED

- Place Mode switch to shutdown
- Confirm all rods have inserted and power is decreasing
- Insert neutron monitoring detectors
- Confirm main turbines trip and main generator lockout.
- Monitor and control reactor pressure
- Monitor and control reactor water level
- Cool down the reactor per standard procedure (if required)
- Monitor entry condition parameters for other Emergency Operating Procedures

TABLE 15E.1.4-1

SEQUENCE OF EVENTS FOR INADVERTENT
SAFETY RELIEF VALVE OPENING

| TIME (SEC.) | EVENT |
|---|---|
| 0 | Opening of 1 safety relief valve, reaches full flow and remains open throughout the event. |
| 1,200 | Reactor scrammed on high suppression pool temperature. Technical Specification limit of 110°F.<br>Closure of all MSIVs.<br>Two loops of RHR suppression pool cooling placed into service. |
| 5,200 | Reactor depressurization initiated on high suppression pool temperature Technical Specification limit of 120°F. |
| 59,200 | Reactor depressurized to 14.7 psia, terminating blowdown through safety relief valve. |

TABLE 15E.1.4-2

SAFETY RELIEF VALVE OPENING EVENT
ACTIVITY ABOVE SUPPRESSION POOL (curies)

| Isotope | Realistic | Design Basis |
|---|---|---|
| I-131 | 1.35E-03(1) | 5.40E-01 |
| I-132 | 3.64E-02 | 6.19E+00 |
| I-133 | 1.90E-02 | 3.81E+00 |
| I-134 | 9.27E-02 | 1.54E+01 |
| I-135 | 2.23E-02 | 5.87E+00 |
| Kr-83m | 1.44E+01 | 2.93E+00 |
| Kr-85m | 2.54E+00 | 5.25E+00 |
| Kr-85 | 7.94E-03 | 1.72E-02 |
| Kr-87 | 8.73E+00 | 1.72E+01 |
| Kr-88 | 8.73E+00 | 1.72E+01 |
| Kr-89 | 5.40E+01 | 1.12E+02 |
| Xe-131m | 6.19E-03 | 1.29E-02 |
| Xe-133m | 1.19E-01 | 2.50E-01 |
| Xe-133 | 3.33E+00 | 7.06E+00 |
| Xe-135m | 1.11E+01 | 2.24E+01 |
| Xe-135 | 9.53E+00 | 1.89E+01 |
| Xe-137 | 6.19E+01 | 1.29E+02 |
| Xe-138 | 3.65E+01 | 7.67E+01 |

1. 1.35E-03 = $1.35 \times 10^{-03}$

TABLE 15E.1.4-3

SAFETY RELIEF VALVE OPENING EVENT
ACTIVITY RELEASED TO THE ENVIRONS (curies)

| Isotope | Realistic | Design Basis |
|---|---|---|
| I-131 | 1.31E-05[1] | 5.24E-03 |
| I-132 | 3.35E-05 | 5.71E-03 |
| I-133 | 1.46E-04 | 2.92E-02 |
| I-134 | 1.52E-06 | 2.52E-04 |
| I-135 | 9.80E-05 | 2.58E-02 |
| Kr-83m | 7.31E-01 | 1.48E-01 |
| Kr-85m | 7.18E-01 | 1.48E+00 |
| Kr-85 | 7.94E-03 | 1.72E-02 |
| Kr-87 | 1.10E-01 | 2.17E-01 |
| Kr-88 | 1.20E+00 | 2.37E+00 |
| Kr-89 | 1.65E-44 | 3.43E-44 |
| Xe-131m | 6.07E-03 | 1.27E-02 |
| Xe-133m | 1.08E-01 | 2.35E-01 |
| Xe-133 | 3.20E+00 | 6.91E+00 |
| Xe-135m | 1.68E-03 | 4.42E-01 |
| Xe-135m | 5.37E+00 | 1.27E+01 |
| Xe-137 | 4.13E-36 | 8.62E-36 |
| Xe-138 | 1.12E-07 | 2.36E-07 |

1. 1.31E-05 = $1.31 \times 10^{-05}$

TABLE 15E.1.4-4

SAFETY RELIEF VALVE OPENING EVENT
OFFSITE RADIOLOGICAL DOSES (rems)

| Source Terms | Total Whole Body Gamma | Thyroid Inhalation |
|---|---|---|
| Realistic | 1.12E-06(1) | 2.65E-08 |
| Design Basis | 2.43E-06 | 7.16E-06 |

1. 1.12E-06 = $1.12 \times 10^{-06}$

TABLE 15E.1.6-1

SEQUENCE OF EVENTS FOR INADVERTENT RHR SHUTDOWN COOLING OPERATION

| APPROXIMATE ELAPSED TIME | EVENT |
|---|---|
| 0 | Reactor at states B or D (of Appendix 15A) when RHR shutdown cooling inadvertently activated. |
| 0-10 min. | Slow rise in reactor power. |
| ±10 min. | Operator may take action to limit power rise. Flux scram will occur if no action is taken. |

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TABLE 15E.2.2-1

SEQUENCE OF EVENTS FOR FIGURE 15E2.2-1
GENERATOR LOAD REJECTION, BYPASS ON

| TIME, SEC | EVENT |
|---|---|
| (-)0.015 (approx.) | Turbine-generator detection of loss of electrical load. |
| 0 | Generator lockout relays act to initiate turbine control fast valve closure. |
| 0 | Turbine-generator PLU trip initiates main turbine bypass system operation. |
| 0.016 | Fast control valve closure (FCV) initiates scram trip |
| 0.016 | Fast control valve closure (FCV) initiates a recirculation pump trip (RPT). |
| 0.07 | Turbine control valves closed. |
| 0.11 | Turbine bypass valves start to open. |
| 1.145 | Group 1 relief valves actuated. |
| 1.160 | Group 2 relief valves actuated. |
| 1.356 | Group 3 relief valves actuated. |
| 1.520 | Group 4 relief valves actuated. |
| 1.789 | Group 5 relief valves actuated. |

TABLE 15E.2.3-1

SEQUENCE OF EVENTS FOR TURBINE TRIP
WITH BYPASS OPERABLE FIGURE 15E.2.3-1

| TIME, SEC | EVENT |
|---|---|
| 0 | Turbine trip initiates closure of main stop valves. |
| 0 | Turbine trip initiates bypass operation. |
| 0.01 | Main turbine stop valves reach 90% open position and initiate reactor scram trip. |
| 0.01 | Main turbine stop valves reach 80% open position and initiate a recirculation pump trip (RPT) |
| 0.1 | Turbine stop valves closed. |
| 0.1 | Turbine bypass valves start to open to regulate pressure. |
| 1.7 | Group 1 relief valves actuated. |
| 1.9 | Group 2 relief valves actuated. |
| 2.2 | Group 3 relief valves actuated. |
| 2.4 | Group 4 relief valves actuated. |
| 2.6 | Group 5 relief valves actuated. |
| 4.3 | L8 vessel level set point trips feedwater pumps. |
| 10.1 | Group 1 relief valves close. |
| 44.8 | Vessel water level decreases to L2 vessel level set point. |
| 75 (est.) | HPCI/RCIC flow enters vessel not simulated). |

TABLE 15E.2.4-1

SEQUENCE OF EVENTS FOR MSIV CLOSURE, FIGURE 15E.2.4-1

| TIME, SEC | EVENT |
|---|---|
| 0 | Initiate closure of all main steam line isolation valves (MSIV). |
| 0.30 | MSIVs reach 90%* open. |
| 0.36 | MSIV position trip scram initiated. |
| - | Group 1 safety valves assumed to be out of service |
| 3.7 | Group 2 safety valves open. |
| 3.8 | Group 3 safety valves open. |
| ~20 | All safety valves reclose (estimate). |
| 23.0 | Group 1 pressure relief valves reopen. |
| 29.0 | Group 1 pressure relief valves reclose. |
| 36.0 | Group 1 pressure relief valves reopen. |
| 40.0 | Group 1 pressure relief valves reclose. |

Valves opening based on safety settings is conservative
*Changed to 85% with no significant impact on transient results.

TABLE 15E.2.5-1

TYPICAL RATES OF DECAY FOR CONDENSER VACUUM

| CAUSE | ESTIMATED VACUUM DECAY RATE |
|---|---|
| 1. Failure or Isolation of Steam Jet Air Ejectors | <1 inch Hg/minute |
| 2. Loss of Sealing Steam to Shaft Gland Seals | ~1 to 2 inches Hg/minute |
| 3. Opening of Vacuum Breaker Valves | ~2 to 12 inches Hg/minute |
| 4. Loss of One or More Circulating Water Pumps | ~4 to 24 inches Hg/minute |

TABLE 15E.2.5-2

LOSS OF CONDENSER VACUUM
SEQUENCE OF EVENTS FOR FIGURE 15E.2.5-1

| TIME, SEC | EVENT |
|---|---|
| -0.0 (est) | Initiate simulated loss of condenser vacuum at 2 inches of Hg per second. |
| 0.0 (est) | Low condenser vacuum main turbine trip actuated. |
| 0.0 (est) | Low condenser vacuum feedwater trip actuated. |
| -0.01 (est) | Main turbine trip initiates reactor scram. |
| 0.01 (est) | Main turbine trip initiates recirculation pump trip (RPT) |
| .1 (est) | Turbine stop valve closes. |
| 1.7 | Group 1 relief valves set points actuated. |
| 1.9 | Group 2 relief valves set points actuated. |
| 2.2 | Group 3 relief valves set points actuated. |
| 2.4 | Group 4 relief valves set points actuated. |
| 6.5 | Low condenser vacuum initiates main steam line isolation valve closure. |
| 6.5 | Low condenser vacuum initiates bypass valve closure. |
| 21.5 | Group 1 relief valves close. |
| 23.5 | Vessel water level decreases to L2 vessel level set point. |
| 53 (est) | HPCI/RCIC system flow enters vessel (not included in simulation). |
| 90+ | Relief valves cycle as required on pressure. |

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TABLE 15E.2.5-3

TRIPS SIGNALS ASSOCIATED WITH LOSS OF CONDENSER VACUUM

| VACUUM (INCHES OF HG) | PROTECTIVE ACTION INITIATED |
|---|---|
| 27 to 28 | Normal Vacuum Range |
| 21.7 | Main Turbine Trip (Stop Valve Closure) |
| 10.2 | Main Steam Line Isolation Valve (MSIV) Closure |
| 7 | Mainsteam Turbine Bypass Valves Closure |
| 17.4 | Reactor Feed Pump Turbine Trip (Stop Valves Closure) |

TABLE 15E.2.6-1

LOSS OF AUXILIARY POWER
SEQUENCE OF EVENTS FOR FIGURE 15E.2.6-1

| TIME, SEC | EVENT |
|---|---|
| 0 | Loss of auxiliary power transformer occurs. |
| 0 | Recirculation system pump motors are tripped. |
| 0 | Condensate booster pumps are tripped. |
| 0 | Condenser circulating water pumps tripped. |
| 2.0 | Closure of main steamline isolation valves initiated. |
| 2.0 | Reactor scram initiated. |
| 4.0 | Feedwater turbines tripped off. |
| 4.4 | Group 1 Safety/Relief valves actuated. |
| 21 | Group 1 Safety/Relief valves closed. |
| 32 | Initiate HPCI and RCIC operation (not simulated). |

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TABLE 15E.2.6-2

LOSS OF ALL GRID CONNECTIONS
SEQUENCE OF EVENTS FOR FIGURE 15E.2.6-2

| TIME, SEC | EVENT |
|---|---|
| (-)0.015 (approx.) | Loss of Grid causes turbine-generator to detect a loss of electrical load. |
| 0 | Control valve fast closure. |
| 0 | Turbine-generator trip initiates main turbine bypass system operation. |
| 0 | Recirculation system pump motors are tripped. |
| 0 | Fast control valve closure (FCV) initiates a reactor scram trip. |
| 0 | Initiation of standby AC power systems. |
| 0.1 | Turbine bypass valves open. |
| 0.15 | Turbine control valves closed. |
| 1.2 | Group 1 relief valves actuated. |
| 1.4 | Group 2 relief valves actuated. |
| 1.5 | Group 3 relief valves actuated. |
| 1.7 | Group 4 relief valves actuated. |
| 2.0 | MSIV's start to closure. |
| 4.0 | Feedwater turbines tripped off. |
| 18.7 | Group 1 safety relief valves close. |
| 37.2 | Initiate Containment Isolation, HPCI and RCIC operation, (L2) (not simulated). |

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TABLE 15E.2.7-1

LOSS OF FEEDWATER FLOW
SEQUENCE OF EVENTS FOR FIGURE 15E.2.7-1

| TIME, SEC | EVENT |
|---|---|
| 0 | Trip of all feedwater pumps initiated. |
| 5.0 | Feedwater flow decays essentially to zero. |
| 5.1 | Recirculation pumps runback, low feed water flow |
| 6.8 | Vessel water level (L3) trip initiates scram trip. |
| 52.8 | Vessel water level (L2) trip initiates recirculation pump system trip. |
| 52.8 | Vessel water level (L2) trip initiates containment isolation. |
| 82.8 | Vessel water level (L2) trip initiates RCIC operation – (30 sec. delay) (HPCI not simulated) |
| | The MSIVs will not close until water level reaches L1. Water level is not expected to reach L1 during this event since RCIC initiates at L2. |
| | SRVs Do Not Open |

TABLE 15E.2.9-1

SEQUENCE OF EVENTS FOR FAILURE OF RHR SHUTDOWN COOLING

| TIME | EVENT |
|---|---|
| 0 | Reactor is operating at 102% of rated thermal power when LOP transient occurs initiating plant shutdown |
| 0 | Concurrently loss of one division of power occurs |
| 10 min. | Controlled depressurization initiated (100°F/hr) and continues until vessel pressure reaches approximately 115 psia |
| 15 min. | Operators initiate suppression pool cooling |
| 140 min. | When vessel pressure reaches 115 psia, a failure in a shutdown cooling suction valve prevents operation of normal shutdown cooling |
| 170 min. | Operator initiates core spray for use with alternate shutdown cooling. Operator opens ADS valves to achieve continuous core flow |
| 6.5 hrs | Peak suppression pool temperature is attained |

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TABLE 15E.2.9-2

INPUT PARAMETERS FOR EVALUATION OF FAILURE
OF RHR SHUTDOWN COOLING

| | |
|---|---|
| Core Thermal Power (MWt) | 4031 |
| Initial RPV Pressure (psia) | 1050 |
| Initial Vessel Temperature (°F) | 550 |
| Suppression Pool Temperature (°F) | 90 |
| Suppression Pool Liquid Volume ($ft^3$) | 115,810 |
| Service Water Temperature (°F) | 97 |
| RHR Heat Exchanger K-value (Btu/sec-°F) | 317.5 |
| RHR Pool Cooling Flow Rate (gpm) | 9750 |
| Core Spray (1 Loop) Flow Rate (gpm) | 7900 |

TABLE 15E.3.1-1

SEQUENCE OF EVENTS FOR TRIP OF ONE RECIRCULATION PUMP

| TIME, SEC | EVENT |
|---|---|
| 0 | Trip of one recirculation pump initiated. |
| 5.7 | Diffuser flow decreases significantly in the tripped loop. |
| 30.0 | Core flow stabilizes at new equilibrium conditions. |
| 42.0 | Power level stabilizes at new equilibrium conditions |

TABLE 15E.3.1-2

SEQUENCE OF EVENTS FOR TRIP OF TWO RECIRCULATION PUMPS

| TIME, SEC | EVENT |
|---|---|
| 0 | Trip of both recirculation pumps initiated. |
| 4.0 | Vessel water level (L8) trip initiates turbine trip. |
| 4.0 | Feedwater pumps are tripped off. |
| 4.0 | Turbine trip initiates bypass operation. |
| 4.0 | Turbine trip initiates reactor scram trip. |
| 7.0 | Group 1 pressure relief valves open. |
| 12.0 | Group 1 pressure relief valves closed. |
| 46.0 | L2 vessel level set point initiate HPCI and RCIC. |
| 76 | HPCI/RCIC flow enter vessel (not simulated). |

TABLE 15E.4.4-1

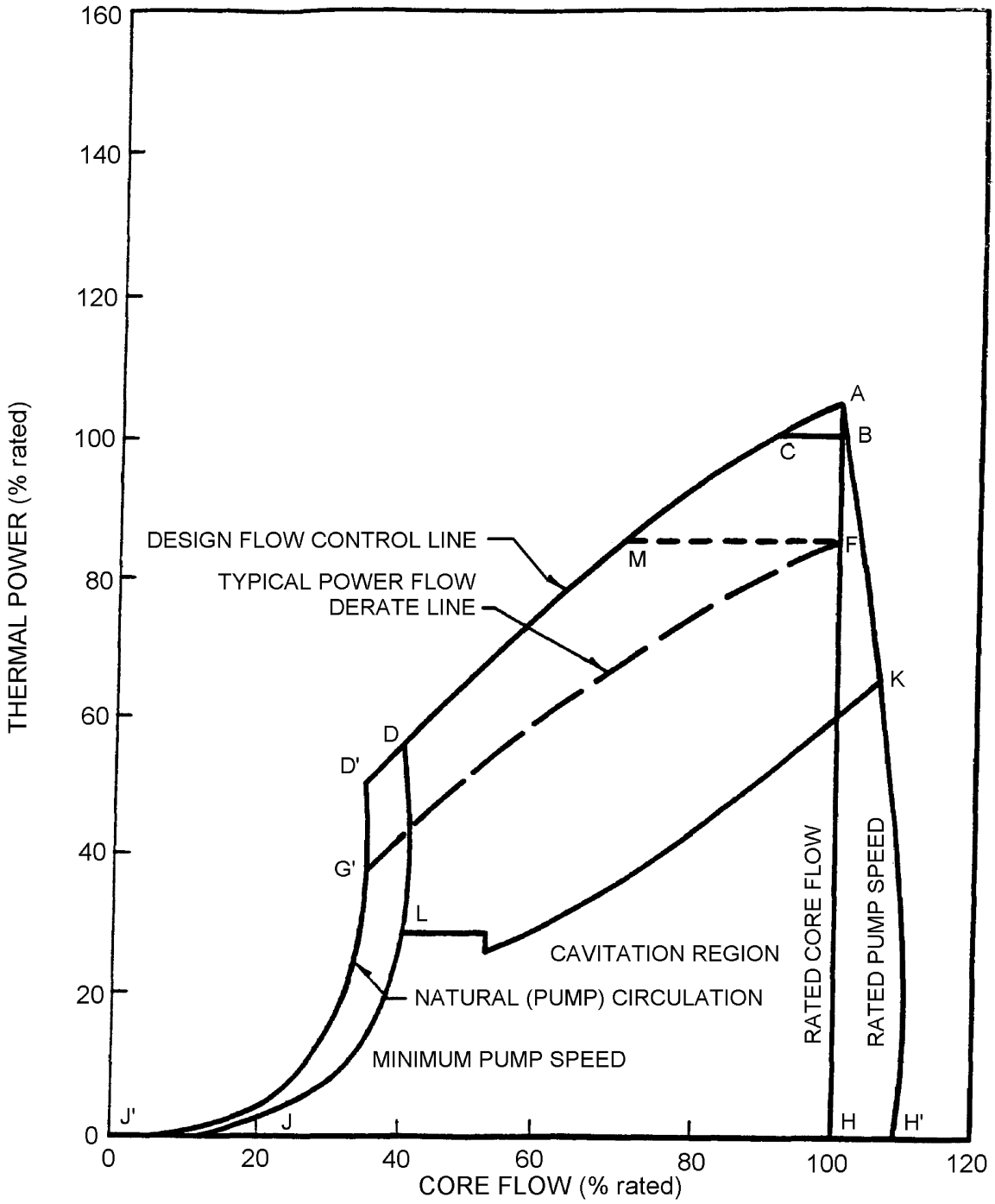
SEQUENCE OF EVENTS ABNORMAL STARTUP OF IDLE RECIRCULATION PUMP FOR FIGURE 15E.4.4-1

| TIME, SECOND | EVENT |
|---|---|
| 0 | Start pump motor. |
| 9.0 | Startup loop flow starts to increase significantly. |
| 10.0 | Reactor high flux scram initiated. |
| 11.0 | Vessel level reaches (L4) Low Level Alarm. |
| 23.5 | Vessel level reaches (L3) Low Level Scram Trip. |
| 35.0 | Diffuser flows and pressures begin to stabilize. |
| 50.0 | Vessel level begins to stabilize. |

**TABLE 15E.5.1-1**

**SEQUENCE OF EVENTS FOR INADVERTENT STARTUP OF HPCI**

| Time, sec. | Event |
|---|---|
| 0.0 | Simulate HPCI cold water injection |
| 1.0 | Full flow established for HPCI |
| | No reactor scram |
| | No recirculation pump trip |
| | No SRV flow |
| ≈50 | Reactor variables settle into new steady state |




FSAR REV.65

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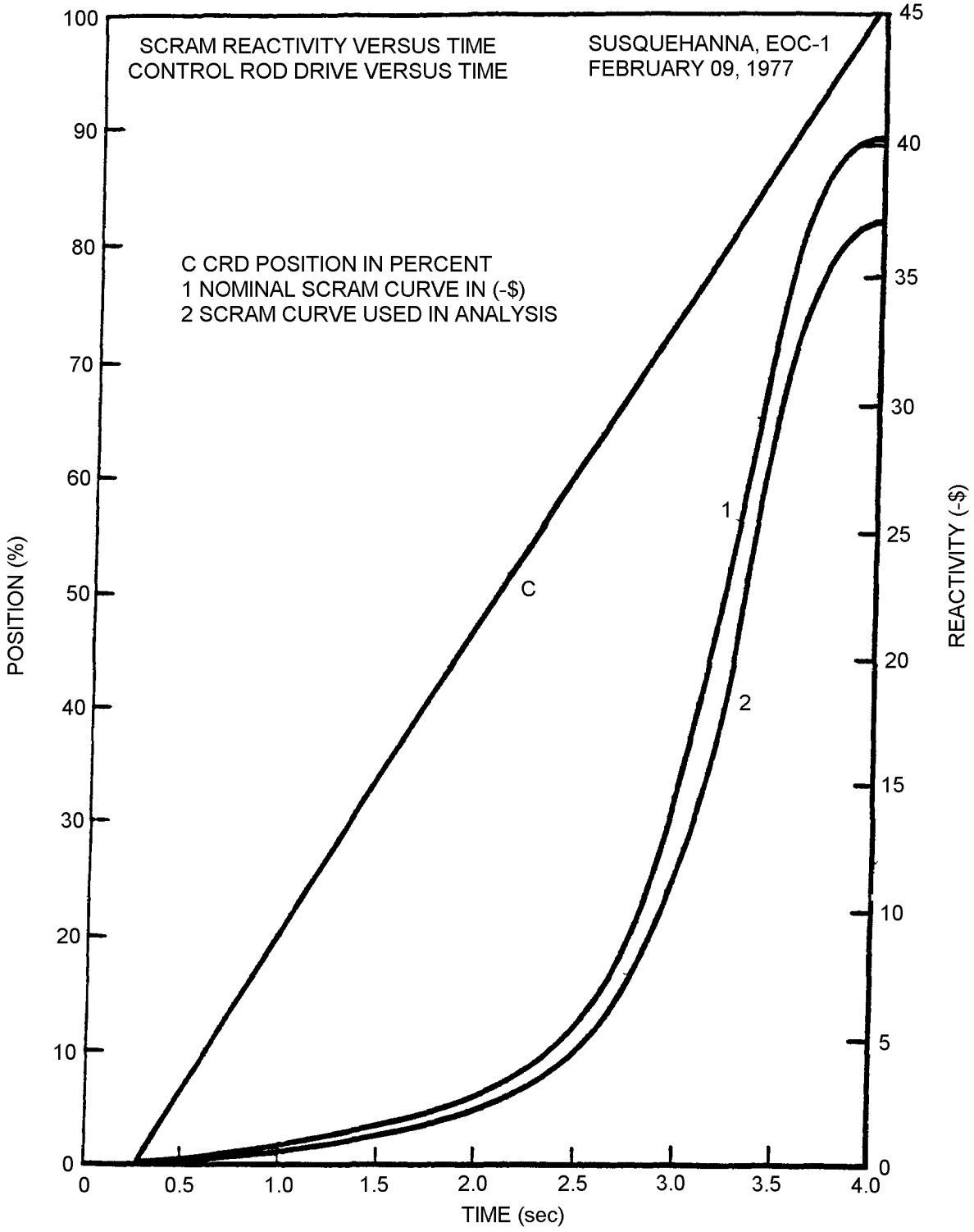
| SUSQUEHANNA STEAM ELECTRIC STATION<br>UNITS 1 & 2<br>FINAL SAFETY ANALYSIS REPORT |
| TYPICAL POWER/FLOW MAP<br><br>FIGURE 15E.0-1, Rev 54 |

AutoCAD: Figure Fsar 15E_0_1.dwg

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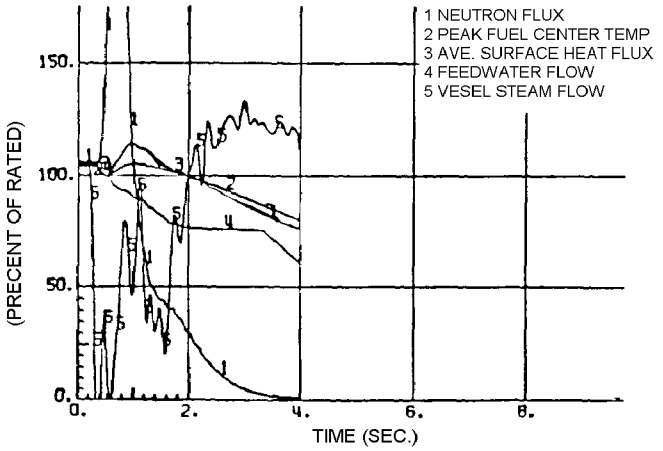
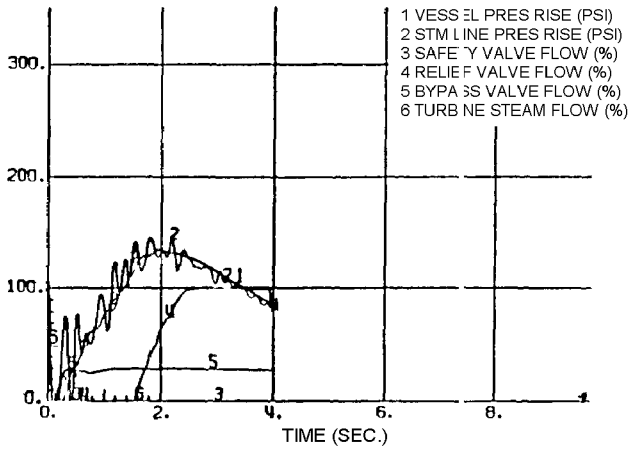
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

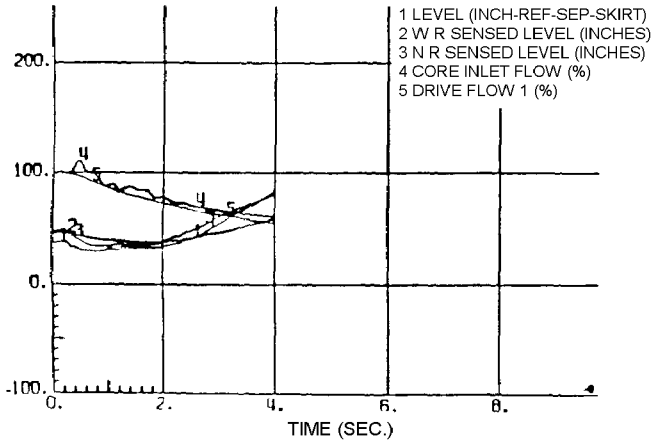
SCRAM POSITION
AND
REACTIVITY CHARACTERISTICS

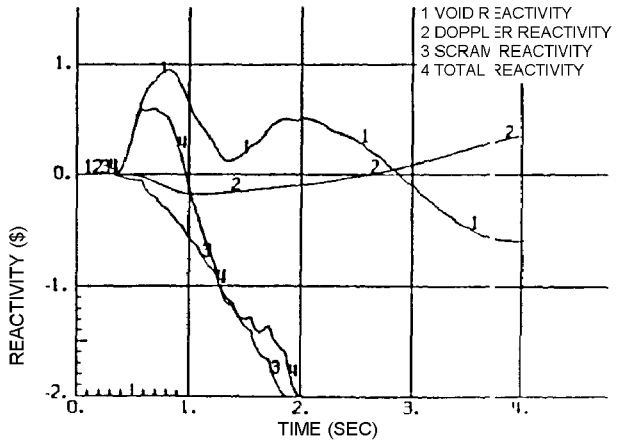
FIGURE 15E.0-2, Rev 54

AutoCAD: Figure Fsar 15E_0_2.dwg

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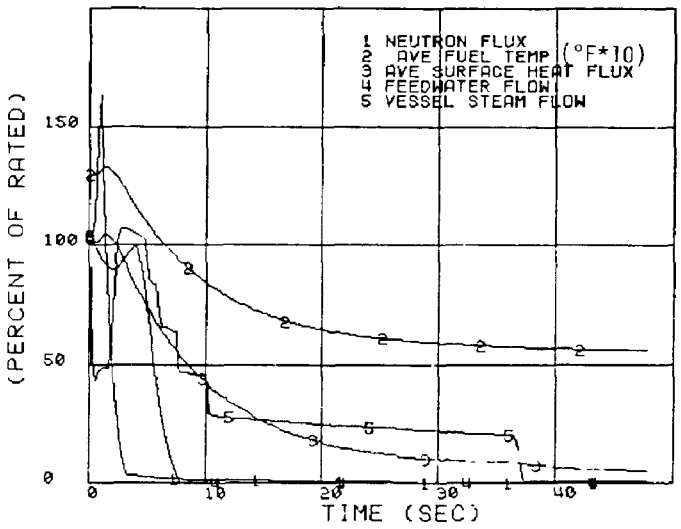
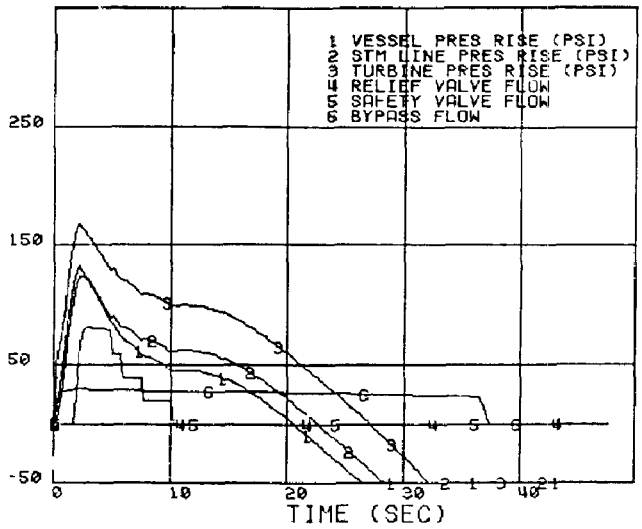
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

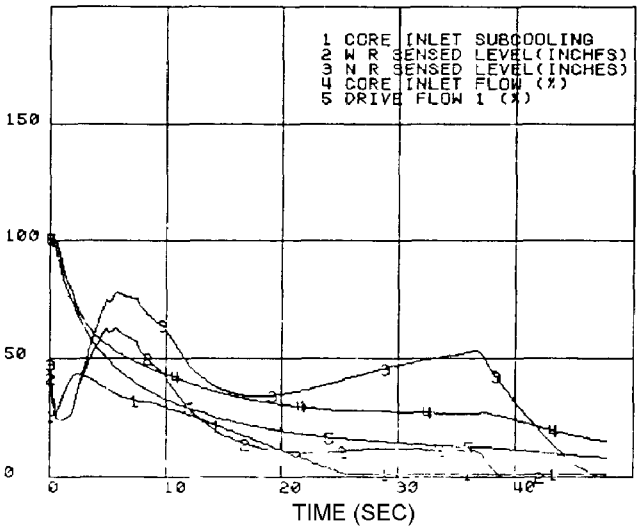
SUSQUEHANNA GENERATOR
LOAD REJECTION,
WITH BYPASS ON

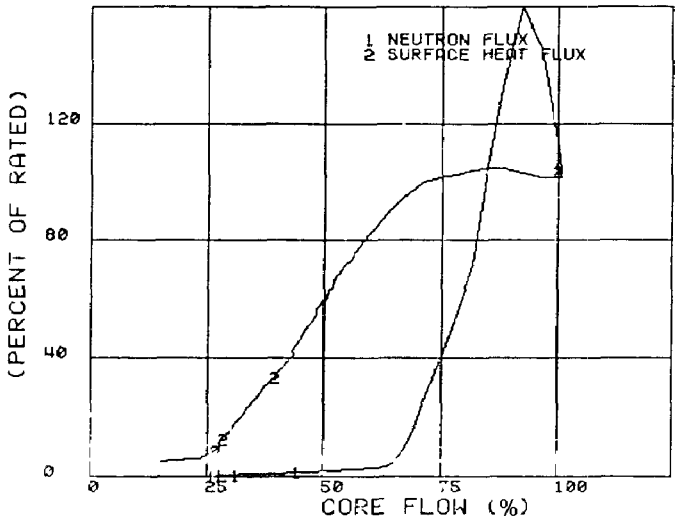
FIGURE 15E.2.2-1, Rev 54

AutoCAD: Figure Fsar 15E_2_2_1.dwg

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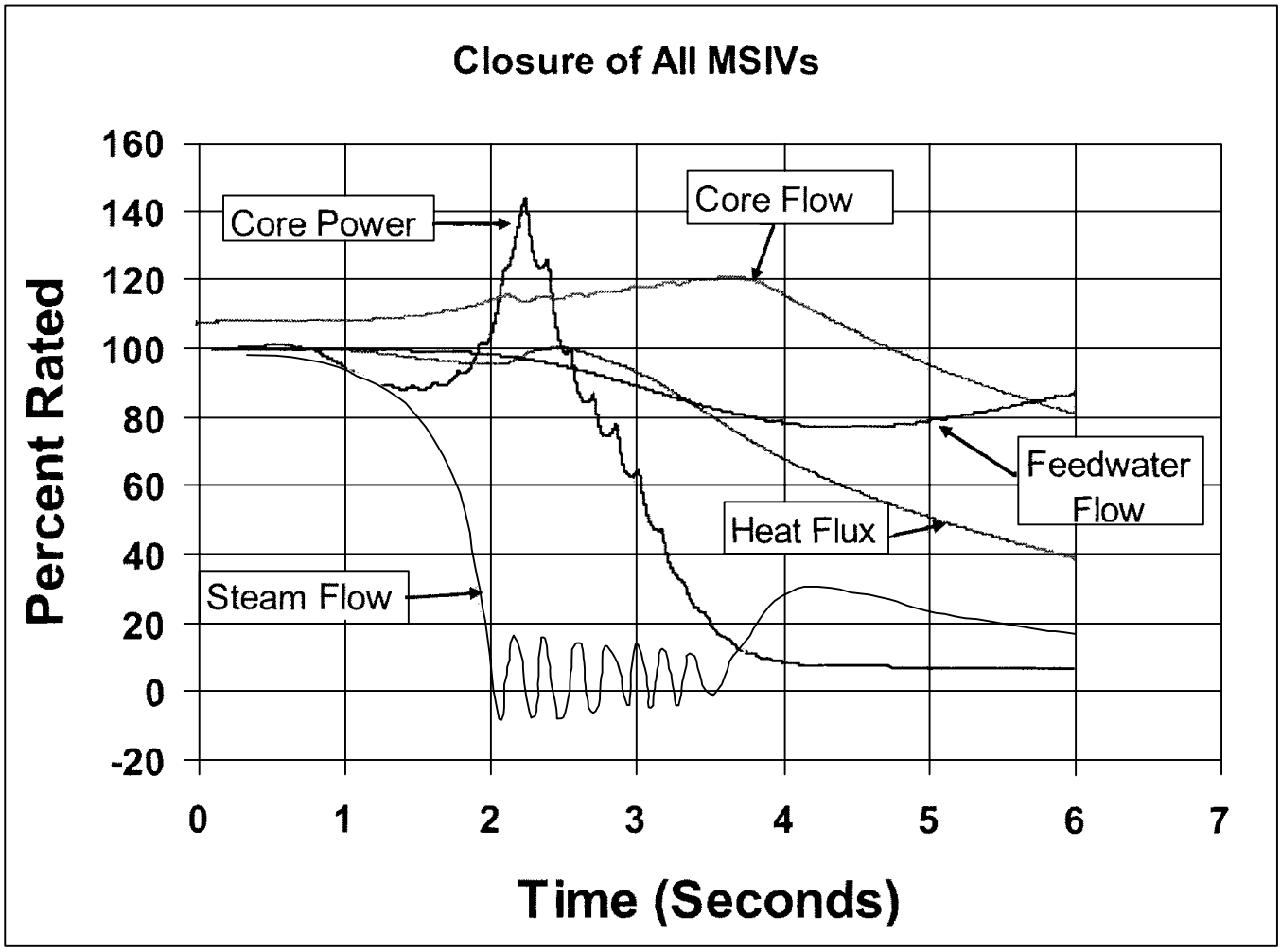
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

TURBINE TRIP,
TRIP SCRAM,
BYPASS AND RPT-ON

FIGURE 15E.2.3-1, Rev 54

AutoCAD: Figure Fsar 15E_2_3_1.dwg

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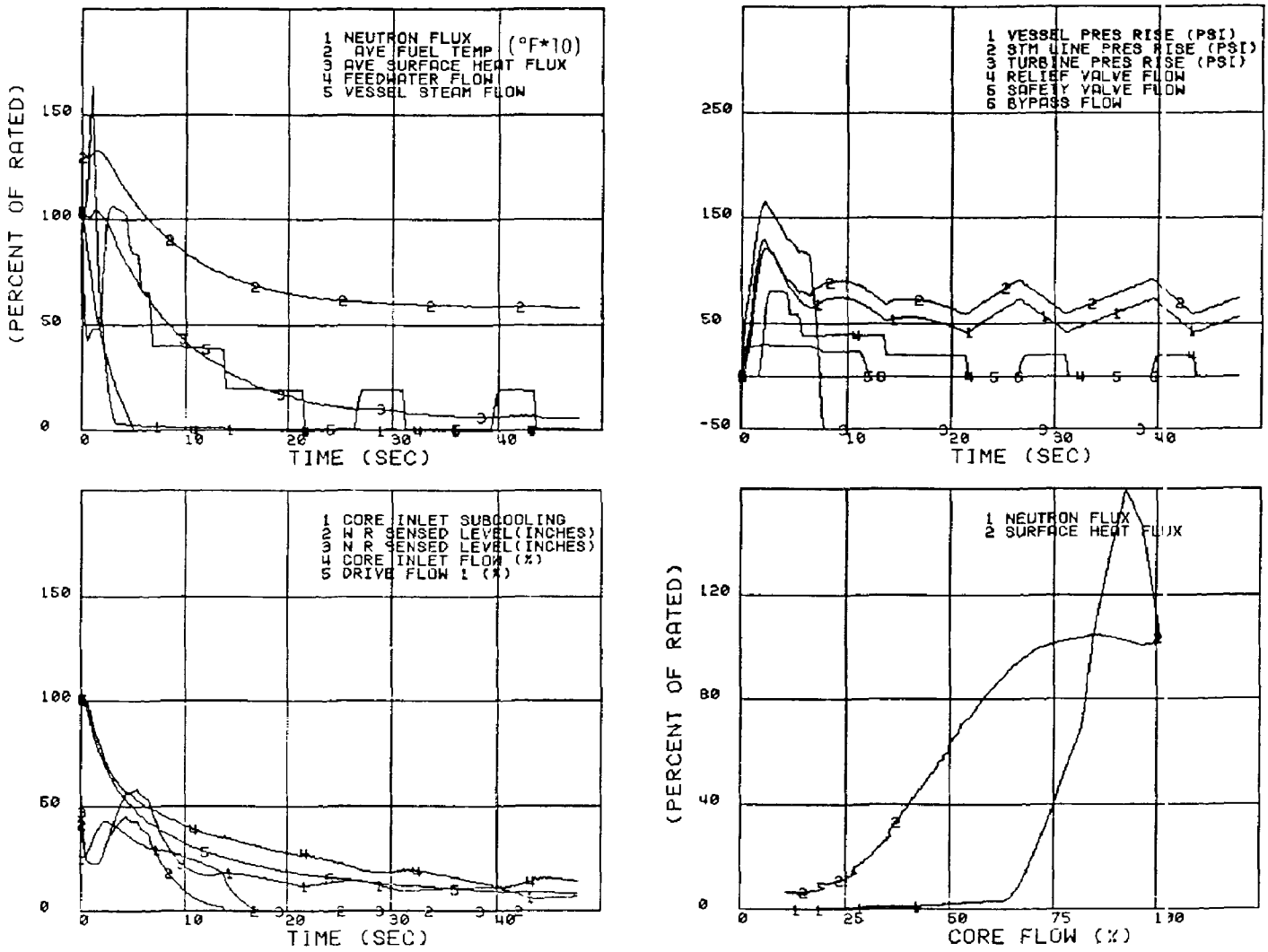
| SUSQUEHANNA STEAM ELECTRIC STATION<br>UNITS 1 & 2<br>FINAL SAFETY ANALYSIS REPORT |
| CLOSURE OF ALL MSIVs<br><br>FIGURE 15E.2.4-1, Rev 55 |

AutoCAD: Figure Fsar 15E_2_4_1.dwg

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
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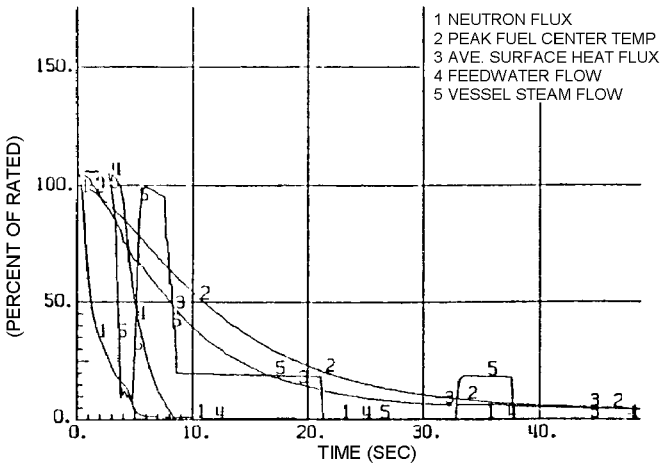
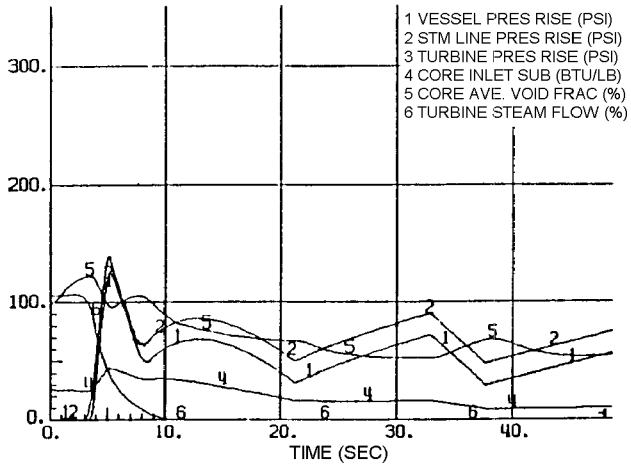
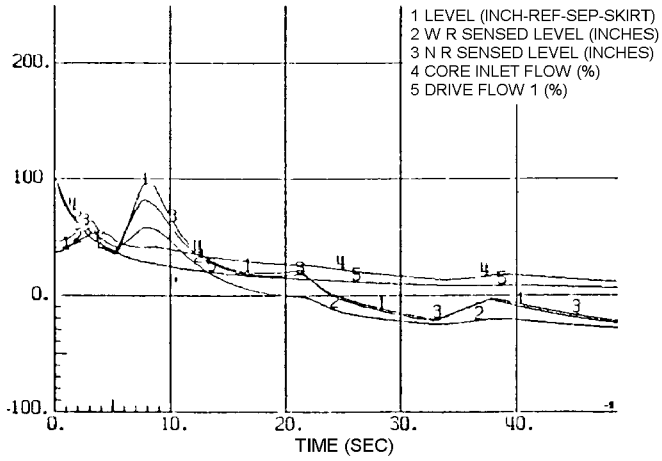
LOSS OF
CONDENSER VACUUM AT
2 INCHES PER SECOND

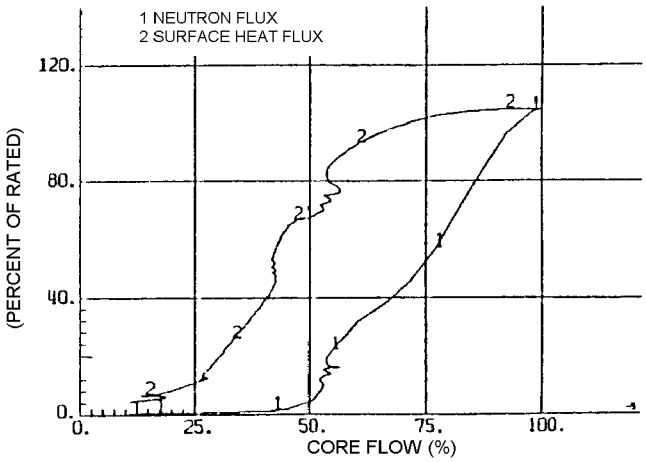
FIGURE 15E.2.5-1, Rev 54

AutoCAD: Figure Fsar 15E_2_5_1.dwg

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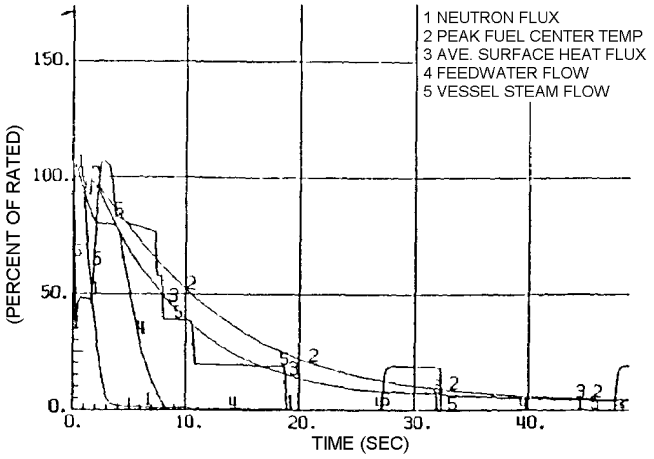
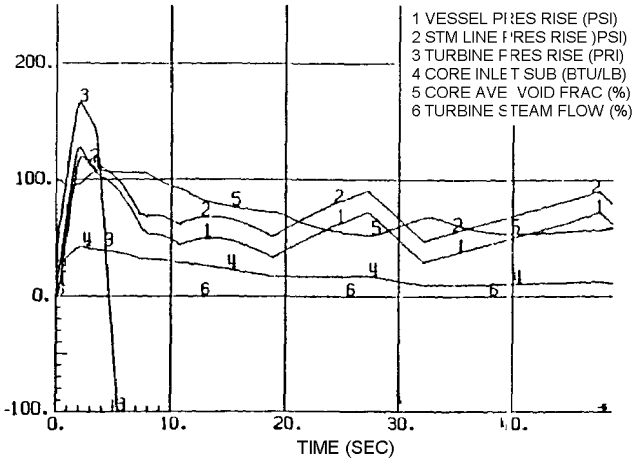
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

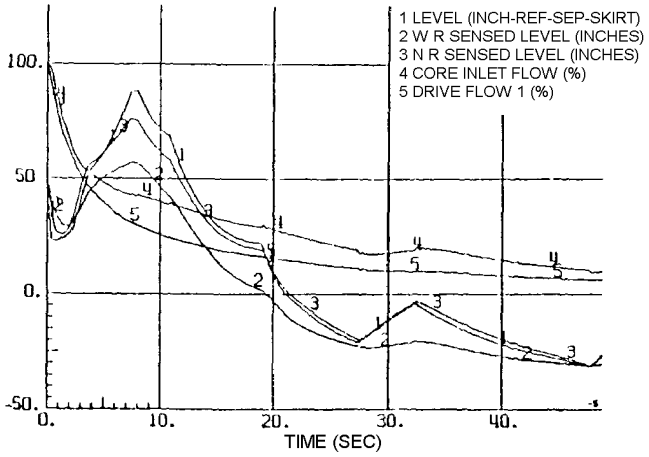
LOSS OF
AUXILIARY POWER
TRANSFORMER

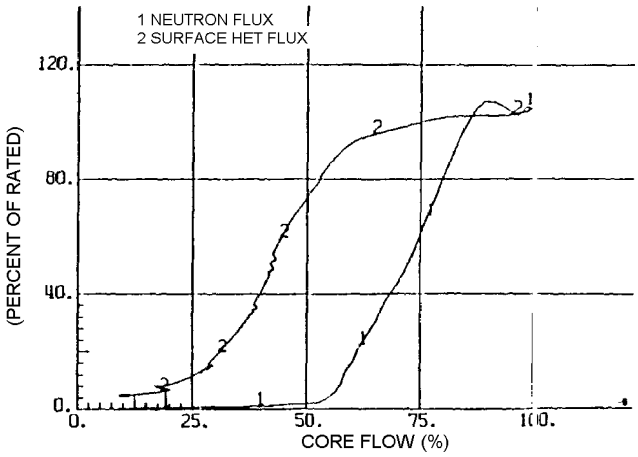
FIGURE 15E.2.6-1, Rev 54

AutoCAD: Figure Fsar 15E_2_6_1.dwg

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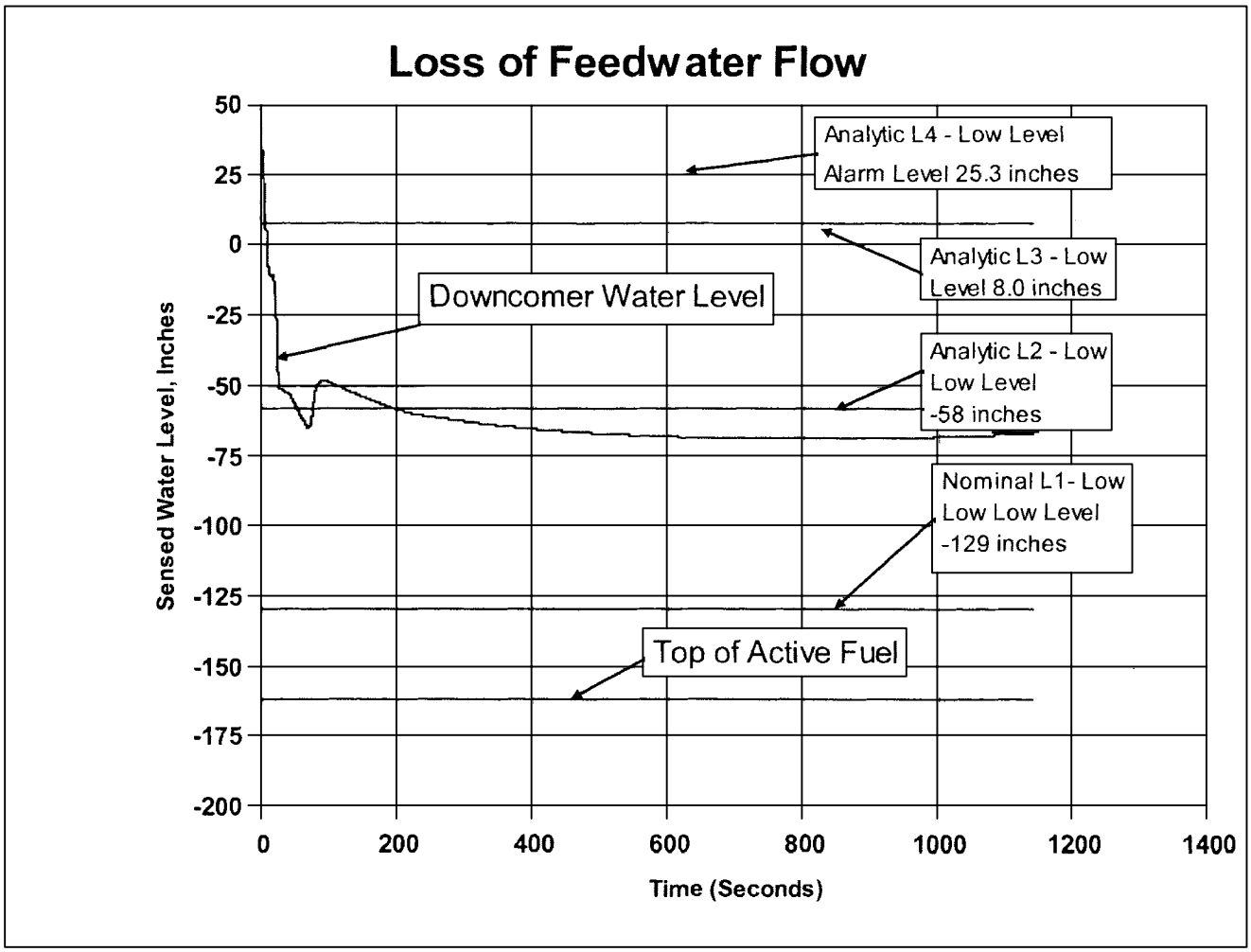
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

LOSS OF ALL GRID CONNECTIONS

FIGURE 15E.2.6-2, Rev 54

AutoCAD: Figure Fsar 15E_2_6_2.dwg

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
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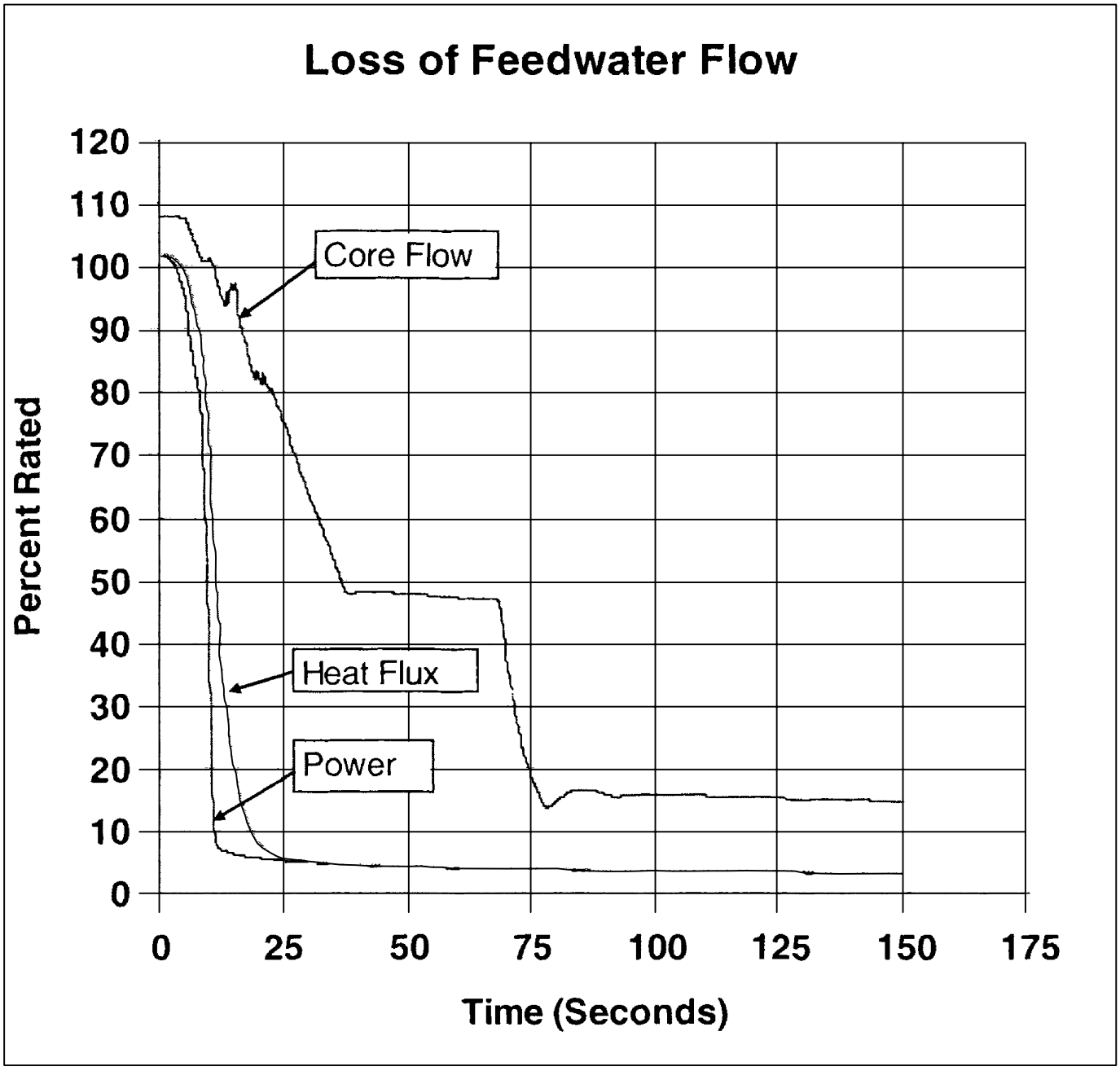
LOSS OF FEEDWATER
SENSED WATER LEVEL

FIGURE 15E.2.7-1, Rev 55

AutoCAD: Figure Fsar 15E_2_7_1.dwg

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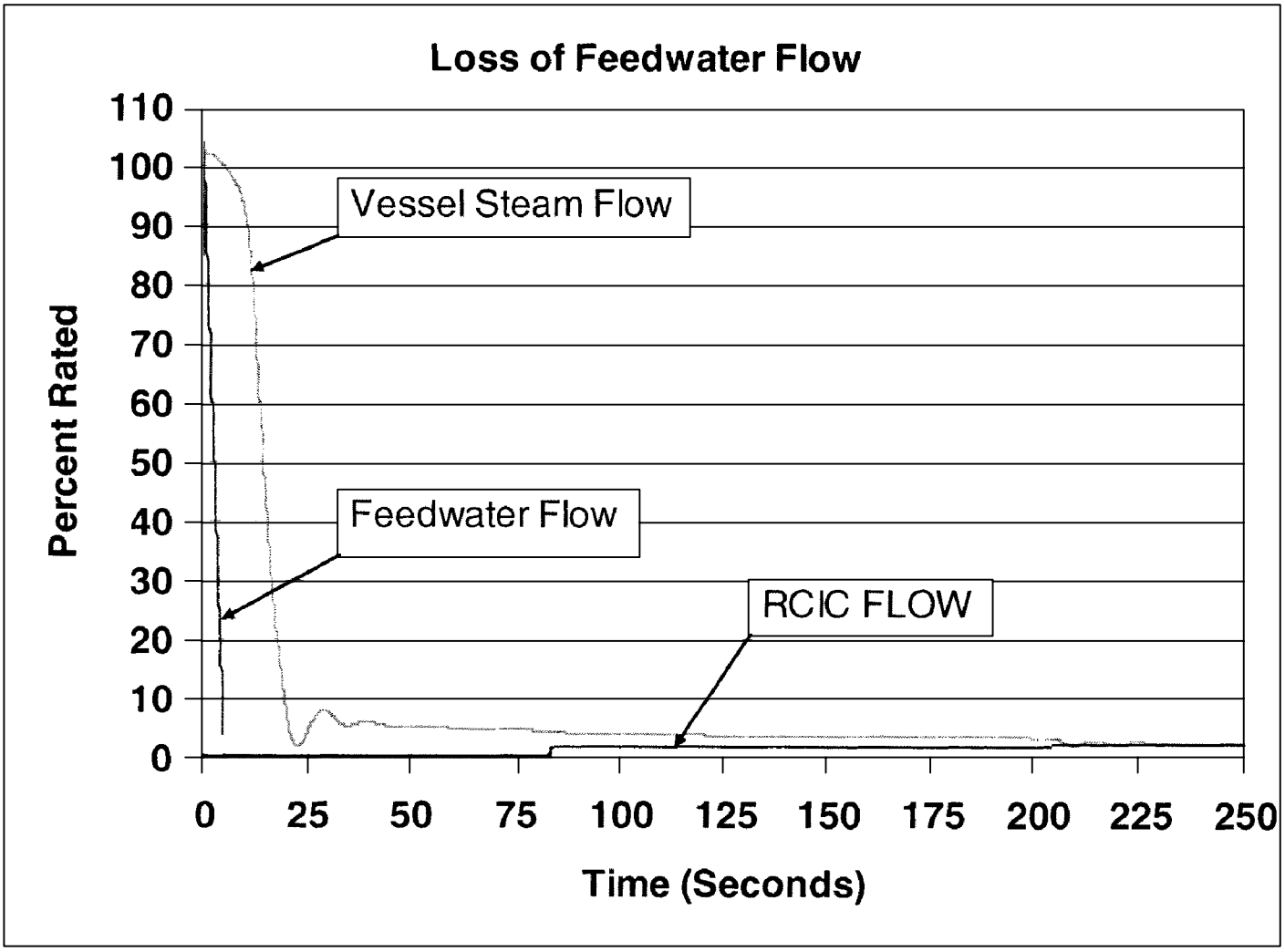
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

LOSS OF FEEDWATER
CORE POWER, HEAT FLUX AND CORE FLOW

FIGURE 15E.2.7-2, Rev 1

AutoCAD: Figure Fsar 15E_2_7_2.dwg

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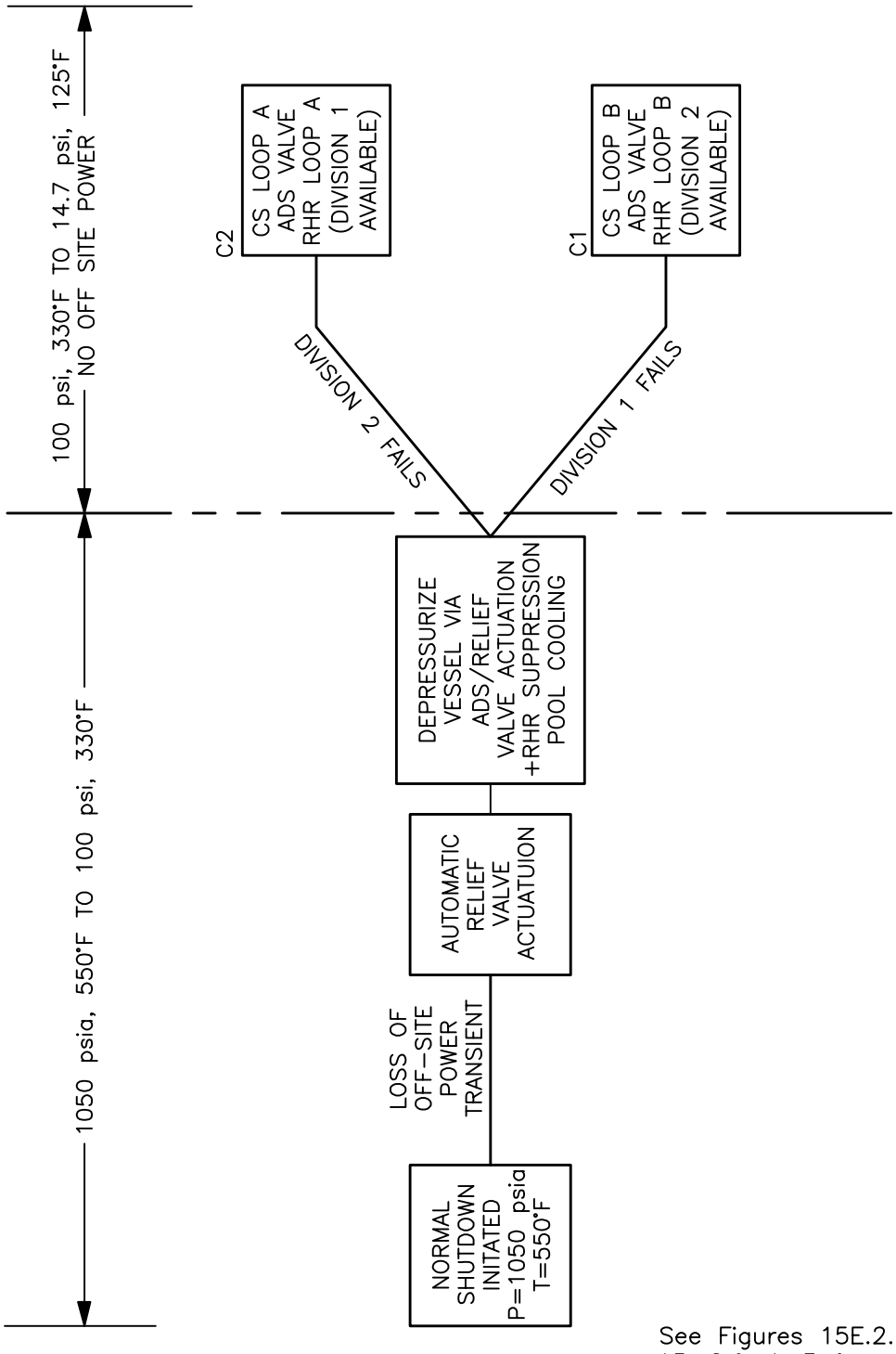
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

LOSS OF FEEDWATER
FEEWATER FLOW, STEAM FLOW AND RCIC FLOW

FIGURE 15E.2.7-3, Rev 1

AutoCAD: Figure Fsar 15E_2_7_3.dwg




See Figures 15E.2.9-1-2 & 15e.2.9-1-3 for notes.

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

ADS/RHR COOLING LOOPS

FIGURE 15E.2.9-1-1, Rev 55

AutoCAD: Figure Fsar 15E_2_9_1_1.dwg

# NOTES FOR FIGURE 15E.2.9.1–1

## ACTIVITY A

Initial pressure = 1050 psia
initial temperature = 550°F

For purposes of this analysis, the followinng worst-case conditions are assumed to exist.

(1) the reactor is assumed to be operating at 100% nuclear boiler rated steam flow;

(2) a loss of power transient occurs;

(3) a simultaneous loss of onsite power (Division 1 or Division 2), which eventually results in the operator not being able to open one of the RHR shutdown cooling line suction valves.

## ACTIVITY B

Initial system pressure = 1050 psia
initial system temperature = 550°F

Operator Actions

During approximately the first 30 minutes, reactor decay heat is passed to the suppression pool by the automatic operation of the reactor relief valves. Reactor water level will be returned to normal by the HPCI and RCIC system automatic operation.

After approximately 10 minutes, it is assumed one RHR heat exchanger will be placed in the suppression pool cooling mode to remove decay heat. The operator will then initiate depressurization of the reactor vessel to control vessel pressure. Controlled depressurization procedures consisit of controlling vessel pressure and water level by using the ADS, RCIC and/or HPCI systems.

When the reactor pressure approaches 100 psig, the operator would normally prepare for operation of the RHR system in the shutdown cooling mode.

# NOTES FOR FIGURE 15E.2.9.1−1

## ACTIVITY C1

(Division 1 fails, Division 2 available) (Figure 15E.2.9-5)

System pressure - 100psi
System temperature - 330°F

Operator Actions

The operator establishes a closed cooling path as follows:

(1) One ADS valve (DC Division 2) is powered open;

(2) Water is pumped from the suppression pool into the reactor vessel. The cooled suppression pool water picks up decay heat and flows out of the vessel through the open ADS valves and back to the suppression pool as shown in Figure 15E.2.9-5. The RHR B loop is used to cool the suppression pool as required.

## ACTIVITY C2

(Division 2 fails, Division 1available) (Figure 15E.2.9-6)

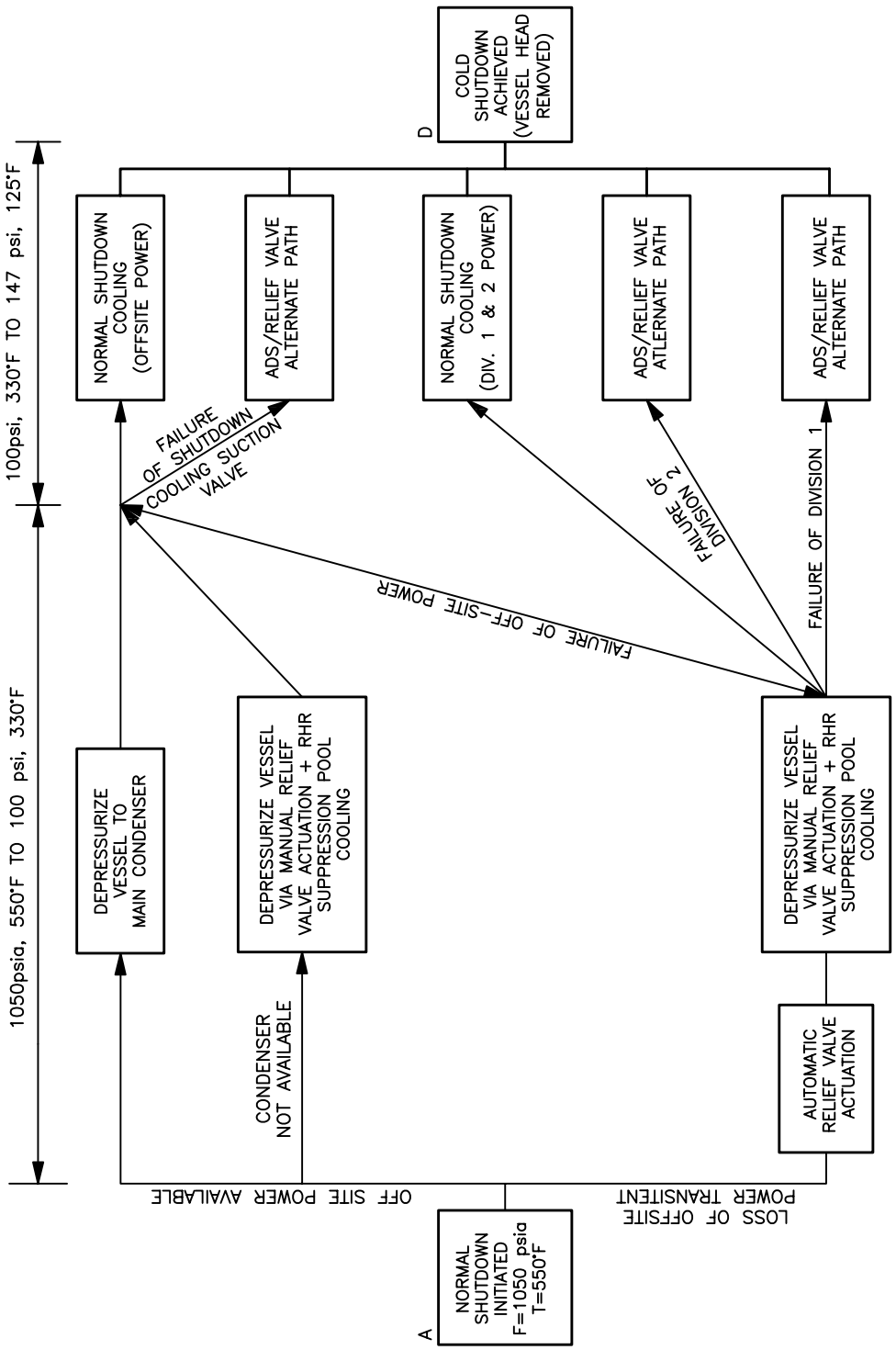
System pressure - 100psi
System temperature - 330°F

Operator Actions

The operator establishes a closed cooling path as follows:

(1) One ADS valve (DC Division 1) is powered open;

(2) Water is pumped from the suppression pool and into the reactor vessel as shown in Figure 15E.2.9-6. The cooled suppression pool water picks up decay heat and flows out of the vessel through the open ADS valves and back to the suppression pool. The RHR loop is used to cool the suppression pool as required. Cold shutdown (P=14.7psia. T RPV=200°F is reached in approxiamately 36 hours.)

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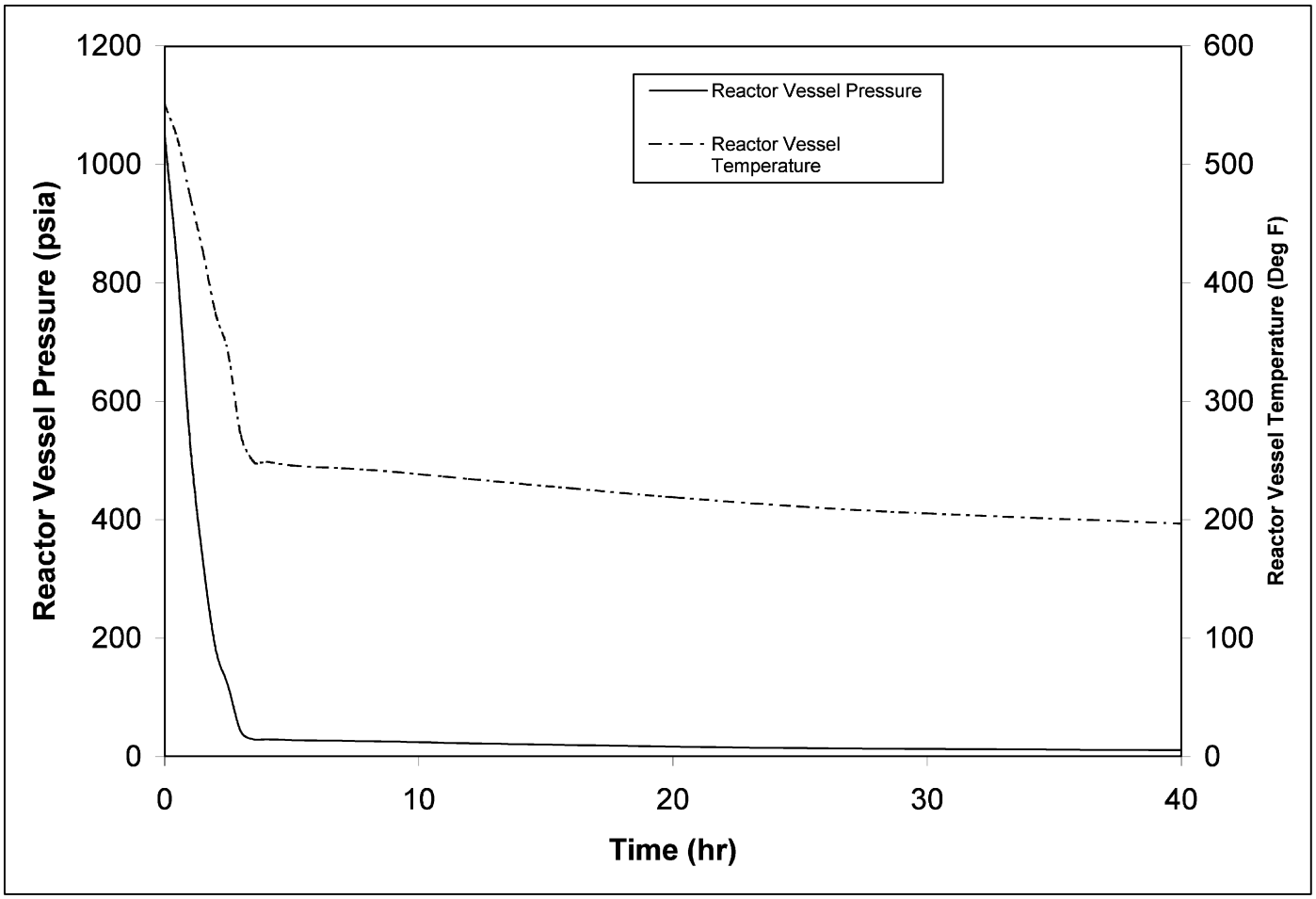
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

SUMMARY OF PATHS
AVAILABLE TO ACHIEVE
COLD SHUT DOWN

FIGURE 15E.2.9-2, Rev 55

AutoCAD: Figure Fsar 15E_2_9_2.dwg

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SUSQUEHANNA STEAM ELECTRIC STATION
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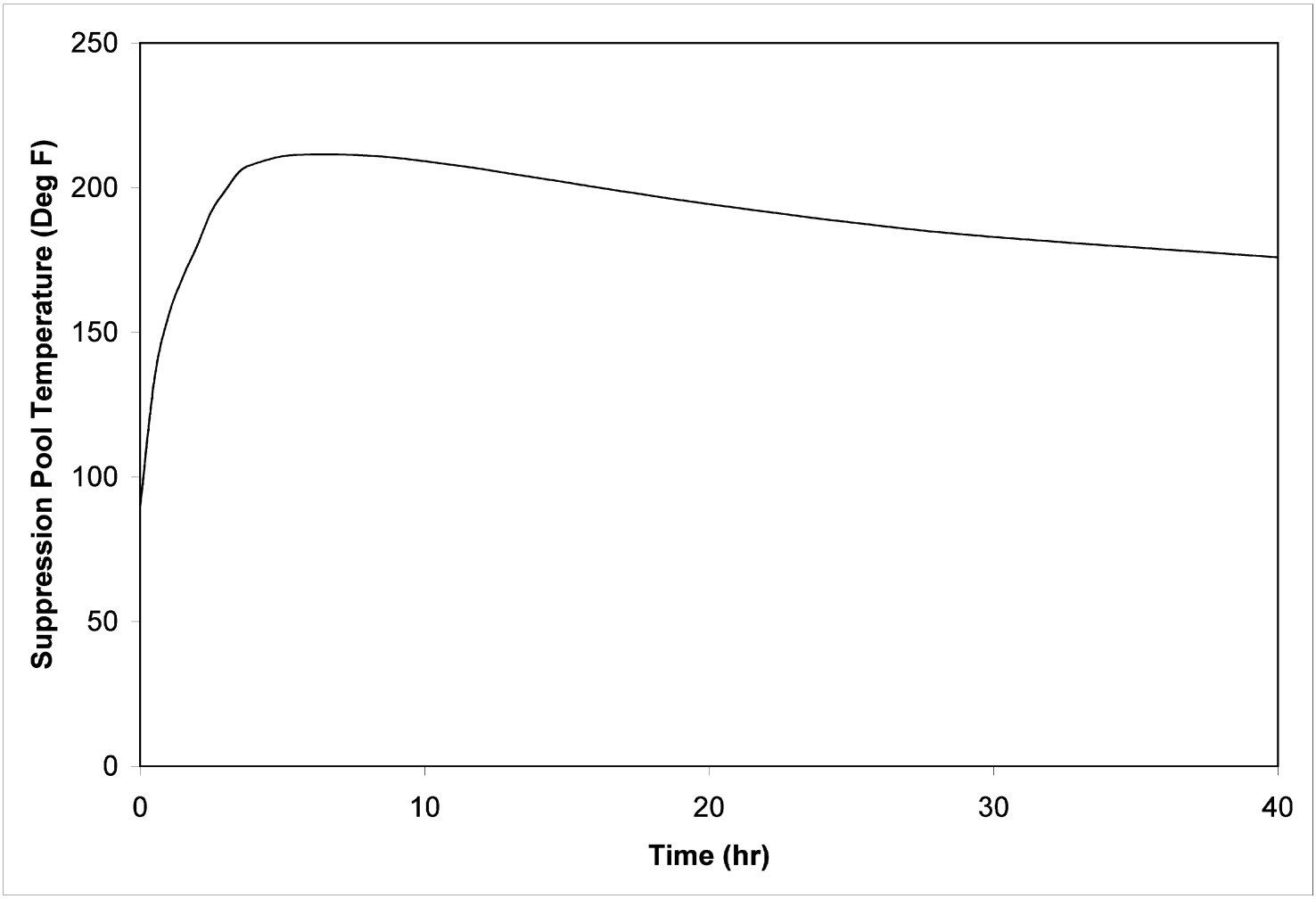
FINAL SAFETY ANALYSIS REPORT

VESSEL TEMPERATURE AND
PRESSURE VERSUS TIME
(ACTIVITY C1 OR C2)

FIGURE 15E.2.9-3, Rev 55

AutoCAD: Figure Fsar 15E_2_9_3.dwg

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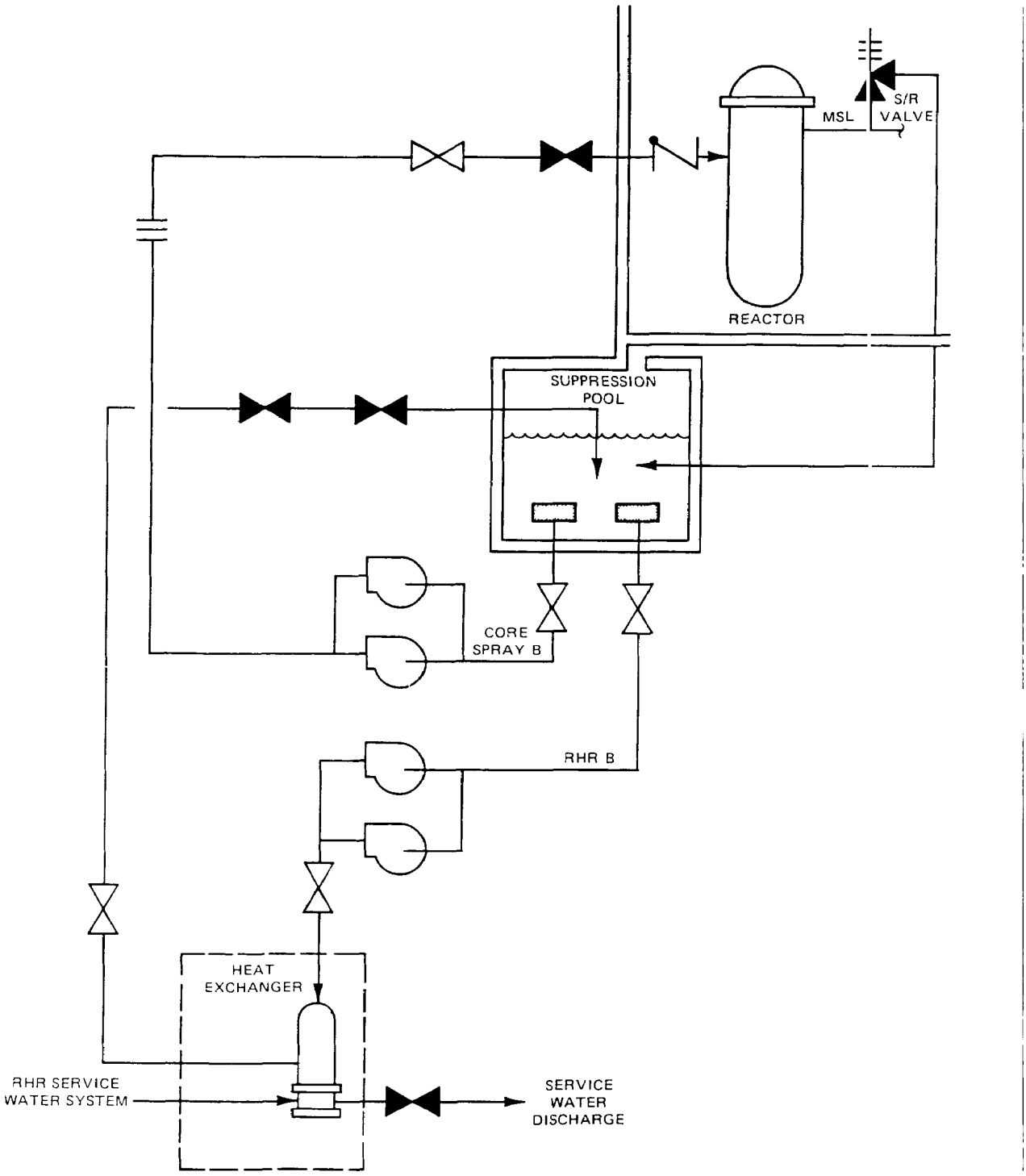
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

SUPPRESSION POOL TEMPERATURE
VERSUS TIME (90° SERVICE
WATER TEMPERATURE)
CAPACITY C1 OR C2

FIGURE 15E.2.9-4, Rev 55

AutoCAD: Figure Fsar 15E_2_9_4.dwg

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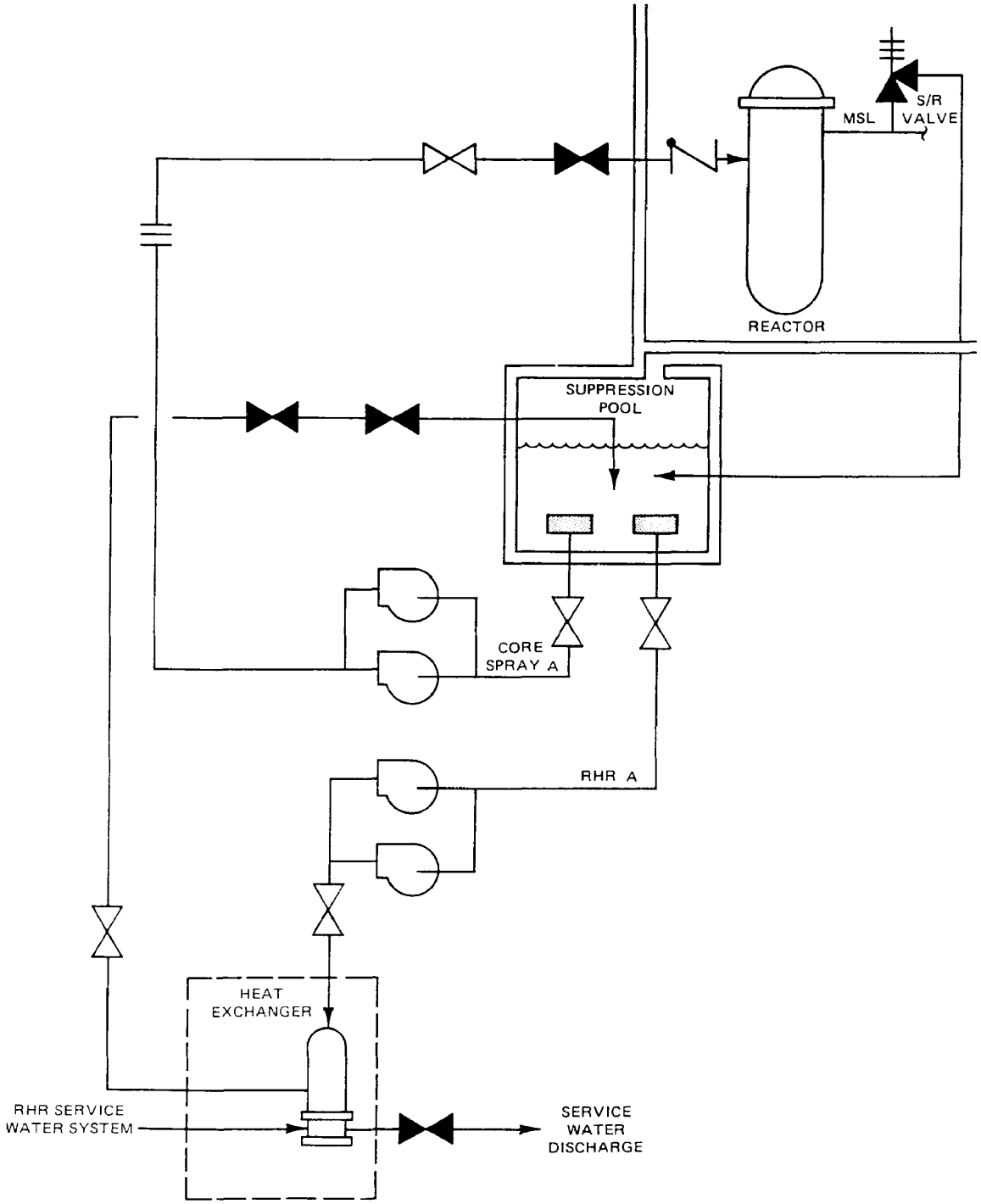
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

ACTIVITY C1 ALTERNATE
SHUTDOWN COOLING PATH
UTILIZING RHR LOOP B

FIGURE 15E.2.9-5, Rev 54

AutoCAD: Figure Fsar 15E_2_9_5.dwg

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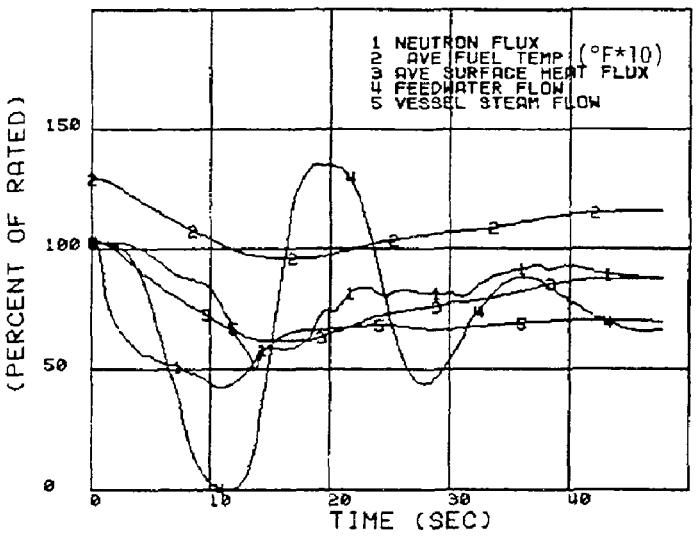
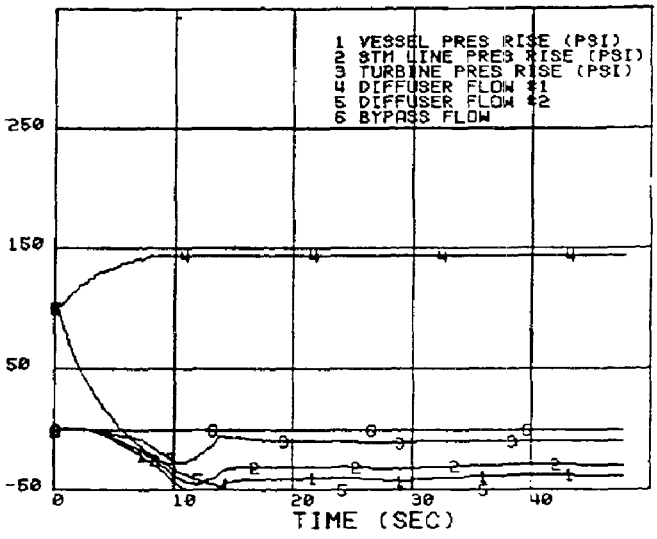
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

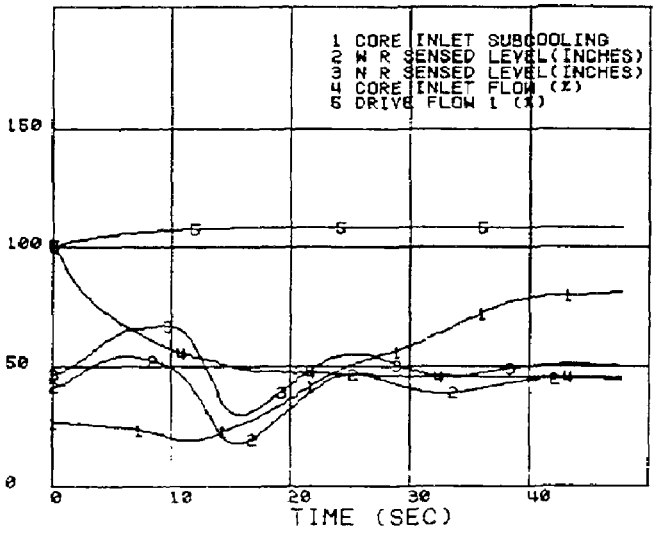
ACTIVITY C2 ALTERNATE
SHUTDOWN COOLING PATH
UTILIZING RHR LOOP A

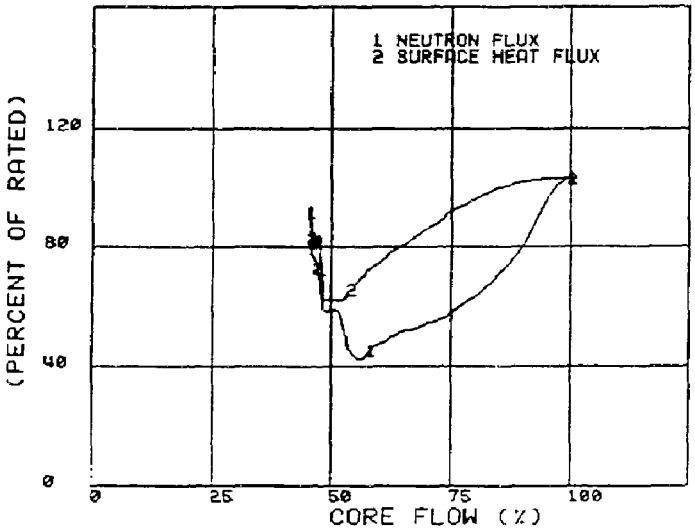
FIGURE 15E.2.9-6, Rev 54

AutoCAD: Figure Fsar 15E_2_9_6.dwg

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SUSQUEHANNA STEAM ELECTRIC STATION
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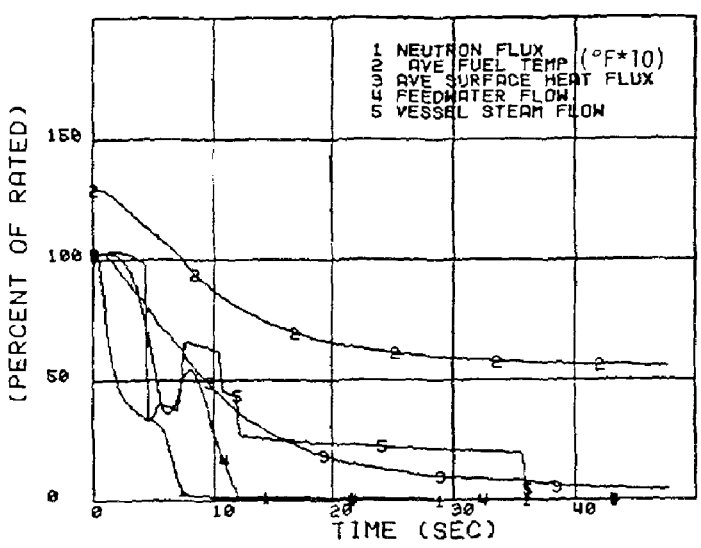
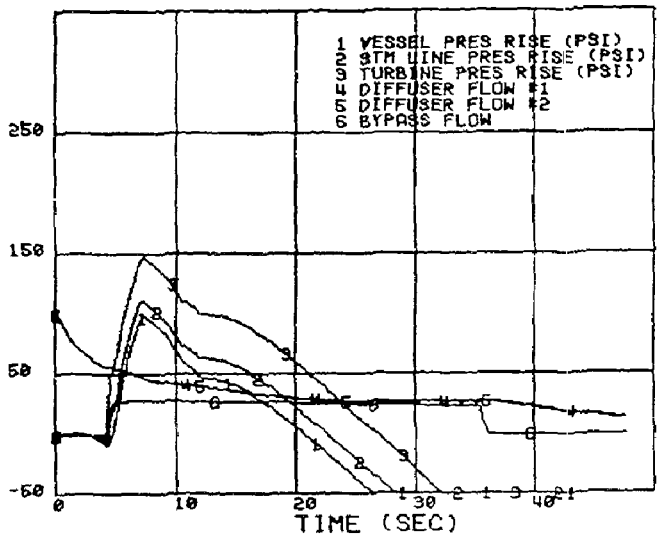
FINAL SAFETY ANALYSIS REPORT

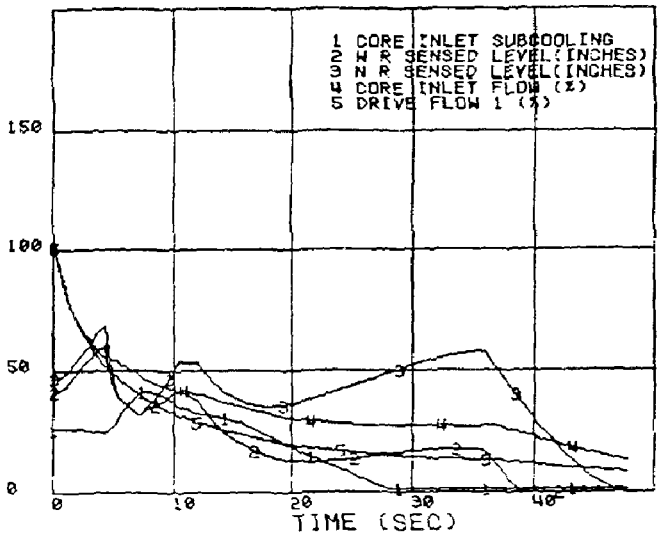
TRIP OF ONE
RECIRCULATION
PUMP MOTOR

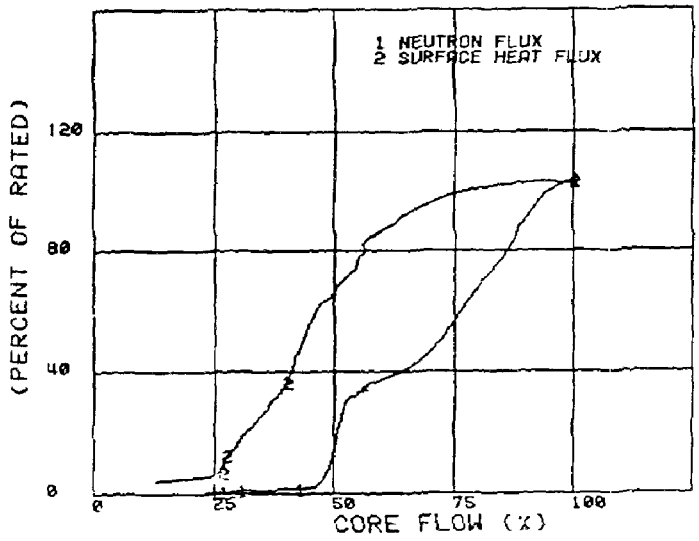
FIGURE 15E.3.1-1, Rev 54

AutoCAD: Figure Fsar 15E_3_1_1.dwg

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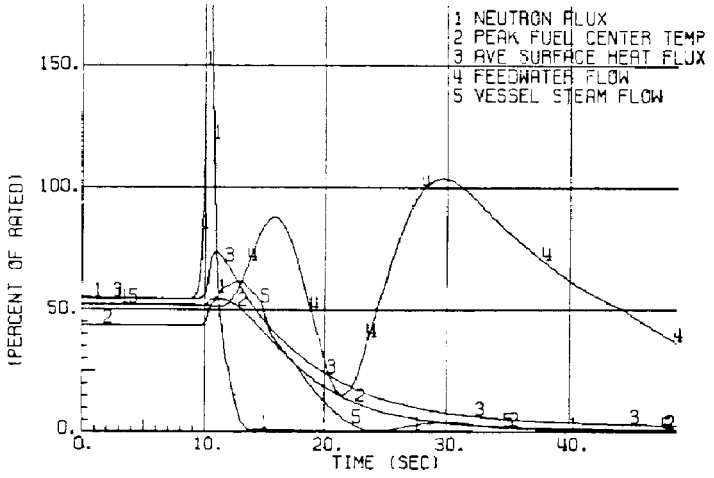
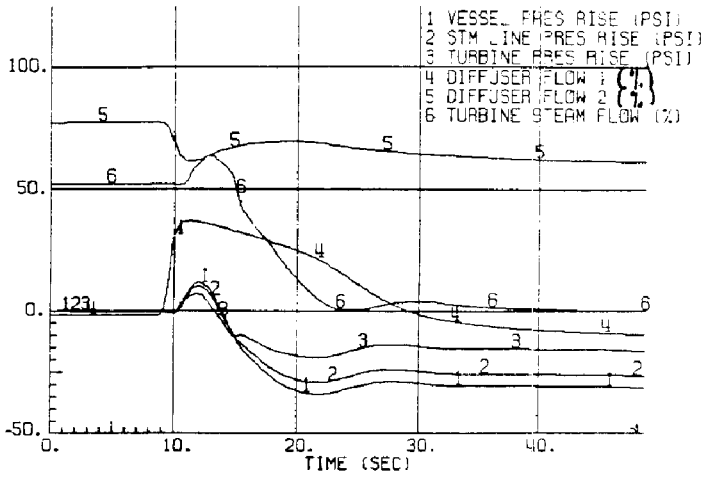
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

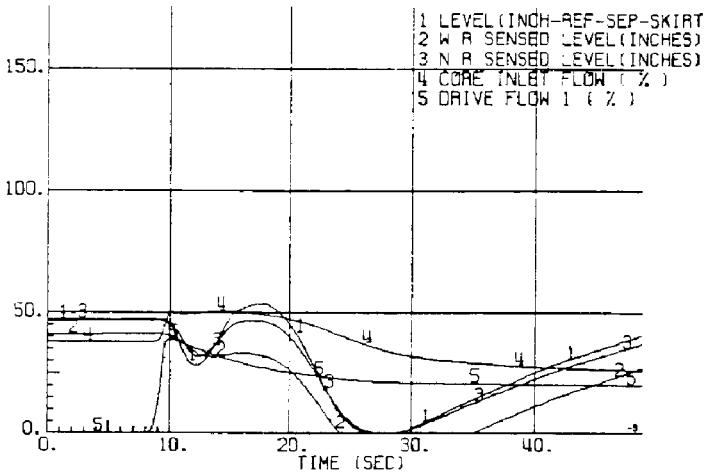
TRIP OF BOTH
RECIRCULATION
PUMP MOTORS

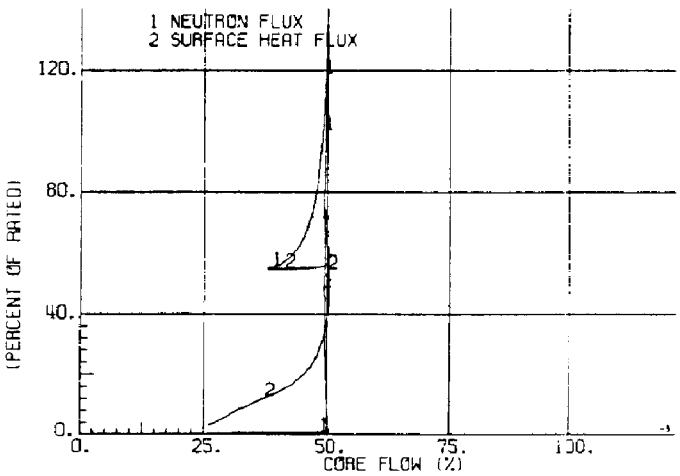
FIGURE 15E.3.1-2, Rev 54

AutoCAD: Figure Fsar 15E_3_1_2.dwg

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SUSQUEHANNA STEAM ELECTRIC STATION
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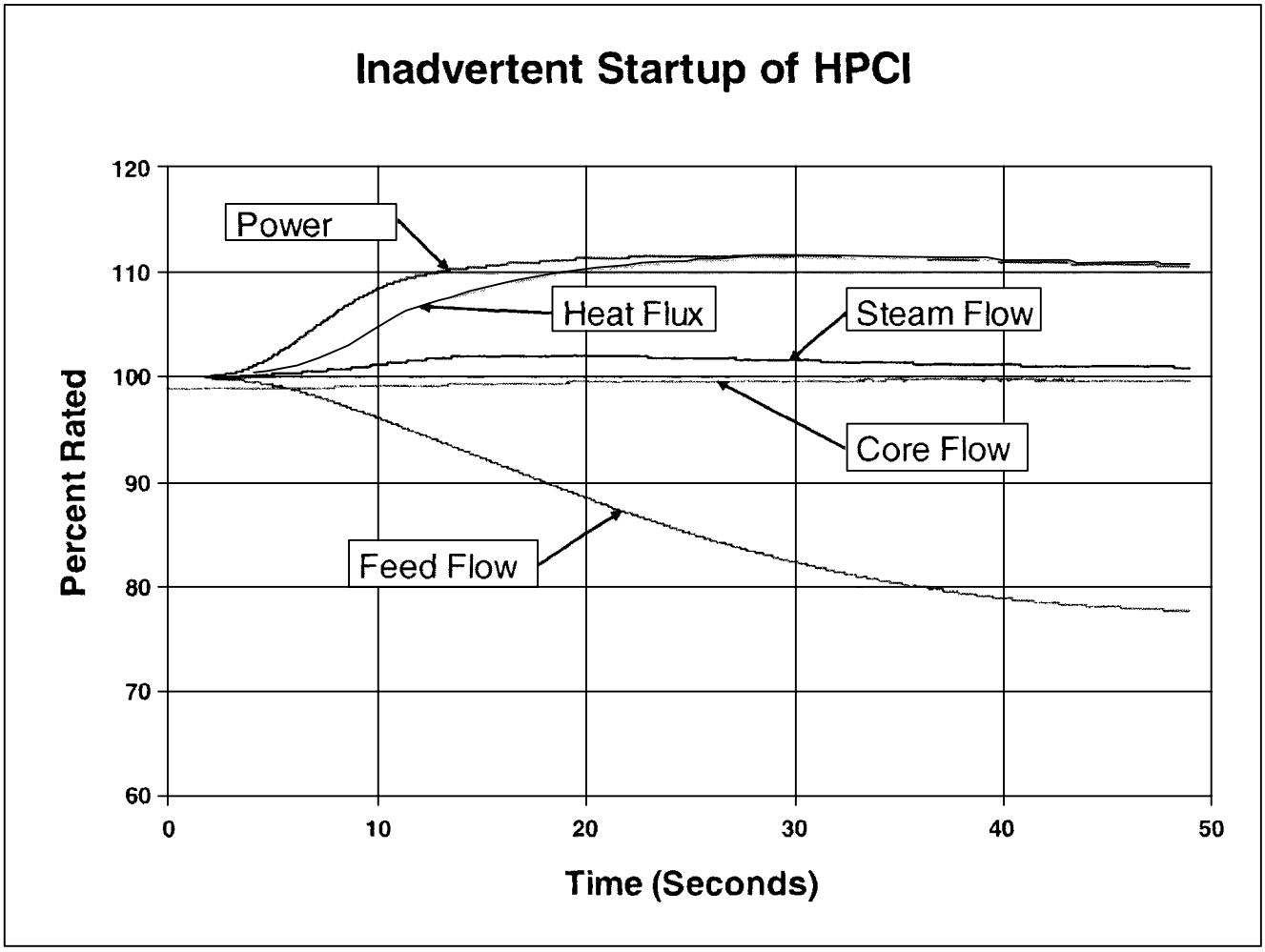
FINAL SAFETY ANALYSIS REPORT

STARTUP OF IDLE
RECIRCULATION LOOP
PUMP

FIGURE 15E.4.4-1, Rev 54

AutoCAD: Figure Fsar 15E_4_4_1.dwg




FSAR REV.65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

INADVERTENT HPCI PUMP START

FIGURE 15E.5.1-1, Rev 3

AutoCAD: Figure Fsar 15E_5_1_1.dwg