**Table 10.4.9-3—Emergency Feedwater System Failure Analysis**
**Sheet 1 of 5**

| Component | Component Function | Failure Mode | Failure Mechanism | Failure Symptoms/ Effect | Can EFWS Satisfy Mission Success Criteria? |
|---|---|---|---|---|---|
| EFW Pump/Motor<br>30LAS11 AP001<br>30LAS21 AP001<br>30LAS31 AP001<br>30LAS41 AP001 | Develops Required Flow and Head | (a) Fails to start | Electrical/Mechanical/ I&C Failure | No flow to SG | Yes, only affects one EFW pump.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to the intact SG of the train in maintenance is required. |
| | | (b) Fails to run | Mechanical Failure | No flow to SG | Yes, bounded by (a) |
| | | (c) Too much flow | Mechanical Failure | None, as FCV will set flow to required flow. | Yes, only affects one EFW pump. If pump operability is in question, another EFW pump can be aligned per (a). |
| | | (d) Too little flow | Mechanical Failure | Insufficient flow to SG | Yes, bounded by (a) |
| EFW Pump Protective Trips<br>(This scenario is unlikely as the trips are bypassed following a safety actuation signal) | Provide pump protection for:<br>Low Suction Pressure<br>Pump Flow<br>Pump Bearing Temp.<br>Pump Motor Winding Temperature | (a) Spurious trip signal | Electrical/I&C Failure | No flow to SG | Yes, only affects one EFW pump.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to the intact SG of the train in maintenance is required |
| EFW Pump Flow Measurement<br>30LAR11 CF801<br>30LAR21 CF801<br>30LAR31 CF801<br>30LAR41 CF801 | Measures EFW Pump Flow (input to FCV) | (a) No flow signal | Electrical/I&C Failure | FCV remains closed – no flow to SG | Yes, only affects one EFW pump.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to the intact SG of the train in maintenance is required |
| | | (b) False insufficient flow signal | Mechanical/I&C Failure | FCV will open beyond design point. | Yes, only affects one EFW pump.<br>If feeding an intact SG and if determined necessary due to pump operability concerns, isolation of flow and cross-connection of the pump feeding faulted SG to the intact SG of the train in maintenance can be performed. |
| | | (c) False excess flow signal | Mechanical/I&C Failure | FCV will close beyond design flow point | Yes, only affects one EFW pump and is bounded by (a). |
| | | (d) Erratic signal | Mechanical/I&C Failure | Loss of flow control to SG | Yes, only affects one EFW pump. The required actions are the same as (a). |
| Flow Control Valve<br>30LAR11 AA103<br>30LAR21 AA103<br>30LAR31 AA103<br>30LAR41 AA103 | Controls EFW Pump Flow | (a) Fails open (maximum flow) | Electrical/Mechanical/ I&C Failure | High flow to SG | Yes, only affects one EFW pump.<br>If feeding an intact SG and if determined necessary due to pump operability concerns, isolation of flow and cross-connection of the pump feeding faulted SG to the intact SG of the train in maintenance can be performed. |
| | | (b) Fails closed (minimum flow) | Electrical/Mechanical/ I&C Failure | No flow to SG | Yes, only affects one EFW pump.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to the intact SG of the train in maintenance is required. |

**Table 10.4.9-3—Emergency Feedwater System Failure Analysis**
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| Component | Component Function | Failure Mode | Failure Mechanism | Failure Symptoms/ Effect | Can EFWS Satisfy Mission Success Criteria? |
|---|---|---|---|---|---|
| Minimum Flow Check Valve<br>30LAR11 AA002<br>30LAR21 AA002<br>30LAR31 AA002<br>30LAR41 AA002 | Pump Protection | (a) Injection path fails closed | Mechanical Failure | No flow to SG | Yes, only affects one EFW pump.<br><br>If feeding faulted SG – no impact<br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to the intact SG of the train in maintenance is required |
| | | (b) Injection path fails open | Mechanical Failure | No back flow prevention | Yes, backflow prevention function of valve would not apply during SG injection.<br><br>Temperature alarms are provided to alert the operators of back flow during normal plant operation. Procedures will call for appropriate actions to be taken. |
| | | (c) Recirculation path fails closed | Mechanical Failure | Pump failure due to over heating | Same as (a) |
| | | (d) Recirculation path fails open | Mechanical Failure | Inadequate flow to SG | Isolation of flow and cross-connection of the pump feeding the faulted SG to the intact SG of the train in maintenance is required. |
| Level Control Valve<br>30LAR11 AA105<br>30LAR21 AA105<br>30LAR31 AA105<br>30LAR41 AA105 | Controls SG Level and Isolation of EFW Flow to SG | (a) Fails open | Electrical/Mechanical/ I&C Failure | Loss of level control and cannot be used to isolate SG | Yes, if feeding the faulted SG, the SGIV can be used to isolate the SG, or if the failure also prevents the closure of the SGIV.<br><br>If feeding an intact SG, isolation of flow per above and cross-connection of the pump feeding the faulted SG to the intact SG of the train in maintenance is required. RCS cooldown must consider stagnant loop conditions. |
| | | (b) Fails closed | Electrical/Mechanical/ I&C Failure | No flow to SG | Yes, if feeding faulted SG – no impact.<br><br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to the SG of the train in maintenance is required. RCS cooldown must consider stagnant loop conditions. |
| SG Isolation Valve<br>30LAR11 AA006<br>30LAR21 AA006<br>30LAR31 AA006<br>30LAR41 AA006 | Isolation of EFW Flow to SG | (a) Fails to close | Electrical/Mechanical/ I&C Failure | Cannot be used to isolate flow to SG | Yes, if feeding the faulted SG, the LCV can be used to isolate the SG.<br>If feeding an intact SG – no impact. |
| | | (b) Fails to stay closed | Mechanical/I&C Failure | Same as (a) | Yes, same as (a). |
| | | (c) Fails closed | Mechanical/I&C Failure | No flow to SG | Yes, if feeding faulted SG – no impact.<br><br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to the intact SG of the train in maintenance is required. RCS cooldown must consider stagnant loop conditions. |

**Table 10.4.9-3—Emergency Feedwater System Failure Analysis**
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| Component | Component Function | Failure Mode | Failure Mechanism | Failure Symptoms/ Effect | Can EFWS Satisfy Mission Success Criteria? |
|---|---|---|---|---|---|
| Discharge Header Cross-connect Valve<br>30LAR14 AA001<br>30LAR24 AA001<br>30LAR34 AA001<br>30LAR44 AA001 | Cross-connect SG Injection Paths | (a) Fails to open | Electrical/Mechanical/ I&C Failure | Not a concern, as cross-connection of trains is only required if another failure has occurred. | Yes |
| | | (b) Spurious closure | Electrical/I&C Failure | Not a concern, as cross-connection of trains is only required if another failure has occurred. | Yes |
| | | (c) Fails to stay closed | Electrical/I&C Failure | Pressurizes discharge header piping | Yes, closed cross-connect valves of other trains will maintain pressure boundary. |
| Emergency Diesel Generator (EDG)<br>30XKA10<br>30XKA20<br>30XKA30<br>30XKA40 | Provide Emergency Power to one EFW train (Assumes LOOP) | (a) Failure to start | Electrical/Mechanical/ I&C Failure | Loss of interruptible emergency power to the EFW train | Yes, only affects one EFW train.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to an intact SG is required. |
| | | (b) Failure to run | Mechanical/I&C Failure | Bounded by above | Yes, bounded by above |
| Emergency Diesel Generator (EDG) – in alternate feed mode<br>30XKA10<br>30XKA20<br>30XKA30<br>30XKA40 | Provide Emergency Power to one EFW train and to selected equipment of a second EFW train (with its pump, FCV, and EDG out for maintenance) and MSRT train (Assumes LOOP) | (a) Failure to start | Electrical/Mechanical/ I&C Failure | Immediate loss of the EFW pump and FCV powered by the division providing the alternate feed.<br>At two hours, loss of the LCVs and SGIVs, and DCCVs, and MSRTs of the train providing and the train receiving the alternate feed. | Yes, taking credit for the following actions:<br>Time (0-30 minutes)<br>• 1 intact train of EFW and MSRT is available<br>• 1 EFW train feeding the faulted SG for 30 minutes<br>• 2 EFW trains are unavailable (Single Failure and Maintenance)<br>Time (30 -120 minutes)<br>• 1 intact train of EFW and MSRT is available<br>• Manual isolation from the MCR of the affected SG<br>• Manual re-alignment from the MCR of the EFW train feeding the faulted SG to the SG associated with the EFW train out for maintenance or with the single failure (using EUPS power for valves)<br>• From the MCR, manually open the MSRCV and EFW LCV of the train receiving the cross feed (while EUPS power is available)<br>Time (120 minutes to RHR Cut-in)<br>• From the MCR, throttle the DCCV of the EFW train providing the cross feed, as needed, to control SG level<br>At RHR cut-in, manually isolate, from the MCR, the MSRIV of the SG being manually fed and shut down EFW trains. |
| | | (a) Failure to run | Mechanical/I&C Failure | Bounded by above | Yes, bounded by above |

**Table 10.4.9-3—Emergency Feedwater System Failure Analysis**
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| Component | Component Function | Failure Mode | Failure Mechanism | Failure Symptoms/ Effect | Can EFWS Satisfy Mission Success Criteria? |
|---|---|---|---|---|---|
| DC Bus Failure<br>BUC31<br>BUC32<br>BUC33<br>BUC34 | Provide start and run capability to associated EDG and supply power to associated EUPS<br>Provides start-stop control power for associated EFW pump<br>Provides motive power for associated LCV, SGIV, and DCCV.<br>(Assumes LOOP) | (a) Failure to provide power | Electrical/Mechanical Failure | Loss of power and control to the associated EFW train and MSRT train | Yes, only affects one EFW train.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to an intact SG is required.<br>SG overfill protection is provided from the MCR by closure of the LCV, SGIV, or by tripping the EFW pump. |
| DC Bus Failure – in alternate feed mode<br>BUC31<br>BUC32<br>BUC33<br>BUC34 | Provide start and run capability to associated EDG and supply power to associated EUPS<br>Provides start-stop control power for associated EFW pump<br>Provides motive power for associated LCV, SGIV, and DCCV.<br>(Assumes LOOP) | (a) Failure to provide power | Electrical/Mechanical Failure | Immediate loss of power and control to the associated EFW train and MSRT train. In addition, loss of power and control to the equipment in the EFW train being alternate fed that is not powered by the EUPS.<br>At two hours, loss of the LCVs, SGIVs, and DCCVs, of the EFW train receiving the alternate feed; and the associated MSRT. | Yes, taking credit for the following actions:<br>Time (0-30 minutes)<br>● 1 intact train of EFW and MSRT is available<br>● 1 EFW train feeding the faulted SG for 30 minutes<br>● 2 EFW trains are unavailable (Single Failure and Maintenance)<br>Time (30 -120 minutes)<br>● 1 intact train of EFW and MSRT is available<br>● Manual isolation from the MCR of the affected SG<br>● Manual re-alignment from the MCR of the EFW train feeding the faulted SG to the SG associated with the EFW train out for maintenance (using EUPS power for valves)<br>● From the MCR, manually open the MSRCV and EFW LCV of the train receiving the cross feed (while EUPS power is available)<br>Time (120 minutes to RHR Cut-in)<br>● From the MCR, throttle the DCCV of the EFW train providing the cross feed, as needed, to control SG level<br>At RHR cut-in, manually isolate, from the MCR, the MSRIV of the SG being manually fed and shut down EFW trains.<br>SG overfill protection is provided from the MCR by closure of the LCV, SGIV, or by tripping the EFW pump. |
| I&C Protection System (ESFAS EFW actuations) | Initiate automatic EFWS actuations | (a) No automatic actuation signal | I&C signal failure | Loss of EFW low level actuation, SIS with LOOP actuation, and EFW trip during EDG sequencing following a LOOP | Yes, only affects one EFW train.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, cross-connection of the pump feeding the faulted SG to the SG of the train in maintenance is required. |
| MSRCV during all modes<br>30LBA13 AA101<br>30LBA23 AA101<br>30LBA33 AA101<br>30LBA43 AA101 | MSRT Pressure Control/ Isolation (supports EFW decay heat removal function) | Fails closed | Electrical/Mechanical/ I&C Failure | Loose pressure control of SG | Yes, only affects one SG<br>The MSRV will close and control power will still be available to two MSRTs for the duration of event.<br>Assumes LOOP<br>Actions are required to depressurize and cool the SG at the initiation of the RCS cooldown. |

**Table 10.4.9-3—Emergency Feedwater System Failure Analysis**
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| Component | Component Function | Failure Mode | Failure Mechanism | Failure Symptoms/ Effect | Can EFWS Satisfy Mission Success Criteria? |
|---|---|---|---|---|---|
| MSRCV during alternate feed mode<br>30LBA13 AA101<br>30LBA23 AA101<br>30LBA33 AA101<br>30LBA43 AA101 | MSRT Pressure Control/ Isolation (supports EFW decay heat removal function) | (a) Fails closed | Electrical/Mechanical/ I&C Failure | Loss of MSRT of SG | Yes, only affects one SG<br>If faulted SG, no impact<br>If intact SG, control power will still be available to two MSRTs for the duration of event |
| | | (b) Fails open | Electrical/Mechanical/ I&C Failure | Loose pressure control of SG | Yes, only affects one SG<br>The MSRIV will close and control power will still be available to two MSRTs for the duration of event |
| | | (c) Fails as-is | Electrical | Bounded by above | Bounded by above |
| MSRIV during all modes<br>30LBA13 AA001<br>30LBA23 AA001<br>30LBA33 AA001<br>30LBA43 AA001 | MSRT Pressure Relief (supports EFW decay heat removal function) | (a) All | All | None | Yes, actuation of the valve is ensured by the single failure proof design provided by the four solenoids. Closure is ensured by the valve's passive (spring loaded) design. |
| SBVSE Recirculation Cooling Units<br>30SAC61 AC001<br>30SAC62 AC001<br>30SAC63 AC001<br>30SAC64 AC001 | Provide Cooling to EFW Pump Rooms | (a) Failure to start | Electrical/Mechanical/ I&C Failure | Failure of EFW Pump, FCV, or LCV | Yes, only affects one EFW train.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, cross-connection of the pump feeding the faulted SG to the SG of the train in maintenance is required. |
| | | (b) Failure to run | Electrical/Mechanical/ I&C Failure | Bounded by (a) | Bounded by (a) |
| | | (c) Failure to cool (SCWS) | Electrical/Mechanical/ I&C Failure | Bounded by (a) | Bounded by (a) |
| SBVS Recirculation Cooling Units<br>30KLC51 AC002<br>30KLC52 AC002<br>30KLC53 AC002<br>30KLC54 AC002 | Provide Cooling to Safeguard Building Penetration Room | (a) Failure to Start | Electrical/Mechanical/ I&C Failure | Increased temperature in Penetration Room containing the SGIV | Yes, only affects one EFW train.<br>If feeding faulted SG – no impact<br>If feeding an intact SG, cross-connection of the pump feeding the faulted SG to the SG of the train in maintenance is required. |
| | | (b) Failure to Run | Electrical/Mechanical/ I&C Failure | Bounded by (a) | Bounded by above |
| | | (c) Failure to cool | Electrical/Mechanical/ I&C Failure | Bounded by (a) | Bounded by (a) |

**Notes:**

1. A MFLB results in RCS heat-up with a faulted SG and is considered the bounding accident/transient with respect to single failure.
2. Mission success requires:
   - The EFWS to operate until the plant is cooled down sufficiently (emergency cut-in point) to permit operation of the residual heat removal (RHR) system.
   - The need for successful operation of two EFW pumps feeding all available SGs, including their main steam relief trans (MSRT).
3. One EFW train is assumed to be in maintenance with the following components out of service: EFW pump, flow control valve, and minimum flow check valve. In addition, the associated division's EDG can be out for maintenance.

Next File