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?
EFW Pump/Motor 30LAS11 AP001 30LAS21 AP001 30LAS31 AP001 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. If feeding faulted SG – no impact. 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 (This scenario is unlikely as the trips are bypassed following a safety actuation signal)	Provide pump protection for: Low Suction Pressure Pump Flow Pump Bearing Temp. Pump Motor Winding Temperature	(a) Spurious trip signal	Electrical/I&C Failure	No flow to SG	Yes, only affects one EFW pump. If feeding faulted SG – no impact. 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 30LAR11 CF801 30LAR21 CF801 30LAR31 CF801 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. If feeding faulted SG – no impact. 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. 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).
Fire Water Distribution System Isolation Check Valve 30LAR55AA001	Prevent backflow from EFW to fire water distribution system	(a) flow path fails open	Mechanical failure	Leakage of EFW flow to the fire water distribution system	Yes, leakage path isolated by normally closed fire water distribution system isolation valve.
Fire Water Distribution System Isolation Valve 30LAR55AA002	Prevent backflow from EFW to fire water distribution system	(a) Fails open	Electrical/Mechanical failure	Leakage of EFW flow to the fire water distribution system	Yes, leakage path isolated by normally closed fire water distribution system isolation valve.

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?
Flow Control Valve 30LAR11 AA103 30LAR21 AA103 30LAR31 AA103 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. 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. If feeding faulted SG – no impact. 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.
Minimum Flow Check Valve 30LAR11 AA002 30LAR21 AA002 30LAR31 AA002 30LAR41 AA002	Pump Protection	(a) Injection path fails closed	Mechanical Failure	No flow to SG	Yes, only affects one EFW pump. If feeding faulted SG – no impact. 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 backflow prevention	Yes, backflow prevention function of valve would not apply during SG injection. Temperature alarms are provided to alert the operators of backflow 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 30LAR11 AA105 30LAR21 AA105 30LAR31 AA105 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. 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. 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.

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?
SG Isolation Valve 30LAR11 AA006 30LAR21 AA006 30LAR31 AA006 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. 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. 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.
Discharge Header Cross-connect Valve 30LAR14 AA001 30LAR24 AA001 30LAR34 AA001 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) 30XKA10 30XKA20 30XKA30 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. If feeding faulted SG – no impact. 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 (a).

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?
Emergency Diesel Generator (EDG) – in alternate feed mode 30XKA10 30XKA20 30XKA30 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. 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: Time (0-30 minutes) • 1 intact train of EFW and MSRT is available • 1 EFW train feeding the faulted SG for 30 minutes • 2 EFW trains are unavailable (Single Failure and Maintenance) Time (30 -120 minutes) • 1 intact train of EFW and MSRT is available • Manual isolation from the MCR of the affected SG • 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) • From the MCR, manually open the MSRCV and EFW LCV of the train receiving the cross feed (while EUPS power is available) Time (120 minutes to RHR Cut-in) • From the MCR, throttle the DCCV of the EFW train providing the cross feed, as needed, to control SG level At RHR cut-in, manually isolate, from the MCR, the MSRIV of the SG being manually fed and shut down EFW trains.
		(b) Failure to run	Mechanical/I&C Failure	Bounded by above	Yes, bounded by (a).
DC Bus Failure BUC31 BUC32 BUC33 BUC34	Provide start and run capability to associated EDG and supply power to associated EUPS Provides start-stop control power for associated EFW pump Provides motive power for associated LCV, SGIV, and DCCV. (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. If feeding faulted SG – no impact. If feeding an intact SG, isolation of flow and cross-connection of the pump feeding the faulted SG to an intact SG is required. SG overfill protection is provided from the MCR by closure of the LCV, SGIV, or by tripping the EFW pump.

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 – in alternate feed mode BUC31 BUC32 BUC33 BUC34	Provide start and run capability to associated EDG and supply power to associated EUPS Provides start-stop control power for associated EFW pump Provides motive power for associated LCV, SGIV, and DCCV. (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. 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: Time (0-30 minutes) • 1 intact train of EFW and MSRT is available • 1 EFW train feeding the faulted SG for 30 minutes • 2 EFW trains are unavailable (Single Failure and Maintenance) Time (30 -120 minutes) • 1 intact train of EFW and MSRT is available • Manual isolation from the MCR of the affected SG • 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) • From the MCR, manually open the MSRCV and EFW LCV of the train receiving the cross feed (while EUPS power is available) Time (120 minutes to RHR Cut-in) • From the MCR, throttle the DCCV of the EFW train providing the cross feed, as needed, to control SG level At RHR cut-in, manually isolate, from the MCR, the MSRIV of the SG being manually fed and shut down EFW trains. 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. If feeding faulted SG – no impact. 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 30LBA13 AA101 30LBA23 AA101 30LBA33 AA101 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. The MSRV will close and control power will still be available to two MSRTs for the duration of event. Assumes LOOP Actions are required to depressurize and cool the SG at the initiation of the RCS cooldown.
MSRCV during alternate feed mode 30LBA13 AA101 30LBA23 AA101 30LBA33 AA101 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. If faulted SG, no impact. 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. 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.

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?
MSRIV during all modes 30LBA13 AA001 30LBA23 AA001 30LBA33 AA001 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 30SAC61 AC001 30SAC62 AC001 30SAC63 AC001 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. If feeding faulted SG – no impact. 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 30KLC51 AC002 30KLC52 AC002 30KLC53 AC002 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. If feeding faulted SG – no impact. 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	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