

Power Supplies and Failure Modes for Auxiliary Feedwater System Electrical Components

Pump	Device Number	Power	Control Power	Auto Start or ^{Auto} Open/Close	SI (Safeguards Sequence)	Low-Low Level Signal Power	Undervoltage Signal Power	Low Suction Pressure Trip Circuit Power	Low Suction Pressure Trip Transmitter Loop Power	Notes
IP-29	IMS-2019 NC - FAI B SG Supply	D-11 [D01] B SG	D-11 [D01] B SG	N/A	N/A	D-16 [D01] LL Level Only [bistables fail safe]	D-11 [D01] D-27 [D02] UV Only	N/A	N/A	Opens on AMSAC, 1A01 and 1A02 undervoltage, or low-low level in both Unit 1 SGs. 1Y-06: Unit 1 AMSAC signal will not open valve. 1Y-06 is an acceptable power supply for the AMSAC signal since AMSAC is not a safety related trip function. Fails AS IS.
	IMS-2020 NC - FAI A SG Supply	D-27 [D02] A SG	D-27 [D02] A SG	N/A	N/A	D-21 [D02] LL Level Only [bistables fail safe]	D-11 [D01] D-27 [D02] UV Only	N/A	N/A	Opens on AMSAC, 1A01 and 1A02 undervoltage, or low-low level in both Unit 1 SGs. 1Y-06: Unit 1 AMSAC signal will not open valve. 1Y-06 is an acceptable power supply for the AMSAC signal since AMSAC is not a safety related trip function. Fails AS IS.
	IMS-2082 NO - FAI Trip Throttle	D-11 [D01] None	D-11 [D01] None	N/A	N/A	N/A	N/A	D-11 [D01] IP-29 Seismic Only	1Y-03 [D03] IP-29 Seismic Only	
	IAF-4000 NT - FAI B SG Feed	D-27 [D02] IP-29 with Faulted B	D-27 [D02] IP-29 with Faulted B	N/A	N/A	N/A	N/A	N/A	N/A	
	IAF-4001 NT - FAI A SG Feed	D-11 [D01] IP-29 with Faulted A	D-11 [D01] IP-29 with Faulted A	N/A	N/A	N/A	N/A	N/A	N/A	
	IAF-4002 NC - FC Recirc	N/A	D-11 [D01] 1-P29	1Y-06 (1DPIS-4002) [1B03] IP-29	N/A	N/A	N/A	N/A	N/A	Normally closed. Opens on IMS-2019 or IMS-2020 opening. Closes via 1DPIS-4002 after flow has been established. Fails closed.
	IAF-4006 NC - FAI SW Supply	1B-42 none	1B-42 none	N/A	N/A	N/A	N/A	N/A	N/A	Normally closed. Manually opened by operators to switch to SW after a low suction pressure trip. Fails AS IS.
	IFI-4002 IP-29 Forward Flow Indicator	N/A	1Y-01 (1FQ-4002) [D01] Loss of Indication	N/A	N/A	N/A	N/A	N/A	N/A	
P-38A	P-38A	1B-03 P-38A	D-11 [D01] P-38A	D-17 [D01] P-38A	D-16 U1 [D01] Safeguards Only U1 D-22 U2 [D01] Safeguards Only U2	D-16 U1 [D01] LL Level Only U1 [bistables fail safe] D-22 U2 [D01] LL Level Only U2 [bistables fail safe]	N/A	D-17 [D01] P-38A Seismic Only	1Y-103 [D03] P-38A Seismic Only	Normally not running. Starts on SI (safeguards sequence), AMSAC, or low-low level in one SG. 1Y-06 and 2Y-06: Unit 1 or Unit 2 AMSAC will not start pump. 1Y-06 and 2Y-06 are acceptable power supplies for the AMSAC signals since AMSAC is not a safety related start function.
	AF-4007 NC-FC Recirc	N/A	D-11 [D01] P-38A	1Y06 (DPIS-4007) [1B03] P-38A	N/A	N/A	N/A	N/A	N/A	
	AF-4012 NC-FO Flow Control	N/A	1Y-01 [D01] P-38A (runout)	N/A	N/A	N/A	N/A	N/A	N/A	
	AF-4022 U2 A SG Feed NC-FAI	2B-32 P-38A U2	2B-32 P-38A U2	D-17 [D01] P-38A U2	D-22 U2 [D01] Safeguards Only U2	D-22 U2 [D01] LL Level Only U2 [bistables fail safe]	N/A	N/A	N/A	
	AF-4023 U1 A SG Feed NC - FAI	1B-32 P-38A U1	1B-32 P-38A U1	D-17 [D01] P-38A U1	D-16 U1 [D01] Safeguards Only U1	D-16 U1 [D01] LL Level Only U1 [bistables fail safe]	N/A	N/A	N/A	
	AF-4009 NC - FAI SW Supply	1B-32 none	1B-32 none	N/A	N/A	N/A	N/A	N/A	N/A	
	FI-4007 P-38A Forward Flow Indicator	N/A	1Y-02 (FQ-4007) [D02] Loss of Indication	N/A	N/A	N/A	N/A	N/A	N/A	
	IFI-4036 U1 A SG Total Flow Indicator	N/A	1Y-03 (1FQ-4036) [D03] Loss of Indication	N/A	N/A	N/A	N/A	N/A	N/A	
	2FI-4036 U2 A SG Total Flow Indicator	N/A	2Y-03 (2FQ-4036) [D03] Loss of Indication	N/A	N/A	N/A	N/A	N/A	N/A	

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P-38B	P-38B	2B-04 P-38B	D-13 [D02] P-38B	D-19 [D02] P-38B	D-21 U1 [D02] Safeguards Only U1 D-18 U2 [D02] Safeguards Only U2	D-21 U1 [D02] LL Level Only U1 [bistables fail safe] D-18 U2 [D02] LL Level Only U2 [bistables fail safe]	N/A	D-19 [D02] P-38B Seismic Only	2Y-104 [D04] P-38B Seismic Only	Normally not running. Starts on SI (safeguards sequence), AMSAC, or low-low level in one SG1Y-06 and 2Y-06: Unit 1 or Unit 2 AMSAC will not start pump. 1Y-06 and 2Y-06 are acceptable power supplies for the AMSAC signals since AMSAC is not a safety related start function. 2Y-104: Pump will not trip on low suction pressure.
	AF-4014 NC-FC Recirc	N/A	D-13 [D02] P-38B	2Y06 (DPIS-4014) [2B04] P-38B	N/A	N/A	N/A	N/A	N/A	
	AF-4019 NC-FO Flow Control	N/A	2Y-02 [D02] P-38B (runout)	N/A	N/A	N/A	N/A	N/A	N/A	
	AF-4020 NC - FAI U2 B SG Feed	2B-42 P-38B U2	2B-42 P-38B U2	D-19 [D02] P-38B	D-18 U2 [D02] Safeguards Only U2	D-18 U2 [D02] LL Level Only U2 [bistables fail safe]	N/A	N/A	N/A	
	AF-4021 NC - FAI U1 B SG Feed	1B-42 P-38B U1	1B-42 P-38B 01	D-19 [D02] P-38B	D-21 U1 [D02] Safeguards Only U2	D-21 U1 [D02] LL Level Only U1 [bistables fail safe]	N/A	N/A	N/A	
	AF-4016 NC- FAI SW Supply	2B-42 none	2B-42 none	N/A	N/A	N/A	N/A	N/A	N/A	NEED TO VERIFY THAT SEISMIC DOES NOT REQUIRE CONTROL ROOM OPERATION
	FI-4014 P-38B Forward Flow Indicator	N/A	2Y-02 (FQ-4014) [D02] Loss of Indication	N/A	N/A	N/A	N/A	N/A	N/A	
	1FI-4037 U1 B SG Total Flow Indicator	N/A	1Y-04 (1FQ-4037) [D04] Loss of Indication	N/A	N/A	N/A	N/A	N/A	N/A	
	2FI-4037 U2 B SG Total Flow Indicator	N/A	2Y-04 (2FQ-4037) [D04] Loss of Indication	N/A	N/A	N/A	N/A	N/A	N/A	
2P-29	2MS-2019 NC - FAI B SG Supply	D-12 [D01] B SG	D-12 [D01] B SG	N/A	N/A	D-22 [D01] LL Level Only [bistables fail safe]	D-12 [D01] D-13 [D02] UV Only	N/A	N/A	Normally closed. Opens on AMSAC, 2A01 and 2A02 undervoltage, or low-low level in both Unit 2 SGs. 2Y-06: Unit 2 AMSAC signal will not open valve. 2Y-06 is an acceptable power supply for the AMSAC signal since AMSAC is not a safety related trip function. Fails AS IS.
	2MS-2020 NC - FAI A SG Supply	D-13 [D02] A SG	D-13 [D02] A SG	N/A	N/A	D-18 [D02] LL Level Only [bistables fail safe]	D-12 [D01] D-13 [D02] UV Only	N/A	N/A	Normally closed. Opens on AMSAC, 2A01 and 2A02 undervoltage, or low-low level in both Unit 2 SGs. 2Y-06: Unit 2 AMSAC signal will not open valve. 2Y-06 is an acceptable power supply for the AMSAC signal since AMSAC is not a safety related trip function. Fails AS IS.
	2MS-2082 NO - FAI Trip Throttle	D-13 [D02] none	D-13 [D02] none	N/A	N/A	N/A	N/A	D-13 [D02] 2P-29 Seismic Only	2Y-04 [D04] 2P-29 Seismic Only	
	2AF-4000 NT - FAI B SG Feed	D-13 [D02] 2P-29 with Faulted B	D-13 [D02] 2P-29 with Faulted B	N/A	N/A	N/A	N/A	N/A	N/A	
	2AF-4001 NT - FAI A SG FEED	D-12 [D01] 2P-29 with Faulted A	D-12 [D01] 2P-29 with Faulted A	N/A	N/A	N/A	N/A	N/A	N/A	
	2AF-4002 NC - FC Recirc	N/A	D-12 [D01] 2P-29	2Y-06 (2DPIS-4002) [2B04] 2P-29	N/A	N/A	N/A	N/A	N/A	Normally closed. Opens on 2MS-2019 or 2MS-2020 opening. Closes via 2DPIS-4002 after flow has been established. Fails closed.
	2AF-4006 NC - FAI SW Supply	2B-42 none	2B-42 none	N/A	N/A	N/A	N/A	N/A	N/A	Normally closed. Manually opened (remotely or locally) by operators to switch to SW after a low suction pressure trip Fails AS IS
	2FI-4002 2P-29 Forward Flow Indicator	N/A	2Y-01 (2FQ-4002) [D01] Loss of Indication	N/A	N/A	N/A	N/A	N/A	N/A	

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The following is a summary of equipment lost during various single failures and the consequences of that equipment being lost:

	D-01	D-02	D-03	D-04	1B-03 AND 2B-03	1B-04 AND 2B-04	NNSR (1Y-06/2Y-06)	NOTES
IMS-2019	B	P						D-01: Loss of valve power and all auto open signals. D-02: Loss of UV open signal only.
IMS-2020	P	A						D-01: Loss of UV open signal only. D-02: Loss of valve power and all auto open signals.
IMS-2082	XS		XS					D-01: Loss of valve power and low suction pressure trip. D-03: Loss of low suction pressure trip.
1AF-4000		1XB						D-02: Loss of valve power. Valve normally throttled open but cannot be remotely isolated.
1AF-4001	1XA							D-01: Loss of valve power. Valve normally throttled open but cannot be remotely isolated.
1AF-4002	X						X	D-01: Loss of valve power. 1Y-06: Loss of auto open/close signal from 1DPIS-4002.
1AF-4006						XS		1B-04 (and 2B-04): Loss of valve power.
1FI-4002	I							D-01: Loss of indication. Flow indication still available from FI-4007, FI-4014, 1FI-4036 and 1FI-4037.
P-38A	X		XS		X			1B03 (and 2B03): Loss of motor power. D-01: Loss of breaker control power, all auto start functions and low suction pressure trip. D-03: Loss of low suction pressure trip.
AF-4007	X						X	D-01: Loss of valve power. 1Y-06: Loss of auto open/close signal from DPIS-4007.
AF-4012	X							D-01: Loss of valve power.
AF-4022	2X				2X			2B-03 (and 1B-03): Loss of valve power. D-01: Loss of all auto open/close signals.
AF-4023	1X				1X			1B-03 (and 2B-03): Loss of valve power. D-01: Loss of all auto open/close signals.
AF-4009					XS			1B-03 (and 2B-03): Loss of valve power.
FI-4007		I						D-02: Loss of indication. Flow indication still available from 1FI-4002, 2FI-4002, 1FI-4036 and 2FI-4036.
1FI-4036			I					D-03: Loss of indication. Flow indication still available from 1FI-4002 and FI-4007.
2FI-4036			I					D-03: Loss of indication. Flow indication still available from 2FI-4002 and FI-4007.
P-38B		X		XS		X		2B03 (and 1B03): Loss of motor power. D-02: Loss of breaker control power, all auto start functions and low suction pressure trip. D-04: Loss of low suction pressure trip.
AF-4014		X					X	D-02: Loss of valve power. 2Y-06: Loss of auto open/close signal from DPIS-4014.
AF-4019		X						D-02: Loss of valve power.
AF-4020		2X				2X		2B-04 (and 1B-04): Loss of valve power. D-02: Loss of all auto open/close signals.
AF-4021		1X				1X		1B-04 (and 2B-04): Loss of valve power. D-02: Loss of all auto open/close signals.
AF-4016						XS		2B-04 (and 1B-04): Loss of valve power.
FI-4014		I						D-02: Loss of indication. Flow indication still available from 1FI-4002, 2FI-4002, 1FI-4037 and 2FI-4037.
1FI-4037				I				D-04: Loss of indication. Flow indication still available from 1FI-4002 and FI-4014.
2FI-4037				I				D-04: Loss of indication. Flow indication still available from 2FI-4002 and FI-4014.
2MS-2019	B	P						D-01: Loss of valve power and all auto open signals. D-02: Loss of UV open signal only.
2MS-2020	P	A						D-01: Loss of UV open signal only. D-02: Loss of valve power and all auto open signals.
2MS-2082		XS		XS				D-02: Loss of valve power and low suction pressure trip. D-04: Loss of low suction pressure trip.
2AF-4000		2XB						D-02: Loss of valve power. Valve normally throttled open but cannot be remotely isolated.
2AF-4001	2XA							D-01: Loss of valve power. Valve normally throttled open but cannot be remotely isolated.
2AF-4002	X						X	D-01: Loss of valve power. 2Y-06: Loss of auto open/close signal from 2DPIS-4002.
2AF-4006						XS		2B-04 (and 1B-04): Loss of valve power.
2FI-4002	I							D-01: Loss of indication. Flow indication still available from FI-4007, FI-4014, 2FI-4036 and 2FI-4037.

Power Supplies and Failure Modes for Auxiliary Feedwater System Electrical Components

Key:

X	Pump lost.
XS	Pump lost for seismic event only.
1XA	Pump lost with faulted Unit 1 "A" steam generator.
1XB	Pump lost with faulted Unit 1 "B" steam generator.
2XA	Pump lost with faulted Unit 2 "A" steam generator.
2XB	Pump lost with faulted Unit 2 "B" steam generator.
1X	Pump lost to Unit 1 only.
2X	Pump lost to Unit 2 only.
P	Only partial loss of pump function (see notes).
A	Loss of A-train steam supply to pump. Pump still operable from B-train steam supply.
B	Loss of B-train steam supply to pump. Pump still operable from A-train steam supply.
I	Partial loss of flow indication (see notes).