

APPENDIX E

FAILURE MODES AND EFFECTS ANALYSIS

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1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

GUIDE FOR USING THE
FAILURE MODES AND EFFECTS ANALYSIS (FMEA)

1. The FMEA's contained herein are segregated by common power supply or sensor. Each system that is affected by this commonality is then analyzed individually to determine the appropriate failure information.

The two "Effects" columns on the FMEA's provide a summary of the results of the combined failure of all the components noted in the "Components" column.

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Docket: 50-387, 50-388

FAILURE MODES AND EFFECTS ANALYSIS

Sheet 1 of 3

Common Power Supply or Sensor: <u>1D615 125VDC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Control System</u>		CD: <u>0160-004-011</u>		Prepared by: <u>[Signature]</u> Date: <u>12/21/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u>	
				Date: <u>12/21/81</u>	
				Date: <u>12/21/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Reactor feed pump turbine A: a. Trip circuit - Level 8 trip contacts	De-energized	<ul style="list-style-type: none"> Trip circuit is de-energized Level 8 trip signal cannot be processed 	<ul style="list-style-type: none"> Trip circuits for feed pump turbines B and C are powered by other DC power supplies 	<ul style="list-style-type: none"> Loss of ability to trip turbine A on Level 8 trip signal 	<ul style="list-style-type: none"> There is no affect on plant performance unless Level 8 trip condition exists

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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 3 of 3

Common Power Supply or Sensor: <u>10615 125 VDC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator and T/G Control</u>		CD: <u>0160-004-011</u>		Prepared by: <u>[Signature]</u> Date: <u>11/11/86</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u> Date: <u>11/11/87</u> Date: <u>11/11/87</u>	

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Trip and alarm switches:					
a. PSL-11981A1, B1/Thrust bearing wear detector and low bearing oil pressure	Fail High	PSLX-11981 A1, B1 will not energize: - Contacts remain unchanged	Logic arrangement (2/3) in EHC trip system prevents a single power supply from interrupting the EHC trip logic	Logic reduced to a 2/2 logic arrangement-both remaining relays must energize to complete the trip configuration	The loss of power does not cause an EHC trip, thus there is no impact on overall plant performance
b. PSL-10180A/Low hydraulic fluid pressure	Fail High	PSLX-10180A will not energize: - Contacts remain unchanged	If turbines are shut down, back-up unit protection available for anti-monitoring	Loss of primary unit protection on generator	
c. PSL-11932A/Shaft pump discharge low pressure	Fail High	PSLX-11932A will not energize: - Contacts remain unchanged		Any generator malfunctions cannot induce an EHC trip by way of primary unit protection	
d. TSSH-10115A1-C1/Exhaust hood high temperature generator-end trip	Fail Low	TSSH-10115A1-C1 will not energize: - Contacts remain unchanged		Logic for unit protection initiated EHC trip is reduced to 1/1 from 1/2	
e. LSH-10127A, -28A, -29A/Moisture separator reheater drain tank 1A high water level	Fail Low	LSHX-1027A will not energize: - Contacts remain unchanged			

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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 2 of 3

Common Power Supply or Sensor: <u>1D615 125VDC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Recirculation Flow Control</u>		CD: <u>0160-004-011</u>		Prepared by: <u>Paul W. Spuckler</u> Date: <u>12/21/81</u> Checked by: <u>David M. W.</u> Approved by: <u>W. Berdine</u>	
				Rev. <u>0</u> Date: <u>11/11/86</u> Date: <u>12/1/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Temperature switch: TSH-14021A2	Off	<ul style="list-style-type: none"> Failure of the temperature switch has no local effects 	<ul style="list-style-type: none"> Redundant lube oil temperature indicators and a temperature switch-alarm combination provide additional monitoring 	<ul style="list-style-type: none"> Loss of automatic compensation for high lube oil temperature For recirculation loop A, the M-G set must be restarted after the bus is recovered 	<ul style="list-style-type: none"> Loss of recirculation flow is caused by the loss of flow in loop A
2. Feedwater system control of reactor recirculation system runback circuitry - recirculation flow loop A: a. Feedwater low flow: 1. FSL-10604A1 2. FSL-10604B1 3. FSL-10604C1 b. Feedwater high level: 1. LSIHH-10317A2 2. LSIHH-10317B2 3. LSIHH-10317C2 4. LSIHH-10305A2 5. LSIHH-10305B2 6. LSIHH-10305C2 c. Condensate pump low discharge pressure: 1. PSL-10507A 2. PSL-10507B 3. PSL-10507C 4. PSL-10507D d. Circulating water pump trip circuit: 1. COIL 52X1-10105	Off	<ul style="list-style-type: none"> Loss of bus voltage is predominant Loss of bus voltage causes: <ul style="list-style-type: none"> Low flow runback signal transmitted to auxiliary circuits A and B Circulating water pump trip signal transmitted to auxiliary circuits A and B Generator field breaker for loop A will open and trip the M-G set (recirculation pump) Scoop tube for loop A M-G set will lock in position at the instant the bus voltage is lost In loop A, speed control circuitry speed limiter No. 2 is enabled 	<ul style="list-style-type: none"> No inherent compensating provision for loop A Compensation of loop B is limited to a flow reduction via recirculation pump B 	<ul style="list-style-type: none"> Control of loop A is re-established after the restart procedure For recirculation loop B, control may still be exercised over the recirculation pump Operation of the recirculation pump in loop B must be governed by the criteria for single loop operation 	<ul style="list-style-type: none"> A core flux difference will result from the flow imbalance
3. Loop A circuits: a. Under-voltage relay b. Lockout c. Pump vibration reset d. Scoop tube power failure lock and reset e. Auxiliary circuits f. Generator field breaker	Off	<ul style="list-style-type: none"> Loop B controller adjusts the scoop tube to reduce M-G set speed 			

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Common Power Supply or Sensor:		1D615 125 VDC		CSID: 0160-004-001	Job No. 0160-004-671
Control System Affected:		Pressure Regulator and T/G Control		CD: 0160-004-011	Prepared by: <u>Therrell J. Miller</u> Date: <u>11/12/76</u> Checked by: <u>(Signature)</u> Approved by: <u>(Signature)</u>
				Rev. _____	Date: <u>12/1/77</u>
				Date: <u>12/1/77</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
2. Sequential trip:					
a. ZS-10160A2-F2, A5-F5/ Position switches on intercept and intermediate stop valves-servo valves	Fail Off	. All contacts must close to complete the sequential trip			
b. ZS-10141A2-D2/Position switches on main stop valve-servo valves	Fail Off				
c. 52XT1-1R101/A-C circuit breaker	Fail Off	. Fails to energize and open contacts: - Causing an interruption in the generator sequential trip			
d. 33X1-10141/Position switch relay - main stop valve	Fail Off	. Coil fails to energize and change state of contacts in the anti-motoring circuit	. Anti-motoring circuit in unit protection is also on 1D615, primary lock-out relays on unit protection bus are disabled . Power directional relay fails to energize and complete circuit that contains contacts from sequential trip - therefore, any adverse effects from the improper configuration of sequential trip contacts is eliminated		
3. Primary unit protection					
a. 86GC/Primary lockout relays -unit protection	Fail Off	. Coils do not energize to close contacts in EHC and initiate a trip . Primary unit protection is disabled			

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Sheet 1 of 4

Common Power Supply or Sensor:		1D625 125 VDC		CSID: 0160-004-001	Job No. 0160-004-671
Control System Affected:		Reactor Feedwater Control System		CD: 0160-004-012	Prepared by: <u>[Signature]</u> Date: <u>11/1/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Reactor feed pump turbine B trip circuit - Level 8 trip contacts	De-energized	. Trip circuit is de-energized . Level 8 trip signal cannot be processed	. Trip circuits for reactor feed pump turbines A and C are powered by other DC power supplies	. Loss of ability to trip turbine B on a Level 8 trip signal	. There is no affect on plant performance unless a Level 8 trip condition exists

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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 2 of 4

Common Power Supply or Sensor: <u>1D625 125 VDC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Recirculation Flow Control</u>		CD: <u>0160-004-012</u>		Prepared by: <u>Paul W. Stephens</u> Date: <u>12/21/81</u> Checked by: <u>John J. Smith</u> Approved by: <u>W. Smith</u>	
				Rev. <u>0</u> Date: <u>12/1/81</u> Date: <u>12/1/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Temperature switch: TSH-14021B2	Off	<ul style="list-style-type: none"> Failure of the temperature switch has no local effects There are no dependent failures associated with the switch failure Loss of bus voltage is predominant 	<ul style="list-style-type: none"> Redundant lube oil temperature indicators and a temperature switch-alarm combination provide additional monitoring 	<ul style="list-style-type: none"> Loss of automatic compensation for high lube oil temperature Operation of the recirculation pump in loop A must be governed by the flow criteria for single pump operation Control of loop B recirculation is lost and cannot be re-established until the bus voltage is recovered Control of recirculation loop A may be exercised via the master controller, M/A transfer station and speed control circuitry 	<ul style="list-style-type: none"> Recirculation flow is reduced due to the loss of flow in loop B A core flux difference will result from the flow imbalance
2. Circuits - recirculation flow loop B: a. Under-voltage relay b. Lockout c. Pump vibration reset d. Scoop tube power failure lock and reset e. Auxiliary circuits f. Generator field breaker	Off	<ul style="list-style-type: none"> Loss of bus voltage will cause the following: <ul style="list-style-type: none"> Generator field breaker for loop B will open The scoop tube for M-G set loop B will lock in position at the instant bus voltage is lost The M-G set and recirculation pump for loop B will trip and coast to a stop 	<ul style="list-style-type: none"> Recirculation loop A will continue to operate normally Reactor runback signals will be processed in the auxiliary and speed control circuitry for loop A No compensation effect for the loss of flow in loop B 		

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Common Power Supply or Sensor: 1D625 125 VDC		CSID: 0160-004-001		Job No. 0160-004-671	
Control System Affected: Pressure Regulator - T/G Control		CD: 0160-004-012		Prepared by: <u>Thomas M. D.</u> Date: <u>6/1/81</u> Checked by: <u>S. R. D.</u> Approved by: <u>A. R. D.</u>	
				Rev. <u>0</u> Date: <u>8/1/81</u> Date: <u>8/1/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Unit protection: a. 1R101/Generator oil circuit breaker-230kv power	Fail Off	<ul style="list-style-type: none"> 52X coil in 1R101 control system fails to remain energized Contacts in breaker auxiliary SWS2-1 will close (normally closed state when de-energized) Closed contacts initiate an EHC trip 		<ul style="list-style-type: none"> Initiates the T/G trip signal in the EHC system - no need for further turbine relay circuitry 	The main generator 1R101 oil circuit breaker de-energizes and trips the T/G
2. Trip and alarm switches: a. PSL-11981A2, B2/Thrust bearing wear detector and low bearing oil pressure	Fail High	<ul style="list-style-type: none"> PSLX-10112A2-B2 will not energize: - Contacts remain unchanged in logic circuit 	Circuit logic (2/3) prevents inadvertent trip via the instrumentation circuits	<ul style="list-style-type: none"> Any two energized trip and alarm switches, registering a transient sufficient to change their associated contacts will cause a T/G trip 	
b. PSL-10180B/Low hydraulic fluid pressure	Fail High	<ul style="list-style-type: none"> PSLX10180B will not energize: - Contacts remain unchanged in logic circuit 		<ul style="list-style-type: none"> Remaining relays become arranged in a 2/2 logic 	
c. PSL-11932B/Shaft pump discharge-low pressure	Fail High	<ul style="list-style-type: none"> PSLX11932B will not energize: - Contacts remain unchanged in logic circuit 		<ul style="list-style-type: none"> The generator sequential trip becomes disabled 	
d. TSHHX-10118A2-C2/Exhaust hood high temperature generator end trip	Fail Low	<ul style="list-style-type: none"> TSHHX-10118A2-C2 will not energize: - Contacts remain unchanged in logic circuit 		<ul style="list-style-type: none"> There are no further actions or trips involved when the sequential trip is lost 	
e. LSHX-10127B, -28B, -29B/Moisture separator reheater drain tank 1B high water level	Fail Low	<ul style="list-style-type: none"> LSHX10127B will not energize: - Contacts remain unchanged in logic circuit 			

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Sheet 3a of 4

Common Power Supply or Sensor: <u>1D625 125 VDC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator - T/G Control</u>		CD: <u>0160-004-012</u>		Prepared by: <u>[Signature]</u> Rev. <u>0</u> Date: <u>12/1/81</u> Checked by: <u>[Signature]</u> Date: <u>12/1/81</u> Approved by: <u>[Signature]</u> Date: <u>12/1/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
3. Sequential trip instrumentation:					
a. ZS-10160A2-F2, A5-P5/ Position transducers - intercept and intermediate stop valves-servo valves	Fail Off	Sequential trip disabled by the failure to energize 33X2-10141 Contact 5X2T2-1R101 fails to open due to the inability to energize the corresponding coil in the auxiliary circuit			
b. ZS-10141A2-D2/Position transducers - main stop valves-servo valves	Fail Off	Same as ZS-10160			
c. 52XT2-1R101 52XT1-1R101/Main generator auxiliary relay	Fail Off	Fails to energize and open contact in generator sequential trip			

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Job No. 0160-004-671
Prepared by: Y. J. J.
Date: 12/1/81
Checked by: Robert M. D.
Approved by: W. K. L.
Rev. 0
Date: 12/1/81

Common Power Supply or Sensor: 10625 125 VDS

CSID: 0160-004-001

Control System Affected: Traversing In-Core Probe (TIP)

CD: 0160-004-012

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Valve control monitor	Off	<ul style="list-style-type: none">Shear valve is inoperativeDry gas purge circuit is inoperative	<ul style="list-style-type: none">On loss of 125 VDC, TIP is automatically withdrawn	<ul style="list-style-type: none">Control system returns TIP probe to normally housed positionFurther system operation is not possible until DC power is restored	<ul style="list-style-type: none">Unable to perform TIP operationUnable to obtain core flux readings through TIP probe

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Sheet 1 of 2

Common Power Supply or Sensor: <u>1D635 125 VDC</u>				Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Flow Control</u>				Prepared by: <u>Handy, D.</u>	
CSID: <u>0160-004-001</u>				Date: <u>12/21/57</u>	
CD: <u>0160-004-013</u>				Rev. <u>0</u>	
				Checked by: <u>G. J. [illegible]</u>	
				Approved by: <u>W. Parker</u>	
				Date: <u>12/21/57</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Feedwater flow instrumentation: a. Feedwater flow sensor train B/C32-N002	Off	Flow signal from sensor B goes to zero for flow signal processing circuit		In the 3 element mode: - A zero flow input signal to the flow control circuit causes an increase in speed for reactor feed pump turbine A, B, and C	If Level 8 trip is reached, RPPT C will not trip due to the disabling of the trip circuit
2. Feedwater level instrumentation: a. Reactor vessel level sensor C/C32-N004C	Off	Lose C train reactor water level signal		In start-up mode there is no affect	A Level 8 trip is possible due to the zero flow input signal to the flow control circuit
b. Reactor vessel high level alarm train C/C32-K624C	Alarm Armed	High level alarm is armed for Level 8 trip	Level 8 trip logic is reduced from 2/3 to 1/2 and prevents an inadvertent trip caused by a power failure	Reactor vessel high level (Level 8) trip is armed in train C	
3. Reactor feed pump turbine trip (RPPT) circuit train C	Off	Level 8 contact in trip circuit not processed		Circuits are in 1/2 logic There is no affect on the control system, providing the trip condition is not present	

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Common Power Supply or Sensor: <u>1D635 125 VDC</u>			CSID: <u>0160-004-001</u>	Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator and T/G Control</u>			CD: <u>0160-004-013</u>	Prepared by: <u>Handwritten Signature</u>	Rev. <u>0</u>
				Date: <u>2/2/86</u>	Date: <u>2/2/86</u>
				Checked by: <u>Handwritten Signature</u>	Date: <u>2/2/86</u>
				Approved by: <u>Handwritten Signature</u>	Date: <u>2/2/86</u>

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Trip and Alarm switches: a. PSL-11981A3, B3/Thrust bearing wear detector and low bearing oil pressure	Fail High	Coil does not energize and fails to change state of contacts in EHC logic circuit	Circuit logic (2/3) prevents inadvertent EHC trip	Control logic circuit reduces to a 2/2 logic system	No trip of EHC occurs when power supply lost
b. PSL-10180C/Low hydraulic fluid pressure	Fail High			Level 8 trip logic is reduced from 2/3 to 1/2	No impact to overall plant performance will occur
c. PSL-110132C/Shaft pump discharge low pressure	Fail High			Loss of back-up unit protection	
d. TSHH-1019A3-C3/High exhaust hood temperature generator end	Fail Low				
e. Level 8 reactor high water level trip, train C	Armed	One third of Level 8 trip circuit armed	Level 8 trip can still trip T/G		
2. Back-up unit protection 86GD Back-up lockout relay unit protection	Off	Loss of redundant unit protection system	Primary unit protection remains activated		

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FAILURE MODES AND EFFECTS ANALYSIS

Common Power Supply or Sensor:
Control System Affected:

10645 125 VDC
Pressure Regulator & T/G Control

CSID: 0160-004-001
CD: 0160-004-014

Job No. _____
Prepared by: Flannery, J. W.
Date: 1-14-69
Checked by: W. J. Miller
Approved by: _____
0160-004-671
Rev _____
Date _____
Date _____

System Inherent
Compensating Provision

Summary:
Effect Upon
Control System

Summary:
Effect Upon
Plant Performance

1. EHC control instrumentation:
a. Generator breaker
(speed control logic)

Failure
Mode

Symptoms and Local
Effects Including
Dependent Failures

Off

- Failure to trip turbine if generator load becomes unsynchronized or if a loss of generator electrical load occurs

b. PSU-10504A-C/Bypass valve
low vacuum pressure trip

Off

- A loss of vacuum cannot initiate a T/G trip

c. PSLX-10112A1-A3
PSLX-10112B1-B3/Thrust
bearing wear detector
and bearing oil low
pressure trip

Off

- The thrust bearing wear detector and bearing oil low pressure trip and bearing wear detector test are disabled

d. PSLX-11932A-C/Shaft pump
discharge low pressure
trip

Off

- Low pressure trip disabled

e. PSLX-10180A-C/Hydraulic
fluid low pressure trip

Off

- Low pressure trip disabled

f. TSHHX-10119A1-A3, B1-B3,
C1-C3/Exhaust hood high
temperature trip

Off

- Exhaust hood high temperature trip disabled

g. LSHX-10127A, B/Moisture
separator reheater high
level trip

Off

- Moisture separator reheater high water level trip disabled

h. 2S-10141A4-D4/Load limit
switch (load unit)

Off

- All switches disabled

i. 2S-10160A4, C4, E4/Inter-
mediate stop valve 1, 3,
5 open switches

Off

- Switches disabled, valves cannot be positioned

- Jumper cables installed during construction will prevent a T/G trip if the 125 VDC bus is lost
- A circuit breaker is installed which trips T/G when at standstill or low speed, when there is no customer supplied DC

- Inactivation of the following T/G protective trips:
1. High exhaust hood temperature

- At rated speed, there is no effect on the P
- At standstill and low speed, loss of DC T/G

- 2. Low shaft pump discharge pressure

- 3. Thrust bearing wear detect and low bearing oil pressure

- 4. Low hydraulic fluid pressure

- 5. Low vacuum

- 6. Mechanical trip solenoid

- 7. Moisture separator reheater high water level

- 8. Generator main oil circuit breaker

- The load unit is disabled
- All feed

- At low speeds or standstill
- confi



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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 1a of 2

Common Power Supply or Sensor: <u>1D645 125 VDC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator & T/G Control</u>		CD: <u>0160-004-014</u>		Prepared by: <u>Handwritten Name</u> Date: <u>12/1/76</u> Checked by: <u>Handwritten Name</u> Approved by: <u>Handwritten Name</u>	
				Rev. <u>0</u>	Date: <u>12/1/76</u>
				Date: <u>12/1/76</u>	Date: <u>12/1/76</u>

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
j. ZS-10160A1-F1, A7, C7, E7/ Open switches, close switches, respectively	Off	. Switches are disabled and intercept valves 1, 3, and 5 cannot be properly positioned			
k. ZS-10140A1-E1, A2-E2/ Position switches	Off	. All position switches on bypass valves are disabled; - Bypass valve cannot be positioned	All valves that are operated by position are disabled		
l. Valve test logic circuits	Off	. No tests on valves can be conducted while customer DC is not functioning	. The Emergency Trip system will close valves, if activated		
m. Level 8 reactor high water level trip, train 8	Armed	. One third of Level 8 trip circuit armed	. Level 8 trip can still trip T/G on high level		



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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 2 of 2

Common Power Supply or Sensor: <u>1D645 125 VDC</u>			CSID: <u>0160-004-001</u>	Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Control System</u>			CD: <u>0160-004-014</u>	Prepared by: <u>Wanda M. D.</u> Date: <u>1/24/87</u> Checked by: <u>Wanda M. D.</u> Approved by: <u>Wanda M. D.</u>	
				Rev. <u>0</u>	
				Date: <u>1/21/87</u>	Date: <u>1/21/87</u>
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Feedwater level instrumentation: a. Reactor vessel level sensor train B/C32-M004B	Off	<ul style="list-style-type: none"> If B is selected, the level signal input to the flow control circuit goes to zero Level signal input to flow control circuit becomes zero 	<ul style="list-style-type: none"> If level A is selected as input to flow control circuit, there is no effect on the resulting control signal A and C train input signals to Level 8 trip circuit are not enabled 	<ul style="list-style-type: none"> If level A is selected as input to the control system, there will be no affect on the control system If level B is selected as the input signal to the control system, a zero level signal results in: -Reactor feed pump turbine speed will increase causing a high steady state reactor vessel level to compensate for the low level signal Level 8 trip logic (2/3) is reduced to 1/2 logic due to arming of the B train portion of the Level 8 trip circuit 	<ul style="list-style-type: none"> For level A selected, there is no affect on plant performance For level B selected, the higher steady state reactor vessel water level may result in Level 8 trip of reactor feed pump turbines A, B, and C
b. Reactor vessel high level alarm/C32-K624B	Armed	<ul style="list-style-type: none"> Loss of power to alarm enables 1/3 logic of the Level 8 trip circuit 			

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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 1 of 17

Common Power Supply or Sensor: <u>1Y218 120 VAC</u>				CSID: <u>0160-004-001</u>	
Control System Affected: <u>Nuclear Pressure Relief</u>				CD: <u>0160-004-015</u>	
Job No. <u>0160-004-671</u>				Prepared by: <u>[Signature]</u>	
Date: <u>12/21/87</u>				Rev. <u>0</u>	
Checked by: <u>[Signature]</u>				Date: <u>12/21/87</u>	
Approved by: <u>[Signature]</u>				Date: <u>12/21/87</u>	

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Temperature monitoring/leak detection subsystem: a. Thermocouple/1N004 G, N, K, M, N, A, B, C, D, E, F, H, P, R, S	As Is	. Loss of signal to switch in R614	. There are no inherent compensating provisions	. Loss of safety relief valve leakage detection	. Loss of ability to monitor for downstream leakage from safety relief valve
b. Temperature recorder/R614	Off	. Loss of high temperature alarm indication		. Loss of high temperature signal to annunciator circuit . Loss of temperature indication/leak detection	. Loss of temperature indication downstream of safety relief valve

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FAILURE MODES AND EFFECTS ANALYSIS

Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator - T/G Control</u>		CD: <u>0160-004-015</u>		Prepared by: <u>Theresa M. P.</u>	
				Date: <u>12/11/90</u>	
				Checked by: <u>J. J. P.</u>	
				Approved by: <u>W. K.</u>	
				Rev. <u>0</u>	
				Date: <u>12/11/91</u>	
				Date: <u>12/11/91</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Level 8 trip circuit for T/G train A	Armed	One third of Level 8 trip circuit armed		Level 8 trip logic reduced from 2/3 to 1/2	No affect on plant performance

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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 3 of 17

Common Power Supply or Sensor: <u>1Y218 120 VAC</u>			CSID: <u>0160-004-001</u>	Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Flow Control</u>			CD: <u>0160-004-015</u>	Prepared by: <u>Handwritten Signature</u>	Rev. <u>0</u>
				Date: <u>12/1/81</u>	Date: <u>12/1/81</u>
				Checked by: <u>Handwritten Signature</u>	Date: <u>12/1/81</u>
				Approved by: <u>Handwritten Signature</u>	Date: <u>12/1/81</u>

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Feedwater flow control instrumentation:					
a. Feedwater flow sensor C32-N002A, C	Off	. Zero output trains A, C		. Loss of feedwater flow signals and automatic control in 1 or 3 element mode	. In start up or at power, the RFPT M/A controls are disabled
b. Steam flow sensor C32-N003A, B, C, D	Off	. Zero output all trains		. Loss of steam flow signals	. Feedwater flow remains invariant due to a "Speed Freeze"
c. Reactor water level sensor C32-N004A	Off	. Zero output train A	. Two level sensors remain on 2/3 logic for reactor water level (level 8) trip	. Loss of entire instrumentation loop connected to SRUs 1, 4, and 5	. Feedwater flow regulation is unavailable due to the loss of the start-up valve control station
d. Reactor pressure level C32-N005	Off	. Zero output		. At low flow, control system fails to regulate flow	. Reactor runback signal transmitted to the recirculation system
e. Main turbine first stage pressure, steam flow C32-N007	Off	. Zero output		. M/A control of RFPTs via a single control signal is lost	. Prior to the Level 8 trip, the RFPTs may be terminated only via an operator-initiated trip
f. Reactor pressure sensor C32-N008	Off	. Zero output		. All control of individual RFPTs within the feedwater control system is disabled	. See sheet 16 for the effects on the recirculation system
g. Square rooter C32-K605 C32-K606	Off	. Zero output		. Active trip system is reduced to 1/2 logic	. Reactor vessel high water level (Level 8) trip is possible if "Speed Freeze" occurs at maximum demand. Reactor vessel low level (Level 2) trip is possible if "Speed Freeze" occurs at minimum demand
h. Gain and bias control	Off	. Zero output		. Any additional alarm will trip the system	
i. Bias/gain steam flow signal/C32-K603	Off	. Zero output		. "Speed Freeze" initiated via the LC-12730/electric automatic positioner on each RFPT	
j. Gain and bias inputs/C32-K602	Off	. Zero output			
k. Proportional amplifier/C32-K616 (summer)	Off	. Zero output			
l. Dynamic Compensator/C32-K649	Off	. Zero output			
m. Function generator/C32-K630	Off	. Zero output			

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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 3a of 17

Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Control System</u>		CD: <u>0160-004-015</u>		Prepared by: <u>[Signature]</u> Date: <u>11/21/87</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u> Date: <u>12/21/87</u> Date: <u>7/2/88</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
2. 24V GE power supply: a. C32-K611 b. C32-K612 c. C32-K613	Off	. Zero output power to the individual instrument loops			
3. Control stations: a. Low flow demand signal logic/C32-K645, K646 b. Feedwater demand signal (1 or 3 element level control)/C-32-K633, K634, K653 c. RFPT logic control/C32-K637, K638A, B, C d. M/A transfer station/C32-R600, R601A, B, C, R602	Off	. Loss of auto/manual control of the feedwater start-up control valve . Loss of all auto/manual control of feedwater control system . Loss of auto/manual control associated with each RFPT - No speed freeze override available in feedwater system . Loss of transfer station due to failure of associated devices powered by 1Y218	. "Speed Freeze" is initiated when the control signal is lost		
4. Alarms: a. Recirculation loop pump cavitation interlock/C32-K618 b. Feedwater pump interlock/recirculation loop flow reduction alarm/C32-K628 c. Steam flow level/C32-K608	Fail Low	. Transmits a low-low run-back signal to the recirculation system . Transmits a trip signal to the recirculation system . Transmits a low flow signal to the computer			

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FAILURE MODES AND EFFECTS ANALYSIS

Common Power Supply or Sensor: 1Y218 120 VAC			CSID: 0160-004-001	Job No. 0160-004-671	
Control System Affected: Reactor Feedwater Control System			CD: 0160-004-015	Prepared by: <u>Theresa 2/2/81</u> Date: <u>12/14/80</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
		Rev. <u>2</u> Date: <u>12/21/81</u> Date: <u>2/2/81</u>			
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
d. Bi-level alarm/C32-K635	Fail High and Low	High and low level annunciators for reactor water level are energized on the control room display panel	High water level logic (2/3) prevents inadvertent trip with arming of train A alarm		
e. High reactor water level turbine trip/C32-K624A	Fail High	Train A alarm indicates high reactor water level			
f. RPPT control signal loss/C32-K607	Fail Difference	The alarm for the loss of control signal is armed A "Speed Freeze" is initiated			



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FAILURE MODES AND EFFECTS ANALYSIS

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Common Power Supply or Sensor: <u>1Y218 (120 VAC) to C32-K611 (24VDC)</u>				CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Control System</u>				CD: <u>0160-004-015</u>		Prepared by: <u>Handwritten Signature</u> Date: <u>9/1/81</u> Checked by: <u>Handwritten Signature</u> Approved by: <u>Handwritten Signature</u>	
Component Name and Number		Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance	
1. a. K605B/Steam signal square roter	Off	Loss of signal input, zero output from B train to controller		Loss of signals will induce feed pumps to increase flow in 3 element control	Runback signals sent to recirculation system		
b. K606B/Feedwater flow signal square roter	Off				Optimum water level may not be maintained by automatic control		
2. K607B/Feed pump B speed control signal loss	Fail Loss of Signal	Loss of automatic signal input to the auto positioner for feed pump B	"Speed Freeze" on train B initiated	Automatic control for train B and C feed pump is lost	Initiation of a "Speed Freeze" at high pump speed may result in a high level (Level 8) trip		
3. a. K618B/Recirculation loop pump cavitation interlock alarm	Fail Low	Runback signal transmitted to recirculation system	No compensating devices	Trip signals transmitted to recirculation system			
b. K628B/Feedwater pump trip interlock/runback signal to recirculation system	Fail Low			No manual override of "Speed Freeze" circuit is available on RPPT B and C	Initiation of a "Speed Freeze" at low pump speed may result in a low level (Level 2) trip		
4. K630B, C/Function generator	Off	Zero output signal		RPPT speed is increased due to the loss of train B signal			
5. K637B & C, K638B & C, K638B-1 & C-1, R601B & C/Feed pump manual/auto transfer control station	Off	Loss of all automatic and manual control of reactor feed pump turbines B and C	"Speed Freeze" on feed pumps B & C initiated				

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FAILURE MODES AND EFFECTS ANALYSIS

Sheet 5 of 17

Common Power Supply or Sensor: <u>1Y218 (120 VAC) to C32-K612 (24VDC)</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Control System</u>		CD: <u>0160-004-015</u>		Prepared by: <u>Howard J. [Signature]</u> Date: <u>12/1/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. a. K606A/Feedwater flow A square rooter	Off	. Control signals are lost from train A	. No compensating devices	. Input signals via automatic monitoring of the reactor water level are lost - level controller cannot be operated in the auto mode	. Low flow runback signal transmitted to the recirculation system
b. K616/Proportional amplifier	Off	. Input signals to the level controller are lost			
c. K630A/Function generator train A	Off	. Input signals to each feed pump control station are reduced to zero		. Initiates a "Speed Freeze" on trains A, B, and C	
d. K605A/Steam flow A square rooter	Off			. Loss of all 1 or 3 mode level control	
2. K624A/High level turbine trip alarm	Fail High	. Fails in high water level mode	. Trip logic (2/3) prevents an inadvertent Level 8 trip resulting from a power failure	. Manual or automatic control of all 3 feed pumps from a single station cannot be exercised	
		. Level 8 trip logic (1/3) is armed			
3. K607A/Alarm for feed pump control signal loss	Fail Loss of Signal	. Fails in "Speed Freeze" orientation	. No compensating device needed	. Loss of manual override of feed pump A	
4. K633, 634, 634-1, 653, R-600/Level controller	Off	. Since input signals are reduced to zero, all automatic control is lost	. Each pump can be controlled by separate manual control stations	. For conditions of low feedwater flow demand, control of feedwater flow cannot be performed via the start-up valve	
		. Manual control of all 3 feed pumps from a single control station is unavailable	. Auto mode is disabled for all pumps	. Manual override of "Speed Freeze" for RPPT B and C is available	
5. K637A, 638A, 638A-1, R-601A/Feed pump A manual/automatic transfer control station	Off	. All automatic/manual control of feed pump A is lost	. "Speed Freeze" is initiated		
6. K645, 646, 646-1, R602/Start-up, low flow control station	Off	. For low feedwater flow, manual/automatic control of the start-up valve is lost	. Low flow conditions will be altered by manual control of feed pump turbines		

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FAILURE MODES AND EFFECTS ANALYSIS

Common Power Supply or Sensor: <u>1Y218 (120 VAC) to C32-K612 (24VDC)</u>			CSID: <u>0160-004-001</u>	Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Control System</u>			CD: <u>0160-004-015</u>	Prepared by: <u>[Signature]</u> Date: <u>12/1/81</u>	Rev. <u>0</u> Date: <u>12/31/81</u>
Checked by: <u>[Signature]</u>				Approved by: <u>[Signature]</u> Date: <u>12/1/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
7. a. K618A/Recirculation loop pump cavitation interlock	Fail Low	Runback signal is transmitted to the recirculation system			
b. K628A/Feedwater pump trip interlock/runback signal to recirculation system	Fail Low				

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FAILURE MODES AND EFFECTS ANALYSIS

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Common Power Supply or Sensor: <u>1Y218 (120 VAC) to C32-K613 (24VDC)</u>				CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Feedwater Control System</u>				CD: <u>0160-004-015</u>		Prepared by: <u>[Signature]</u> Date: <u>12/2/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance		
1. a. K602/Steam and feedwater signals gain and bias	Off	. All output signals go to zero	. No compensation is available or necessary	. In 1 element mode, a loss of bias and gain has no consequence	. Recirculation system receives a low flow runback signal due to the loss of the feedwater flow signal		
b. K603/Steam flow signal gain and bias	Off			. In 3 element mode, the level controller output will initiate a speed increase of all 3 feed pumps	. Level 8 trip may be initiated as the result of speed increase of feedwater pumps		
c. K615/Feedwater signal gain and bias	Off			. Automatic control for feed pump C is lost	. The speed of pump C cannot be increased due to the "Speed Freeze"		
d. K605 C&D/Steam flow C and D square rooter	Off						
e. K606C/Feedwater to train C square rooter	Off						
f. K649/Dynamic compensator	Off						
2. K635/Bi-level trip alarm	Fail Low	. Annunciators for high and low reactor water level are energized in the control room	. Same as item 1				
3. K636/High pressure alarm	Fail High	. Annunciator for reactor high pressure is energized	. Same as item 1				
4. K608/Steam level alarm	Fail Low	. Low flow signal is transmitted to computer	. Same as item 1				
5. K607C/Feed pump speed signal loss alarm unit	Fail Loss of Signal	. "Speed Freeze" signal is transmitted to the electric automatic positioner	. "Speed Freeze" circuit is available for train C when in the auto mode - Manual override of "Speed Freeze" available				

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FAILURE MODES AND EFFECTS ANALYSIS

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Common Power Supply or Sensor: 1Y218 120 VAC			CSID: 0160-004-001	Job No. 0160-004-671	
Control System Affected: Reactor Manual Control System (RMCS)			CD: 0160-004-015	Prepared by: J. D. Field Date: 12/21/81 Checked by: [Signature] Approved by: [Signature]	
Rev. 0		Date: 12/21/81			
Date: 12/21/81		Date: 12/21/81			

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
SUMMARY - REACTOR MANUAL CONTROL SYSTEM					
1. Rod control unit operating benchboard	Off	. See sheet 9	. Control rods cannot be operated due to a loss of power to these sub-systems	. Full core display is not available	. Control rod movement is not possible: - Power changes cannot be made - Rod testing cannot be accomplished (if in progress)
2. Rod position information system	Off	. See sheet 10		. Operator signals cannot be transmitted to rod drive control	
3. Rod sequence control system	Off	. See sheet 8		. Rod position information is not available	
4. Trip unit, turbine pressure	Off	. See sheet 12		. Rod sequence control is de-energized	
5. Scram time test panel	Off	. See sheet 11		. Rod movement limitation associated with RCS are still imposed	
6. Control rod drive hydraulic control	Off	. See sheets 13, 14		. Scram timing test cannot be operated	

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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Manual Control System (RMCS)</u>		CD: <u>0160-004-015</u>		Prepared by: <u>[Signature]</u> Date: <u>12/21/87</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u> Date: <u>12/21/87</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Rod sequence control system/ P659: a. RSCS page	Off	<ul style="list-style-type: none"> Loss of timing and gating signals Loss of test signals 	See summary sheet page 1	Rod block function with-draw and insert signals to input isolation of RDCC are activated	RSCS rod movement limitations are invoked: 1. Prevents out-of-sequence rods from being moved 2. Limits movement of out-of-sequence rod
b. Rod pattern controller	Off	<ul style="list-style-type: none"> Loss of memory circuitry processing Rod block contacts open if closed and remain open if already open 			



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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Manual Control System (RMCS)</u>		CD: <u>0160-004-015</u>		Prepared by: <u>J. J. J. J.</u> Date: <u>12/21/81</u> Checked by: <u>W. J. J. J.</u> Approved by: <u>W. J. J. J.</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Rod control unit operating benchboard/P680: a. Full core display module b. Rod select switch assembly c. Rod select and transmitter module	Off Off Off	. Loss of full core display . Switch assembly inoperative . Signals cannot be transmitted to rod drive control	. See summary sheet page 1	. Lose full core display module . Lose rod select switch assembly . Lose rod select and transmitter module - cannot transmit to rod drive control system. . Lose rod worth minimizer operator panel - initiation	. Loss of ability to select and move control rods

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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Manual Control System (RMCS)</u>		CD: <u>0160-004-015</u>		Prepared by: <u>Y. J. [Signature]</u> Date: <u>12/1/88</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>2</u> Date: <u>12/1/88</u> Date: <u>12/1/88</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Rod position information system/P615:					
a. Control module - control file, multiplex file	Off	<ul style="list-style-type: none"> All electrical control signals are de-energized (control file) Rod position indicator probe signals are not processed 	See summary sheet page 1	<ul style="list-style-type: none"> Lose rod position output to scram time test panel Lose rod position output to 4 rod control file Lose "Rods In" signal to refueling hoist control Lose rod position indication 	Control rod position cannot be monitored
b. Multiplex module (2)	Off	<ul style="list-style-type: none"> Rod position indicator probe signals are not processed 			

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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Manual Control System (RMCS)</u>		CD: <u>0160-004-015</u>		Prepared by: <u>[Signature]</u> Date: <u>12/21/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
Rev. <u>0</u> Date: <u>12/21/81</u>					
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Scram time test panel/P610	Off	<ul style="list-style-type: none">Loss of rod position/movement signal from the rod position information systemLoss of input from the master clock from RDCC P616Loss of scram test signal from the output isolation of RDCC P616Loss the of scram signal processing input to scram time test panel from reactor protection	See summary sheet page 1	Loss of ability to measure scram time for control rods	Normal operation of control rods is not affected - scram testing function is lost

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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Manual Control System (RMCS)</u>		CD: <u>0160-004-015</u>		Prepared by: <u>[Signature]</u> Date: <u>5/21/87</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Trip unit first stage turbine press/P613					
a. SRU-1	Off	. Instrument loop is de-energized	. See summary sheet page 1	. Pressure transmitter signals are not processed	. Rod movement limitations of RSCS are still present even after low power set-point is reached:
b. Press indicating switch/ PIS-1N654A, B	Off	. Contacts in switch remain open		. Trip unit signal is not bypassed when low power set-point is reached - signal is not sent to RSCS P659	1. Cannot move out-of-sequence rod
c. Pressure transmitter/ PT-1N054A, B	Off	. Signal from transmitter is not processed			2. Limits movement of in-sequence rod

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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Manual Control System (RMCS)</u>		CD: <u>0160-004-015</u>		Prepared by: <u>[Signature]</u> Date: <u>12/11/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u> Date: <u>12/11/81</u> Date: <u>01/12/82</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Control rod drive (CRD) hydraulic control:			See summary sheet page 1		
a. Flow control station 1D-009A/B:	Off				
1. FE-1N003/Flow element		Loss of power does not effect flow element		Loss of automatic flow control capability.	
2. FC-1R600/Controller		Controller does not send signals to converter		Loss of system flow indication	
3. FY-1K001/Converter		Converter does not reposition to allow control air to reposition air-operated valve		Differential pressure indication required to properly adjust drive water pressure control valve is not available	
4. FT-1N004/Flow transmitter		Flow signal is not transmitted to controller		Cannot maintain proper differential pressure between reactor vessel and drive water header	
5. 1K600/Power supply		Loss of power (AC to DC conversion) to control/instrument loop		Loss of alarm indication for high charging water header pressure	
b. Drive/cooling water pressure control:	Off				
1. PDT-1N011/Differential pressure		Loss of transmitted differential pressure (reactor coolant/drive water header) downstream of pressure control station			Normal control rod movement cannot be accomplished due to loss of normal control rod drive hydraulic control instrumentation
2. PDT-1N008/Differential pressure		Loss of transmitted differential pressure upstream of pressure control station			

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Common Power Supply or Sensor: 1X218 120 VAC			CSID: 0160-004-001	Job No. 0160-004-671	
Control System Affected: Reactor Manual Control System (RMCS)			CD: 0160-004-015	Prepared by: [Signature]	Rev. 0
				Date: 12/31/81	Date: 12/31/81
				Checked by: [Signature]	Date: 12/31/81
				Approved by: [Signature]	Date: 12/31/81
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
3. FE-1N010, FT-1N009/ Cooling water flow		. Loss of cooling water flow indication			
4. 1K600/Power supply		. Loss of instrumentation/control loop for pressure control			
5. FE-1N006, FE-1N007/ Drive header flow		. Loss of drive water header flow indication			
c. Charging water header pressure instrumentation:	Off				
1. PT-1N005/Pressure transmitter		. Loss of charging water pressure signal to switch			
2. PISH-1N600/Pressure switch		. Loss of high pressure signal to alarm			
3. PAH-14604/Charging water high pressure alarm		. Loss of alarm signal indication			

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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Water Cleanup System (RWCS)</u>		CD: <u>0160-004-015</u>		Prepared by: <u>J. [Signature]</u>	
				Date: <u>12/21/81</u>	
				Checked by: <u>[Signature]</u>	
				Approved by: <u>[Signature]</u>	
				Rev. <u>0</u>	
				Date: <u>12/21/81</u>	
				Date: <u>12/21/81</u>	

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Differential flow instrumentation: a. FT-1N036-RWCS inlet flow FT-1N012-RWCS blowdown flow FT-1N041-RWCS return flow SRV1	Off	. Instrument loops de-energized . Signal processing lost . Signal to isolation valves HV-1F001, HV-1F004 lost	. RWCS Leak Detection System	. RWCS system isolation protection (in event of high differential flow due to RWCS system leakage) is lost	. RWCS system will continue to operate normally - If system leakage is present isolation will be provided by the RWCS Leak Detection System

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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Recirculation Flow Control</u>		CD: <u>0160-004-015</u>		Prepared by: <u>Paul W. Synkes</u> Date: <u>12/21/81</u> Checked by: <u>W. J. D.</u> Approved by: <u>W. J. D.</u>	
				Rev. <u>0</u> Date: <u>1-4/82</u> Date: <u>2-1/82</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Recirculation flow control system:					
a. M/A transfer station and speed control for Loop A	Off	<ul style="list-style-type: none"> Loss of the bus voltage causes the following to become inoperative: - Master Controller - M/A Transfer Stations A and B - Speed Control Circuitry for Loops A and B 	<ul style="list-style-type: none"> Scoop tube locking circuitry permits recirculation pumps A and B to maintain the flows prior to loss of bus voltage 	<ul style="list-style-type: none"> Speed controls for both recirculation pumps are lost until: - Manual speed adjustments are made 	<ul style="list-style-type: none"> Recirculation flow rate maintained at the value prior to loss of bus voltage
M/A transfer station and speed control for Loop B	Off			<ul style="list-style-type: none"> - Bus voltage is recovered 	<ul style="list-style-type: none"> Variation of the reactor power level cannot be performed unless the recirculation flow rates are altered via manual positioning of the scoop tubes
Master Controller	Off	<ul style="list-style-type: none"> The following reactor runback signals are transmitted to auxiliary circuits A and B: - Low flow from feedwater system alarm/relay - Low NPSH from feedwater system alarm/relay Runback signals cannot be processed because of the loss of the above components Scoop tubes on the M-G sets A and B will lock in their last positions prior to the bus failure - Recirculation pumps maintain previous speed Indicators for speed and speed set point indicate zero 	<ul style="list-style-type: none"> Manual adjustment of the recirculation pump speed can be performed at the M-G sets through positioning of the scoop tubes 	<ul style="list-style-type: none"> Reactor runback signals cannot be processed 	

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Common Power Supply or Sensor: <u>1Y218 120 VAC</u>				CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Traversing In-Core Probe (TIP)</u>				CD: <u>0160-004-015</u>		Prepared by: <u>[Signature]</u> Date: <u>12/21/77</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
Rev. <u>0</u>		Date: <u>12/21/77</u>					
Rev. <u>0</u>		Date: <u>12/21/77</u>					
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance		
1. TIP control and monitor:							
a. Flux probe monitor/J600-2	Off	Flux detection processing circuit is de-energized - No signal input to X-Y recorder	TIP can be isolated through either of the following: - Isolation signal from primary containment reactor vessel isolation system	Cannot record TIP flux signals vs detection position	Loss of ability to operate TIP - Core flux levels cannot be obtained		
b. X-Y recorder/J600-1	Off	Plotter drive circuit is de-energized		Loss of flux signals to process computer			
c. Drive control unit/J600-A-E	Off	Control circuit for processing signals to the drive mechanism and indexing is de-energized	- Manual isolation through shear valve operation powered off DC	Loss of control capability to successfully process signals to the drive and indexing mechanisms			
d. Valve Control Monitor-Purge circuit	Off	Mechanism, computer and X-Y recorder pen lift					

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Common Power Supply or Sensor: <u>1Y219 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Manual Control System</u>		CD: <u>0160-004-016</u>		Prepared by: <u>[Signature]</u> Date: <u>11/21/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u> Date: <u>11/21/81</u> Date: <u>11/21/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Control Rod Drive Temperature Monitoring: a. Thermocouple TC-(185) b. Recorder R018	N/A Off	. Thermocouple signals are not processed . Recorder is de-energized	. There are no inherent compensating provisions	. Temperature signal from the thermocouple is not processed through the temperature circuitry . CRD temperature monitoring/recording is not available	. CRD temperature information is not available . Potential CRD high temperature condition cannot be detected

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Common Power Supply or Sensor: <u>1Y219 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Water Cleanup System (RWCS)</u>		CD: <u>0160-004-016</u>		Prepared by: <u>JA-JLS</u> Date: <u>12/31/77</u> Checked by: <u>Theresa D.</u> Approved by: <u>W. B. Baker</u>	
				Rev. <u>0</u> Date: <u>12/1/78</u> Date: <u>01/1/79</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Liquid radwaste/main condenser flow control instruments: a. PSL-1N013, PSH-1N014, SV-14438	Off	<ul style="list-style-type: none"> Flow control solenoid valve SV-14438 de-energizes shutting flow control valve to condenser/liquid radwaste system Pressure switch signals high or low have no affect on solenoid valve since it is already closed on loss of power 	Normal system flow return to feedwater system is still available	<ul style="list-style-type: none"> Normal operation of the RWCS is not effected Automatic operation of isolation valve to the condenser or liquid radwaste system is not available High temp. shutoff protection for RWCS pump is lost Ability to monitor key RWCS temperatures is lost 	Loss of ability to direct RWCS liquid to either main condenser or liquid radwaste system
2. RWCS pump cooling water high temperature shutoff: a. TE-1N001A, B, TISH-1N002A,B	Off	<ul style="list-style-type: none"> Instrument loop de-energized High temperature annunciators are inoperative 	No inherent compensating effect		
3. RWCS temperature monitoring: a. TE-1N004/Inlet, temperature TE-1N015/Outlet, temperature TE-1N019/Non-regenerative - heat exchange effluent TE-1N006/Regenerative - heat exchanges effluent TE-1N043/Reactor bottom head drain TT-1N045/Temperature transmitter	Off	<ul style="list-style-type: none"> Instrument loop is de-energized 	No inherent compensating effect		

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Common Power Supply or Sensor: <u>1Y226 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-071</u>	
Control System Affected: <u>Nuclear Pressure Relief</u>		CD: <u>0160-004-017</u>		Prepared by: <u>[Signature]</u> Date: <u>12/21/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u> Date: <u>1-14/82</u> Date: <u>1/21/82</u>	

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. SRV flow monitoring/DIV. II:					
a. Vibration transmitter VT-14180 B1-B8	Off	Transmitter unable to transmit flow information	Division I Safety Relief valve flow monitoring system is still available (powered by a different power supply)	Loss of Division II Safety Relief Valve flow monitoring capability	Operator is unable to monitor safety relief valve flow for 8 Division II SRV's
b. Vibration indicating switch (high)	Off	Switch unable to indicate high flow condition			

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Common Power Supply or Sensor: <u>1Y226 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Water Cleanup System (RWCS)</u>		CD: <u>0160-004-017</u>		Prepared by: <u>[Signature]</u> Date: <u>12/1/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
Rev. <u>0</u> Date: <u>1-24/82</u>		Rev. <u>0</u> Date: <u>1/24/82</u>			
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Filter demineralizer temperature instrumentation: a. TE-1N007, TE-1N008	Off	Filter demineralizer instrument loop is de-energized	Alternate system high temperature available through TSH-1N020/TAH-14420 at the inlet to filter demineralizer	Automatic RWCS system shutdown (pump and valves) is disabled	RWCS system will still operate normally Operator action is required to ensure system protection

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Common Power Supply or Sensor: 1Y629 120 VAC		CSID: 0160-004-001		Job No. 0160-004-671	
Control System Affected: Reactor Manual Control System (RMCS)		CD: 0160-004-018		Prepared by: <i>[Signature]</i> Date: 12/21/81 Checked by: <i>[Signature]</i> Approved by: <i>[Signature]</i>	
				Rev. 0 Date: 1/23/82 Date: 1/24/82	

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Rod Drive Control Cabinet/ P616:					
a. Power Section	Off	<ul style="list-style-type: none"> Loss of power to branch junction modules Loss of power to logic power supply (RDCC elec.) Loss of power to contact power supply (external contacts to RDCC) 	<ul style="list-style-type: none"> Can disconnect power to the system if the self test sub-system in the analyzer determines a malfunction has occurred 	<ul style="list-style-type: none"> The major effect on the RMCS is the loss of power to operate the HCU's; therefore, no rod movement is possible Command signals cannot be processed 	<ul style="list-style-type: none"> Loss of reactor power control through the RMCS Loss of rod movement capability during rod testing
b. Activity Control	Off	<ul style="list-style-type: none"> Loss of input processing and isolation Loss of rod motion signal processing Loss of rod motion sequence timing signal 	<ul style="list-style-type: none"> Effect of loss of power in 1-a. is the overriding factor Loss of the activity control is enveloped by the loss of power 	<ul style="list-style-type: none"> The solenoid valves if in operation will fail shut; therefore, rod movement will stop at the nearest mechanical latch position All modes of operation are lost - operator control, scan, and self test 	
c. Analyzer	Off	<ul style="list-style-type: none"> Loss of system signal comparison device Loss of fault mapping circuitry 	<ul style="list-style-type: none"> Effect of loss of power in 1-a. is the overriding factor Loss of the analyzer is enveloped by the loss of power 	<ul style="list-style-type: none"> There is also a loss of electrical output from the accumulator pressure/level limit switches, scram valve position, scram test 	
d. Branch Junction Module	Off	<ul style="list-style-type: none"> Loss of "COMMAND" word signal processing to valves Loss of power to transporter 	<ul style="list-style-type: none"> Effect of loss of power in 1-a. is the overriding factor Loss of the transporter is enveloped by the loss of power 	<ul style="list-style-type: none"> NOTE: The loss of the RMCS does not impact on the scram function 	

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Common Power Supply or Sensor: <u>1Y629 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Reactor Manual Control System (RMCS)</u>		CD: <u>0160-004-018</u>		Prepared by: <u>[Signature]</u> Date: <u>12/21/81</u>	
				Rev. <u>0</u> Date: <u>12/21/81</u>	
				Checked by: <u>[Signature]</u> Date: <u>12/21/81</u>	
				Approved by: <u>[Signature]</u> Date: <u>12/21/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
e. Transponder.	Off	<ul style="list-style-type: none">Loss of command signal processing from the transponder to the directional control valves (HCU)Loss of power to the directional control valves (HCU)Loss of accumulator pressure and the level limit switch circuitLoss of the scram valve position switch circuitLoss of the scram test switch circuit	Directional control valves fail shut on loss of power		

Sheet 2 of 3.

Common Power Supply or Sensor: 1Y629 120 VAC				CSID: 0160-004-001	Job No. 0160-004-671
Control System Affected: Recirculation Flow Control				CD: 0160-004-018	Prepared by: [Signature] Date: 12/21/81 Checked by: [Signature] Approved by: [Signature]
Component Name and Number		Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System
1. Reactor runback instrumentation:					Reactor runback circuitry is partially armed
a. Feedwater system train A:		Off	Low flow signal transmitted from the feedwater system control of reactor recirculation system runback circuitry to auxiliary circuits A and B	Bus failure will not system to react to the runback signal without the following inputs to auxiliary circuits A and B:	Plant performance is not affected
1. FT-10604A1				- Low flow input from feedwater system alarm relay	Recirculation flow is identical to the flow prior to the loss of power
2. FY-10604A1					
3. PSL-10604A1				- Circulating water pump	
Feedwater system train B:		Off	Relay contacts in the auxiliary circuitry logic are activated as part of the runback signal processing	- Low NPSH input from the feedwater system	
1. FT-10604B1					
2. FY-10604B1					
3. PSL-10604B1					
Feedwater system train C:		Off			
1. FT-10604C1					
2. FY-10604C1					
3. PSL-10604C1					

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Common Power Supply or Sensor: <u>1Y629 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator and T/G Control</u>		CD: <u>0160-004-018</u>		Prepared by: <u>[Signature]</u> Date: <u>12/1/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u> Date: <u>12/1/81</u> Date: <u>12/1/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Non-redundant power supplied devices			<ul style="list-style-type: none"> Inherent compensating devices unnecessary for non-redundant power supplied devices 	<ul style="list-style-type: none"> Loss of the AC bus voltage without PMG results in: <ul style="list-style-type: none"> - Loss of 24, -22, 30 VDC 	<ul style="list-style-type: none"> T/G trip is actuated when PMG is not providing redundant electrical power - otherwise no trip will occur
a. First stage pressure feedback potentiometer	As Is	<ul style="list-style-type: none"> Gain is not applied to the signal which operates the control valves at start-up 	<ul style="list-style-type: none"> The solenoid valves that fail "as is" will be closed by ETS only if loss of load occurs simultaneously with loss of power supply 	<ul style="list-style-type: none"> - Electrical trip system disabled - Both master trip pilot solenoid valves of the Master Trip Solenoid become de-energized 	<ul style="list-style-type: none"> Reactor scram will occur following T/G trip only if reactor power is greater than 30%
b. PA/PA transfer potentiometer	As Is	<ul style="list-style-type: none"> Modulating control is not transferred from the stop valves to the control valves 		<ul style="list-style-type: none"> The Master Trip Solenoid valve will close and results in: <ul style="list-style-type: none"> - Emergency Trip System actuates to trip T/G 	
c. Load reference motor	As Is	<ul style="list-style-type: none"> Automatic modulation of the load reference signal can not be conducted -The power/load unbalance circuit cannot reset load signal automatically 		<ul style="list-style-type: none"> At speeds sufficient to operate the permanent magnet generator (PMG), redundant power for essential devices is supplied - All 24, -22, 30 VDC operated devices 	
d. Bypass valve jack motor	Off	<ul style="list-style-type: none"> Disable manual positioning of the bypass valves during start-up and cool-down 		<ul style="list-style-type: none"> Although several regulating control features will be unavailable, a trip will not occur when the PMG is supplying redundant power 	
e. Pressure reference signal motor	Off	<ul style="list-style-type: none"> Manual control of pressure set-point is disabled - No variable set-point pressure for pressure control unit's primary pressure amplifier 		<ul style="list-style-type: none"> At operating speeds, devices without redundant power supply either: <ul style="list-style-type: none"> - Are not required at operating speeds 	
f. Fast-acting solenoid valve - intermediate valve/SV-10160A2 - F2	As Is	<ul style="list-style-type: none"> Intermediate valve fails "As Is" 			

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FAILURE MODES AND EFFECTS ANALYSIS

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Common Power Supply or Sensor: <u>1Y629 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator and T/G Control</u>		CD: <u>0160-004-018</u>		Prepared by: <u>Harold M. [Signature]</u>	
				Date: <u>12/21/51</u>	
				Checked by: <u>[Signature]</u>	
				Approved by: <u>[Signature]</u>	
				Rev. <u>0</u>	
				Date: <u>12/21/51</u>	
				Date: <u>12/21/51</u>	

Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
g. Fast-acting solenoid valve - intercept valve/SV-10160A1 - B1	As Is	. Intercept valve fails "As Is"		- fail as is and have a hydraulic backup system	
h. Solenoid valve - bypass valve/SV-1014A - E	Closed	. Bypass valves will fail closed - the bypass system is disabled		- "Freeze" in its last configuration prior to the failure of the AC bus	
i. Solenoid test valve - stop valve/SV-10142	Off	. Inability to energize prevents valve positioning by chest/shell warming stop valve			
j. Reset oil valve solenoid/SV-10123	Off	. Cannot be energized to reset mechanical trip valve			
k. Lockout valve solenoid/SV-10124	Off	. Prevents lockout valve from bypassing mechanical trip valve, whereby the mechanical trip valve remains effective			
l. Oil trip valve solenoid/SV-10122	Off	. Valve closes and prevents acceptable hydraulic pressure by closing mechanical trip valve			
m. Closing solenoid valve intercept valve/SV-10160C1 - F1	As Is	. Intercept valve fails "As Is"			
n. Closing solenoid - control valve/SV-10150A - D	As Is	. The control valves will fail "As Is"			
o. Fast-acting solenoid valve - stop valve/SV-10141A - D	As Is	. Stop valve fails "As Is"			

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Sheet 3b of 3

Common Power Supply or Sensor: <u>1Y629 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator and T/G Control</u>		CD: <u>0160-004-018</u>		Prepared by: <u>[Signature]</u> Date: <u>[Signature]</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
				Rev. <u>0</u> Date: <u>12/21/81</u> Date: <u>1/1/82</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
p. Solenoid test valve - stop valve #3/SV-10143 Solenoid test valve - stop valve #4/SV-10144 Solenoid test valve - intermediate valve/SV-10160A3 - F3	Off	. Inability to energize prevents opening and closing of valve when controlled by positioning unit in shell/chest warming stop valve			
2. Redundant power-supplied devices:			. At operating speeds, redundant power is available from the permanent magnet generator (PMG)		
a. Speed control	Off	. Loss of speed signals			
b. Pressure control	Off	. Loss of pressure control			
c. Load control	Off	. Loss of power-load matching	. Several devices are essential at low speeds without redundant power - the emergency trip is activated		
d. Bypass control unit	Off	. Loss of bypass system, to direct steam to condenser. Required system at low speeds			
e. Automatic pressure set-point adjustment	Off	. Loss of pressure set-point signal to other systems			
f. Main steam sensor/PT-10101	Off	. Loss of main steam pressure signals			
g. Intermediate steam pressure sensor/PT-10107	Off	. Loss of intermediate steam pressure signal (power-level signal)			
h. Electronic pressure transmitter in steam chest/PT-10102	Off	. Loss of steam chest pressure signal			

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Common Power Supply or Sensor: <u>1Y629 120 VAC</u>		CSID: <u>0160-004-001</u>	Job No. <u>0160-004-671</u>		
Control System Affected: <u>Pressure Regulator and T/G Control</u>		CD: <u>0160-004-018</u>	Prepared by: <u>[Signature]</u> Date: <u>[Signature]</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>		
			Rev. <u>0</u> Date: <u>12/1/81</u> Date: <u>01/1/82</u>		
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
i. Servo valve - control valve/XV-10148A - D	Off	. Loss of control valve positioning			
j. Servo valve - main stop valve/XV-10141	Off	. Loss of stop valve #2 positioning for chest/shell warming			
k. Servo valve - intercept valve/XV-10161A, C, E Servo valve - bypass valve/XV-10139A - E	Off	. Loss of intercept valve positioning			
l. Auto load following unit	Off	. Loss of tracking signals			
m. Frequency-voltage converter	Off				
n. Line speed matcher	Off	. Unnecessary at low speeds			
o. Chest/shell warming circuit and logic	Off	. Loss of chest/shell warming circuit. Required in start-up mode (low speeds)			
p. Current/voltage converter	Off	. Loss of converter			
q. Rate-sensitive power-load unbalance circuit	Off	. Loss of rate-sensitive load control			
r. Valve positioning units	Off	. Loss of flow control			
s. Master trip bus	Off	. Fails to energize			
t. Position transducer - control valve/ZT-10150A - D	Off	. Loss of position feedback signal to the position unit in flow control			
Position transducer - main stop valve/ZT-10141A - D	Off				

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Common Power Supply or Sensor: <u>1Y629 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Pressure Regulator and T/G Control</u>		CD: <u>0160-004-018</u>		Prepared by: <u>Handel M.R.</u>	
				Date: <u>12/21/81</u>	
				Checked by: <u>W. J. [Signature]</u>	
				Approved by: <u>[Signature]</u>	
				Rev. <u>0</u>	
				Date: <u>12/21/81</u>	
				Date: <u>12/21/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
Position transducer - intercept valves/ 2T10160A1 - E1	Off				
Position transducer - intermediate stop valve/ 2T-10160A2 - F2	Off				
u. Master trip solenoids	Off	Both solenoids de-energized actuates Emergency Trip System			

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FAILURE MODES AND EFFECTS ANALYSIS

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Common Power Supply or Sensor: FE-1N001A, B, C - Flow Elements		CSID: 0160-004-001		Job No. 0160-004-671	
Control System Affected: Reactor Feedwater Control System		CD: 0160-004-020		Prepared by: <u>Thomson, J. D.</u> Date: <u>11/21/61</u> Checked by: <u>W. G. Sullivan</u> Approved by: <u>W. G. Sullivan</u>	
				Rev. <u>0</u> Date: <u>12/21/61</u> Date: <u>1/21/62</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Feedwater flow signal instrumentation: Flow element/FE-1N001A, B, C*	Fail High	High flow level signal from 1 of 3 sensors will be transmitted to level controller	There are no inherent compensating provisions	Upon failing high, the feedwater signals are summed together and fed into the control system The sensed flow rate will be too high to maintain the desired level The feed pumps will receive a speed runback control signal from the level controller The reactor water level signal will in turn counteract the flow signal and attempt to stabilize the water level Level 2 and 3 trips may occur in dynamic transient	There will be no affect on plant performance unless Level 2 and 3 trips are reached
	Fail low	Low flow level signal from 1 of 3 sensors will be transmitted to level controller	There are no inherent system compensating provisions	Upon failing low, the control signal speeds up the reactor feed pumps to counter lower feedwater flow rates. The reactor level will rise and in turn attempt to counteract low flow signal Level 8 trip may occur in dynamic transient	There will be no affect on plant performance unless Level 8 trip is reached

* Assumes failure of one element only, FMEA is the same for any one element failure.

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FAILURE MODES AND EFFECTS ANALYSIS

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Common Power Supply or Sensor: <u>FE-1N001A, B, C - Flow Elements</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>Recirculation Flow Control</u>		CD: <u>0160-004-020</u>		Prepared by: <u>Paul W. Lynch</u> Date: <u>12/21/81</u> Checked by: <u>W. E. Baker</u> Approved by: <u>W. E. Baker</u>	
				Rev. <u>0</u> Date: <u>12/21/81</u> Date: <u>12/21/81</u>	
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
1. Reactor Runback Signal Instrumentation-Feedwater System: a. Flow element, FE-1N001A, B C	Fail High	No low flow runback signal associated with instrument failure	There are no inherent compensating provisions	Loss of ability to monitor actual low flow conditions from the failed instruments	Plant performance is not affected
	Fails Low	Low flow signal transmitted from the feedwater system control of reactor recirculation system runback circuitry to auxiliary circuits A and B Relay contacts in the auxiliary circuitry logic are activated as part of the reactor runback signal processing	Recirculation control system will not react to the runback signal without the following inputs to the auxiliary circuits: - Low flow input from feedwater system Alarm/Relay - Circulating water pump trip input - Low NPSH input from feedwater system	Reactor runback circuitry is partially armed	Plant performance is not affected. Recirculation flow is identical to the flow prior to instrument's failure

* Assumes failure of one element only, PHEA is the same for any one failure.



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FAILURE MODES AND EFFECTS ANALYSIS

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Common Power Supply or Sensor: <u>Cascading Power Supply Effect 1Y218 and 1Y219 120 VAC</u>		CSID: <u>0160-004-001</u>		Job No. <u>0160-004-671</u>	
Control System Affected: <u>See Note</u>		CD: <u>0160-004-019</u>		Prepared by: <u>[Signature]</u> Date: <u>12/21/81</u> Checked by: <u>[Signature]</u> Approved by: <u>[Signature]</u>	
Rev. <u>0</u> Date: <u>12/21/81</u>					
Component Name and Number	Failure Mode	Symptoms and Local Effects Including Dependent Failures	System Inherent Compensating Provision	Summary: Effect Upon Control System	Summary: Effect Upon Plant Performance
<p>Note: The PNEAs for these power supplies are addressed individually under 1Y218 and 1Y219, respectively.</p>					