7.3 ENGINEERED SAFETY FEATURES ACTUATION SYSTEMS

The Engineered Safety Features Actuation Systems (ESFAS) initiate the start of equipment which protects the public and plant personnel from the accidental release of radioactive fission products in the unlikely event of a loss-of-coolant, main steam line break (MSLB), or loss of feedwater incident. The safety features function to localize, control, mitigate, and terminate such incidents in order to minimize radiation exposure levels for the general public.

(Unit 1 only) Additional features were provided to the ESFAS with components supplied by Vitro Corporation. These features are maintenance bypass switches and bypass module, isolation module fault indication, and auctioneered 15 Volt DC power supplies for the logic modules, which are sequenced with the actuation relays' 28 Volt DC power supply. They were installed to minimize the potential for inadvertent actuations during maintenance and test activities.

(Unit 2 only) The FRAMATOME ESFAS system contains ·several features to prevent inadvertent operation during normal operation, maintenance and test. These features include redundant DC power supplies, coordination of power supplies, maintenance bypass switches, and TMR logic processing.

The ESFAS provides independent (from RPS) actuation for the Auxiliary Feedwater Actuation System (AFAS). Implementation of Diverse Scram System (DSS) provides independent (from RPS) actuation of Diverse Turbine Trip (DTT). Implementation of DSS provides independent (from RPS) actuation of reactor trip. This satisfies the 10 CFR 50.62 requirements for mitigation of Anticipated Transient Without Scram (ATWS) events. (Section 7.10, 7.11)

7.3.1 DESIGN BASIS

7.3.1.1 Conformance to Standards

The design of the ESFAS and component parts was based on the applicable requirements of IEEE 279, "Criteria for Protection Systems for Nuclear Power Generating Stations." Maximum consideration has been given to the following criteria consistent with the objectives of this document:

a. Single Failure

   Any single failure within the protection system will not prevent proper protection system action when required.

b. Quality of Components and Modules

   Components and modules used in the manufacture of the actuation systems exhibit a quality consistent with the nuclear power plant 40-year design life objective and with minimum maintenance requirements and low failure rates.

c. Channel Independence

   The actuation systems include four redundant sensor subsystems and two redundant actuation subsystems. Independence has been provided between redundant subsystems or channels to accomplish decoupling of the effects of unsafe environmental factors, electric transients, and physical accident consequences and to reduce the likelihood of interactions between channels during maintenance operations or in the event of channel malfunction. Independence has been obtained by:

   1. Electrical Isolation

Electrical isolation has been provided between redundant channels, between sensor and actuation subsystems and between the ESFAS and ancillary equipment. Where electrical isolation is provided, an application of short circuit, open wire, ground, or potential does not inhibit a protective action as a result of the failure of the redundant system (NOTE 1).

2. Physical Separation

Physical separation has been maintained between redundant sensor subsystems, between sensor and actuation subsystems, and between redundant actuation subsystems by providing separate and isolated cabinets for each of the four sensor subsystems and each of the two actuation subsystems. Each of the four containment pressure sensor channels has a different containment penetration. A minimum of 3' is provided for each sensor channel (NOTE 1).

NOTE 1: The Containment Spray Actuation Signal (CSAS)/Steam Generator Isolation Signal (SGIS) trip of the main feedwater isolation valves (MFIVs), main feedwater (MFW) pump, Condensate Booster Pump, and Heater Drain Pump does not meet physical separation criteria. Electrical isolation is provided by relay contacts, 480 to 120 Volt control transformers, and fuses.

3. System Repair

The system has been designed such that routine servicing and preventative maintenance can be performed without interfering with normal plant operation and without loss of system function availability. Performance of these operations does not result in a simultaneous unavailability of both actuation subsystems (Section 7.3.1.2). The system is mechanically and electrically divided into subunits or modules based on the following considerations:

a) Standardization of subunits
b) Minimization of interconnections and interwiring
c) Interchangeability of subunits

The subunits include associated equipment such as indicating lights, pushbuttons, potentiometers, and selector switches.

7.3.1.2 <u>Security and Annunciation</u>

The ESFAS is designed to provide annunciation and indication of loss of power. Loss of power to a sensor module results in a trip signal to its associated two-out-of-four logic matrices. Sensor modules are not interlocked to prevent withdrawal of more than one module; however, withdrawal of two sensor modules of a common actuation signal will result in a trip of the associated actuation channels.

A maintenance bypass capability is provided for each sensor module bistable. When a sensor module bistable is bypass with its keylock switch, local indication and a Control Room alarm annunciate the bypass condition. The doors of each ESFAS cabinet are equipped with a lock; one key fits all doors (Unit 1 only). Contacts are provided for annunciation of an unlocked or open sensor cabinet door.

A withdrawal of an actuation logic module will not result in a trip of that channel.

7.3.1.3 Seismic Requirements

The ESFAS is classified as Seismic Category I and are designed to withstand all simultaneous horizontal and vertical accelerations resulting from the Safe Shutdown Earthquake without loss of functions.

The specifications for the ESFs and the emergency power system components incorporate the applicable seismic requirements for each component, including spectrum response curves for the specific component location generated by the time-history method.

These components are qualified by either of the following methods:

In most cases, the supplier is required to qualify his equipment by calculation or testing, or a combination of both. This qualification is formally documented and submitted for approval.

In other cases, tests or calculations are performed by independent consultants or laboratories who submit a formal report. Acceptance of the equipment from the supplier is contingent upon the proof of suitability as established by the results of those tests or calculations.

The choice of an analytical or experimental qualification procedure is determined by the size, shape, and structural or functional simplicity of the equipment in accordance with criteria equivalent to or exceeding that outlined in IEEE 344, "Guide for Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations." Racks, panels, or other supporting structures are generally qualified by analysis, while bistable trip units and other modules are generally qualified through testing. Tests and calculations are performed following criteria equivalent to or exceeding that outlined in the guidelines of IEEE 344.

For the original Unit 1 EFAS System provided by the Vitro Corporation, the 1971 version of IEEE 384 was applied. The new components supplied by Vitro Corporation for Facility Change Request (FCR) 87-87 are qualified to the 1987 version of IEEE 344. These components are very similar to the original equipment and were qualified by analysis based on similarity. The Unit 2 ESFAS system, provided by FRAMATOME and installed by Engineering Change Package ECP-16-000760, was qualified by analysis and test to the 1987 version of IEEE 384.

Equipment in the ESFs and the emergency power system requiring dynamic test is listed in Table 7-3.

All dynamic test results were in conformance to the seismic specifications indicating no failure or no loss of functions.

7.3.1.4 Environmental Requirements

All components which must operate in a LOCA environment were type-tested at the expected temperature, pressure, and humidity.

The Unit 1 components installed by FCR 87-87 and the Unit 2 ESFAS system meet the requirements of IEEE 323, 1983, "Qualifying Class IE Equipment for Nuclear Power Generating Stations" for the mild environments of the cable spreading rooms.

7.3.2 SYSTEM DESCRIPTION

The ESFAS is shown on Figures 7-10 and 7-22. The actuation system is divided into four sensor subsystems (sensor channels ZD, ZE, ZF, and ZG), two actuation subsystems (actuation channels ZA and ZB), and two logic subsystems for sequential loading of the diesel generators.

The cabinets of the ESFAS are tagged ZA, ZB, ZD, ZE, ZF, and ZG, respectively, to distinguish between channels. The ESFAS and emergency bus switchgear are distinguished from non-safety-related equipment by the use of red nameplates. At termination points, the incoming and outgoing cables of the ESFs are tagged to identify the channel, and additionally, the tag attachment devices are color coded to distinguish between channels.

7.3.2.1 Sensor Subsystems

The sensor subsystems monitor redundant and independent process variables and trip when the variables reach unsatisfactory levels. Physical locations of the sensors are shown on instrument location drawings prepared from plant general arrangement drawings. Each of the sensor subsystems consists of one sensor channel of the following process variables:

a. Containment Pressure - one each for Safety Injection Actuation Signal (SIAS), CSAS, and Containment Isolation Signal (CIS)
b. Pressurizer Pressure
c. Containment Radiation
d. Refueling Water Tank (RWT) Level
e. SG Pressure
f. SG Level (one for each SG)
g. Undervoltage
h. West Penetration Room Pressure and Letdown Heat-Exchanger Room Pressure

All process variables provide analog signals with the exception of the RWT level which produces a digital signal by actuation of level switches. (Unit 1) Each analog sensor channel includes an indicator located at the actuation system cabinets for monitoring of the process variable. (Unit 2) Analog indicators are provided for the process variables associated with Pressurizer Pressure, Steam Generator Pressure, and the containment pressure for each SIAS, CSAS, and CIS sensor channel.

In addition to the digital signals provided for the ESFs for the RWT subsystems, the RWT is equipped with level transmitters which provide analog signals to indicators mounted on the ESFs control board in the Control Room. The two indicators are separated by fire barriers and all electrical wiring to them is routed in separate paths. One indicator provides full (wide) range indication of tank level, and the other indicator provides narrow range indication of the normal water level. The full range indicator provides only a low level alarm. The narrow range indicator provides both a high level and a low level alarm. The high level alarm is to alert the operators of an impending overflow of water from the RWT to the Miscellaneous Waste Processing System. The low level alarms are used to assist the operator in monitoring for sufficient water inventory in the RWT. The alarms are located in the Control Room on the ESFs control board.

The RWT level switches are located within a room of the Auxiliary Building. This room is heated which will, in conjunction with the tank heating system, prevent freeze-up of the switches and will shelter the switches from rain, wind, etc.

Damage from missiles is extremely unlikely as only the tank heating pump, tank heating heat exchanger, and a room heater are located near the switches. To minimize damage in the unlikely event of a missile, the switches are physically separated. This physical separation, coupled with the curvature of the tank, will minimize the possibility of damage to more than one switch due to a missile of credible size.

Loss of one level switch will not adversely affect operation of the ESFs (Recirculation Actuation) since loss of the signal will not initiate or prevent actuation of the affected channel in the two-out-of-four logic network.

Recirculation is normally actuated automatically. Redundant level transmitters, alarms, and indicators are provided in the Control Room, to provide the operator with the necessary information to actuate the system.

The locating of the level switches within the Auxiliary Building, in conjunction with the guard force, provides protection from vandalism.

7.3.2.2 Actuation Subsystems

Two redundant and independent actuation subsystems monitor the sensor subsystem trip outputs and, by means of coincidence logics, determine whether a protective action is required. Each actuation subsystem initiates independent and redundant equipment. Either the A channel or the B channel controls sufficient equipment to protect the public in case of a LOCA, MSLB, or loss of feedwater.

Particular sensor and actuation channels are arranged to produce signals to initiate equipment consistent with the type of protective action required. These signals are designated:

a. SIAS
b. CSAS
c. CIS
d. Containment Radiation Signal (CRS)
e. Recirculation Actuation Signal (RAS)
f. SGIS
g. AFAS (The independent (from RPS) initiation of the AFW system satisfies the Diverse AFAS requirement for mitigation of ATWS events as required by 10 CFR 50.62)
h. Chemical Volume Control Isolation Signal (CVCIS)
i. DSS (see Section 7.11)
j. DTT [DSS (Section 7.11) provides an independent turbine trip from RPS, which satisfies the requirement for mitigation of ATWS events as required by 10 CFR 50.62]

The actuation channels of safety injection, containment spray, and containment isolation are subdivided into multiple actuation subchannels. The number of pieces of equipment initiated by a single actuation subchannel has therefore been reduced, allowing convenience and flexibility of periodic actuation system and equipment tests.

The response times given in Table 7-4 provide one of the bases for operability determination of the ESFAS instrumentation referred to in the Technical Specifications.

Safety Injection Actuation Signal - Providing signal inputs to SIAS are four independent pressurized pressure transmitters and four independent containment pressure transmitters (Figure 7-9). The containment pressure transmitters are separate from those used for initiation of the CSAS and the containment isolation actuation signal. Actuation occurs as a result of either two-out-of-four pressurizer pressure sensor channel trip signals, two-out-of-four containment pressure sensor channel trip signals, or manual initiation from the Control Room. Each of the two independent SIASs from the two redundant actuation subsystems initiates the following:

SIAS ACTUATION SUBCHANNEL NO.			ACTION
1		a)	Opens Loop 11A(21B) Low Pressure Safety Injection (LPSI) Valve, 1(2)-MOV-615
		b)	Opens Loop 11B(21A) LPSI Valve, 1(2)-MOV-625
		c)	Opens Loop 12A(22B) LPSI Valve, 1(2)-MOV-635
		d)	Opens Loop 12B(22A) LPSI Valve, 1(2)-MOV-645
		e)	Starts Saltwater System Air Compressor Nos. 11 & 12, (21 & 22)
		f)	CR HVAC Temperature Control Bypass, Dampers Positioned in Recirculation, Post-Loss-of-Coolant Incident (LOCI) Filtration Starts, CR Lavatory/Kitchen Exhaust Fan Secures
	(d)	g)	Starts Service Water (SRW) Pumps No. 11, 12, & 13 (21, 22 ,& 23)
2		a)	Opens Loop 11A(21B) High Pressure Safety Injection (HPSI) Valve, 1(2)-MOV-616
		b)	Opens Loop 11B(21A) HPSI Valve, 1(2)-MOV-626
		c)	Opens Loop 12A(22B) HPSI Valve, 1(2)-MOV-636
		d)	Opens Loop 12B(22A) HPSI Valve, 1(2)-MOV-646
		e)	Opens Loop 11A(21B) Auxiliary HPSI Valve, 1(2)-MOV-617
		f)	Opens Loop 11B(21A) Auxiliary HPSI Valve, 1(2)-MOV-627
		g)	Opens Loop 12A(22B) Auxiliary HPSI Valve, 1(2)-MOV-637
		h)	Opens Loop 12B(22A) Auxiliary HPSI Valve, 1(2)-MOV-647
	(j)	i)	Starts HPSI Pump No. 11, 12, & 13 (21, 22, & 23)
3	(k)	a)	Throttles Containment Air Cooler 11(21) Service Water Inlet Valve 1(2)-CV-1581
	(k)	b)	Throttles Containment Air Cooler 12(22) Service Water Inlet Valve 1(2)-CV-1584
	(k)	c)	Throttles Containment Air Cooler 13(23) Service Water Inlet Valve 1(2)-CV-1589
	(k)	d)	Throttles Containment Air Cooler 14(24) Service Water Inlet Valve 1(2)-CV-1592
	(d)	e)	Starts Saltwater Pumps No. 11, 12, & 13 (21, 22, & 23)
4	(f)	a)	Opens Boric Acid Storage Tank No. 11(21) Gravity Feed Valve, 1(2)-MOV-509
	(f)	b)	Closes Boric Acid Storage Tank No. 11(21) Recirculating Valve, 1(2)-CV-510

SIAS ACTUATION SUBCHANNEL NO.		ACTION
	(f)	c) Closes Boric Acid Storage Tank No. 12(22) Recirculating Valve, 1(2)-CV-511
	(f)	d) Opens Boric Acid Direct Make-up Valve, 1(2)-MOV-514
		e) Closes Containment Waste Gas Header Vent Valve, 1(2)-CV-2180
	(h)	f) Closes Reactor Coolant Loop Hot Leg Sample Valve, 1(2)-CV-5467
	(b)	g) Closes Safety Injection Tank Bleedoff Valve, 1(2)-CV-661
	(h)	h) Closes Reactor Coolant Sample Containment Isolation Valve, 1(2)-CV-5464
		i) Closes Safety Injection Loop No. 11A(21B) Leakage Check Valve, 1(2)-CV-618
		j) Closes Safety Injection Loop No. 11B(21A) Leakage Check Valve, 1(2)-CV-628
		k) Closes Safety Injection Loop No. 12A(22B) Leakage Check Valve, 1(2)-CV-638
		l) Closes Safety Injection Loop No. 12B(22A) Leakage Check Valve, 1(2)-CV-648
	(c)	m) Closes Volume Control Tank Make-up Stop Valve, 1(2)-CV-512
		n) Opens Pressurizer Back-up Heater Bank No. 1, Breaker 52-1127(52-2127)
		o) Opens Pressurizer Back-up Heater Bank No. 3, Breaker 52-1427(52-2427)
		p) Opens Containment Cooler No. 11(21) SRW Out Valve 1(2)-CV-1582
		q) Opens Containment Cooler No. 12(22) SRW Out Valve 1(2)-CV-1585
		r) Opens Containment Cooler No. 13(23) SRW Out Valve 1(2)-CV-1590
		s) Opens Containment Cooler No. 14(24) SRW Out Valve 1(2)-CV-1593
5		a) Closes Turbine Building SRW Isolation Valve 1(2)-CV-1600
		b) Closes Turbine Lube Oil & EHC Oil Cooler Water Isolation Valve, 1(2)-CV-1637
		c) Closes RCP Seals Bleedoff Containment Isolation Valve, 1(2)-CV-506
		d) Closes RCP Seals Bleedoff Containment Isolation Valve, 1(2)-CV-505
	(c)	e) Closes Volume Control Tank Outlet Valve, 1(2)-MOV-501
		f) Closes Turbine Building SRW Isolation Valve, 1(2)-CV-1638
		g) Closes Turbine Lube Oil & EHC Oil Cooler Water Isolation Valve, 1(2)-CV-1639
	(e)	h) Closes Loop 12A(22A) Letdown Line Containment Isolation Valve, 1(2)-CV-515
	(e)	i) Closes Loop 12A(22A) Letdown Line Containment Isolation Valve, 1(2)-CV-516
6	(f)	a) Opens Boric Acid Storage Tank No. 12(22) Gravity Feed Valve, 1(2)-MOV-508
		b) Starts Boric Acid Pump Nos. 11 & 12 (21 & 22)

SIAS ACTUATION SUBCHANNEL NO.			ACTION
	[a]	c)	Starts Charging Pump Nos. 11, 12 & 13 (21, 22, & 23)
7	[d]	a)	Starts Component Cooling (CC) Pump Nos. 11, 12, & 13 (21, 22, & 23)
		b)	Opens CC Shutdown Cooling Heat Exchanger No. 11(21) Out Valve, 1(2)-CV-3828
		c)	Opens CC Shutdown Cooling Heat Exchanger No. 12(22) Out Valve, 1(2)-CV-3830
8		a)	Close Signal to Circulating Water Pump Room Air Cooler(s) Saltwater Isolation Valves Circuits, 1(2)-MOV-5250 & 1(2)-MOV-5251 (valves are spared in place and no longer required to function upon receipt of a SIAS signal)
		b)	Starts Containment Cooler Nos. 11, 12, 13, & 14 (21, 22, 23, & 24)
		c)	Starts Containment Spray Pump Nos. 11 & 12 (21 & 22)
	[a]	d)	Starts Containment Charcoal Filter Units Nos. 11, 12, & 13 (21, 22, & 23)
		e)	Closes Liquid Waste Evaporator No. 11(21) (Retired in place) Component Cooling Isolation Valve, 1(2)-CV-3840
		f)	Closes Liquid Waste Evaporator No. 11(21) (Retired in place) Component Cooling Isolation Valve, 1(2)-CV-3842
		g)	Starts LPSI Pumps No. 11 & 12 (21 & 22)
9		a)	Closes Containment Normal Sump Drain Isolation Valve, 1(2)-MOV-5462
		b)	Closes Containment Waste Gas Header Vent Valve, 1(2)-CV-2181
		c)	Closes Containment Normal Sump Drain Isolation Valve, 1(2)-MOV-5463
		d)	Stops Containment Purge Air Sample Isolation Valve, 1(2)-CV-5291
		e)	Closes Containment Purge Air Sample Isolation Valve, 1(2)-CV-5292
	[h]	f)	Closes Pressurizer No. 11(21) Vapor Sample Valve, 1(2)-CV-5465
	[h]	g)	Closes Pressurizer No. 11(21) Liquid Sample Valve, 1(2)-CV-5466
	[b]	h)	Closes Reactor Coolant Drain Tank Pump No. 11(21) Discharge Containment Isolation Valve, 1(2)-CV-4260
		i)	Closes Pressurizer Quench Tank O_2 Sample Valve, 1(2)SV-6531
		j)	Closes H_2 Purge Exhaust Valves, 1(2)-MOV-6900 & 1(2)-MOV-6901
10		a)	Opens Safety Injection Tank No. 11A(21B) Isolation Valve, 1(2)-MOV-614
		b)	Opens Safety Injection Tank No. 11B(21A) Isolation Valve, 1(2)-MOV-624
		c)	Opens Safety Injection Tank No. 12A(22B) Isolation Valve, 1(2)-MOV-634

SIAS ACTUATION SUBCHANNEL NO.		ACTION
	d)	Opens Safety Injection Tank No. 12B(22A) Isolation Valve, 1(2)-MOV-644
	e)	Starts Diesel Generator(s) No. 1A & 1B (2A & 2B)
	f)	Opens 480 V Unit Bus 17 Feeder Breaker 52-1702
	g)	Opens 480 V Unit Bus 17 Tie Breaker 52-1704
	h)	Starts Diesel Generator 1A Building Supply Fan F-10
	i)	Opens Diesel Generator 1A Essential Lighting Transformer Breaker 52-12308
	j)	Opens Diesel Generator 0C Feeder Breaker 152-1106 (152-2106)
	k)	Opens Diesel Generator 0C Feeder Breaker 152-1406 (152-2406)

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[a] Same as [d] except the success of circuit breaker closure is dependent upon the position of the isolating disconnect switch only.

[b] This action is not duplicated by the redundant actuation subsystem.

[c] The volume control tank discharge valve is closed by actuation Subsystem A. The make-up valve is closed by actuation Subsystem B.

[d] Where three 100% capacity pumps are provided, one pump is exclusively connected to ESFs electrical Bus No. 11(21) and started by actuation Subsystem A. Another pump is exclusively connected to the redundant ESFs Bus No. 14(24) and started by actuation Subsystem B. The third pump can be arranged electrically by movement of circuit breaker position and/or operation of disconnect switches for operation from either of the two independent ESFs electrical busses. Each actuation subsystem initiates a starting signal to the third pump which attempts closure of the third pump's circuit breaker associated with each subsystem. The success of circuit breaker closure is dependent upon failure of circuit breaker closure of the other pump associated with the same subsystem, and position of the isolating disconnect switch (attachment to Subsystem A or to Subsystem B).

[e] These valves cannot be closed for test during normal plant operation.

[f] Gravity valves are opened only by actuation Subsystem A. Feed valves are opened only by actuation Subsystem B. The gravity system and the feed system provide two redundant boric acid injection functions.

[h] Hot leg sample, pressurizer vapor sample, and pressurizer liquid sample valves are closed only by actuation Subsystem A. The redundant isolation function is provided by the main sample line valve closure by actuation system B. A key-locked, manual override of the SIAS signal to these valves is provided in the Control Room for the purpose of allowing post-accident sampling of the RCS. The override is annunciated in the Control Room via the plant annunciator system.

[j] Pump No. 11(21) is exclusively connected to Bus No. 11(21) and started by actuation Subsystem A. Pump No. 12(22), in pull-to-lock, is exclusively connected to Bus No. 14(24) and actuation Subsystem B. Pump No. 13(23) is connected to Bus No. 14(24) and started by actuation Subsystem B.

[k] The valves move to a throttled position upon a SIAS, and return to the full open position upon receipt of a RAS.

In addition to the capability for manual initiation of the actuation signal from the Control Room, each of the above listed actions may be individually initiated in the Control Room by appropriate control switch operation.

A safety injection block is provided to permit shutdown depressurization of the RCS without initiating safety injection. Block is accomplished manually. This process is under strict administrative control with block indicated by a local light and annunciated on the station annunciator system. It will not be possible to block above a present pressure and, if the system is blocked and pressure rises above this point, the block is automatically removed. The block circuit is designed to conform to the single failure criterion as specified in IEEE 279.

Wide range pressure and level transmitters are also provided to furnish pressurizer pressure and level measurements during reactor warm-up, when the reactor is shut down, or following a LOCA. These measurements will permit knowledgeable manual control of the safety injection pumps and valves.

The control switches for the manual control of those valves which isolate systems from the containment are wired so that the control switches must all be in their appropriate ESF position prior to allowing the ESF isolation signal to the valves to be reset to a non-isolation position. Upon loss of control air or loss of control circuit power, the ESF isolation valves automatically assume the operating position for the LOCA condition. Where two isolation control valves are provided for a single containment penetration, each valve is controlled by a separate actuation subsystem. Where one isolation valve is available, a single actuation subsystem initiates closure of the valve.

<u>Containment Spray Actuation Signal</u> - To provide the CSAS, four independent containment pressure transmitters are utilized. The pressure transmitters are separate from those used for initiation of the SIAS and the containment isolation actuation signal. Actuation occurs as a result of either two-out-of-four containment pressure sensor channel trip signals or manual initiation from the Control Room. Each of the two independent CSASs from the two redundant actuation subsystems initiates the following:

CSAS ACTUATION SUBCHANNEL NO.		**ACTION**
1		
2	a)	Opens Containment Spray Header No. 11(21) Isolation Valve, 1(2)-CV-4150
	b)	Opens Containment Spray Header No. 12(22) Isolation Valve, 1(2)-CV-4151
	c)	Closes SG Blowdown Service Water Isolation Valve, 1(2)-CV-1640
	d)	Closes SG 11(21) Top Bld Cont Valve, 1(2)-CV-4010
	e)	Closes SG 11(21) Bottom Bld Cont Valve, 1(2)-CV-4011
	f)	Closes SG 12(22) Top Bld Cont Valve, 1(2)-CV-4012
	g)	Closes SG 12(22) Bottom Bld Cont Valve, 1(2)-CV-4013
	h)	Closes Spent Fuel Pool Cooler No. 11 Service Water Out Valve, 1-CV-1596
	i)	Closes Spent Fuel Pool Cooler No. 11 Service Water In Valve, 1-CV-1597
	j)	Closes Spent Fuel Pool Cooler No. 12 Service Water Out Valve, 2-CV-1598

CSAS ACTUATION SUBCHANNEL NO.		ACTION
	k)	Closes Spent Fuel Pool Cooler No. 12 Service Water In Valve, 2-CV-1599
3	a)	Closes SG 11(21) Feedwater Isolation 1(2)-MOV-4516
	b)	Closes SG 12(22) Feedwater Isolation. 1(2)-MOV-4517
	c)	Closes MSIV 12(22) 1(2)-CV-4048
	d)	Closes MSIV 11(21) 1(2)-CV-4043
	e)	Stops Heater Drain Pump Nos. 11, 12, 21, 22
	f)	Stops Main Feedwater Pumps No. 11, 12, 21, 22
	g)	Stops Condensate Booster Pumps No. 11, 12, 13, 21, 22, & 23

NOTE: Actions 3a, b, e, f, and g may be overridden by a key-operated alarmed switch.

In addition to the capability for manual initiation of the actuation signal from the Control Room, each of the above-listed actions may be individually initiated in the Control Room by appropriate control switch operation.

To prevent an inadvertent Containment Spray System actuation in the case of an undesired trip of the CSAS, the containment spray pumps are started by SIAS, while the containment spray valves are opened by CSAS. These valves are fail-safe, i.e., upon loss of power, the valves open. While the containment spray valves are open, containment isolation is maintained by backup check valves in the spray system piping.

Containment Isolation Signal - The CIS is produced by either two-out-of-four containment pressure sensor channel trip signals or manual initiation from the Control Room. Containment pressure is monitored by four independent pressure transmitters which are separate from those utilized for SIAS and CSAS. Each of the two independent CISs from the two redundant actuation subsystems initiates the following:

CIS ACTUATION SUBCHANNEL NO.			ACTION
1			
3	(c)	a)	Starts Penetration Room Exhaust Fans Nos. 11 & 12 (21 & 22)
		b)	Deenergizes Penetration Room Filter 11(21) Damper Solenoid Valve 1(2)-SV-5285 which opens Isolation Dampers 1(2)-PO-5285 & 1(2)-PO-5286
	(c)	c)	Deenergizes Penetration Room Filter 12(22) Damper Solenoid Valve 1(2)-SV-5287 which opens Isolation Dampers 1(2)-PO-5287 & 1(2)-PO-5288
5	(a)	a)	Closes Instrument Air Containment Isolation Valve, 1(2)-MOV-2080
	(b)	b)	Closes RCP CCW Containment Isolation In Valve, 1(2)-CV-3832
	(b)	c)	Closes RCP CCW Containment Isolation Out Valve, 1(2)-CV-3833

(a) A key-operated, manual override of CIS is provided to this valve.

(b) These valves cannot be closed for test during normal plant operation.

[c] Solenoid valves are normally deenergized and the dampers are normally opened using the handswitch.

In addition to the capability for manual initiation of the actuation signals from the Control Room, each of the above-listed actions may be individually initiated by appropriate control switch operation. Upon loss of control air or loss of control circuit power, the ESF isolation valves automatically assume the operating position for the LOCA condition. Where two isolation control valves are provided for a single containment penetration, each valve is controlled by a separate actuation subsystem. Where one isolation valve is available, a single actuation subsystem initiates closure of the valve.

The control switches for the manual control of those valves which isolate systems from the containment are wired so that the control switches must all be in the appropriate ESF position prior to allowing the ESF isolation signal to the valves to be reset to a non-isolation position.

Containment Radiation Signal - The CRS is provided in order to limit release of radioactive fission products during refueling and maintenance periods when containment integrity is breached. Four independent radiation detectors located within the containment are provided and, upon coincidence of two-out-of-four trip signals or manual initiation from the Control Room, actuation occurs. The CRS (also, SIAS) isolates and secures the containment purge system. Each of the two independent signals from the two redundant actuation subsystems initiates the following:

CRS ACTUATION SUBCHANNEL NO.		**ACTION**
1	[a] a)	Closes Containment Purge Air Supply Isolation Valve, 1(2)-CV-1410
	[a] b)	Closes Containment Purge Air Exhaust Isolation Valve, 1(2)-CV-1412
	[a] c)	Stops Containment Purge Air Exhaust Fan No. 11(21)
	[a] d)	Stops Containment Purge Air Supply Fan No. 11(21)
	e)	Closes H_2 Purge Exhaust Valves, 1(2)-MOV-6900 & 1(2)-MOV-6901

[a] This action is not duplicated by the redundant subsystem.

In addition to the capability for manual initiation of the actuation signals from the Control Room, each of the above actions may be individually initiated in the Control Room by appropriate control switch operation.

The control switches for the manual control of those valves which isolate systems from the containment are wired so that the control switches must all be in the appropriate ESF position prior to allowing the ESF isolation signal to the valves to be reset to a non-isolation position. Upon loss of control air or loss of control circuit power, the ESF isolation valves automatically assume the operating position for the LOCA condition. Where two isolation control valves are provided for a single containment penetration, each valve is controlled by a separate actuation subsystem. Where one isolation valve is available, a single actuation subsystem initiates closure of the valve.

Recirculation Actuation Signal - Four independent RWT level switches provide digital inputs to the RAS. Upon coincidence of two-out-of-four low water tank level trip signals, or manual initiation from the Control Room, the RAS is generated. Each of the two independent signals from the two redundant actuation subsystems initiates the following:

RAS ACTUATION SUBCHANNEL NO.			ACTION
1			
		f)	Opens Containment Sump Discharge Valve, 1(2)-MOV-4144
		g)	Opens Containment Sump Discharge Valve, 1(2)-MOV-4145
	(a)	h)	Closes Containment Spray & Safety Injection Pumps Recirculating Valve, 1(2)-MOV-659
	(a)	i)	Closes Containment Spray & Safety Injection Pumps Recirculating Valve, 1(2)-MOV-660
		j)	Stops LPSI Pumps No. 11 & 12 (21 & 22)
		k)	Allows Containment Air Cooler 11(21) Service Water Inlet Valve 1(2)-CV-1581 to return to full open
		l)	Allows Containment Air Cooler 12(22) Service Water Inlet Valve 1(2)-CV-1584 to return to full open
		m)	Allows Containment Air Cooler 13(23) Service Water Inlet Valve 1(2)-CV-1589 to return to full open
		n)	Allows Containment Air Cooler 14(24) Service Water Inlet Valve 1(2)-CV-1592 to return to full open
	(b)	o)	Closes RWT Outlet Valve, 1-MOV-4142
	(b)	p)	Closes RWT Outlet Valve, 1-MOV-4143

[a] A handswitch provides manual override of RAS to this valve. Switch is normally in lockout position with valve open. Switch is turned to ON at low RWT level to permit valve closure on RAS. Receipt of RAS when valve is in LOCKOUT and OPEN results in Control Room alarm. Lockout is provided to ensure minimum flow for safety injection pumps.

[b] The MOV handswitch includes an AUTO position that allows the RWT outlet valves to close when a RAS is received. Operators place the handswitch in AUTO in preparation for RAS after verifying sump level is increasing and RWT level is decreasing. Manual control of the RWT outlet valves is maintained pre- and post-RAS via the handswitch.

In addition to the capability for manual initiation of the actuation signal from the Control Room, each of the above actions may be individually initiated in the Control Room by appropriate control switch operation.

The RWT discharge valve is normally open and upon loss of control power the valve remains in the open position. Valve failure in the open position during the recirculation mode of operation does not affect pump suction since check valves are provided to maintain containment integrity and prevent reverse flow during the recirculation mode. The containment sump discharge valve is normally closed and upon loss of control power, the valve remains in the closed position.

Steam Generator Isolation Signal - Each SG is equipped with four independent pressure transmitters, the outputs of which are monitored by four independent bistables. Upon low SG pressure (which would occur as a result of steam line break) and two-out-of-four coincidence bistable trip signals, SG isolation signal is

generated. The output of each independent isolation signal initiates closure of both steam line isolation valves and both main feed header isolation valves. In addition, the output of each independent isolation signal stops both heater drain pumps, both main feedwater pumps, and all three condensate booster pumps. This action reduces main feedwater flow to the steam generators while the main feed heater isolation valves are closing. The isolation signal may also be initiated by control switch operation in the Control Room.

A bypass is provided for shutdown depressurization and is accomplished manually by means of a momentary key operator switch in the Control Room. The bypass is enabled only below a preset pressure and is automatically removed above this pressure.

The control switches for the manual control of those valves which isolate systems from the containment are wired so that the control switches must all be in the appropriate ESF position prior to allowing the ESF isolation signal to the valves to be reset to a non-isolation position. Upon loss of control air or loss of control circuit power, the ESF isolation valves automatically assume the operating position for the LOCA condition. Where two isolation control valves are provided for a single containment penetration, each valve is controlled by a separate actuation subsystem. Where one isolation valve is available, a single actuation subsystem initiates closure of the valve.

SGIS ACTUATION SUBCHANNEL NO.		ACTION
1	a)	Closes SG No. 11(21) Isolation Valve, 1(2)-MOV-4516
	b)	Closes SG No. 12(22) Isolation Valve, 1(2)-MOV-4517
	c)	Closes MSIV No. 11(21), 1(2)-CV-4043
	d)	Closes MSIV No. 12(22), 1(2)-CV-4048
	e)	Stops Heater Drain Pump Nos. 11, 12, 21, 22
	f)	Stops Main Feedwater Pump Nos. 11, 12, 21, 22
	g)	Stops Condensate Booster Pump Nos. 11, 12, 13, 21, 22, & 23

NOTE: Actions a, b, e, f, and g may be overridden by a key-operated alarm switch.

7.3.2.3 Undervoltage, Blocking, and Sequencing

Emergency diesel generators are provided for supplying power to ESFs in case of loss of the normal auxiliary system power. Undervoltage, blocking, and sequencing are required for sequential loading of the diesel generator and are a part of the engineered safety features actuation subsystem. Undervoltage, blocking, and sequencing signals associated with Bus No. 11 are a part of actuation Channel A. Those signals associated with Bus No. 14 are a part of actuation Channel B. Sequential actuation system blocking initially blocks, then unblocks in programmed steps, some of the actuation subchannels of safety injection, containment spray, and RASs when normal auxiliary power sources are unavailable and the loading of diesel generators is necessary. The undervoltage system contains multiple redundant undervoltage relays designated 127/B which are located at the 4160 Volt switchgear. The trip outputs are delayed, and then, by means of coincidence logic, it is determined whether action is required. The undervoltage system initiates the starting of the diesel generators and provides multiple contact outputs for load shedding.

Upon degradation of the normal auxiliary system voltage without a LOCA, the undervoltage system initiates the starting of diesel generators and load sheds the bus. The shutdown sequencer then automatically initiates the starting of the SRW pumps, the saltwater pumps, the instrument air compressor, Control Room air conditioning compressors, switchgear room air conditioning compressors, motor-driven auxiliary feedwater pumps, and 72' computer room air conditioning units.

7.3.3 SYSTEM SURVEILLANCE

7.3.3.1 Remote Annunciation

a. Tripped sensor channel
b. Tripped actuation channel
c. Permission to block pressurizer pressure
d. Blocked pressurizer pressure
e. Permission to block SG pressure
f. Blocked SG pressure
g. Tripped undervoltage relay
h. Tripped two-out-of-four undervoltage matrix
i. Blocked step of sequential actuation system blocking
j. Loss of power supply
k. Sequencer initiated
l. Sensor cabinet in maintenance bypass

7.3.3.2 Local Sensor Channel Surveillance

Each module or subunit is equipped with indicating lights. Typical functions to be indicated are:

a. Bistable trip
b. Power supply available
c. Cabinet fan failure
d. Sensor module bistable in maintenance bypass
e. (Unit 1 only) Isolation module fault or trip signal

All indicating lights are visible with the cabinet doors closed.

(Unit 1 only) Each indicating light is a push-to-test to check the lamp, except the indicating lights mounted with the maintenance bypass switches.

7.3.3.3 Local Actuation Channel Surveillance

Each module or subunit is equipped with indicating lights. Typical functions indicated are:

a. Tripped actuation subchannel
b. Blocked step of sequential actuation system blocking
c. Power supply available
d. Cabinet fan failure
e. Sequencer tripped
f. Undervoltage relay tripped
g. Tripped two-out-of-four undervoltage
h. Pressurizer pressure blocked

i. SG pressure blocked

7.3.4 ELECTRICAL POWER SUPPLY

The four redundant 118 Volt, 60 Hz, vital sources of supply (Section 8.3.5) are utilized by the ESFAS. Two vital sources provide power for a sensor subsystem and an actuation subsystem. The remaining two sensor subsystems receive power from the remaining vital sources. Physical and electrical isolation is maintained between the various redundant power supplies. Short circuit protection is provided at each system cabinet, and a trip of the protective device is indicated locally and annunciated in the Control Room.

7.3.5 SYSTEM EVALUATION

The ESFs initiation, control, and power supply systems were designed in accordance with Proposed IEEE Criteria No. 279, dated August 1968, so that no single fault in components, units, channels, or sensors will prevent ESFs operation.

The wiring is installed so that no single fault or failure, including either an open or shorted circuit, will negate minimum ESFs operation. Wiring for redundant circuits is protected and routed so that damage to any one path will not prevent minimum ESFs action. Sensors are piped so that blockage or failure of any one connection does not prevent ESFs operation.

The detailed design incorporates the following characteristics in order to counteract faults resulting in loss of power:

a. All redundant components are powered from separate busses;
b. The reliability of the 125 Volt DC and 120 Volt AC vital power busses used, as discussed in detail in Chapter 8;
c. The reliability of the 4160 Volt and 480 Volt systems, as discussed in Chapter 8;
d. The starting and loading of diesel generators, as described in Chapter 8; and,
e. Whenever practical, components of the ESFs system assume on loss of power the position called for under emergency conditions.

There are no ESFs instrumentation transmitters for which the trip setpoints are within 5% of the high or low end of the calibrated range or within 5% of the overall instrument design range.

The following features of the ESFAS cabinets reduce the potential for inadvertent actuation signals.

a) Maintenance Bypass - Each Unit 1 sensor cabinet has a lower front panel installed which contains 20 keylock/indicating light sets (some are spare) along with one bypass module.

   Each Unit 2 sensor cabinet has 18 sensor maintenance modules which each contain a keylock/indicating light.

   Each sensor module (Unit 1) / sensor maintenance module (Unit 2) has its own switch and light set which, when placed in the bypass position, turns on the switch light, a light on the bypass module (Unit 1), and a remote alarm in the Control Room.

   When bypassed, the bistable is removed from logic processing, resulting in two-out-of-three (three-out-of-three for the pressurizer and steam generator block

permissive) because the input to the logic from the bypassed channel cannot change to a trip signal input.

The maintenance bypass allows maintenance or testing of a bistable or its input loop without providing a trip signal to the coincidence logic. For Unit 1, a trip signal input is indicated on the bypassed module. For Unit 2, a trip signal input is indicated on the associated sensor maintenance module.

b. (Unit 1 only) Isolation Module Fault Indication - Each isolation module contains 15 subchannel optical isolators, each having a voltage comparator to detect an optical isolator output of 3 Volt DC or greater, which is possible with an actual trip signal or a faulty isolator. If the isolator output is greater than 3 Volt DC, the indicating light enables personnel to determine if an optical isolator is faulty.

c. Actuation Channel Sequenced Power Supplies – (Unit 1 only) The actuation channels each contain a 28 Volt DC power supply for the actuation relays and redundant 15 Volt DC power supplies for the logic modules. The 28 Volt DC power supply is interlocked with the 15 Volt DC power supplies to ensure that the logic modules are energized before the relays, or deenergized after the relays. This prevents having power available to the relays with the logic modules in a potentially unstable state which could result in inadvertent equipment actuation. Using redundant 15 Volt DC power supplies accomplishes the same function in the event of a failure of one power supply.

Actuation Channel Sequenced Power Supplies ·The cabinet DC power supplies are coordinated to ensure that the logic modules are energized before the relays, or deenergized after the relays. This prevents having power available to the relays with the logic modules in a potentially unstable state which could result in inadvertent equipment actuation.

7.3.6 MANUAL TESTING FEATURES

7.3.6.1 Bistable Trip Test

Each bistable has built-in provisions for locally testing bistable operation. While initiating the test, the process variable input to the bistable is not interrupted. Local indicating lights and Control Room annunicators verify proper operation.

7.3.6.2 Testing of Refueling Water Tank Level Switches

The water level in the float chamber is lowered manually for each channel individually. Local indicating lights and Control Room annunciators verify proper operation.

7.3.6.3 Actuation Channel Trip Test

Each coincidence two-out-of-four matrix includes a local independent test switch. The test with simultaneous presence of a sensor channel trip causes an output of the associated coincidence matrix and trips the actuation channel logic.

A light is provided within the matrix for indication of each bistable trip test. The test switch is initiated with each sensor channel individually, and in each case actuation channel output is observed both by remote annunciation in the Control Room and local indication. The combination of the testing procedure and the arrangement of the matrix provides for overlapping and ensures that a protective action will occur if any combination of two sensor channels simultaneously trip. For further information see the two-out-of-four matrix expansion as shown on Figures 7-10 and 7-22.

Except in the cases of actuation subchannels SIAS No. 5, CIS No. 5, CSAS No. 3, and SGIS No. 1, the actuation channel trip test as described above can be performed during normal plant operation for each actuation subchannel on an individual basis. The performance of the equipment associated with each subchannel is observed to assure proper operation. Equipment associated with subchannels SIAS No. 5, CIS No. 5, CSAS No. 3, and SGIS No. 1 is to be tested during plant shutdown (Section 7.3.7).

7.3.6.4 Undervoltage, Blocking, and Sequencing Tests

Each undervoltage sensor channel may be tested individually by the interruption of the potential transformer connection to the undervoltage relays. This is accomplished by depressing a pushbutton at the associated switchgear. For Unit 1, this feature may also be tested in the ESFAS sensor cabinets. Proper operation is verified by local indicating lights and Control Room annunciators. Each coincidence undervoltage two-out-of-four matrix and the associated function may be tested in the same manner as described in Section 7.3.6.3. Four undervoltage matrices are provided, three of which can be tested on an individual basis during normal plant operation. Proper function is verified by actual opening of the appropriate circuit breakers and starting of the diesel generators. The matrix, which opens the 4160 Volt feed circuit breakers (through which the normal auxiliary power source feeds the 4160 Volt ESFs bus),can be tested during plant shutdown. The two matrices which shed various loads are not tested during normal operation in order to minimize system transients and risk.

Sequential actuation system blocking can be tested by depression of local switches simulating open 4160 Volt feeder circuit breakers and by initiation of the appropriate undervoltage matrix. The LOCI Sequencer is tested in conjunction with the sequential actuation system blocking and proper operation is observed by local indicating lights and Control Room annunciators.

In order to initiate the LOCI Sequencer, the diesel generator circuit breaker may be closed after synchronization to the normal auxiliary power supply, or circuit breaker closure may be simulated by depressing the test pushbutton located on the ESFs cabinet. After initiation of SIAS Subchannel No. 10, the LOCI Sequencer is started. The shutdown sequencer is initiated when the diesel generator circuit breaker closes without SIAS and can be tested at any time. Proper starting of motors can be verified to assure operability.

7.3.7 PORTIONS NOT TESTED AT POWER

Those portions of the ESFAS that cannot be completely tested with the reactor at power are listed below:

	Unit 1	Unit 2
RCP	1-CV-505	2-CV-505
Seal Bleedoff Isolation Valves	1-CV-506	2-CV-506
SRW Isolation Valves	1-CV-1600	2-CV-1600
SRW Isolation Valves	1-CV-1637	2-CV-1637
SRW Isolation Valves	1-CV-1638	2-CV-1638
SRW Isolation Valves	1-CV-1639	2-CV-1639
Volume Control Tank Discharge Valves	1-MOV-501	2-MOV-501
Letdown Stop Valves	1-CV-515	2-CV-515
Letdown Stop Valves	1-CV-516	2-CV-516

	Unit 1	Unit 2
CCW to Reactor Coolant Pumps	1-CV-3832	2-CV-3832
CCW from RCPs	1-CV-3833	2-CV-3833
MSIVs	1-CV-4043	2-CV-4043
MSIVs	1-CV-4048	2-CV-4048
Feedwater Isolation Valves	1-MOV-4516	2-MOV-4516
Feedwater Isolation Valves	1-MOV-4517	2-MOV-4517
Instrument Air Containment Isolation Valves	1-MOV-2080	2-MOV-2080
Heater Drain Pumps	11, 12	21, 22
Main Feedwater Pump	11, 12	21, 22
Condensate Booster Pumps	11, 12, 13	21, 22, 23
Mini Flow Return to RWT	1-MOV-659 1-MOV-660	2-MOV-659 2-MOV-660

The SRW Isolation Valves, 1(2) CV-1600, 1(2) CV-1637, 1(2) CV-1638, and 1(2) CV-1639, supply cooling water to the main turbine auxiliary systems (i.e., turbine lube oil coolers, electrohydraulic control (EHC) oil coolers, generator exciter coolers, generator hydrogen and stator liquid coolers, etc.). The turbine manufacturer recommends against securing cooling water to the turbine auxiliary systems while the unit is on line. The SRW isolation valves can be tested prior to putting the unit on line or during the periodic valve tightness tests for the turbine main stop and control valves.

The volume control tank discharge valve and the letdown stop valves cannot be exercised during normal operation because of the thermal transient imposed on the regenerative heat exchanger. These valves can be tested when the RCS is cooled down for refueling.

The CCW control valves cannot be periodically cycled during normal operation as this would impose undue transients to the RCP seals. These valves can be tested when the reactor is cooled down and pumps secured.

Though the MSIVs cannot be fully tested during normal operation, provisions have been incorporated which allows partial stroking of the valves from the Control Room. These valves can be fully tested when the reactor is shutdown.

The safety injection tank isolation valves cannot be tested during reactor operation since the valves must be open at all times while the plant is in Modes 1 through 3. The valves can be tested when the reactor is shutdown and cooled down.

	Unit 1	Unit 2
Safety Injection Tank Isolation Valves	1-MOV-614 1-MOV-624 1-MOV-634 1-MOV-644	2-MOV-614 2-MOV-624 2-MOV-634 2-MOV-644

The RCP seal bleedoff isolation valves cannot be tested at power since the pumps must be shut off during the test. The valves can be tested when the reactor is shut down.

The feedwater isolation valves, heater drain pump, main feedwater pumps, and condensate booster pumps cannot be tested at power. The reactor must be shut down to test these components.

Instrument Air Containment Isolation valves cannot be tested during reactor operation since the valves must be open to supply air to components necessary to plant operation in Modes 1 through 3. The valves can be tested when the reactor is shutdown.

Miniflow isolation valves (MOV-659, MOV-660) to RWT cannot be tested during reactor operation since the valves are to remain open with the power removed during Modes 1, 2, and 3 with the pressurizer pressure ≥ 1750 psia. The valves can be tested when the reactor is shutdown.

TABLE 7-3

LIST OF CLASS I (SEISMIC) EQUIPMENT SUBJECTED TO DYNAMIC LOAD TEST

EQUIPMENT SPECIFICATION NUMBER	DESCRIPTION
E- 6	480 Volts Load Centers
E- 7	480 Volts Motor Control Centers
E- 19	Station Control Battery
E- 20	Station Control Battery Chargers
E- 21	Inverters for Vital AC System
E- 27	125 Volts DC Busses, Unit Control Panels
E- 96	4 kV Diesel Generator Isolating Switches
M-191	Controls for Class I (Seismic) HVAC System
M-237	Radiation Monitoring System
M-350	Miscellaneous Panel Mounted Indicators
M-363	Level Switches
M-369	Control System and Field Transmitters
M-370 (Unit 1)/SP-5938 (Unit 2)	ESFAS

TABLE 7-4

ENGINEERED SAFETY FEATURES RESPONSE TIMES

INITIATING SIGNAL AND FUNCTION			RESPONSE TIME IN SECONDS
1.	Manual		
	a.	SIAS	
		Safety Injection [Emergency Core Cooling System (ECCS)]	Not Applicable
	b.	CSAS	
		Containment Spray	Not Applicable
	c.	CIS	
		Containment Isolation	Not Applicable
	d.	RAS	
		Containment Sump Recirculation	Not Applicable
	e.	AFAS	
		Auxiliary Feedwater Initiation	Not Applicable
2.	Pressurizer Pressure-Low		
	a.	Safety Injection (ECCS)	≤ 30[a]/30[b]
		(Low Pressure Safety Injection Flow	≤ 45)
3.	Containment Pressure-High		
	a.	Safety Injection (ECCS)	≤ 30[a]/30[b]
		(Low Pressure Safety Injection Flow	≤ 45)
	b.	Containment Isolation	≤ 30
	c.	Containment Fan Coolers	≤ 35[a]/10[b]
4.	Containment Pressure-High		
	a.	Containment Spray Isolation Valve	≤ 60.9[a]/60.9[b]
	b.	Containment Spray Pump	≤ 28.9 [a]/18.9 [b]
5.	Containment Radiation-High		
	a.	Containment Purge Valves Isolation	≤ 15
6.	Steam Generator Pressure-Low		
	a.	Main Steam Isolation	≤ 6.9[e]
	b.	Feedwater Isolation	≤ 65
7.	Refueling Water Tank-Low		
	a.	Containment Sump Recirculation	≤ 150
8.	Loss of Power		
	a.	4.16 kV Emergency Bus Undervoltage (Loss of Voltage)	≤ 2.2[c]
	b.	4.16 kV Emergency Bus Undervoltage (Steady State Undervoltage)	≤ 104.5
	c.	4.16 kV Emergency Bus Undervoltage (Transient Undervoltage)	≤ 8.4[c]
9.	Steam Generator Level-Low		
	a.	Steam Driven AFW Pump	≤ 180
	b.	Motor Driven AFW Pump	≤ 180
	c.	Isolate Steam Generator Blowdown	≤ 35
10.	Steam Generator ΔP – High		
	a.	Auxiliary Feedwater Isolation	≤ 20.0

TABLE 7-4

ENGINEERED SAFETY FEATURES RESPONSE TIMES

INITIATING SIGNAL AND FUNCTION	**RESPONSE TIME IN SECONDS**
11. Penetration Room Pressure – High	
a. CVCS Isolation	≤ 9

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[a] Diesel generator starting and sequence loading delays included.

[b] Diesel generator starting and sequence loading delays not included. Offsite power available.

[c] Response time measured from the incident of the undervoltage condition to the diesel generator start signal.

[e] Response time accounts for isolation under accident steam flow conditions. In accordance with Section 14.14.2, “Discussion of Main Steam Isolation Valve Testing,” ESF response time under no-flow test conditions is ≤ 6.1 seconds.