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APPENDICES

1. SCOPE

1.1 Purpose. This specification defines the requirements for the design, performance, configuration, and testing for the Isolation Condenser System (B32). It also defines the interface requirements with other systems in the complete nuclear system and with the balance of plant.

1.2 Use. The use of this design specification is applicable to the Simplified Boiling Water Reactor (SBWR) Project only.

2. APPLICABLE DOCUMENTS

2.1 Supporting and Supplemental Documents. The following documents form a part of this specification to the extent specified herein.

2.1.1 Supporting Documents

			MPL NO.
a.	Isolation Condenser System P&ID (ANSALDO document number: SBW5280DNJXN012001/2)	(107E5154)	B32-1010
b.	Isolation Condenser System Process Diagram (ANSALDO document number: SBW5280DNIXN011001/2)		B32-1020
c.	Isolation Condenser System Logic Diagram (ANSALDO document number: SBW5280DNRX013000)	(137C9292)	B32-1030
d.	Isolation Condenser System P&ID Data		B32-1010
e.	Isolation Condenser System Data Sheet		B32-4010
f.	Reactor Cycles	(107E6372)	B11-3040

2.1.2 Supplemental Documents

2.1.2.1 Documents under the following identities are to be used in conjunction with this specification:

		MPL NO.
a.	Nuclear Boiler System Design Specification (ANSALDO document number: SBW5100SNPXN001000)	B21-4010
b.	Nuclear Boiler System P&ID (ANSALDO document number: SBW5100DNJXN001001/6)	B21-1010

2.1.2.1 (Continued)

c.	Passive Containment Cooling System Design Specification (ANSALDO document number: SBW5280SNPXN003000)	(25A5020)	T15-4010
d.	Passive Containment Cooling System P&ID (ANSALDO document number: SBW5280DNJXN014001)	(107E5160)	T15-1010
e.	Leak Detection and Isolation System Design Specification		C21-4010
f.	Fuel and Auxiliary Pools Cooling System Design Specification	(23A6921)	G21-4010
g.	Fuel and Auxiliary Pools Cooling System P&ID	(103E1581)	G21-1010
h.	Makeup Water System Design Specification		P10-4010
i.	System Design Specification Standard	(23A6857)	A00-3050
j.	Pressure Integrity of Nuclear Components	(25A5061)	A11-2029
k.	Source Terms		A11-2052
l.	Process Instrumentation		A11-4001
m.	Procedure for Preparation of System Man-Machine Interface Requirements		A32-1034
n.	Reliability, Availability & Maintainability (RAM) Criteria	(23A6899)	A18-1020
o.	Equipment Environmental Data		A11-2020

2.1.2.2 The following documents are to be used in conjunction with this specification to the extent specified herein:

a.	Composite Design Specification	(23A6723)	A11-5299
b.	Generic Operations and Maintenance Requirements Specification	(23A6822)	A80-89010
c.	Plant Transient/Stability Performance Requirements	(23A6918)	A11-3006
d.	Composite Design Specification Data Sheet	(23A6723AC)	A11-5299
e.	Materials and Process Control		A11-2043
f.	SBWR Design and Certification Program Quality Assurance Plan		NEDG-31831

2.2 Codes and Standards. The following codes and standards form a part of this specification to the extent specified herein. The applicable code and standard edition dates together with exceptions to code and standard requirements are defined in reference 2.1.2.2.d for those specified herein.

2.2.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code

a. Section III: Nuclear Power Plant Components

b. Section XI: Rules for Inservice Inspection of Nuclear Power Plant Components

2.2.2 Institute of Electrical and Electronic Engineers (IEEE)

2.2.3 Standards of the Tubular Exchanger Manufacturers Association (TEMA)

2.3 Laws and Regulations. The following laws and regulations form a part of this specification to the extent specified herein:

2.3.1 NRC Regulations

a. None specified as part of this specification.

2.3.2 Regulatory Guides

a. None specified as part of this specification.

3. DESIGN DESCRIPTION

3.1 Summary Description. The Isolation Condenser System (ICS-B32) basically consists of three totally independent loops, each containing a heat exchanger that condenses steam on the tube side and transfers heat to water in a large pool (IC/PCC pool) which is vented to atmosphere.

The condenser, connected by piping to the reactor pressure vessel, is placed at an elevation above the source of steam (vessel) and, when the steam is condensed, condensate is returned to the vessel via a condensate return pipe.

The steam side connection between the vessel and the IC is normally open and the condensate line is normally closed. This allows the isolation condenser and drain piping to fill with condensate which is maintained at a subcooled temperature by the IC/PCC pool water during normal reactor operation.

The isolation condenser is started into operation by draining the condensate to the reactor, thus causing steam from the reactor to fill the tubes which transfer heat to the cooler pool water.

3.2 Detailed System Description. The Isolation Condenser System (ICS) limits reactor pressure and temperature within an acceptable range so that safety/relief valve operation is limited and automatic reactor depressurization will not occur when the reactor becomes isolated during power operations.

The ICS consists of three, high-pressure, totally independent loops, each containing a steam isolation condenser (IC) as shown on the ICS P&ID (ref. paragraph 2.1.1.a). The ICS P&ID defines piping system interconnections, valves, instruments, special arrangement requirements, manually operated controls and system input sources and outputs.
Each IC is designed for 30 MWt capacity and is made of two identical modules.

The units are located in the IC/PCC pool positioned above, and outside, the SBWR containment (drywell).

The IC is configured as follows.

The steam supply line (properly insulated and enclosed in a guard pipe which penetrates the containment roof slab) is vertical and feeds two horizontal headers through four branch pipes. Each pipe is provided with a built-in flow limiter, sized to allow natural circulation operation of the IC at its maximum heat transfer capacity while addressing the concern of IC breaks downstream of the steam supply pipe. Steam is condensed inside vertical tubes and is collected in two lower headers. Two pipes, one from each lower header, take the condensate to the common drain line which vertically penetrates the containment roof slab.

A vent line is provided for both upper and lower headers, to remove the noncondensable gases away from the unit, during IC operation. The vent lines are routed to the containment through a single penetration.

A purge line is provided to assure that, during normal plant operation (ICS standby conditions), the excess of hydrogen (from hydrogen water chemistry control additions) or air from the feedwater will not accumulate in the IC steam supply line, thus assuring that the IC tubes will not be blanketed with noncondensables when the system is first started.

Two fail as-is isolation valves in series (F001, nitrogen rotary motor-operated and F002, motor-operated) are located in the run of steam supply piping inboard of the containment boundary. They are used to isolate that part of the ICS which is located outside the containment. Two different valve actuator types are used to assure flow path closure.

On the condensate-return piping, two fail as-is isolation valves in series (F003, motor-operated and F004, nitrogen rotary motor-operated) are provided, also located both inboard of the containment boundary. They are also used to isolate parts of the ICS outside the containment, and two different valve actuator types are used to assure flow path closure.

Located on the condensate return piping, just upstream of the reactor entry point, is a loop seal and a parallel-connected pair of valves: a condensate return valve (F005, motor-operated, fail as-is) and a condensate return bypass valve (F006, nitrogen piston operated, fail open). These two valves are closed during normal station power operations. Since the steam supply line valves are normally open, condensate will form in the IC and will develop a level up to the steam

8.2 (Continued)

distributor, above the upper headers. To start an IC into operation, the motor-operated condensate return valve (F005) is opened, whereupon the standing condensate drains into the reactor and the steam-water interface in the IC tube bundle moves downward, below the lower headers, to a point in the main condensate return line. The fail open nitrogen piston operated condensate return bypass valve (F006) opens if the 125 V DC power is lost or on reactor water level signal (below L2).

System controls allow the reactor operator to remote manually open both of the condensate return valves at any time.

The loop seal assures that condensate valves do not have 285°C (545°F) water on one side of disk and subcooled water (as low as 10°C (50°F)) on the other side during normal plant operation, thus affecting leakage during system standby conditions. Furthermore, the loop seal assures that steam continues to enter the IC preferentially through the steam riser, irrespective of water level inside the reactor, and does not move counter-current back up the condensate-return line.

During ICS normal operation, any noncondensable gases collected in the IC are vented, from the IC top and bottom headers, to the suppression pool.

Venting is controlled as follows:

Two normally closed, fail closed, solenoid operated valves (F009 and F010) are located in the vent line from the lower headers. They can be actuated both, automatically (when RPV pressure is high and either of condensate return valves is open) and manually, by the control room operator. Two bypass motor operated valves, F011 and F012, (normally closed) allow the operator to vent noncondensable gases in case of F009 and/or F010 failure.

The vent line from the upper headers with two normally closed, fail closed, solenoid operated valves (F007 and F008) is provided to permit opening of this noncondensable gas flow path by the operator, if necessary.

All the vent valves are located in a vertical pipe run near the top of the drywell. The vent piping minimum slope to the suppression pool is equal to or greater than 1/25, to prevent steam-condensate induced water hammer.

A catalytic converter is provided to recombine noncondensable gases (hydrogen and oxygen) under normal plant operation (ICS standby condition).

The hydrogen recombiner is a plating of platinum, palladium and rare earth oxides onto metal surface that has about 35% nickel (Ni) such as "Carpenter 20" or "330 stainless steel".

The catalytic converter is located on the steam distributor cover, at the top end of the steam supply line to the IC.

3.2 (Continued)

As a backup to the catalyst and to discharge hydrogen excess (SBWR has hydrogen water chemistry) or air, a vent is provided that takes a small stream of gas from the top of the IC and vents it downstream of the RPV, on the main steam line, upstream of the MSIVs.

Each IC is located in a subcompartment of the IC/PCC pool and all pool subcompartments communicate at their lower ends to enable full utilization of the collective water inventory, independent of the operational status of any given IC subloop. A valve is provided at the bottom of each IC/PCC pool subcompartment that can be closed so the subcompartment can be emptied of water to allow IC maintenance.

Pool water can heat up to about 101°C (214°F); steam formed, being nonradioactive and having a slight positive pressure relative to station ambient, vents from the steam space above each IC where it is released to the atmosphere through large-diameter discharge vents.

A moisture separator is installed at the entrance to the discharge vent lines to preclude excessive moisture carryover.

IC/PCC pool make-up clean water supply for replenishing level is provided from the Makeup Water System (MWS) (ref. 2.1.2.1.h). Pool level control is accomplished by using an air-operated valve in the make-up water supply line. The valve opening/closing is controlled by a water level signal sent by a level transmitter sensing water level in the IC/PCC pool.

Cooling/clean-up of IC/PCC pool water is performed by the Fuel and Auxiliary Pools Cooling System (FAPCS) (ref. 2.1.2.1.f and g). Several suction lines, at different locations, draw water from the sides of the IC/PCC pool at an elevation above the minimum water level that is required to be maintained during normal plant operation. The water is cooled/cleaned and is returned back to the pool.

A safety-related independent FAPCS IC/PCC pool makeup line is provided which is routed to the pool from a valved connection located in the yard just outside the reactor building.

Four radiation monitors, shielded from all radiation sources other than the flow passing through the specific IC loop exhaust passages, are installed in the IC/PCC pool exhaust passages to atmosphere to detect any IC tube leakage. Detection of a low-level leak (radiation level above background - logic 2/4) shall result in alarms to the operator. At high radiation levels (exceeding site boundary limits - logic 2/4), isolation of the leaking isolation condenser will occur automatically (closure of the isolation valves F001 through F004).

Four sets of differential pressure instrumentation are located on the steam line and another four sets on the condensate return line; detection of excessive flow in the steam supply line or in the condensate return line (logic 2/4 signals) will result in alarms to the operator, plus automatic isolation of both steam supply and condensate return lines of the affected IC loop.

3.3 System Boundaries

3.3.1 Includes. The ICS design scope includes the following:

a. Outside vent to atmosphere.

b. Steam dryers in the pool vent flow path.

c. IC/PCC pool subcompartment interconnections (pipes and valves).

3.3.2 Excludes. The ICS design scope excludes the following:

a. IC/PCC pool.

b. Pool makeup and water recirculation systems.

c. Pool instrumentation.

d. Radiation monitors.

3.4 System Operation

3.4.1 Normal Plant Operation. During normal plant operation, the IC subloop is in "ready standby", with both steam supply isolation valves and both isolation valves on the condensate return line in a normally open position, condensate level in the IC extending above upper headers, condensate return valve-pair both closed, and with the small-vent lines from the IC top and bottom headers to the suppression pool closed. A hydrogen recombiner, located inside the IC, on the steam distributor, at the main steam supply line top end, recombines the small quantity of noncondensable gases. Steam flow is induced from the steam distributor through the purge line by the pressure differential caused by main steam line flow.

The valve status, failure mode, actuation mode, pipe size, valve type and line are as follows:

Valve Number	Status (1)	Failure mode (2)	Actuator type (3)	Size	Valve type	Location
F001	NO	AI	NMO	12"	gate	steam line
F002	NO	AI	MO	12"	gate	steam line
F003	NO	AI	MO	6"	gate	condensate to RPV
F004	NO	AI	NMO	6"	gate	condensate to RPV
F005	NC	AI	MO	6"	gate	condensate to RPV
F006	NC	FO	NO	6"	globe	condensate to RPV
F007	NC	FC	SO	3/4"	globe	vent line to SP
F008	NC	FC	SO	3/4"	globe	vent line to SP
F009	NC	FC	SO	3/4"	globe	vent line to SP
F010	NC	FC	SO	3/4"	globe	vent line to SP

3.4.1 (Continued)

Valve Number	Status (1)	Failure mode (2)	Actuator type (3)	Size	Valve type	Location
F011	NC	AI	MO	3/4"	globe	vent line to SP
F012	NC	AI	MO	3/4"	globe	vent line to SP
F013	NO	AI	MO	3/4"	globe	purge line to MSL

Legend:
(1) NO = normally open; NC = normally closed;
(2) AI = as is; FO = fail open; FC = fail closed;
(3) NMO = nitrogen rotary motor operated; SO = solenoid operated; NO = nitrogen piston operated; MO = electric motor operated.

3.4.2 Plant Shutdown Operation. During refueling, the IC is isolated from the reactor, with all isolation valves closed (F001 through F004). The vent valves (F007 through F012) are also closed.

3.4.3 Isolation Condenser Operation. Any of the following sets of signals will generate an actuation signal for ICS to come into operation (see also ref. 2.1.1.a & c) to implement the control requirements of ref. 2.1.2.2.c:

a. MSIV valve position on MSL A ≤ 90% open,
plus
MSIV valve position on MSL B ≤ 90% open,
(Reactor Mode Switch in "RUN" only);

(Note: 90% open is the nominal setpoint value; the MSIV position minimum plant safety analytical limit is 85% open)

or:

b. RPV pressure ≥ 7.447 MPag (1080 psig) for 10 seconds;

or:

c. Reactor water level below Level 2;

or:

d. Operator remote manual initiation.

When one of these ICS initiation signals occurs, the condensate return valves F005 and/or F006 open within 30 seconds; that starts IC operation. If the IC does not operate, the RPV pressure will peak and gradually increase to the SRV setpoint of 8.619 MPag (1250 psig). The isolation valves are signaled to open to assure that they are opened during or after a test closure of the valves.

3.4.3 (Continued)

If, during IC operation and after the initial transient, the RPV pressure increases above 7.516 MPag (1090 psig), the bottom vent valves F009 and F010 automatically open; when the RPV pressure decreases below 7.447 MPag (1080 psig) (reset value) and after a time delay to avoid too many cycles, these two valves close.

After reactor isolation and automatic ICS operation, the control room operator can control the venting of noncondensable gases from the ICs to enable them to hold reactor pressure below safe shutdown limits.

3.5 System Interfaces. The document listed in paragraph 2.1.1.a shows the mechanical interfaces of ICS with other systems. The following paragraphs describe all ICS interfaces with other systems.

3.5.1 Nuclear Boiler System (NBS) (B21). The steam to be condensed is directed to the ICs from RPV stub tubes which are part of the NBS. The RPV stub tube nozzle locations are shown on the ICS P&ID (ref. paragraph 2.1.1.a).

Another physical and functional interface between NBS and ICS is the vent line that purges noncondensables downstream of the RPV, during normal plant operation. The IC loop purge line is connected to both NBS main steam lines, upstream of the MSIVs.

NBS and ICS each also have certain instrumentation interfaces: MSIV limit switches and reactor pressure sensors that actuate ICS (see ref. 2.1.1.c and ref. 2.1.2.1.b).

3.5.2 Leak Detection and Isolation System (LD&IS) (C21). The LD&IS will isolate each IC loop individually on high pool radiation or on high flow (as measured by high differential pressure) in the steam supply line or the condensate return line (see Paragraph 3.2 for detailed system description).

3.5.3 Fuel and Auxiliary Pools Cooling System (FAPCS) (G21). This system performs a cooling/cleanup of IC/PCC pool water.

Several suction lines, at different locations, draw water from the sides of the IC/PCC pool at an elevation above the minimum water level that is required to be maintained during normal plant operation. The water is cooled/cleaned and is returned back to the pool at several different locations.

There is a separate supply pipe to the IC/PCC pool with a connection through which, under an emergency, water can be supplied from fire or tanker trucks.

3.5.4 <u>Makeup Water System (MWS) (P10)</u>. This system provides IC/PCC pool makeup clean water supply for replenishing level.

Level control is accomplished by using an air-operated valve in the makeup water supply line. The valve opening/closing is controlled by a water level signal sent by a level transmitter sensing water level in the IC/PCC pool.

3.5.5 <u>High Pressure Nitrogen Supply System (HPNSS) (P54)</u>. The valves F001 and F004, nitrogen rotary motor operated, and the valve F006, nitrogen piston operated, all located inside containment, utilize clean nitrogen gas, supplied by this system, if available.

During abnormal conditions, (i.e., emergency) the valves are fed by pneumatic accumulators (nitrogen charged).

3.5.6 <u>Passive Containment Cooling System (PCCS) (T15)</u>. The ICS and the PCCS do not have any functional interface. But all ICs and PCC Condensers will be located in the common IC/PCC pool (but in separate subcompartments) and thus will use the same water.

3.5.7 <u>Direct Current Power Supply (R42)</u>. 125 V DC Power (divisions I, II and III) shall be used for solenoid operated and motor operated valves as defined by ref. paragraph 2.1.1.c.

3.5.8 <u>Safety System Logic and Control (SSLC) (C74)</u>. The logic defined by ref. paragraph 2.1.1.c shall be incorporated into the SSLC.

3.6 <u>Instrumentation and Control</u>. The ICS instrumentation is shown in the document listed in paragraph 2.1.1.a. Control logic for the system is given in the document listed in paragraph 2.1.1.c. The following paragraphs give a brief description for the system instrumentation and control logic.

3.6.1 <u>Instrumentation</u>. Four radiation sensors are installed in the IC/PCC pool exhaust passages to the outside vent lines that vent the air and evaporated coolant (vapor) to the environment. These sensors are part of the LD&IS (ref. paragraph 2.1.2.e).

On high radiation signal, coming from 2-out-of-4 radiation monitors installed near each IC compartment, all the lines from/to the IC are isolated. This means closure of the isolation valves F001, F002, F003 and F004. The high radiation can be due to a leak from any IC tube and a subsequent release of noble gas to the air above the IC/PCC pool surface.

Four sets of differential pressure instrumentation on each steam supply line and another four sets on each condensate return line are used to detect a possible LOCA.

High dPT signal coming from two of four dPT on the same line (steam or condensate) closes all isolation valves and therefore renders the IC inoperable.

The operator cannot override either the high radiation signals from the IC atmosphere vents or the high differential pressure IC-isolation signals.

3.6.1 (Continued)

A temperature element is provided in each vent line, at the downstream of the valves, to confirm vent valves function. Each temperature element is connected to a temperature recorder located in the main control room.

A temperature element is provided in each condensate return line, downstream of isolation valve F004. Each temperature element is connected to a temperature recorder located in the main control room. This temperature recorder, together with the differential pressure recorder which get the signal from one of the dPTs located on the condensate return line, allows operators to conduct the five year heat removal capability test on the IC.

A test connection with an end cap is provided at the upstream side of the outer isolation valve, F002 on the steam supply line, to perform leak tests on isolation valves F001 and F002.

A test connection with an end cap is provided at the downstream side of the outer isolation valve, on the condensate return line, F003, to perform leak tests on isolation valves F003 and F004.

A test connection with an end cap is provided upstream of the motor operated valve F013, on the purge line, to perform leak tests on excess flow valve F014.

3.6.2 Control Logic and Interlocks

3.6.2.1 The initiation signals which actuate all three ICS loops at the same time, opening the valve F005, are described as follows:

a. Inboard or outboard MSIV's position ≤ 90% open on MSL(A) and inboard or outboard MSIV's position ≤ 90% open on MSL(B) and the "reactor mode switch in RUN".

   There are two MSIVs on each main steam line. The logic is: 1-out-of-2 limit switches of either MSIVs on the same line plus 1-out-of-2 limit switches of either MSIVs on the other line (logic 1-out-of-2 twice). Both MSI s must be closed for IC actuation.

   However, during MSIV testing, one MSL is temporarily out of service. During these conditions a 1-out-of-2 signal coming from the limit switches of the operational MSL will cause ICS operation.

b. RPV pressure (with logic 2-out-of-4) ≥ 7.447 MPa(g) (1080 psig) for 10 seconds.

c. Operator Manual Initiation.

The MSIV position switches for ICS control are electrically separate from similar switches that feed position signals to the RPS.

When the RPV pressure decreases below a reset value 5.516 MPa(g) (800 psig), the operator is able to stop ICS loops individually, by overriding the signal coming from MSIV's closure.

3.6.2.2 Condensate return valve F006 opens, automatically, in a loss of the two feeding electrical power divisions, or if the reactor level drops to L2, or, manually, by operator action.

3.6.2.3 Automatic actuation for the vent valves (F009 and F010, located in series) is provided by high RPV pressure (above system actuation value) and either of condensate return valves not fully closed (with time delay to avoid vent opening during the initial transient). The valves close, preventing loss of inventory, when the RPV pressure decreases below a reset value.

3.6.2.4 Closure of the isolation valves (F001 through F004) and alarms shall be automatic on the following signals coming from their own loop (logic 2/4):

a. High mass flow in the IC steam supply line; or

b. High mass flow in the IC condensate return line; or

c. High radiation in the pool steam flow path.

4. FUNCTIONS AND REQUIREMENTS

4.1 Functions. The ICS shall automatically limit the reactor pressure and prevent SRV operation when the reactor becomes isolated following scram during power operations. Furthermore, the ICS, together with the water stored in the RPV, shall conserve sufficient reactor coolant volume to avoid automatic depressurization caused by low reactor water level.

It must also, over a longer duration, remove excess sensible and core decay heat from the reactor, in a passive way and with minimal loss of coolant inventory from the reactor, when the normal heat removal system is unavailable, following any of the following events:

- Sudden reactor isolation from power operating conditions;
- Station blackout (i.e., unavailability of all AC power) for 72 hours;
- Anticipated Transient Without Scram (ATWS).

To accomplish these functions, the minimum heat removal capacity of the ICS shall be 60 MWt at a reactor pressure of 7.420 MPa(g) (1050 psig) and the condensate return valve stroke-open time shall be 30 seconds with a logic delay time not to exceed 1 second after opening setpoint is reached.

The ICS is not an "Engineered Safety Feature" (ESF is defined in reference 2.1.2.2.a.) because other ESFs provide protection if the ICS is not available; however, the ICS is designed as a safety-related system to remove reactor decay heat following reactor shutdown and isolation and to prevent unnecessary reactor depressurization and operation of ESFs which can also perform this function.

4.2 General System-Level Requirements. The ICs shall be capable of removing post-reactor isolation decay heat with 2 out of 3 ICs operating and to reduce reactor pressure and temperature to safe shutdown conditions (2.068 MPa (g) (300 psig) and 215°C (420°F), in 36 hours, with occasional venting of radiolytically generated noncondensable gases to the pressure suppression pool.

4.2.1 Performance Requirements. For operating temperatures and pressures, system operating modes and performance requirements, see paragraph 3.4 and the document "ICS Process Diagram" (ref. paragraph 2.1.1.b).

The IC may have a steady state condensing capacity as high as 140% of nominal rating when new and unfouled. Therefore, the ICS shall be designed such that IC tubes are completely drained at 140% of nominal rating to minimize cyclic operation due to intermittent tube flooding.

The system and equipment duty cycles are as follows (refer to document paragraph 2.1.1.f for event descriptions):

4.2.1.1 Normal (Planned Operation) and Upset Conditions (Moderately Frequent Transients)

	Occurrences
a. Heatups:	525

event 3 (405 cycles); events 10 and 11 (60 cycles); event 20 (60 cycles).

Steam heatup cycles, starting from cold conditions of 10°C, 0 MPa(g) to 289°C, 7.240 MPa(g) (50°F, 0 psig to 552°F, 1050 psig) at 55°C/hr (100°F/hr) max.

b. Cooldowns without IC operation:	403

event 15 (395 cycles); event 21 (8 cycles).

Cooldown cycles starting from steam saturation temperature of 289°C, 7.240 MPa(g) to 10°C, 0 MPa(g) (552°F, 1050 psig to 50°F, 0 psig) at 55.5°C/hr (100°F/hr)max.

4.2.1.1 (Continued)

	Occurrences
c) Isolation condenser operations:	135

event 10 and 11 (60 cycles); event 12 (13 performance test cycles); event 20 (60 cycles); event 23 (2 cycles).

Starting from the IC standby conditions, the condensate return valve is opened and 10°C (50°F) condensate is replaced by 301.7°C (575°F) steam inside the IC tubes. After two hours, when the operator closes the valve F005, the temperature of IC tubes and condensate return line decreases to 10°C (50°F).
For one event the valve F005 is supposed to be closed after 72 hrs of IC operation.

d) OBE (Operating Basis Earthquake)	10

Dynamic analysis including OBE shall be based on the floor response spectra of figures 4.1 and 4.2.

4.2.1.2 Emergency Conditions (Infrequent Incidents)

a) ATWS (Anticipated Transient Without Scram): event 22	<10E-02 events/year

Starting from the IC standby conditions, in 0.5 minutes the pressure rise up to 9.5 MPa(g) (1378 psig). Then the steam supply pressure remains constant for an indefinite period of time (until thermal equilibrium is reached). Then, the temperature decreases to 10°C (50°F) at 55.5°C/hr (100°F/hr).

4.2.1.3 Faulted Conditions (Postulated Accidents)

a) Large LOCA (Loss of Coolant Accident): event 27.	<10E-04 events/year

Starting from the IC standby conditions, in one minute the temperature rises up to 301.7°C (575°F) and the pressure increases to 8.619 MPa(g) (1250 psig), with the condensate remaining at 10°C (50°F). Then there is a 3.3 minute depressurization to 1.103 MPa(g) (160 psig), then exponentially to 0.1 MPa(g) (15 psig) (10 minutes is the total time).

4.2.1.3 (Continued)

	Occurrences
b) SSE (Safe Shutdown Earthquake)	<10E-04 events/year

Dynamic analysis including SSE shall be based on the floor response spectra of figures 4.3 and 4.4

4.2.1.4 Test Conditions

a) Primary Side Hydrostatic Test	10

Test pressure = 1.25 design pressure test temperature: see ASME III App. G temperature limits apply to assure adequate fracture toughness.

b) Tube Leakage Test	(later)

(Test requirements to be defined)

c) Others	(later)

For the isolation valves operational readiness tests, 240 full stroke closures tests in 60 years shall also be considered. The tests are done during normal plant operation at 7.240 MPa(g), 10°C (1050 psig, 50°F) (for valves on the condensate return line) or 287.8°C (550°F) (for valves on the steam supply line).

Full stroke closure is needed so the isolation condenser will not operate when the condensate return valves (F005 & F006), which are in series with these isolation valves, are opened during their operational readiness tests.

For the condensate return valves operational readiness tests, 240 open-close tests in 60 years shall be considered. The tests are done during normal plant operation at 7.240 MPa(g) (1050 psig) and 10°C (50°F) minimum.

Isolation valves F003 and F004 must be closed prior to opening these condensate return valves, so the isolation condenser will not operate when F005 and/or F006 are opened, during operational readiness testing.

4.2.2 Configuration and Arrangement

4.2.2.1 The elevation difference between the IC pool bottom and the Reactor Pressure Vessel level 8 shall be equal to or greater than 6.5 meters.

According to this elevation difference, the isolation condenser loop pressure drop (piping, elbow, valves and heat exchanger) shall be limited to 41.5 kPa (6 psi) at the maximum flow rate.

4.2.2.2 After thermal expansion the steam supply line piping minimum slope toward the Reactor Pressure Vessel shall be equal to or greater than one unit length elevation drop per one hundred unit lengths of horizontal line run (i.e., 1/100) and the condensate return line minimum slope shall be 1/25; the only exception is the loop seal piping located at an elevation below the RPV nozzle.

The loop seal is needed so there is not a high temperature difference between the two sides of the condensate return valves disk, and so that back flow through the condensate return line is avoided. The loop seal shall be made by providing a reduction in the pipe line elevation of 0.5 meters (minimum) below the RPV nozzle elevation.

4.2.2.3 The vent valves (F007 through F012) shall be located near the top of the drywell in a vertical pipe run.

The piping minimum slope to the suppression pool shall be equal to or greater than 1/25, to prevent steam condensate induced water hammer.

4.2.2.4 The piping minimum slope toward the main steam line shall be, for the purge line, equal to or greater than 1/25.

4.2.2.5 The straight length of IC piping upstream and downstream of the elbow taps shall be (later from test) minimum. This length shall be sufficient to give a repeatable differential pressure at the highest flow rate.

4.2.2.6 The instrument piping which connects to the condensing chamber for differential pressure measurement shall be routed downward with a continuous slope equal to or greater than 1/25.

4.2.2.7 System configuration shall permit inservice inspection. The physical arrangement and access of piping and valves for inservice inspection is defined in ref. paragraph 2.1.2.2.b.

4.2.2.8 System configuration shall permit component servicing in accordance with the plant operation and maintenance requirements (ref. 2.1.2.2.b.).

4.2.3 <u>Safety</u>

4.2.3.1 The ICS is used to transfer decay and residual heat from the reactor after the reactor is shutdown and isolated. This function can also be performed by the Engineered Safety Features of ADS, PCCS, and GDCS. The ICS shall be designed and qualified as a safety-related system to comply with 10CFR50 Appendix A, Criterion 34. Its function is to avoid unnecessary use of these ESFs for residual heat removal, but it is not an Engineered Safety Feature (see Appendix 10 Figure 10-1 which shows plant operational logic as it relates to the several systems, including the ICS, which can be used to remove decay heat after reactor isolation).

4.2.3.1 (Continued)

The ICS parts (including isolation valves) which are located inside the containment and out to the IC flow restrictors shall be designed to ASME Code Section III, Class 1 Quality Group A. The ICS parts which are located outside the containment downstream of the flow restrictor shall be designed to ASME Code Section III, Class 2, Quality Group B. The electrical design shall comply with IEEE Class 1E, and the entire system shall be designed to Seismic Category I. (See ref. 2.1.2.2 a for quality group, electrical, and seismic classifications).

The common cooling pool that ICs share with the PCC Condensers of the PCCS is safety related.

4.2.3.2 Two out of three ICS loops are initially needed to remove post reactor isolation decay heat, after sustained reactor operation at 100% power (see Appendix 10 for ICS operational requirements).

4.2.3.3 As protection from missile, tornado and wind, the ICS parts outside the containment (the IC itself) are located in a subcompartment of the safety related IC/PCC pool to comply with 10CFR50 Appendix A, Criteria 2, 4 and 5. The IC steam supply pipes include flow restrictors, and the IC condensate drain pipes are of limited area so that an IC piping or tube rupture in the safety-related IC/PCC pool will limit flow-induced dynamic loads and pressure buildup in the IC/PCC pool.

Also guard pipes and special transition fittings are used at the locations where the IC steam supply and condensate return pipes enter the pool at the containment pressure boundary.

4.2.3.4 The valve actuators shall be qualified for service inside the drywell for continuous service under normal conditions and to be operable for 4 hours with a steam environment. Thereafter, the valves are required to remain in their last position.

4.2.3.5 The ICs shall not fail in a manner that damages the safety related IC/PCC pool as a result of dynamic loads, including combined seismic, DPV/SRV or LOCA induced loads.

4.2.4 Design Life. Material and equipment selection for the system components shall be based on a useful life of 60 years.

Therefore each IC unit shall be designed for 60 years life and, if necessary, repair operations will be performed during refueling. However, in case of major damage of some component part, the module shall be easily removable.

The electrical and pneumatic devices for the valves shall have a design life of 10 years (minimum).

Valve seals, gaskets and lubricants shall be based on a minimum 5 years' life.

4.2.5 System Interfaces

4.2.5.1 Nuclear Boiler System (NBS) (B21). See paragraph 3.5.1.

4.2.5.2 Leak Detection and Isolation System (LD&IS) (C21). See paragraph 3.2.

4.2.5.3 Fuel and Auxiliary Pools Cooling System (FAPCS) (G21).

Description	Duration
Cooling and clean-up of IC/PCC pool	Intermittent

4.2.5.4 Makeup Water System (MWS) (P10).

Description	Duration
Water to maintain IC/PCC pool level	Intermittent

4.2.5.5 High Pressure Nitrogen Supply System (HPNSS) (P54).

Description	Duration
Service in 21°C to 57°C (70°F to 135°F) max., 40% to 90% relative humidity	Continuous

4.2.5.6 Passive Containment Cooling System (PCCS) (T15). See paragraph 3.5.6.

4.2.5.7 Direct Current Power Supply (R42).

Description	Duration
125 V DC	Continuous

4.2.5.8 Safety System Logic and Control (SSLC) (C74). See paragraph 3.5.8.

4.2.6 Instrumentation and Control

4.2.6.1 Instrumentation Requirements. The document "Isolation Condenser System P&ID Data" (reference paragraph 2.1.1.d) - later - specifies system instrumentation requirements and settings.

4.2.6.2 Control Requirements. The document "Isolation Condenser System LD" (reference paragraph 2.1.1.c) specifies requirements for system control logic. On this matter, see also paragraph 3.6.2.

4.2.6.3 Man-Machine Interface Requirements. The system man-machine interface requirements will be developed later, in conformance with the document listed in paragraph 2.1.2.1.m.

4.2.7 Availability

4.2.7.1 The ICS contribution to the total plant unavailability (plant forced outage time) shall be equal to or less than 0.17%, according to the document listed in paragraph 2.1.2.1.n.

4.2.7.2 The system maintenance has to be performed during refueling. (The maintainability criterion for SBWR is that regular refueling and planned plant maintenance can be accomplished in one 50-day outage every two years).

4.2.7.3 From the point of view of refueling outage time, the ICS is not in a critical path.

4.2.7.4 The mean time between failures shall be, as an objective, two years: valve gaskets ≥5 years; pressure retaining parts ≥60 years.

4.2.7.5 The mean time to repair (MTTR) of a failed component shall be low such that the repair has minimal impact on system availability and on equivalent availability factor (EAF).

4.2.8 Environment

4.2.8.1 ICS components required to function under upset conditions shall be designed to remain functional under the abnormal environmental conditions in addition to the normal conditions defined in document paragraph 2.1.2.1.o.

4.2.8.2 For purposes of radiation shielding design, "Source Terms" document (see paragraph 2.1.2.1.k) shall be used.

4.2.8.3 The ICS steam supply and steam purge line piping and valves plus the drain line within shield wall and structural penetrations shall be provided with thermal insulation, which limits heat loss to 252 W/m^2 (80 $Btu/hr\text{-}ft^2$) of piping surface area during normal reactor operation. Insulation shall contain no chlorides and shall retain no moisture if wetted. Insulation shall be simply removable to permit inservice inspection of piping. The remainder of the IC drain and vent lines that connect to the bottom and top of the IC and are flooded during normal operation need not be insulated.

4.2.9 Maintenance. No preventive maintenance actions are expected to be performed during normal plant operation.

Corrective maintenance for IC tube plugging following tube leak detection can be performed during refueling.

4.2.9 (Continued)

After closing the isolation valves to/from the IC and after emptying its pool subcompartment (see paragraph 4.3.2.2), plugging of the leaking tube can be performed by personnel operating from the refueling floor. Maintenance will be performed from upper and lower end, after removal of the header covers. A remotely operated tool shall be used.

If there is considerable damage to some component part of the IC, each module of IC unit shall be easily removable, after cutting the feed, drain and vent lines.

The pool water in the isolation condenser subcompartment shall be removable without emptying the entire IC/PCC pool.

4.2.10 Surveillance Testing and Inservice Inspection.

4.2.10.1 During plant outages routine ISI is required for the isolation condenser, piping containment penetration sleeves, and supports according to ASME Code Section III and Section XI (requirements for design and accessibility of welds).

IC removal for routine inspection is not required.

Ultrasonic inspection is required for IC tubes/headers welds.

IC tubes shall be inspected by the eddy current method.

4.2.10.2 IC five year heat removal capability test is required. This test is accomplished with data derived from the temperature sensor located downstream of isolation valve F004 together with the LD&IS differential pressure transmitter registering differential pressure on the condensate return line.

4.2.10.3 During plant normal operations, quarterly surveillance testing of normally-closed valves F005 and F006 on each IC condensate line to the RPV is expected to be performed.

The test procedure for these condensate return valves starts after the condensate return line isolation valves F003 and F004 are closed; this avoids subjecting the IC to unnecessary thermal heat-up/cooldown cycles.

Isolation valves on the steam supply line (i.e. F001 and F002) shall remain open to avoid IC depressurization.

The test is performed by the control room operator via remote manual switches that actuate the isolation valves and the condensate return valves; the opening and closure of the valves is verified by their status light.

4.2.10.3 (Continued)

The procedure is as follows:

- close F003 and F004 valves;
- fully open, and subsequently close, valve F005 and then F006;
- re-open isolation valves to put the IC in stand-by condition.

4.2.10.4 The isolation valves (F001, F002, F003, F004) shall be tested, quarterly, one at a time.

If a system actuation signal occurs during test, all the valves are aligned automatically to permit the IC to start operation.

4.2.10.5 Each vent valve (F007 through F012) shall be tested quarterly.

The valves which are located in series, shall be opened one at a time during normal plant operation. A permissive is provided such that the operator can open one vent valve if the other one in series is closed.

4.2.10.6 The purge line root valve F013 shall be tested quarterly.

4.3 Specific Requirements for Components

4.3.1 Isolation Condenser

4.3.1.1 The IC shall be designed for 30 MWt capacity.

4.3.1.2 Design pressure and temperature:

8.619 MPa(g) (1250 psig),

302°C (575°F).

4.3.1.3 The IC is an extension of the reactor coolant pressure boundary .

ASME Code Section III Class I (for parts through the containment boundary) and Class II (beyond the containment boundary) and TEMA Class R apply. ASME Code Section XI requirements for design and accessibility of welds for inservice inspection apply.

4.3.1.4 Tube surface (heat transfer area) is to be defined with 7.240 MPa(g) (1050 psig) saturated reactor steam in the tubes and 100°C (212°F) pool water temperature.

Fouling factor shall be considered only on the shell side, and a value to be used is 0.00009 $m^2 \cdot °C/W$ (0.0005 $ft^2 \cdot °F \cdot h/Btu$).

4.3.1.4 (Continued)

A margin of 5% for tube plugging shall be included. Other additional margins used for defining heat transfer surface shall not be included.

4.3.1.5 Material shall be nuclear grade stainless steel, or inconel, or other material which is not susceptible to IGSC (Intergranular Stress Corrosion). The special requirements of reference 2.1.2.2.e apply.

4.3.1.6 Pressure losses shall be limited to 20.68 kPa (3 psig) from the steam line penetration to the main drain line penetration (top of drywell top slab) at maximum expected steady state IC condensing capacity (140% of nominal capacity).

4.3.1.7 The acceptable rate of heat loss from an IC heat exchanger and its piping is 0.06 MWt.

4.3.1.8 The IC modules must be removable for replacement, if needed, during plant shutdowns.

4.3.1.9 The IC shall be provided with an appropriately mounted (in the high point above the water level) catalyst for hydrogen and oxygen recombination, during normal plant operating conditions.

As a backup to the catalyst and for long term assurance in the hydrogen water chemistry condition case, a vent shall be provided that takes a small stream of "gas" mixture (steam and noncondensables) from the top of the IC and vents the mixture downstream of the RPV.

4.3.2 Isolation Condenser Pool

4.3.2.1 Both the ICs and the PCC Condensers are located in a large water pool, positioned above the drywell.

The large IC/PCC pool is partitioned but each IC and PCC must be able to draw water from the entire pool. The pool air/steam space also is open.

4.3.2.2 The pool subcompartment interconnections shall be as follows: except for the IC and PCC pool compartments, all other pool subcompartments shall be interconnected below pool water level; the IC and PCC pool subcompartments shall be connected to the other pools below the water level by locked open valves, one for each subcompartment, which can be closed to isolate and empty, using a portable pump, the individual partitioned subcompartment for maintenance of the unit (see ref. 2.1.1.a).

4.3.2.3 The water volume above the top of the IC tubes shall be such as to guarantee the required performance over a duration lasting 72 hours after reactor isolation, and to remove reactor system stored heat during station blackout (ref. 2.1.2.2.a).

4.3.2.4 Locked open subcompartment valve remote handwheels shall be extended above water level, to locations which are accessible to the operator.

4.3.2.5 The walls which contain the airspace flow path shall extend above the normal water level. This enhances the flow stability and heat removal of the condensers by establishing a flow path for the makeup water through the lower pipes.

4.3.2.6 The vent flow path area shall limit the pool pressure to 34.4 kPa(g) (5 psig) (maximum) under postulated IC pipe rupture flow conditions (critical flow through an area equivalent to two 3" pipes plus one 4" pipe).

4.3.2.7 For the leak detection systems located in the IC/PCC pool see paragraph 3.2.

4.3.2.8 For IC/PCC pool instrumentation see ref. paragraph 2.1.2.1.f and 2.1.2.1.g.

4.3.2.9 For IC/PCC pool makeup see paragraph 3.2 and ref. paragraph 2.1.2.1.h.

4.3.2.10 Steam dryers are needed to remove carryover moisture from the steam leaving the IC/PCC pool before this steam is released to the atmosphere. The moisture content of the steam leaving the vent pipe shall not exceed 2% of the mass flow of the steam generated in the IC/PCC pool.

The inlet vane face area required is 4.5 square meters for each unit (13.5 square meters total).

The required minimum elevation of the dryers above the pool water level is equal to the head loss due to the flow through the flow path, from the pool water surface to downstream the steam dryers.

4.3.3 Isolation Valves (F001, F002, F003, F004). Two isolation valves in series are located both in the steam supply line and in the condensate return line of each loop. The inner valves (F001, F004) are nitrogen-motor-operated and shall be Div. II, DC, power operated; the outer valves (F002, F003) are motor-operated and shall be Div. I, DC, power operated.

Gate type valves are required for low pressure losses. Double disk wedge gate type (or equivalent) which apply axial seating force after the parallel disks are in the closed position are preferred to prevent sticking closed when signaled to open.

The isolation valves shall be both automatically and remote manually actuated with automatic closure overriding manual opening.

The isolation valves shall be signaled to open if the initiation signal occurs during the test of normally closed condensate return valves.

A remote manual closure switch position is provided for the isolation valves to permit the operator a means to isolate the IC.

4.3.3 (Continued)

Closure of the isolation valves to any IC unit, and alarms, shall be automatic by an electrical signal initiated by any 2 of 4 of the following signals, coming from the respective loop:

High mass flow in the IC steam supply line;

High mass flow in the IC condensate return line;

High radiation in the pool vents.

The position of the isolation valves shall be indicated in the control room to permit the operator to evaluate the effectiveness of drywell and containment isolation.

Isolation valves shall close at a nominal rate of 30.5 cm (12 inches) of stem movement per minute (one minute maximum) with critical flow through the valves or in an adequate time such as to limit offsite doses below the limit values in case of IC pipe break, assuming the reactor coolant contains radioactivity at the limiting value for continued power operation, as specified in technical specification operating limit.

Each nitrogen-motor-operated valve shall be provided with a pneumatic accumulator which is sized to provide sufficient capacity to ensure adequate supply pressure to the valve actuator to close, re-open and re-close the valve while the discharge pressure is at containment design pressure. The accumulator shall be charged by the HPNSS (ref. paragraph 4.2.5.5) which shall also provide makeup for valve actuator system leakage.

The accumulator shall be of corrosion resistant material and be provided with low point drain.

Pneumatic inlet and outlet piping shall be arranged to permit the accumulator to act as a crud trap.

The fittings and pipe between the accumulator and the valve actuator should be austenitic stainless steel piping or flexible tubing.

A check valve of corrosion resistant material shall be provided on the line supplying the nitrogen accumulator to prevent leakage of gas out of the accumulator in the event of a gas supply failure.

The check valve shall have a resilient seat and be spring loaded.

The IC pneumatic system (piping and equipment) leakages and accumulator volumes shall be established as input to containment pressure determinations.

4.3.4 Condensate Return Valves (F005, F006)

4.3.4.1 Condensate Return Valve (F005). This valve shall be a motor-operated, double disk wedge gate type valve, ON/OFF, and designed to fail as-is on loss of essential 125 V DC power. For the different loops the valve shall be powered as following: loop A, Div. I; loop B, Div. II; loop C, Div. III.

A gate type valve is required for low pressure losses. Double disk wedge gate type (or equivalent) which apply axial seating force after the parallel disks are in the closed position is needed to minimize leakage and to prevent sticking closed when signaled to open. A device or small passageway shall be provided to relieve bonnet pressure to the upstream end (IC side) of the valve. This is to prevent lockup of the valve due to thermal expansion of water inside the bonnet and between the disks.

ICS automatic actuation is provided by the following signals:

a. MSIV valve position on MSL A $\leq$ 90% open,
   plus
   MSIV valve position on MSL B $\leq$ 90% open,
   (Reactor Mode Switch in "run" only);

b. RPV pressure $\geq$ 7.447 MPag (1080 psig) for 10 seconds;

c. operator manual initiation.

The logic shall be arranged so as to actuate all three loops at the same time. A stroke-open time of 30 seconds is required to meet system performance requirements.

The operator shall be able to stop any individual ICS loop whenever the RPV pressure is below a reset value of 5.516 MPag (800 psig), overriding ICS automatic actuation signal coming from MSIV's closure. Automatic reset of this override is provided when the pressure increases above the stated reset value.

The RPV high pressure automatic signal shall not have an override.

4.3.4.2 Condensate Return Bypass Valve (F006). This valve shall be a spring-loaded, pneumatic, piston-operated globe valve, designed to fail open on loss of pneumatic pressure to the valve actuator. This valve shall also be signaled to open when reactor water level drops to L2.

The valve shall be piloted by two DC solenoid-operated pilot valves, supplied from two separated source of safety-grade (Class 1E) battery power (loop A, Div. 1, 2; loop B, Div. 2, 3; loop C Div. 3, 1).

A pneumatic accumulator shall be located close to the valve to provide pneumatic pressure for the purpose of assisting in valve closure when both pilots are energized or in the event of failure of pneumatic supply pressure to the valve operator.

4.8.4.2 (Continued)

The valve actuation system and the actuation pressure source shall be piped in such a way that when one or both DC solenoids are energized, the accumulator shall pressurize the valve operator to close the valve, overcoming the opening force exerted by the spring. When both solenoids are de-energized, as in a loss of two divisions of electrical power supply or manual switch in the open position, the accumulator path shall be closed and the nitrogen in the valve operator shall be vented, so that the spring opens the valve.

4.8.5 Vent Valves (F007, F008, F009, F010, F011, F012)

4.8.5.1 Top Vent Valves (F007, F008). Two valves in series are located in the vent line from the top headers.

Normally closed, fail closed, solenoid-operated, globe type, these valves can be opened by the control room operator via remote manual switch (only if either of the condensate return valves is not fully closed) if discharging noncondensable gases also from the IC top is necessary.

During plant startup the valves shall be opened by the operator (a permissive is provided for that) to discharge air from the IC and ICS piping.

The valves can also be opened, one at a time, during normal plant operation, to perform a quarterly test.

Both valves for loop A, B and C shall be Div. 1, 2, 3 125 V DC power operated, respectively.

4.8.5.2 Bottom Vent Valves (F009, F010, F011, F012). The bottom vent valves F009 and F010 shall be normally closed, globe type, solenoid-operated valves, designed to fail close on loss of 125 V DC power.

Automatic actuation for these two series vent valves (F009, F010), is provided by the following signals: high RPV pressure of 7.516 MPa(g) (1090 psig) and either of the condensate return or condensate return bypass valves not fully closed, with time delay, to avoid vent opening when the IC enters in operation. This time delay shall be chosen so that the peak transient reactor pressure will have dropped below the automatic vent set pressure after the condensate drain valves are opened. When the RPV pressure decreases below a reset value and after a time-delay to avoid too many cycles, these two vent valves close, preventing loss of inventory to the suppression pool.

During normal plant operation the valves F009 and F010 can also be opened by the operator, only if either of the condensate return or condensate return bypass valves is not fully closed, and, one at a time, to perform a quarterly test.

The vent bypass motor-operated valves (F011, F012) permit the operator to open a noncondensable gases flow path (only if either of condensate return valves is not fully closed), in case of F009 and/or F010 fail to open.

4.3.5.2 (Continued)

The valves F011 and F012 can also be opened, one at a time, during normal plant operation, to perform a quarterly test.

These valves are powered by essential 125 V DC, as following:

	loop A	loop B	loop C
F009 – F010	Div. 3	Div. 1	Div. 2
F011 – F012	Div. 1	Div. 2	Div. 3

4.4 Quality Assurance.

4.4.1 General. The requirements of reference paragraph 2.1.2.2.f. apply.

4.4.2 Tests and Examination. Later.

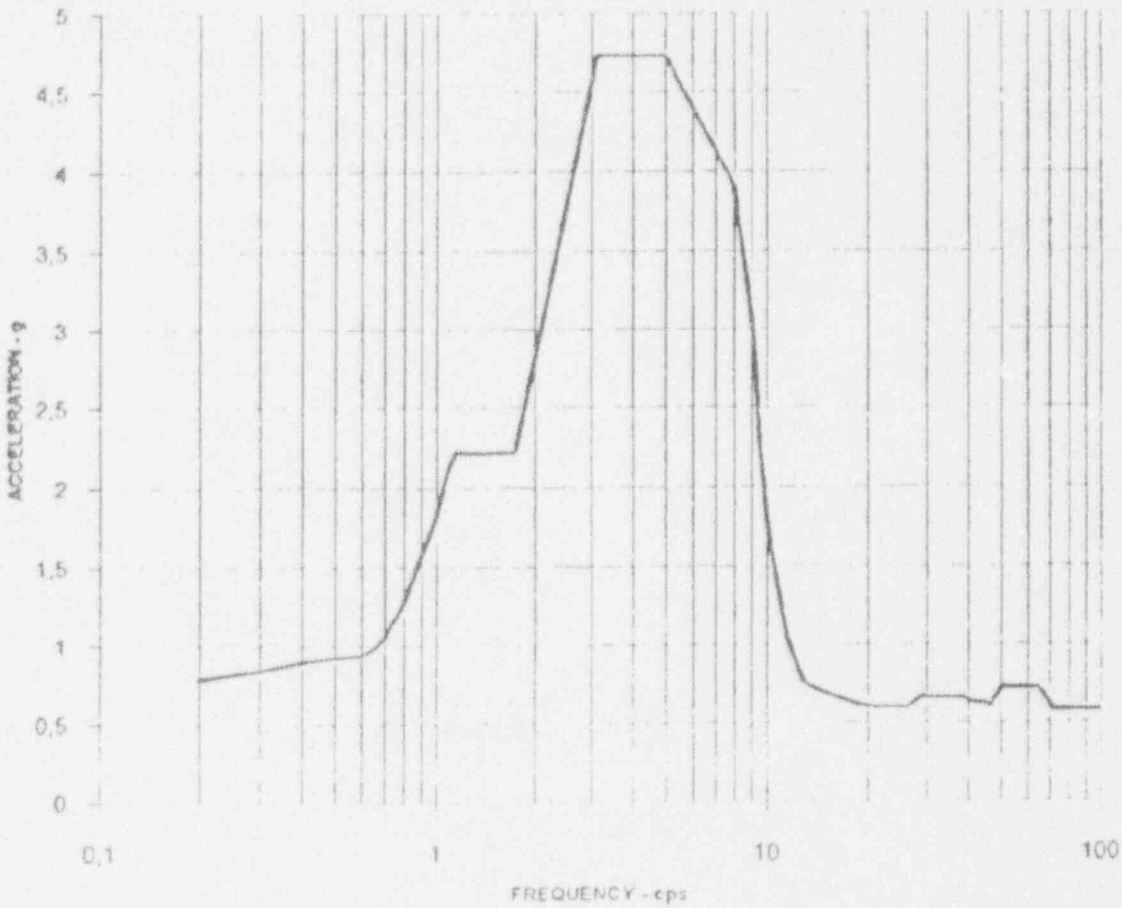


FIGURE 4.1. UPSET CONDITION DYNAMIC LOAD RESPONSE SPECTRA HORIZONTAL

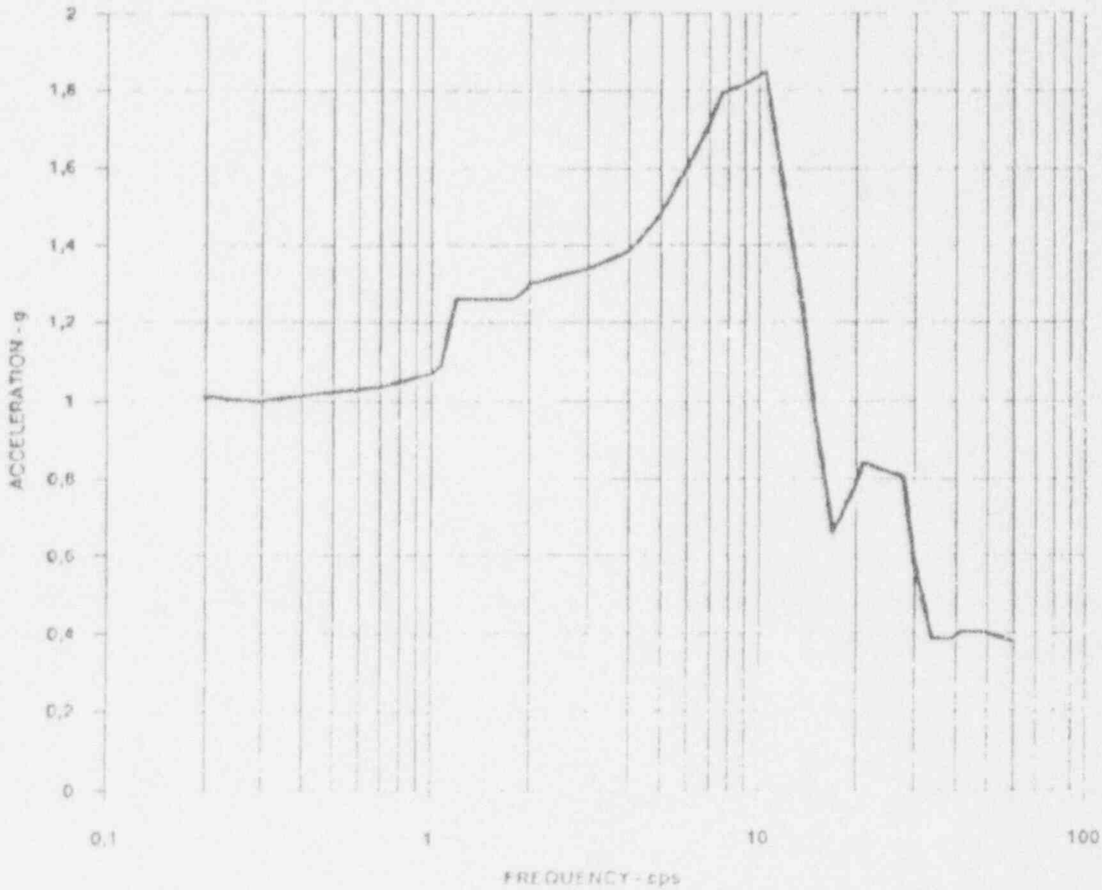


FIGURE 4.2. UPSET CONDITION DYNAMIC LOAD RESPONSE SPECTRA VERTICAL

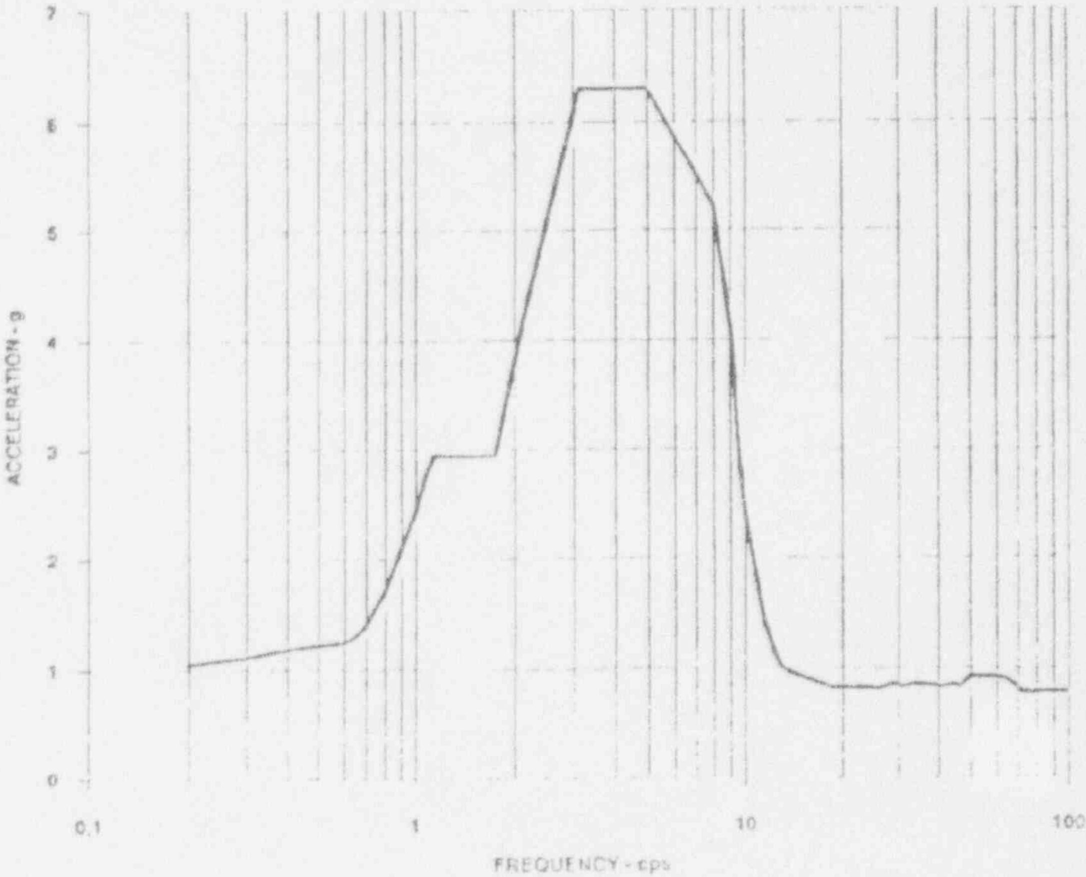


FIGURE 4.3. FAULTED CONDITION DYNAMIC LOADING HORIZONTAL

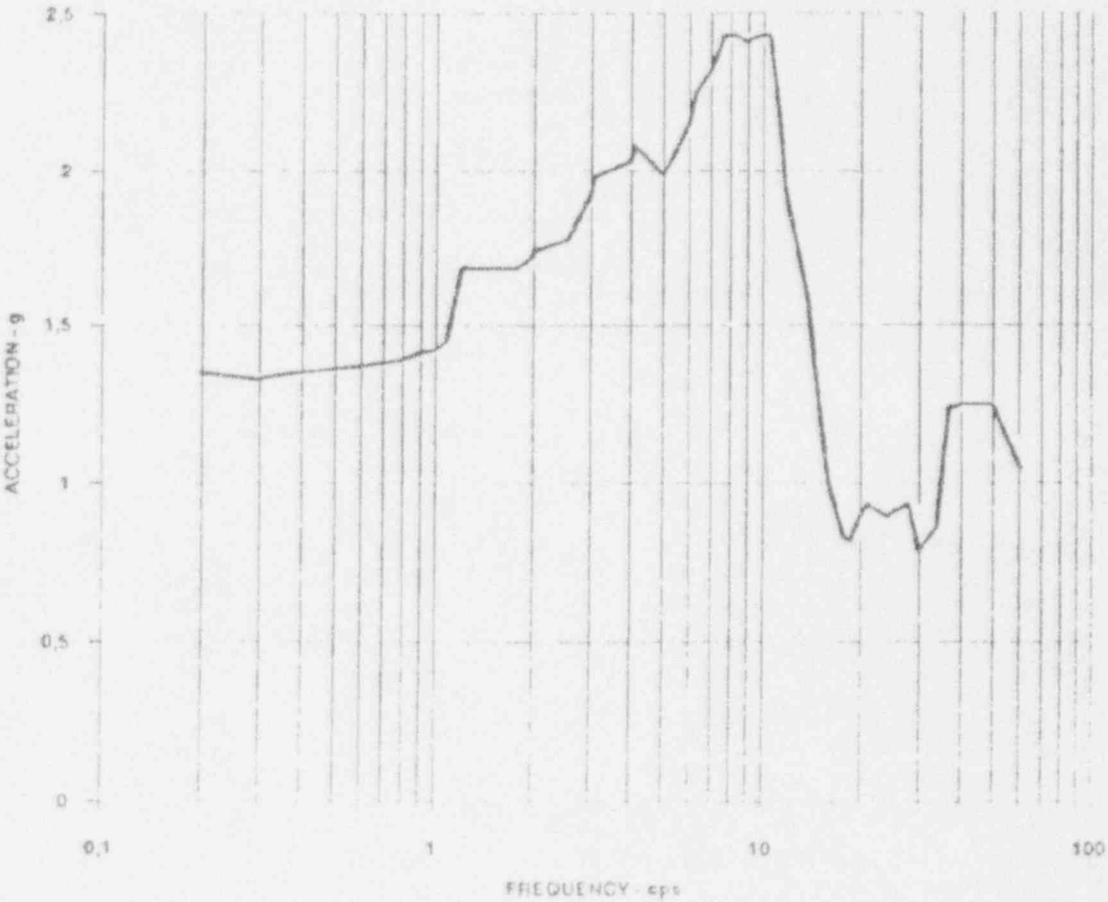


FIGURE 4.4. FAULTED CONDITION DYNAMIC LOADING VERTICAL

APPENDIX 10

SYSTEM TECHNICAL SPECIFICATIONS

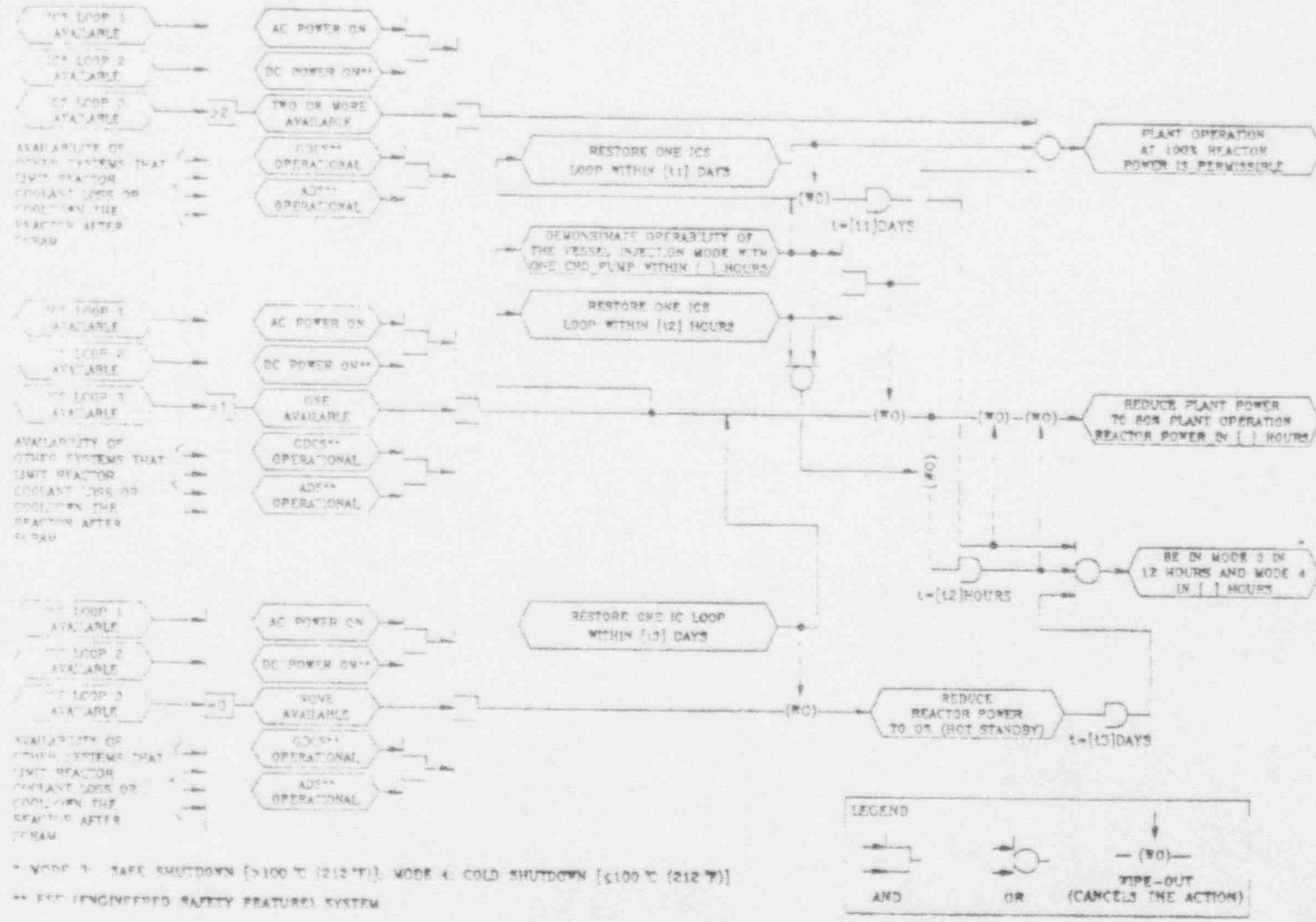
The attached figure 10-1, "Operational Logic Diagram", defines the required IC loop operational status together with other systems and ESFs (Engineered Safety Features) which are needed to operate the reactor at 100%, and lower power, including hot and cold shutdown.

A given ICS loop shall be considered operable if:

- isolation valves closure are successfully tested, at least once every 3 months;
- condensate return valves are successfully tested, at least once every 3 months;
- vent valves are successfully tested, at least once every 3 months;
- IC thermal performance is acceptable (successful test every 5 years);
- DC power division 1, 2 and 3 are available (for ICS valves operability);
- High Pressure Nitrogen Supply System is available (for nitrogen operated valves operability);
- IC/PCC pool water level is normal;
- instruments, logic and control are operational.

The figure 10-2 "ICS Technical Specifications Logic Diagram" which is an abstract of the "Operational Logic Diagram" shall be used to define Technical Operating Specifications for the Plant.

The figure 10-3 "ICS Technical Specification Flow Chart" is a simplified version of figure 10-2 for use by the operator.



* MODE 3: SAFE SHUTDOWN [>100 °C (212 °F)], MODE 4: COLD SHUTDOWN [≤100 °C (212 °F)]

** ESF (ENGINEERED SAFETY FEATURES) SYSTEM

FIGURE 10-1. OPERATIONAL LOGIC DIAGRAM

NEO 807 (REV 4/88)

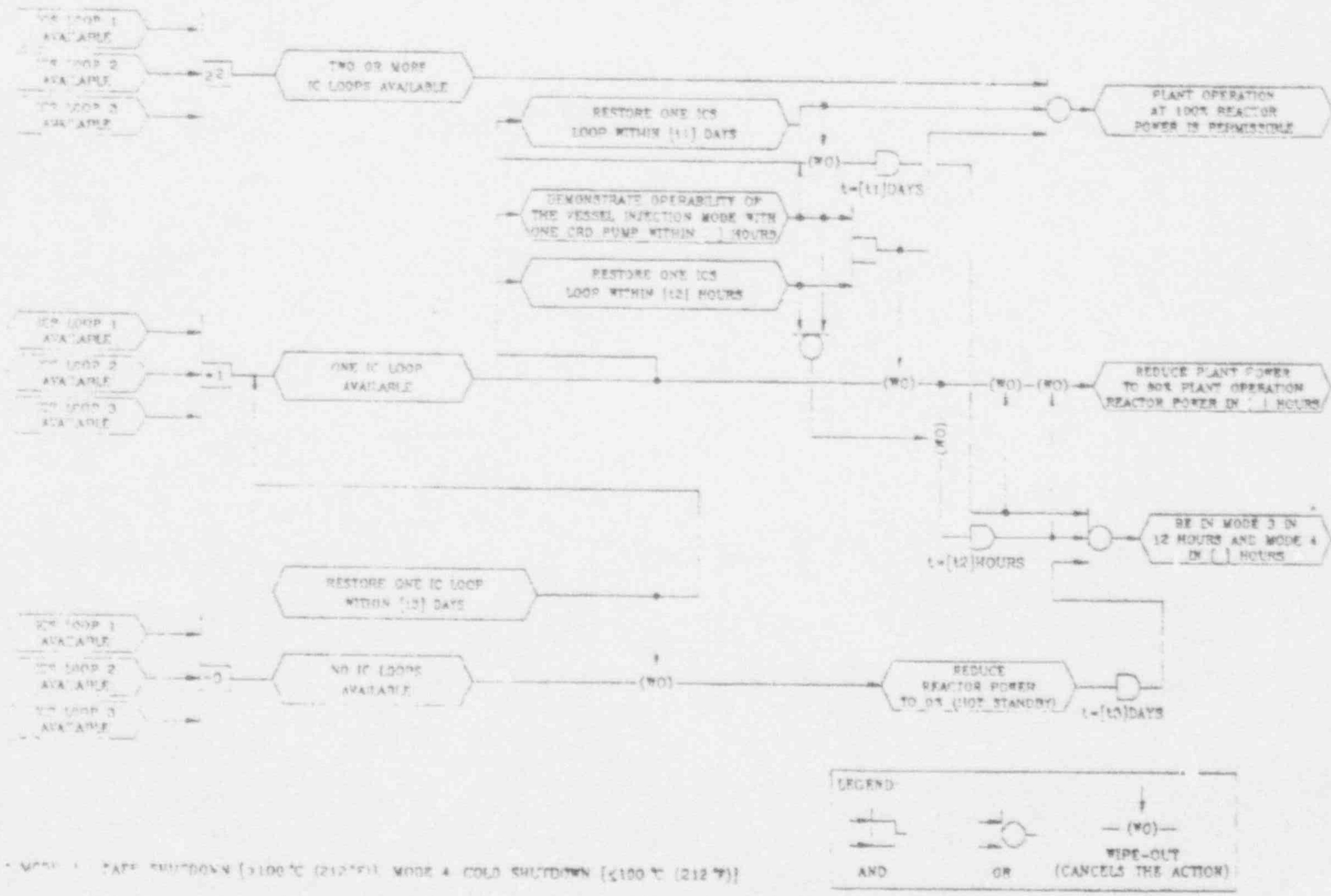
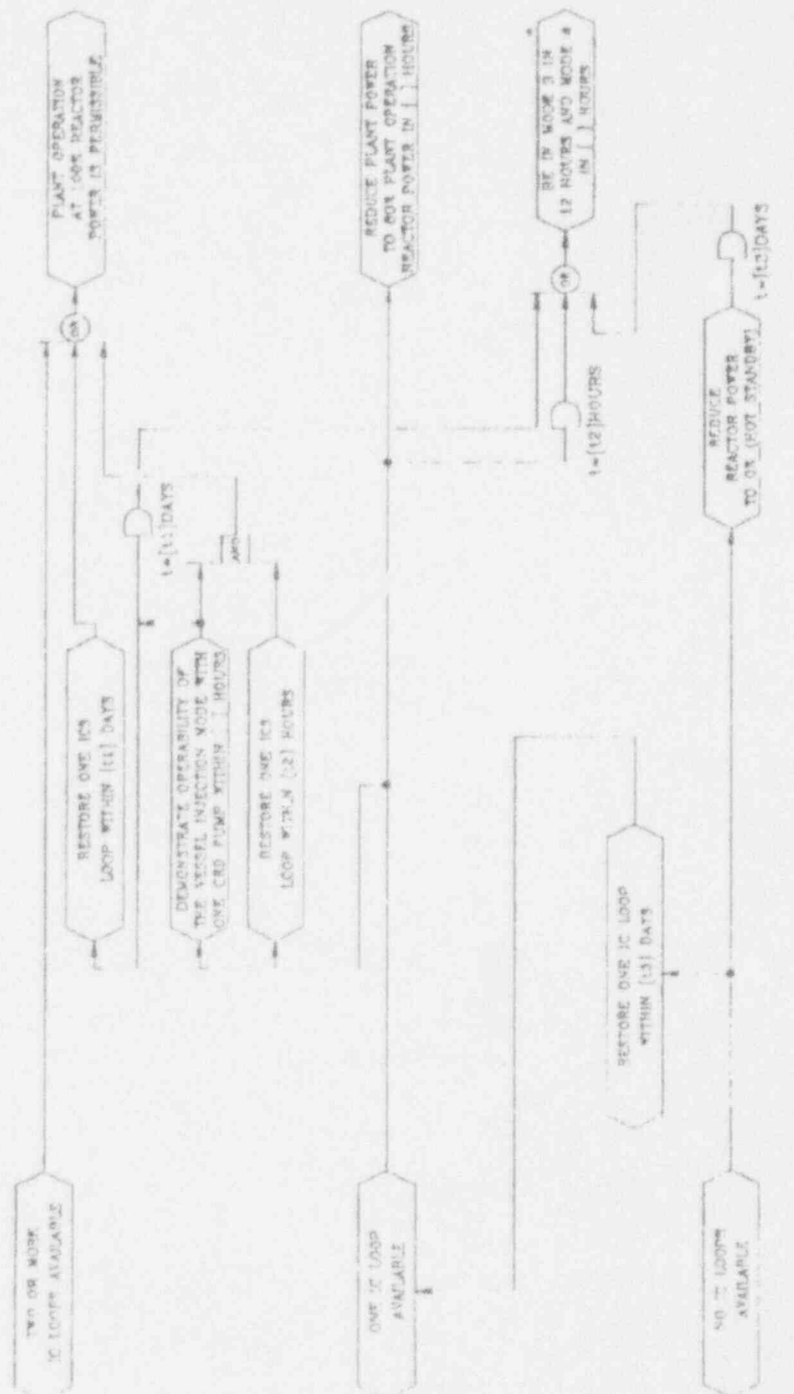


FIGURE 10-2. ICS TECHNICAL SPECIFICATION LOGIC DIAGRAM



* MODE 3: SAFE SHUTDOWN [>100 °C (212 °F)], MODE 4: COLD SHUTDOWN [≤100 °C (212 °F)]

FIGURE 10.3. ICS TECHNICAL SPECIFICATION FLOW CHART

APPENDIX 20

SYSTEM OPERATING CONDITIONS

The operating conditions which are described in the paragraphs which follow are:

a. Startup

  (1) Cold start

  (2) Hot restart

b. Normal Plant Operation

c. Shutdown

d. Refueling

e. Isolation Condenser normal operation (upset conditions)

20.1 Startup -- Cold Start. This paragraph covers start from atmospheric pressure and low temperatures. The initial conditions are as shown on the Isolation Condenser System P&ID (ref. 2.1.1.a), except the top vent valves (F007 and F008) are opened to warm the IC steam line and purge noncondensables during startup heating. In addition:

a. All instruments are in operation.

b. All accumulators are at normal pneumatic pressure.

c. Reactor Mode Switch is in STARTUP mode.

20.2 Startup - Hot Restart. This section covers starts with the reactor pressurized and hot. The initial conditions are as shown on the Isolation Condenser System P&ID; in addition:

a. All instruments are in operation.

b. All accumulators are at normal pneumatic pressure.

c. Reactor Mode Switch is in STARTUP mode.

20.3 Normal Plant Operation. Normal operation includes steady-state operation at a given power level up to rated power. The initial conditions are as shown on the Isolation Condenser System P&ID. In addition:

20.3 (Continued)

a. All instruments are in operation.

b. All accumulators are at normal pneumatic pressure.

c. Reactor Mode Switch is in RUN position.

Normal operation is the condition at the end of Startup followed by switching the Reactor Mode Switch to RUN position or the condition following a planned or unplanned transient which does not scram the reactor.

In case of large leak, no operator action is needed. The affected IC loop is automatically isolated (closure of the valves F001 through F004) by the signals coming from the Leak Detection and Isolation System.

On the purge line, the excess flow valve performs the isolation.

The existence of smaller leaks that cause radiation in the exhaust line that exceed background radiation when the IC units are not in operation is detected, and alarms are generated.

The purpose of the alarms is to alert the operator that there may be an IC leaking and that a further check is needed to confirm the leak.

This further leak check is done by the operator, isolating each IC loop, one at a time, to determine whether the leak can be stopped. The size of a leak cannot be correlated with the characteristics of the alarm signals, therefore the affected IC loop shall remain out of service if the leak indication returns to normal (alarm stopped) when the affected IC is isolated (the affected IC loop shall remain isolated until it is repaired during plant shutdown).

The operator shall close the valve F013 of the leaking loop, to completely isolate the affected isolation condenser from the primary side (the excess flow valve is not effective to prevent back flow through the purge line in case of low flow).

20.4 Shutdown. Shutdown starts from the reactor in Hot Standby with all control rods inserted and all conditions correspond to this.

The Reactor Mode Switch in SHUTDOWN mode and the Isolation Condenser System is "ready to start" as during normal plant operation.

20.5 Refueling. During refueling all IC system valves (F001 through F01) are closed. Then maintenance can be performed.

20.6 Isolation Condenser Normal Operation (upset conditions). During IC normal operation the valve status is as follows:

Valve number	Status	
F001	Open	
F002	Open	
F003	Open	
F004	Open	
F005	Open	(closed if failed)
F006	Closed	(open if level ≤1.2 and/or station blackout with loss of safety grade battery power)
F007 F008 F009 F010 F011 F012	Closed Closed Closed Closed Closed Closed	These vent valves open, automatically (F009/10) or manually (F007 through F012), when venting to the suppression pool is needed.
F013	Open	(the valve can remain open, because MSIVs are closed)

After the ICS loops start into operation no actions are needed by the operator. The condensate return valves can remain opened without reaching RPV level 1. The operator can reclose the condensate return valves only when the RPV pressure is below 5.516 MPag (800 psig).