WESTINGHOUSE CLASS 3

AMENDMENT 1 TO RESAR-SP/90 PDA MODULE 4
REACTOR COOLANT SYSTEM

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INSTRUCTION SHEET

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to either leakage or actual valve operation. For a further discussion on process instrumentation associated with the system, refer to RESAR-SP/90 PDA Module 9, "I&C and Electric Power".

5.2.2.9 System Reliability

The reliability of the pressure relieving devices will be demonstrated for the RESAR-SP/90 FDA document.

5.2.2.10 RCS Pressure Control During Low-Temperature Operation

Operating procedures and administrative controls are provided to prevent unexpected mass addition or heat input to the RCS during low-temperature operation when overpressurization is a concern; however, passive overpressurization protection of the RCS is provided, at or below 350°F, by the relief valves in the RHR portion of the ISS. These relief valves assure that RCS pressure does not exceed the pressure limits as determined by Appendix G to Section III of the ASME Code.

Analyses have shown that two RHR relief valves are sufficient to prevent the Appendix G limits from being exceeded as the result of all credible mass or heat input transients initiated during low temperature operations. Since the RHR function is aligned and maintained during all low temperature operation 1
below 350°F, relief capability will be automatic during low-temperature water solid operation.

5.2.2.10.1 System Operation

During plant cooldown, all four RHR subsystems are normally aligned when the RCS pressure and temperature are below 400 psig and 350°F respectively. Once aligned, the RHR pump suction isolation valves are de-energized in their open position. An RHR relief valve is provided in each of the four RHR pump suction lines. Throughout the refueling/shutdown at least two of four RHR subsystems will be aligned at all times. This will enable pump maintenance/ testing, as required, on the remaining two of four subsystems. Each of the two isolation valves in each suction line has a remote position indicator and the RHR function is continuously monitored on the MCP.

The ISS is interlocked such that before a subsystem is aligned for the RHR function, the high head safety injection pump discharge isolation valve must
1 be closed and other valve alignments satisfied. These interlocks also prevent reopening the HHSI discharge unless several deliberate operator actions are taken which would include re-energizing the RHR suction isolation valves and, isolating the RHR suction line, terminating RHR operation. These actions would be clearly indicated on the MCP.

Refer to Section 7.7 of RESAR-SP/90 PDA Module 9, "I&C and Electric Power", Subsection 5.4.7 of RESAR-SP/90 PDA Module 1, "Primary Side Safeguards System", Subsections 5.4.10 and 5.4.13 of this module, and Subsection 9.3.4 of RESAR-SP/90 PDA Module 13, "Auxiliary Systems" for additional information on
1 RCS pressure and inventory control during other modes of operation.

5.2.2.10.2 Evaluation of Low-Temperature Overpressure Transients - Pressure Transient Analyses

ASME Section III, Appendix G, establishes guidelines and limits for RCS pressure primarily for low temperature conditions ($\leq$350°F). The relief system discussed in Subsection 5.2.2.10 of this module satisfies these conditions.

Both heat input and mass input analyses are based on conservative assumptions
1 and demonstrate that the allowable limits are not exceeded upon occurrence of any of these transients and therefore, these transients do not constitute an impairment to vessel integrity and plant safety.

Westinghouse has performed evaluations to identify the relief requirements for
1 LTOP events and verify the acceptability of using the RHR relief valves to protect the RCS. These evaluations included:

- o A preliminary determination of the RCS Appendix G limiting pressure vs temperature

- o Determination of the individual LTOP event mass/heat inputs and required relief valve relieving rates. Analyzed events include:

  [ ] (a,c)

  a.
  b.
  c.
  d.

The bases for these analyses included:

1) Appendix G Limit - A low Appendix G pressure limit for the RCS was selected [ ] on which to base a conservatively low set pressure for the RHR suction line relief valves. The [ ] pressure limit is judged to be lower than the actual Appendix G limit that would be calculated with reactor vessel material containing a maximum of [ ] copper. (a,c) (a,c) 1 (a,c)

2) The setpoint for the RHR relief valves was established in accordance with Section III of the ASME Code, Part NC-7513. The required capacity is based on the maximum RCS expansion rate determined as described in 3) and 4) below.

3) The effects of flashing flow through the relief valve and/or choked flow in the valve discharge line were evaluated assuming the RCS temperature was at 350°F, the maximum anticipated temperature when RHR provides LTOP protection.

4) RCS expansion rates for the above two (a and b) mass input events were determined at the nominal RHR relief valve set pressure. In the calculations the maximum allowed, as manufactured, pump head/flow delivery curves were used.

5) RCS expansion rates for the above two (c and d) heat input events were conservatively determined as follows:

- o The LOFTRAN code was used to analyze the heat input and RCS expansion due to the inadvertent start of a reactor coolant pump during water solid operation.

1 o The RCS expansion due to inadvertent pressurizer heater operation considered the maximum rate at which water could be displaced from the pressurizer by steam formation.

The results of this analysis show that using relief valves with the capacity of the current standard RHR suction relief valve, two of the four ISS RHR subsystems aligned to the RCS provide acceptable LTOP protection.

5.2.2.10.3 Operating Basis Earthquake Evaluation

1 The ISS, including the portion which provides RCS low-temperature overpressure protection, has been designed in accordance with the ASME code and is seismic

Category I. The relief valves are qualified in accordance with the Westinghouse valve operability program which is described in detail in RESAR-SP/90 PDA Module 7, "Structural/Equipment Design". 1

5.2.2.10.4 Administrative Controls

Although the system described in Subsection 5.2.2.10.1 of this module is designed to maintain RCS pressure within allowable limits, administrative controls are provided in plant procedures for minimizing the potential for any transient that could actuate the cold overpressure mitigation system. The following discussion highlights these procedural controls, listed in order of their importance for mitigating RCS cold overpressurization transients.

Of primary importance is the basic method of operation of the plant. Normal plant operating procedures maximize the use of a pressurizer cushion (steam bubble) during periods of low-pressure, low-temperature operation. This cushion dampens the plants response to potential transient generating inputs, thereby providing easier pressure control with the slower response rates.

An adequate cushion substantially reduces the severity of some potential pressure transients such as reactor coolant pump heat input, and slows the rate of pressure rise for others. In conjunction with the previously discussed alarms, this provides reasonable assurance that most potential transients can be terminated by operator action before the overpressure relief system actuates.

However, for those modes of operation when water solid operation may still be possible, the following procedures further highlight precautions that minimize the potential for developing an overpressurization transient. The following specific recommendations are made:

A. The residual heat removal (RHR) inlet lines from the reactor coolant loop are not isolated unless the charging pumps are stopped. This precaution is to ensure there is a relief path from the reactor coolant loop to the RHR suction line relief valves when the RCS is at low pressure (less than 500 psi) and is water solid.

B. Whenever the plant is water solid and the reactor coolant pressure is being maintained by the low pressure letdown control valve, letdown flow must bypass the normal letdown orifices, and the valve in the bypass line must be in the full-open position. During this mode of operation, all three letdown orifices must also remain open.

C. If all reactor coolant pumps have stopped for more than 5 minutes during plant heatup and the reactor coolant temperature is greater than the charging and seal injection water temperature, no attempt is made to restart a pump unless a steam bubble is formed in the pressurizer. This precaution minimizes the pressure transient when the pump is started and the cold water previously injected by the charging pumps is circulated through the warmer reactor coolant components. The steam bubble accommodates the resultant expansion as the cold water is rapidly warmed.

D. If all reactor coolant pumps are stopped and the RCS is being cooled down by the residual heat exchangers, a nonuniform temperature distribution may occur in the reactor coolant loops. No attempt is made to restart a reactor coolant pump unless a steam bubble is formed in the pressurizer.

E. During plant cooldown, all steam generators are connected to the steam header to ensure a uniform cooldown of the reactor coolant loops.

F. At least one reactor coolant pump is maintained in service until the reactor coolant temperature is reduced to 160°F.

These special precautions back up the normal operational mode of maximizing periods of steam bubble operation so that cold overpressure transient prevention is continued during periods of transitional operations.

The specific plant configurations required for emergency core cooling system (ECCS) testing and during normal ECCS alignment all have interlocks and also procedures intended to prevent development of cold overpressurization 1 transients. During these limited periods of operation, the following administrative controls are applied:

A. To preclude inadvertent ECCS actuation during heatup and cooldown, blocking of the safety injection signal actuation logic below 1975 psia is required.

B. During RCS cooldown, closure and power lockout of the accumulator isolation valves as well as power lockout to all the high head safety 1 injection pumps and to the nonoperating charging pumps is required. This provides protection in addition to Step A above. These actions are taken when RCS pressure is approximately 1000 psig, shortly before RHR operation begins ($T \leq 350°F$).

C. Full flow ECCS pump performance testing may be done during cold shutdown conditions. However, interlocks are provided to ensure proper alignment of the full flow test path and isolation of the injection path to the RCS to minimize the potential for developing a cold overpressurization transient. These tests would only be performed on one HHSI pump at a time. In addition, inadvertent injection from one HHSI pump has been analyzed as a mass input and 1 shown to be acceptable.

1 D. The "S" signal circuitry testing, if performed during cold shutdown, also requires power lockout to the HHSI pumps and non-operating charging pumps, to preclude development of cold overpressurization transients.

The above procedures (covering normal operations with a steam bubble, transitional operations where the RCS can be water solid, followed by specific testing operations) provide in-depth cold overpressure prevention measures augmenting the installed overpressure relief system.

5.2.3 Reactor Coolant Pressure Boundary (RCPB) Materials

5.2.3.1 Material Specifications

Typical material specifications used for the principal pressure retaining in Class 1 primary components and for Class 1 and 2 auxiliary components in systems required for reactor shutdown and for emergency core cooling are listed in Table 5.2-1 of this module. Typical material specifications used for the reactor internals required for emergency core cooling, for any mode of normal operation or under postulated accident conditions, and for core structural load bearing members are listed in Table 5.2-2 of this module.

Tables 5.2-1 and 5.2-2 may not be totally inclusive of the material specifications used in the listed applications; however, the listed specifications are representative.

The materials utilized conform to the applicable American Society of Mechanical Engineers (ASME) code rules.

The welding materials used for joining the ferritic base materials of the RCPB conform or are equivalent to ASME Material Specifications SFA 5.1, 5.2, 5.5, 5.17, 5.18, and 5.20. They are qualified to the requirements of the ASME Code, Section III.

Globe valves are "T" and "Y" styles of outside screw and yoke construction.

Check valves are swing type for sizes 2-1/2 inches or larger. All check valves which contain radioactive fluid are stainless steel and do not have body penetrations other than the inlet, outlet, and bonnet. The check hinge is serviced through the bonnet. All operating parts are contained within the valve body. The disc has limited rotation to provide a change of seating surface and alignment after each valve opening.

5.4.12.3 Design Evaluation

The design requirements for Class 1 valves, as discussed in Section 5.2, limit stresses to levels which ensure the structural integrity of the valves. In addition, the testing programs described in RESAR-SP/90 PDA Module 7, "Structural/Equipment Design", demonstrate the ability of the valves to operate, as required, during anticipated and postulated plant conditions.

Reactor coolant chemistry parameters are specified in the design specifications to ensure compatibility of valve construction materials with the reactor coolant. To ensure that this coolant/materials compatibility continues the chemical composition of the coolant is analyzed periodically, and chemistry parameters are maintained in accordance with the Technical Specifications.

5.4.12.4 Tests and Inspections

Hydrostatic shell test and seat leakage and functional tests are performed on all RCS valves. The tests and inspections discussed in RESAR-SP/90 PDA Module 7, "Structural/Equipment Design" are performed to ensure the operability of the active valves.

There are no full penetration welds within the valve body walls. Valves are accessible for disassembly and internal visual inspection to the extent practical. The valve nondestructive examination program is given in Table 5.4-12. Inservice inspection is discussed in Subsection 5.2.4.

5.4.13 Safety And Relief Valves

5.4.13.1 Design Bases

The combined capacity of the pressurizer safety valves can accommodate the maximum pressurizer surge resulting from complete loss of load without causing RCS pressure to exceed 110 percent of the design pressure at the point of highest pressure in the system. Sizing of the pressurizer safety valves is discussed in Subsection 5.2.2.

The pressurizer power operated relief valves (PORVs) provide a safety-grade
means of reducing Reactor Coolant System (RCS) pressure; they are also
1 designed to limit pressurizer pressure to design values during plant
transients. The PORVs are designed to fail in the closed position on loss of
actuating power.

5.4.13.2 Design Description

The pressurizer safety valves are of the totally enclosed pop type. They are spring loaded self actuated by direct fluid pressure and have backpressure compensation features. The set pressure of each valve is 2485 psig.

1 The pipe connecting each safety valve inlet to its pressurizer nozzle is
shaped in the form of a loop seal. Condensate resulting from normal heat losses accumulates in the lower part of the loop. This water seal minimizes leakage of hydrogen gas and steam through the safety valve seats. If the pressurizer pressure exceeds the set pressure, the safety valves start lifting and the water from the seal discharges during the accumulation period.

The pressurizer PORVs are solenoid operated valves which respond to a signal
from a pressure-sensing system or to manual control. Remotely operated block
1 valves are provided to isolate the inlets to the PORVs in case the PORV's fail
to close on demand.

The primary function of the pressurizer PORV's is to provide a safety-grade means of reducing RCS pressure as may be required in any of the following events:

1) Steam Generator Tube Rupture: to equalize RCS and affected steam generator pressures in order to terminate break flow (see subsection 15.6.3.1(h) of RESAR-SP/90 PDA Module 6/8, "Secondary Side Safeguards System/Steam and Power Conversion System.")

2) Safety Grade Cold Shutdown: to allow the HHSI pumps to inject refueling water from the Emergency Water Storage Tank (EWST) in order to borate the RCS (see Subsection 5.4.7 of RESAR-SP/90 PDA Module 1, "Primary Side Safeguards System.") 1

3) Feed and Bleed Emergency Core Loading: to allow the HHSI pumps to inject refueling water from the EWST ("feed") in order to make up for the inventory lost through the pressurizer PORV's ("bleed") which serves to remove decay heat from the RCS (see Subsection 1.2.3.1.2.6 of RESAR-SP/90 PDA Module 1 "Primary Side Safeguards System")

4) Severe Accidents: to prevent RCS failure from occuring at high pressure.

Because the latter event could occur as the result of a loss-of-all AC scenarios, the power supply for the pressurizer PORV's will be independent of off-site and emergency on-site AC power.

1

The relief valves are designed to limit the pressurizer pressure to a value below the high pressure trip setpoint for all design load reduction transients up to and including a full load rejection with steam dump actuation and automatic reactor control. (It should be noted that this is the same operational event on which the design pressurizer spray rate is based). Operation of these valves also limits the undesirable opening of the spring loaded safety valves.

1

Remotely operated block valves are provided to isolate the inlets to the power operated relief valves. The block valves can be operated either automatically or manually. In the automatic mode, i.e., when the plant is operating under automatic pressure control the valves are opened whenever the pressurizer pressure is above the block valve set pressure, which is approximately 350 psi below the normal pressurizer operating pressure of 2250 psia. They are closed automatically if the pressure falls below the set pressure. These characteristics serve to protect against the consequences of a stuck-open PORV when the plant is operating under automatic pressurizer pressure control. When the pressurizer PORV's are opened by operator action, the automatic block valve closure feature is defeated; in that case, the block are under manual control. 1

As a safeguard against spurious operation of the power operated relief valves or of the PORV block valves, coincident high pressure signals derived from any two of the four pressurizer pressure transmitters are required to open these valves or to keep them open.

In accordance with the requirements of 10CFR50.34(f)(2)(xi), positive position indication (open or closed) is provided in the control room for the pressurizer safety valves and power operated relief valves.

Temperatures in the pressurizer safety and relief valve discharge lines are measured, and an indication and a high alarm are provided on the main control board. An increase in a discharge line temperature is an indication of leakage or relief through the associated valve.

1

Design parameters for the pressurizer safety valves and power relief valves are given in Table 5.4-13.

5.4.13.3 Design Evaluation

The pressurizer safety valves are sized to prevent reactor coolant system pressure from exceeding 110 percent of system design pressure, in compliance with the ASME Code, Section III.

1 The pressurizer PORVs are sized to meet the performance requirements for the various modes of operation; where required, a single failure has been assumed in sizing the valves. The relief valves also limit undesirable opening of the spring loaded safety valves.

5.4.13.4 Tests and Inspections

All safety and relief valves are subjected to hydrostatic tests, seat leakage tests, operational tests, and inspections, as required. For safety valves that are required to function during a faulted condition, additional tests are performed. These tests are described in RESAR-SP/90 PDA Module 7, "Structural/

TABLE 5.4-13

PRESSURIZER SAFETY AND RELIEF VALVES
DESIGN PARAMETERS

Pressurizer safety valves		(a,c)
Number		
Maximum relieving capacity per valve, ASME flowrate (lb/hr), at 3% accumulation		1
Set pressure (psig)		
Design temperature (°F)		
Fluid		
Backpressure		
Normal (psig)		
Expected maximum during discharge (psig)		
Environmental conditions		
Ambient temperature (°F)		
Relative humidity (per		
Pressurizer power-operated relief valves		
Number		
Design pressure (psig)		
Design temperature (°F)		
Saturated steam-relieving capacity at 2335 psig, per valve (lb/hr)		1
Saturated water-relieving capacity at 2335 psig, per valve (lb/hr)		

40