14.8 REACTOR COOLANT SYSTEM DEPRESSURIZATION

14.8.1 IDENTIFICATION OF EVENT AND CAUSE

The primary function of the PSVs is to prevent over-pressurization of the RCS. There are two valves in the system which are located on two parallel pipes off the top of the pressurizer. These valves are spring-loaded and have an opening pressure of 2485 and 2510 psig, respectively. To reduce the number of challenges to the PSVs and to prevent over-pressurization at low system temperature, two PORVs are also installed. These valves tee-off the pipes to the PSVs. Both the PSVs and the PORVs discharge to the quench tank.

An RCS Depressurization event is defined as a rapid, uncontrolled decrease in RCS pressure other than a loss of coolant (Section 14.17). Inadvertent opening the PSVs or PORVs during steady-state operation would result in an RCS Depressurization event.

The most limiting RCS depressurization at HFP is an inadvertent opening of both PORVs. The two PORVs have a larger relieving capacity than one PSV.

If the RCS Depressurization event is not terminated, the event would turn into a small break loss-of-coolant accident (Section 14.17). Therefore, this analysis will only follow the RCS Depressurization event until just after a reactor trip.

14.8.2 SEQUENCE OF EVENTS

An RCS Depressurization event can approach the DNBR SAFDLs. The action of the TM/LP Trip will prevent exceeding the DNBR limit. The LHGR SAFDL and RCS Pressure Upset Limit will not be approached as there is essentially no power rise and no pressure increase for this event. Since no fuel pin failures are postulated to occur, the site boundary dose criteria in the 10 CFR 50.67 guidelines will not be approached.

An RCS Depressurization event is postulated to be initiated at HFP by the inadvertent opening of both PORVs. The immediate system response is a rapid depressurization of the RCS. The level in the pressurizer will initially increase as voids form in response to the decrease in pressure. As the pressure continues to decrease, the level in the pressurizer will decrease due to the steam mass leaving the pressurizer. The discharged steam goes to the quench tank where it is condensed and stored.

To compensate for the decreasing pressure, the water in the pressurizer flashes to steam and the PPCS actuates the proportional heaters in an attempt to maintain pressure. As the pressurizer level decreases, the PLCS will reduce RCS letdown flow to a minimum of 29 gpm and actuate the remaining charging pumps. With the pressure continuing to decrease, all backup heaters will be energized to assist in maintaining pressure. For conservatism in the analysis, no credit is allowed for the pressurizer pressure control system. The pressurizer level control system was not modeled. This has little impact on MDNBR and does not significantly impact the depressurization rate. For both Units at this time, RCS temperatures, core power, core average heat flux, and secondary system pressure will be essentially constant.

With a maximum depressurization rate and the pressurizer pressure and control system inoperable, the RCS pressure will rapidly approach the TM/LP Analysis Trip setpoint. Upon reactor trip, the core power and core average heat flux will rapidly decay. The RCS will approach the saturation temperature corresponding to the normal main steam bypass analysis setpoint pressure of 900 psia.

14.8.3 CORE AND SYSTEM PERFORMANCE

14.8.3.1 Mathematical Models

The transient response of the RCS and steam systems to the RCS Depressurization event was simulated using the S-RELAP5 thermal-hydraulic system code consistent with the methodology in Reference 1. The XCOBRA-IIIC fuel assembly thermal-hydraulic code was used to calculate the flow and enthalpy distributions for the entire core and the DNB performance for the DNB-limiting assembly as part of the TM/LP setpoint verification analysis (Reference 2). The limiting assembly DNBR calculations were performed using a NRC-approved DNB correlation. Both of these computer codes are described in Section 14.1.4.1.

14.8.3.2 Input Parameters and Initial Conditions

The input parameters and initial conditions used in the analysis are listed in Table 14.8-1. Those parameters which are unique to the analysis are discussed below.

For this event, the TM/LP Trip is the primary reactor trip. A single calculation is performed at BOC HFP conditions, maximum Technical Specification core inlet temperature, and minimum Technical Specifications RCS flow rate. This produced the minimum margin to the DNB limit. A conservative moderator density reactivity feedback is used, which is based on the HZP Technical Specification MTC.

The event is assumed to be caused by an inadvertent opening of both pressurizer PORVs while operating at RTP. This results in a rapid drop in the RCS pressure and, consequently, a rapid decrease in DNBR.

The initial axial power shape and the corresponding SCRAM worth versus insertion used in the analysis is a bottom peaked shape. This power distribution maximizes the time required to terminate the decrease in DNBR following a trip.

The pressurizer heaters were assumed inoperable. The charging and letdown system is not modeled. This is due to the event presenting a benign challenge to MDNBR and the event being used to determine the TM/LP pressure bias used in the setpoint verification analysis. The depressurization rate at the time of trip is not significantly impacted by letdown.

14.8.3.3 Results

Table 14.8-2 contains the sequence of events for the event at HFP. Figures 14.8-1 through 14.8-4 present the transient core power, core average heat flux, RCS temperatures, and RCS pressure behavior.

14.8.4 CONCLUSION

The analysis of the RCS Depressurization event demonstrates that the action of the RPS prevents exceeding the fuel SAFDLs. The radiological consequence of opening the atmospheric dump valves upon reactor trip during the most limiting RCS Depressurization event is a site boundary dose which is negligible compared to the 10 CFR 50.67 guidelines.

The key transient parameters for this event are independent of burnup, therefore, extended burnup has no impact on this event.

14.8.5 REFERENCES

1. EMF-2310(P)(A), Revision 1, SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors, May 2004
2. EMF-1961(P)(A), Statistical Setpoints for Combustion Engineering Type Reactors

TABLE 14.8-1

INITIAL CONDITIONS AND INPUT PARAMETERS FOR RCS DEPRESSURIZATION EVENT

PARAMETER	UNITS	VALUE
Initial Core Power	MWt	2754
Initial Core Inlet Temperature	°F	548
Initial RCS Pressure	psia	2250
Initial Vessel Flow Rate	gpm	370,000
TM/LP Trip Delay	sec	0.9
Scram Worth	pcm	5277.6
MTC	pcm/°F	+7
Doppler Reactivity Coefficient	pcm/°F	-0.8
Effective Cross-sectional Area of the PORVs	ft^2	0.02008
PLCS	operating condition	Not Modeled
PPCS	operating condition	Heaters Disabled Spray Available
SDBC	operating condition	Not actuated
SG Tube Plugging	% per SG	0

TABLE 14.8-2

SEQUENCE OF EVENTS FOR THE RCS DEPRESSURIZATION EVENT

TIME (sec)	EVENT	VALUE
0.0	Inadvertent Opening of PORVs	---
37.45	TM/LP Analysis Trip Setpoint is Reached	1862.8 psia
38.35	TM/LP Trip Breakers Open	---
38.80	Time of Maximum Heat Flux	2819.9 MW
38.85	CEAs Begin to drop into Core	---
53.85	Transient Evaluation Terminated[a]	---

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[a] Since the event trips on TM/LP for all cases, the DNBR calculation is covered in the TM/LP setpoint verification analysis. No event specific DNBR calculation is required.