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RCS Overpressure Protection Analysis Using SEBIM POSRV

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SEBIM POSRV를 이용한 원자로 냉각재계통의 과압보호 해석

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Abstract

The overpressure protection system for PWR should be designed with sufficient capacity to limit the pressure to less than 110% of the reactor coolant system design pressure during the most severe abnormal operational transient. In this study, the feasibility of adopting the SEBIM POSRV instead of the current spring loaded pop-opening safety valves to the ABB-CE designed 2825 MWt PWR is investigated for its overpressure protection capability. The required SEBIM POSRV size as well as its opening/closing setpoints are determined through a series of computer analyses using the LTC code which has been used for the overpressure protection analysis for Yonggwang units 3&4. The analysis results show that the overpressure protection system with monobloc SEBIM POSRV can maintain the RCS pressure below 110% of the design pressure demonstrating its overpressure protection capability for the ABB-CE designed 2825 MWt PWRs.

요 약

가압경수로의 과압보호계통은 가장 심각한 비 정상 과도운전시 원자로냉각재계통의 압력을 설계압력의 110% 이내로 유지시킬 수 있는 충분한 용량으로 설계되어져야 한다. 본 연구에서는 ABB-CE 설계의 2825 MWt 가압경수로에 기존의 스프링 탑재형 가압기 안전밸브 대신 SEBIM-POSRV를 채택할 경우 과압보호 기능 수행의 가능성을 연구하였다. 과압보호 기능을 수행하기 위한 SEBIM POSRV의 크기 및 작동 설정치를 영광 3, 4호기의 과압보호 해석에 사용했던 LTC 전산코드를 이용한 분석을 통해서 결정했다. 분석결과 monobloc SEBIM POSRV를 이용한 과압보호계통은 원자로냉각재계통의 압력을 설계압력의 110% 이내로 유지시킴으로써 ABB-CE 형태의 2825 MWt급 가압경수로에서 과압보호 기능을 수행할 수 있음이 입증되었다.

1. Introduction

According to the design requirements for the pressurized water reactors (PWRs), the peak primary and secondary system pressures should not exceed 110% of the system design pressures during the most severe abnormal operational transient[1]. This overpressure protection requirement is accomplished in most PWRs by means of Pressurizer Safety Valves (PSVs), Main Steam Safety Valves (MSSVs), and Reactor Protection System (RPS). Among these components or systems for overpressure protection, the PSVs provide direct means of pressure relief by releasing the steam from the pressurizer when the pressurizer pressure increases to the predetermined setpoints.

The current PSV design utilized in the most PWRs is the spring-loaded safety valve[2] which is a passive component and does not require motive power. However, this spring-loaded safety valve has been reported to have problems in maintaining stable operation such as a premature leakage and reseat failure after opening[3]. Also, it does not provide a remote manual pressure relief function which is an essential function to establish a feed-and-bleed operation during the total loss of feedwater flow event[4]. Therefore, in addition to the spring-loaded safety valves, most PWRs are equipped with a power operated pressure relief system such as Safety Depressurization System (SDS) for Yonggwang units 3 and 4 (YGN 3&4)[5] or Power Operated Relief Valves (PORVs) for the Westinghouse designed PWRs[6].

The SEBIM Power Operated Safety Relief Valve (POSRV) utilized in the Framatome designed PWRs has shown several advantages over the spring loaded safety valves such as an improved tightness, remote controllability, stable operation with various fluid conditions, adjustable blowdown pressure, etc.[7]. Therefore, the purpose of this study is to investigate the feasibility of adopting the SEBIM POSRV to the YGN 5&6, which is an ABB-CE designed 2825 MWt PWR system, for its overpressure protection capability through a series of computer analyses. Additionally, the required valve size is determined through a parametric analysis, and the valve actuation setpoints required to mitigate overpressure transients are calculated considering the opening and closing characteristics of the SEBIM POSRV. The loss of load event in conjunction with a delayed reactor trip is used according to NUREG-0800[1] as the design basis event for the valve sizing as well as the overpressure protection analysis.

2. Method of Analysis

The loss of load event with a delayed reactor trip is used as the design basis event of this analysis[1]. The analysis of this transient is performed with the LTC computer code[8] which has been accepted by the US NRC as well as Korea Institute for Nuclear Safety (KINS) for its application to the overpressure protection analysis performed for System 80[8] and YGN 3&4[5]. The LTC code is a best estimate PWR NSSS simulation code whose performance has been verified by an extensive comparison of code predictions to the plant operation data. The code utilizes a node and flow path approach and includes models for the reactor vessel, core, hot legs, cold legs, steam generators, pressurizer, and reactor coolant pumps, etc. Other systems modeled include the feedtrain, steam lines, auxiliary feedwater, plant protection and plant control systems.

Conservative initial conditions and assumptions are used for the overpressure protection analysis. Some initial conditions are obtained through a parametric study performed for the maximum Reactor Coolant System (RCS) pressurization.

2.1. SEBIM Valve Characteristics and Modeling

As shown in Figure 1, the opening and closing operations of the SEBIM POSRV are controlled by two impulse valves in the pilot cabinet. If the pressurizer pressure increases, the impluse valve V1 closes to isolate the valve piston, VP, from the pressurizer. However, the valve disc, D, remains closed until the pressurizer pressure further increases to a pre-determined setpoint at which the impulse valve V2 opens causing a depressurization of the valve piston VP and the valve disc lifting. Once the POSRV is opened, the pressurizer pressure decreases and the POSRV clos-

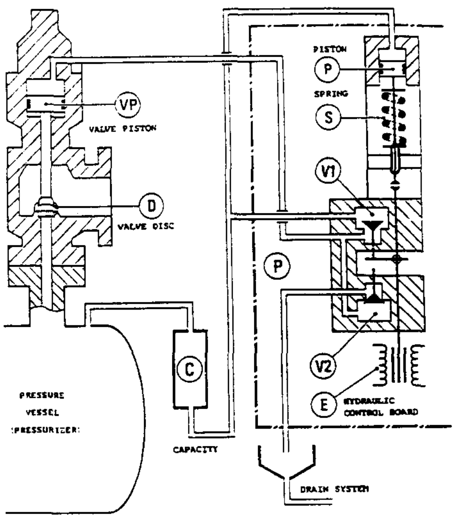

Fig. 1. SEBIM POSRV Pilot Cabinet Operation

ing operation starts in a reverse manner of the opening operation.

The SEBIM POSRV as a safety valve in the pressurizer is provided with three separate relief lines. Each of the three relief lines comprises with two hydraulic pilot operated valves mounted back-to-back as a tandem in series[7]. The first valve in each line serves as a safety valve and the second valve, which is normally open, serves as an isolation valve to prevent steam discharge through the safety valve in case of failure to close the safety valve.

The inlet lines from the pressurizer head to the safety valves are arranged with a U-tube. The U-tube section allows the formation of a water plug at its lower point by condensation of the pressurizer vapor during normal operation. This water plug provides a loop seal to minimize steam or noncondensible gas leakage through the valves. However, this water plug causes the steam flow rate to be reduced to 75% of the total flow capacity during the water plug discharge after valve opening. The time required to completely discharge water plug is 0.25 second[7].

Another characteristic of the SEBIM POSRV compared to the pop-opening spring loaded safety valve is the opening/closing dead time. The dead time, which is 0.3 seconds, is defined as the time interval between the time at which the pressurizer pressure reaches opening or closing setpoint and the time at which the SEBIM valve starts to open or close. After this dead time, the valve opens or closes linearly from the full closed to full open state or vice versa with a valve stroke time of 1.7 seconds. The valve characteristics for both SEBIM POSRV and pop-opening spring loaded safety valves are compared in Figures 2 and 3.

The opening and closing setpoints of each safety valve are staggered between two valves to avoid simultaneous actuations, which might lead to unacceptable hydraulic loads on the discharge line due to the water plug discharge. Therefore, each SEBIM POS-

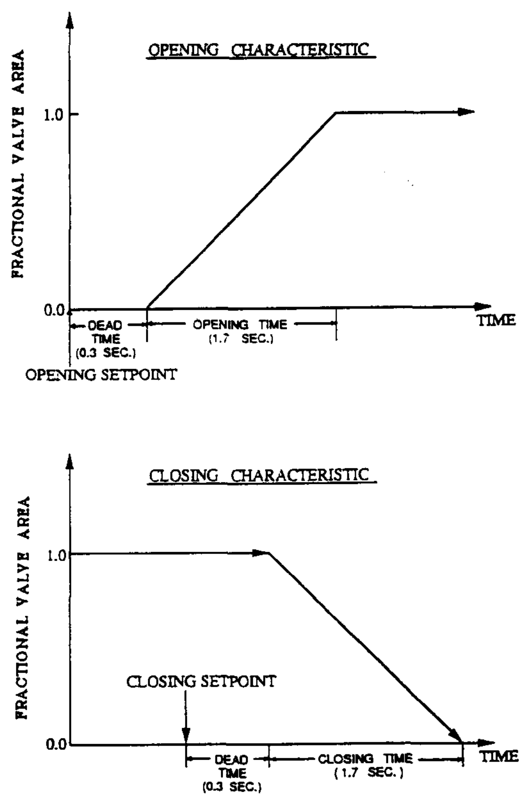

Fig. 2. Characteristics of SEBIM POSRV

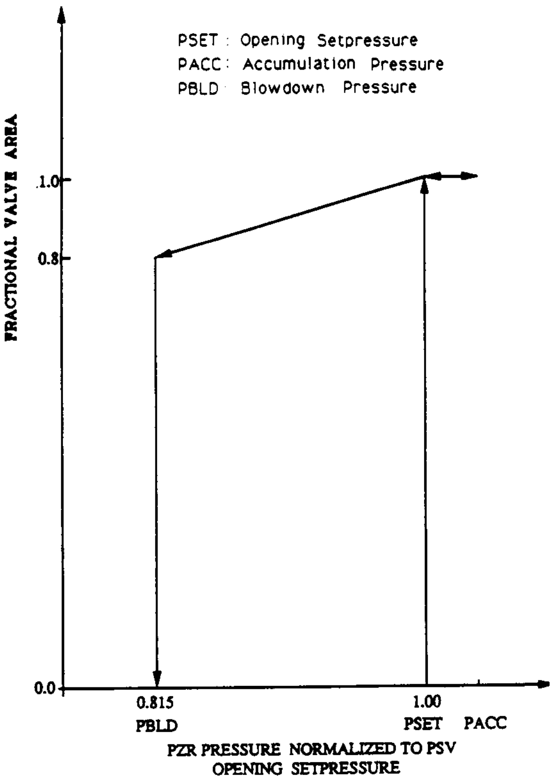

Fig. 3. Characteristics of Spring-loaded PSV

RV is opened one after another in contrast with the concurrent pop-opening safety valves at the same setpoint.

To accomplish the purpose of this analysis, a new model for the SEBIM POSRV has been developed as shown in Figure 4 and Table 1, and the old model for the spring loaded safety valve in the LTC code has been replaced with the new model. The new model for SEBIM POSRV takes into account the dead time and linear open/close characteristics. Major parameters used in the SEBIM valve model are summarized in Table 2.

2.2. Setpoint Determination

The opening/closing setpoints of the SEBIM POSRV as the pressurizer safety valve can be determined

Table 1. List of Variables Used in SEBIM Valve Model

Variable	Definition
TIME	: Problem time, current time, sec.
DTO(I)	: Opening dead time, sec.
DTC(I)	: Closing dead time, sec.
OT(I)	: Opening time (required to open the valve from full closed state to full open state), sec.
CT(I)	: Closing time (required to close the valve from full open state to full closed state), sec.
KOING(I)	: Valve opening status indication flag; 0 = Valve is not in opening process 1 = Valve is in opening process
KCING(I)	: Valve closing status indication flag; 0 = Valve is not in closing process 1 = Valve is in closing process
KODTT(I)	: A flag for opening dead time counter; 0 = Valve is not in the opening dead time period 1 = Valve is in the opening dead time period
KCDTT(I)	: A flag for closing dead time counter; 0 = Valve is not in the closing dead time period 1 = Valve is in the closing dead time period
KPLUG(I)	: A flag for water plug discharge indication 0 = Water plug discharge is not completed 1 = Water plug discharge is completed
OTIME(I)	: Time at which the valve begins to open, sec.
CTIME(I)	: Time at which the valve begins to close, sec.
PTIME(I)	: Time at which the water plug discharge is completed
PT(I)	: Time required to complete the water plug discharge
PSIA	: Pressurizer pressure, psia
PPOP(I)	: Valve opening set pressure, psia
PCLS(I)	: Valve closing set pressure, psia
AXXX(I)	: Fractional valve opening, 0 − 1
DELT	: Calculation time step, sec.
AMXR(I)	: Full open valve area, ft^2
ARELF(I)	: Flow area of each valve, ft^2
AXXY	: Total flow area of all valves, ft^2
G(I)	: Mass flux of each safety valve, lbm/sec. * ft^2
EWSVL(I)	: Mass flow rate of each safety valve, lbm/sec.
WSVL	: Total flow rate of all safety valves, lbm/sec.
I	: Number of valves

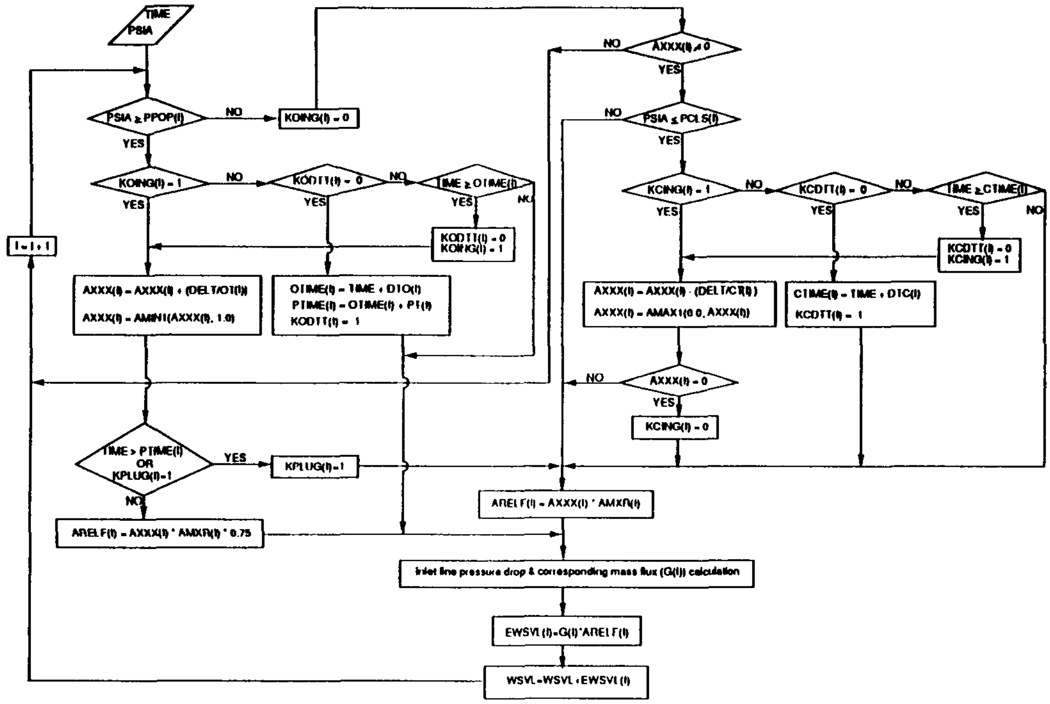

Fig. 4. Flow Chart for SEBIM Valve Model

Table 2. SEBIM Valve Parameters

Parameters	Values
Valve throat area	0.0247466 ft^2
Open/close dead time	0.3 sec.
Water plug discharge time	0.25 sec.
Valve stroke time	1.7 sec.
Steam flow fraction during water plug discharge	0.75
Opening uncertainties	±1 bar
Closing uncertainties	+3, −1 bar

through extensive parametric analyses on the system performance during the design bases events. However, due to the well defined design bases and design concepts of the reference plant, the valve opening and closing setpoints can be determined by technical evaluations and hand calculations in order for the SEBIM POSRV to perform its intended function without affecting the overall plant performance.

2.2.1. Opening Setpoints

In determining the opening setpoints, several criteria are considered such as all three SEBIM POSRVs are credited as safety valve for both overpressure protection and safety analysis and the safety valve with the lowest opening setpoint (i.e., the first opening valve) should not be actuated before reactor trip on high pressurizer pressure (HPP). In these criteria, the most conservative instrument uncertainty for the HPP reactor trip signal and the uncertainty for the valve opening pressure should be considered. Also, the opening setpoints should be low enough to limit the RCS peak pressure below the SRP acceptance criteria of the design bases events and be provided with at least 2 bars (29 psia) staggering between valves. The calculation process and result are as follows :

(1) Normal HPP reactor trip setpoint + channel uncertainty for HPP reactor trip signal + SEBIM valve opening uncertainty
=2370 psia + 90 psia + 14.5 psia ≒ 2475.0 psia

(2) The second and third valve opening setpoints are calculated considering 30 psia (which is slightly greater than 2 bars) staggering requirement, i.e.,
The second valve setpoint:
2475 psia + 30 psia = 2505.0 psia
The third valve setpoint:
2505 psia + 30 psia = 2535.0 psia

2.2.2. Closing Setpoints

As was done for the opening setpoint determination, determining the closing setpoints also should consider several criteria. The pilot valve V1 in the SEBIM POSRV (see Figure 1) with the lowest closing setpoint (i.e., the 1st valve) should not be actuated during normal transients, i.e., the Performance Related Design Bases Events (PRDBEs). The maximum pressurizer pressure allowed during PRDBEs is the HPP reactor trip set pressure. Therefore, in these criteria, the normal performance instrument tolerance for the HPP reactor trip signal and the uncertainty for the valve closing pressure should be considered. Also, the closing setpoints should be low enough to avoid the system re-pressurization and, hence, safety valve re-opening after valve closure and be provided with the same amount of blowdown (i.e., difference between opening and closing setpoints) for all valves. The calculation process and result are as follows :

(1) Normal HPP reactor trip setpoint-Normal performance tolerance for HPP reactor trip signal + SEBIM valve closing uncertainty
=2370.0 psia-21 psia + 14.5 psia ≒ 2365.0 psia

(2) The second and third valve setpoints are calculated considering 110 psia blowdown which is calculated from the first valve setpoints(i.e., 2475 − 2365 = 110 psia), i.e.,
The second valve setpoint:
2505 psia-110 psia = 2395.0 psia
The third valve setpoint:
2535 psia-110psia = 2425 psia

2.3. Assumptions

The following assumptions are introduced in this analysis to conservatively evaluate the system pressurization during the loss of load event :

(1) At the beginning of the loss of load event, the plant is operating at the maximum rated output plus a 2% uncertainty. Choosing the highest possible power output maximizes the heatup rate of the primary loop, the rate of pressurization, and the ultimate peak primary and secondary pressures.

(2) The least negative moderator temperature and doppler coefficients are used to maximize the power and pressure transient.

(3) No credit is taken for CVCS letdown flow, charging flow, pressurizer spray flow, steam bypass system actuation, Reactor Power Cutback System (RPCS) actuation, and feedwater addition during the loss of load event.

(4) Pressurizer pressure and level at the onset of the incident are 2250 psia and 60% of PZR level span based on the results of the parametric study on the initial conditions (see Section 3.1).

(5) The reactor scram is initiated by the second safety grade trip signal with a total trip delay time of 1.15 seconds to maximize primary pressurization.

(6) All three SEBIM POSRVs are credited as pressurizer safety valves.

(7) Full credit is taken for the MSSVs which are spring loaded safety valves designed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code[2] (see Figure 5).

(8) The capacity of the MSSVs remains constant at a value equal to the steam flow rate necessary to pass the 2825 MWt steam flow rate (same as YGN 3&4).

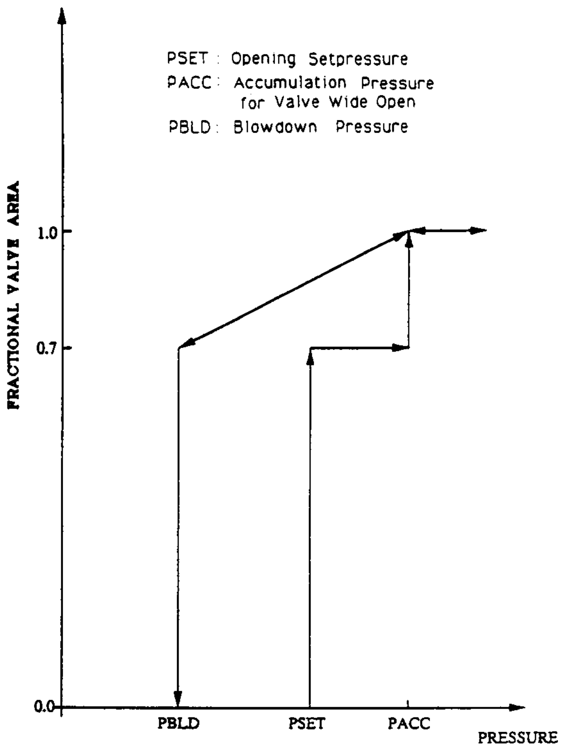

Fig. 5. Characteristics of Main Steam Safety Valve

2.4. Initial Conditions

The loss of load event is analyzed with various initial pressurizer pressures and water levels, steam generator pressures, and steam generator water levels to determine the initial conditions which can maximize the RCS pressurization. The ranges of initial conditions used in this parametric analysis are consistent with those used in the YGN 3&4 FSAR Chapter 15 safety analysis[5]. The nominal full power values are 2250 psia, 52.6%, 1070 psia, and 79% Wide Range (WR) level span for the pressurizer pressure, pressurizer water level, steam generator pressure, and steam generator water level, respectively.

The loss of load event is analyzed at first with various initial pressurizer pressures and water levels. The selected limiting initial conditions which maximize the RCS pressurization are 2250 psia and 60% for the pressurizer pressure and water level, respectively.

The loss of load event with the most limiting initial pressurizer conditions selected above is also analyzed with various initial steam generator pressures (which decides the RCS temperature) and downcomer water levels. The analysis results show that a lower initial steam generator pressure, hence, a lower initial RCS temperature, and a higher initial steam generator water level result in a higher RCS pressure increase. The steam generator pressure of 1033.4 psia, hence 560 °F RCS cold leg temperature, and the steam generator water level of 96% wide range (WR) level span are selected to be the most limiting initial conditions. The initial conditions selected for this analysis are summarized in Table 3.

Table 3. Initial Conditions for the Limiting Case

Parameters	Initial Values
PZR pressure	2250.0 psia
PZR water level	60.0 %
Cold leg temperature	560.0 °F
Hot leg temperature	618.1 °F
S/G pressure	1033.4 psia
S/G water level	96.0 % WR
Number of RCPs operating	4
Feedwater temperature	450.0 °F

2.5. Sensitivity Study on Valve Size

The loss of load event with the most limiting initial conditions is analyzed for various sizes of PSV (SEBIM valve) to determine the sensitivity of pressurizer safety valve capacity on the RCS peak pressure. The valve size has been changed over the range which includes both Monobloc and Bibloc SEBIM POSRVs whose flow capacities are 220 ton/hr and 165 ton/hr, respectively.

3. Results

3.1. Parametric Analysis on Initial Conditions

Parametric analyses on the initial pressurizer pressures and water levels, steam generator pressures and water levels are performed and the results are discussed in the following subsections.

3.1.1. Pressurizer Pressure and Level

The effect of initial pressurizer pressure and level on the RCS pressurization during the loss of load event is analyzed and the results are summarized and delineated in Table 4 and Figure 6. As shown in Table 4, the reactor trip time as well as the PSV opening time can be delayed by using a lower initial pressurizer pressure. In this case, however, the MSSV opening time remains almost same regardless of the initial pressurizer pressure resulting in an early energy removal before the reactor trip and/or the PSV opening. This reduces the pressurization rates before the RCS pressure reaches its maximum value. On the other hand, an early opening of PSV due to a high initial pressurizer pressure results in primary energy relief by PSV before the energy relief through MSSVs. Therefore, the maximum RCS peak pressure

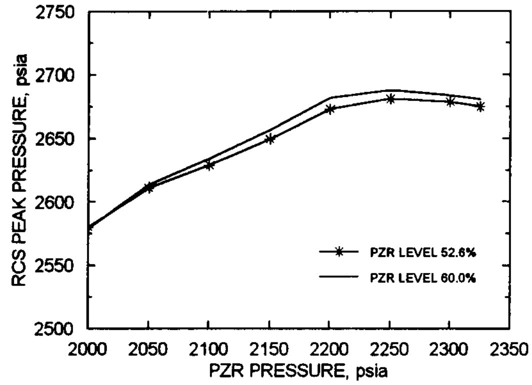

Fig. 6. RCS Peak Pressure as a Function of Initial PZR Pressure

Table 4. Analysis Results for Initial Pressurizer Pressure and Water Level

Case	Input parameter		Output							
	Initial PZR level, %	Initial PZR pressure, psia	RX trip signal sec.	PSV1 open sec.	PSV2 open sec.	PSV3 open sec.	MSSV1 open sec.	MSSV2 open sec.	MSSV3 open sec.	RCS peak pressure psia
1	52.6	2000.0	12.4	13.5	–	–	4.6	7.0	12.5	2580.1
2	52.6	2050.0	10.7	11.6	12.2	–	4.6	7.0	12.4	2610.8
3	52.6	2100.0	9.1	9.9	10.4	–	4.6	7.0	12.5	2628.9
4	52.6	2150.0	7.2	8.2	8.6	9.1	4.6	7.0	–	2649.4
5	52.6	2200.0	5.8	6.6	6.9	7.3	4.5	6.8	–	2672.8
6	52.6	2250.0	4.1	4.8	5.2	5.6	4.5	6.8	–	2680.8
7	52.6	2300.0	3.4	4.2	4.6	5.0	4.5	6.9	–	2678.3
8	52.6	2325.0	3.0	3.8	4.2	4.7	4.5	7.1	–	2674.7
9	60.0	2000.0	12.7	13.8	–	–	4.6	7.0	12.5	2579.0
10	60.0	2050.0	10.9	11.8	12.3	–	4.6	7.0	12.4	2613.4
11	60.0	2100.0	9.1	9.9	10.4	11.0	4.6	7.0	12.5	2633.8
12	60.0	2150.0	7.5	8.2	8.5	9.0	4.6	6.9	–	2656.5
13	60.0	2200.0	5.7	6.4	6.7	7.1	4.6	6.8	–	2681.6
14	60.0	2250.0	3.8	4.6	4.9	5.2	4.5	6.8	–	2687.9
15	60.0	2300.0	3.2	3.9	4.3	4.7	4.5	7.0	–	2683.8
16	60.0	2325.0	2.8	3.6	4.0	4.4	4.5	7.2	–	2680.6

can be obtained with an initial pressurizer pressure which results in a coincident energy relief by the PSV and MSSV.

The results also show that a higher initial pressurizer water level results in a faster RCS pressurization compared to the cases with a lower initial pressurizer water level. Therefore, a slightly higher RCS peak pressure can be obtained by increasing pressurizer water level. As a result, the case with initial pressurizer pressure of 2250 psia and initial pressurizer water level of 60% is selected as a limiting case for the maximum RCS pressurization point of view.

3.1.2. Steam Generator Pressure

The aforementioned limiting case (i.e., initial pressurizer pressure and water level of 2250 psia and 60%, respectively) is analyzed with various initial steam generator pressures and the results are delineated in Figure 7. The range of initial steam generator pressure over which the sensitivity analyses are performed corresponds to the RCS cold leg temperature range of 560 °F to 570 °F. As shown in Figure 7, the RCS peak pressure can be maximized by lowering the initial steam generator pressure due to the delayed MSSV opening. Consequently, the case with initial steam generator pressure of 1033.4 psia is selected as the limiting case for the RCS pressurization point of view.

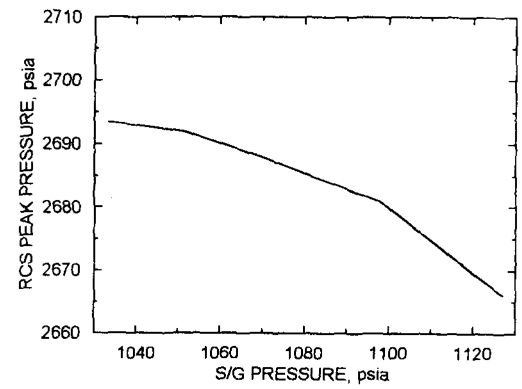

Fig. 7. RCS Peak Pressure as a Function of Initial S/G Pressure

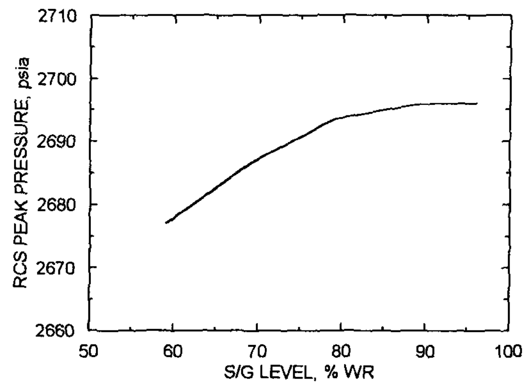

Fig. 8. RCS Peak Pressure as a Function of Initial S/G Level

3.1.3. Steam Generator Level

Finally, the limiting case selected above is analyzed with various initial steam generator water level and the results are delineated in Figure 8. As shown in Figure 8, for a given initial pressurizer conditions and steam generator pressure, a higher RCS peak pressure can be obtained by increasing initial steam generator water level. Therefore, the initial steam generator water level of 96% of wide range level span is selected as the limiting case for the RCS pressurization in this analysis.

3.2. Sensitivity Study on Valve Size

The loss of load event analyses with the limiting initial conditions are performed for various sizes of PSV to determine the sensitivity of PSV capacity on the RCS peak pressure. For the case with Monobloc SEBIM valve size, the transient behaviors of the pressurizer pressure and RCS pressure at the RCP discharge during the loss of load event are plotted in Figure 9, and the transient behavior of steam generator pressure is shown in Figure 10 as a function of time. As shown in these figures, the pressurizer, RCS, and the steam generator pressures start to increase as the event progresses until the RPS reactor trip

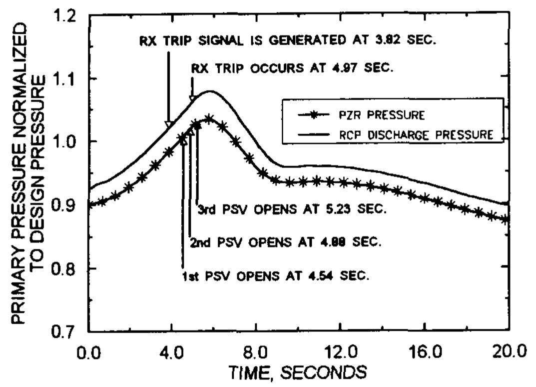

Fig. 9. RCS and PZR Pressures Normalized to Design Pressure vs. Time for the Worst Case Loss of Load Event

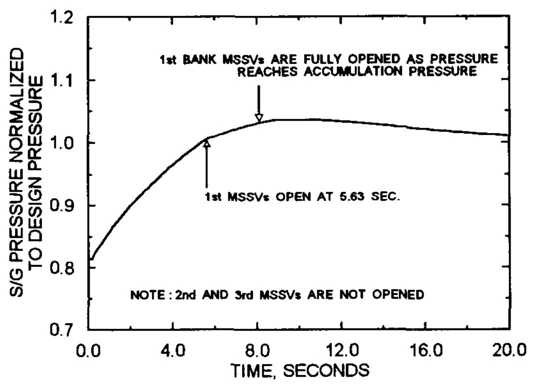

Fig. 10. Steam Generator Pressure Normalized to Design Pressure vs. Time for the Worst Case Loss of Load Event

and opening of PSVs and MSSVs prevent further pressurization. As a result, the RCS and steam generator pressures reach their maximum pressures of 107.8% and 103.6% of the design pressures, respectively, demonstrating their conformance to the acceptance criteria.

The RCS peak pressures obtained with different valve sizes are plotted in Figure 11 as a function of valve size. The results presented in Figure 11 show that if the safety valve size were increased above a certain size, an additional increase of valve size has

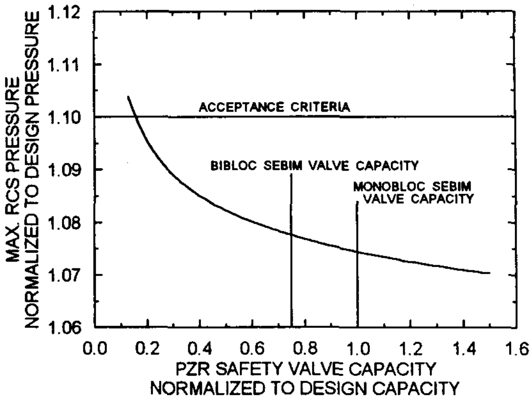

Fig. 11. Optimized Pressurizer Safety Valve Capacities

small effect in reducing the maximum RCS pressure. However, if the valve size were decreased below a certain size, the maximum RCS pressure increases rapidly.

Although both Monobloc and Bibloc SEBIM valve can limit the RCS peak pressure within the acceptance criteria, the Monobloc SEBIM valve provides more margin and is considered to be acceptable for the purpose of overpressure protection for the ABB-CE designed 2825 MWt PWRs.

3.3. Comparison of Results

The overpressure protection analysis results obtained with the SEBIM POSRVs are compared with thos e obtained for the YGN 3&4 FSAR in Table 5. As compared in Table 5, the peak pressures of pressur-

Table 5. Overpressure Protection Analysis Results for YGN 3&4 and SEBIM POSRV

Parameters	YGN 3&4	SEBIM POSRV
Total valve area (ft^2)	0.070425	0.0742398
Pressurizer peak pressure	2549.0	2584.3
RCS peak pressure	2657.9	2696.1
Reactor trip occurrence time(sec.)	7.55	3.82
Reactor trip signal	HPP	HPP
Maximum pressurizer level(%)	92.8	72.5

izer and RCS for the case with SEBIM POSRVs are about 40 psia higher than those of YGN 3&4 FSAR. This result mainly comes from the differences in the safety valve characteristics. The SEBIM valves are opened one after another with different setpoints while the current safety valves for YGN 3&4 are opened at the same time when the pressurizer pressure reaches to the opening setpoint. Also, the SEBIM valve is opened linearly over 1.7 seconds after dead time of 0.3 seconds while the safety valves for YGN 3&4 has pop-opening characteristics as shown in Figure 3.

4. Conclusions

The feasibility of adopting the SEBIM POSRV instead of the spring loaded pop-opening safety valves to the ABB-CE designed 2825 MWt PWR plants is investigated for its overpressure protection capability. After developing a new model for the SEBIM POSRV, a series of overpressure protection analyses are performed to determine the limiting initial conditions as well as the sensitivity of the SEBIM POSRV size on the RCS peak pressure during the loss of load event.

The results of analyses for the various valve sizes show that the RCS peak pressure is higher than that of YGN 3&4 during the loss of load event. However, the RCS overpressure protection with SEBIM POSRV can maintain the RCS pressure and steam generator pressure below 110% of design pressure in spite of different characteristics of SEBIM POSRV compared with the current spring-loaded safety valve. Therefore, it is concluded that the overpressure protection during the loss of load event can be achieved with the Monobloc SEBIM valve as a pressurizer safety valve for the ABB-CE designed 2825 MWt PWR nuclear power plants.

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References

1. "U.S. NRC, Standard Review Plan," Section 5.2.2 : Overpressure Protection, Rev. 2, NUREG-0800, (July 1981)
2. "Spring-loaded Safety Valves," ASME Boiler and Pressure Vessel Code Section III, Article NB-7500
3. "Analysis of French (Paluel) Pressurized Water Reactor Design Differences Compared to Current S. PWR Designs," NUREG-1206, (June 1986)
4. B.E. Boyack, et al., "Los Alamos PWR Decay-Heat-Removal Studies Summary Results and Conclusions," NUREG/CR-4471 (March 1986)
5. "YGN 3&4 Final Safety Analysis Report," KEP CO., (1993)
6. "KNU 7 and 8, Final Safety Analysis Report," KEPCO., (July 1984)
7. D.R. Airey, A. Gemignani, G. Schaumburg, and L. I. Ezekoye, "Development and Application of a Pilot Operated Safety Relief Tandem Valve for Nuclear Power Plant," Valves, Bolted Joints, Pipe Supports, and Restraints, PVP-Vol. 236, (1992)
8. "LTC Code User's Manual," Combustion Engineering, Inc., (1986)
9. "System 80 CE-Standard Safety Analysis Report, FSAR," Combustion Engineering, Inc., (August 1985)