

Pressurizer Spray Valve Fail Open Test

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1. Introduction

On 11th of October 2006, during the start up of reactor after repairing the generator in Ulchin unit 2, reactor coolant pressure was decreased continually on account of pressurizer spray valve open seizing and reactor coolant pressure was recovered by stopping reactor coolant pump(RCP). Based on this experience, under the similar condition and combination of pressurizer spray valve open and number of operating RCP, physical motion of reactor coolant system(RCS) was analyzed through demonstration proof test. Utilizing this test result, abnormal procedure can be validated and complemented and thus plant safety can be secured by improving emergency response capability of operators at similar cases by using it as simulator program validation data.

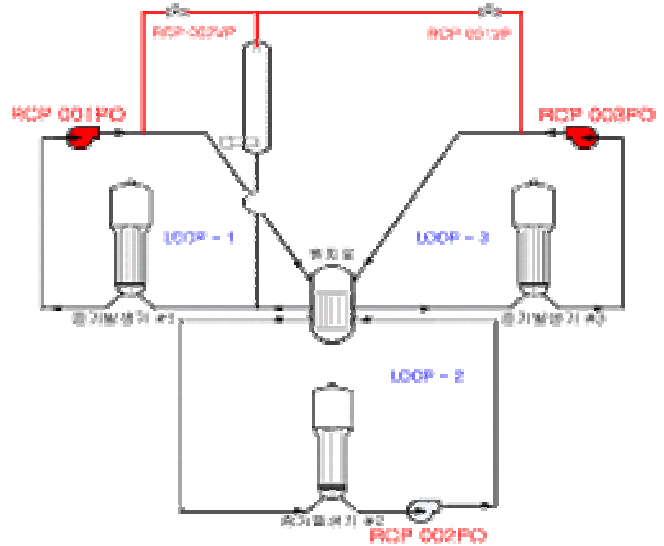


Fig1. Pressurizer spray line valve diagram.

2. Methods and Results

By allowing man-made failure operating condition of October 11th, effect of reactor coolant system was analyzed whether the RCP of the loop with pressurizer installed was in operation.

2.1. test methods

Model NO.	Spray valve fail condition	Test condition	RCP sequence of stop
①	RCP 01VP Manual open	Temp. : 286.5 °C Pr. : 154.4 bar.g	RCP 03PO → RCP 01PO
②	(Loop 3 install)		RCP 01PO → RCP 03PO
③	RCP 02VP Manual open		RCP 01PO → RCP 03PO
④	(Loop 1 install)		RCP 03PO → RCP 01PO

RCP 01PO : Pressurizer and spray valve(002VP)Loop

RCP 03PO : Spray valve (001VP) Loop

2.2. Test Result

2.2.1. Operating parameters status

Test methods	01VP open seizing		02VP open seizing		
	Model ①	Model ②	Model ③	Model ④	
Operating parameters	Valve open	7.7	7.7	8.4	8.3
	A pump stop	4.07	3.68	Pr. recovery	5.34
Maximum temperature of Spray line (°C)	339.8	338.9	* 286.1	338	
Pr. recovery rate (bar.g/min)	1.2	1.12	* 0.9	1.22	
* Only the RCP 01PO(loop with pressurizer installed) is stopped					

2.2.2 Change of Reactor Coolant Pressure

When spray valve (02VP) of the loop with pressurizer installed is opened, depression rate is higher than other case, and difference in depression rate occurred whether RCP 01PO is in operation or not.

As shown, the driving force of spray (Cold leg pressure – Hot leg surge line pressure) has the greatest effects when RCP 01PO stops.

2.2.3. Pressure recovery of pressurizer spray line and Temperature

Model ①②④ : When two reactor coolant pumps stop, spray flow is decreased completely. Then the temperature of spray line rises quickly, and the pressurizer pressure gets recovered at 1.12~1.2 bar.g/min after 10 seconds from two pumps stop.

Model ③ : When spray valve(02VP) of the loop with pressurizer installed is open, the temperature of the spray line is low at stopp of RCP 01PO. And the pressurizer pressure is recovered at 0.9 bar.g/min after 50 seconds. Less flow than heater capacity is estimated to form based on the observation

2.3. Test Results

2.3.1. Compare this test results with Experience case ('06.10.11)

Comparison of decrement from opening of spray valve to stopping of RCP 03PO : Depression rate for experience case is 7.19bar.g/min and the value for this test is 7.7bar.g/min. This result is little different from spray valve fail open progress. The opening time of spray valve; for experience case, the valve is slowly opened, or quickly opened.

Comparison of decrement from first pump stop to second pump stops : Depression rate for experience case is 1.84bar.g/min, and the value for this test is 4.07 bar.g/min. When converting depression rate to proof test, depression rate is 3.4bar.g/min and it is similar to the value from proof test. Small difference is estimated to present due to the test condition (i.e. reactor power).

2.3.2 Compare westinhouse ERG

RCP ON	Depression rate (test) (bar/min)		* Diff. Pr. at spray line (psi)	
	01VP	02VP(PZR connection)	01VP	02VP(PZR connection)
01/02PO (03PO stop)	4.07	5.34	+20.3	+30
02/03PO (01PO stop)	3.68	Pr. recovery	+12.5	+2.9
* Spray Effect of ERG G.I at 25% of pressurizer level				

In ERG G.I, When the spray valve(02VP) stuck opened and the RCP 01PO stopped, the pressure difference for spray line is 2.9psi. In this test, the pressurizer pressure was recovered after 50seconds from the RCP 01PO stopped. According to above result.

Depending on the RCP 01PO operation at pressurizer loop, it has a great effect on pressure decrement and temperature change in spray line.

When the spray valve(02VP) open seizing and pump(01PO) stopped. It is confirmed that spray flow was formed but pressure is recovered by pressurizer heater.

3. Conclusion

From this analysis, validity of abnormal operating procedure for pressurizer spray valve fail open was confirmed. The procedure was modified to stop RCP 01PO is the loop with pressurizer installed regardless to valve failure. Also, this information is applied to simulator program modification and retraining material for operators.

REFERENCES

- [1] Event analysis report about pressurizer spray valve failed open
- [2] MOST(Ministry of Science & Technology) requirements of relate to Subcretical entry in Ulchin unit 2
 - [2-1] Reactor coolant pressure abnormal procedure
 - [2-2] Case about Reactor protection system or ESF bypass
- [3] Test procedure thepressurizer spray valve failed open