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Development of Abnormal Response Guideline for WH SG Tube Leak

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1. Introduction

A abnormal guideline for SG TUBE LEAK for Westinghouse-type plant(Kori-3/4) provides action for responding to a SG tube leak(SGTL) that is within the capacity of the normal charging system. The guideline is entered if there are abnormal radiation levels in the condenser air injector, in any steamline or blowdown line, or if primary-to-secondary leakage is suspected.

To mitigate SG tube leaks, the event and available plant specific procedural guidance was reviewed. Generally-applicable enhancements were identified to include prominent portions of the strategy of SGTL guideline.

2. SGTL Analysis

Analyses for three different initiating events(SG leak sizes) were performed to demonstrate the effectiveness of SGTL guideline for recovering from a SG tube leak. The following set of cases was selected to test the range of expected conditions for the SGTL recovery:

2.3x10 l/hr SG leak / $2.7x10^4$ l/hr charging

For very small leaks requiring plant shutdown, emergency boration via the BIT is determined to be effective in ensuring adequate shutdown margin for the limited initial cooldown.

$2.3x10^4$ l/hr SG leak / $2.3x10^4$ l/hr charging

This leak size was selected as a typical one of SGTL guideline usage. For larger leaks for which adequate shutdown margin would typically be sufficient with RWST makeup(or makeup from the BIT), SGTL guideline provides guidance that will efficiently limit primary-to-secondary leakage. The strategy of performing a concurrent depressurization with the cooldown helps limit the leakage to be much less than that expected for a design basis SG tube rupture.

$3.2x10^4$ or $4.5x10^4$ l/hr SG leak / $2.7x10^4$ l/hr charging

For leaks greater than the capacity of the normal charging system, the operator would be directed to actuate SI and transition to the emergency guideline of reactor trip or safety injection, early in the SGTL guideline. By avoiding the emergency guideline recovery of SG tube rupture(SGTR) when not required and directing SI actuation early in the guideline when SI is required, SGTL guideline ensures plant safety is maintained.

Based on consideration of the range in SG leak rates, charging flow capacities, and makeup sources, the supporting analysis for SGTL guideline demonstrates that it provides appropriate guidance for recovery for a SG tube leak.

3. Recovery Actions for SGTL Guideline

3.1 Summary of Operator Actions

The objective of the summary of operator actions incorporated into SGTL guideline is to provide effective guidance for recovery from a SG tube leak that is within the capacity of the normal charging system.

- Determine whether continued operation is acceptable
- Initiate emergency boration
- Depressurize RCS to minimize RCS subcooling
- Identify and isolate affected SG
- Cooldown RCS to target temperature
- Prepare for plant cooldown using appropriate post-SG tube leak procedure

3.2 Major Development Points

The SGTL recovery guideline requires two major development points which must be made on a plant and event specific basis as follows:

To Ensure Required Shutdown Margin for the Initial Cooldown

There are potentially five ways to address the “short term” shutdown margin requirements for the initial cooldown. These same methods apply for “long term” xenon-free conditions, however, the shutdown margin requirements would be much higher.

- Credit excess shutdown margin from the control rods,
- Borate the RCS via BIT(RWST),
- Perform boration concurrent with the cooldown,
- Sample the RCS/PRZR boron concentraion, and
- Credit xenon buildup.

To Select Post-SG Tube Leak Method

Selecting a post-SG tube leak cooldown method consists of the following tasks:

- Evaluating the steps in post-SGTR emergency guidelines such as cooldown using backfill,

blowdown, or steam dump for applicability on a generic and plant specific basis,
- Evaluating the advantages and disadvantages of each method on a generic and plant specific basis,
- Creating plant specific guidance for each of the strategies based on adaptation of the above emergency guidelines, and
- Prioritizing the use of the plant specific guidelines.

Three alternate means that contain guidance applicable for performing this type of cooldown were developed for the emergency guidelines for post-SGTR cooldown events.

The three post-SGTR guidelines provide the flexibility necessary to cool down and depressurize the plant to cold shutdown conditions for a wide variety of SGTR scenarios and plant design. In their adaptation of the three post-SGTR guidelines, a preferred post-SGTR cooldown method is established and the alternate methods is prioritized.

4. Background Information of SGTL Guideline

This section provides a very detailed discussion of the generic SGTL guideline to aid procedure writing and training. By presenting guideline background information in greater detail through the use of a step description table for each separate guideline step, note, and caution, plant specific applicability can be more easily determined. Table 1 shows a table which presents the existing guideline sequence and identifies the allowed interchangeability of guideline steps for the benefit of the utility procedure.

Table 1. Step Sequence for SGTL guideline.

	STEP	Sequence
1	Check If PRZR Level Can Be Maintained	1
2	Try To Identify Affected SG	2
3	Check If VCT Level Can Be Maintained	2
4	Check If Plant Should Be Shut Down	3
5	Initiate Action To Minimize Secondary Contamination	3
6	Check Reactor Trip Breaker - OPEN	4
7	Initiate Boration	5
8	Set VCT Makeup Controls To Cold Shutdown Boron Concentration	5
9	Increase PRZR Level In Preparation For RCS Cooldown Not To Exceed 76%	5
10	Check VCT Level – MAINTAINED GREATER THAN MINIMUM	5
11	Turn Off PRZR Heaters	5
12	Depressurize RCS To Block SI Actuation	6
13	Continue RCS Depressurization To Minimize RCS Subcooling	7
14	Affected SG - IDENTIFIED	8
15	Isolate Flow From Affected SG	9
16	Check Affected SG Level	9
17	Determine Target Temperature For RCS Cooldown	10
18	Initiate Cooldown Using Intact SGs	11
19	Control Feed Flow As Necessary To Maintain Intact SG Narrow Range Level – AT 50%	11
20	Continue RCS Pressurization Concurrent With RCS Cooldown	12
21	Check If SI Accumulators Should Be Isolated	12
22	Check If RCS Cooldown Should Be Stopped	13
23	Check If RCS Depressurization Should Be Stopped	14
24	Maintain RCS Temperature And Pressure - STABLE	15
25	Stop All But One Charging Pump	16
26	Stop Emergency Boration	16
27	Check VCT Makeup Control System	16
28	Check Letdown – IN SERVICE	16
29	Check Charging Pump Suction – ALIGNED TO VCT	17
30	Turn On PRZR Heaters As Necessary To Saturate PRZR Water At Affected SG Pressure	17
31	Check Shutdown Margin – ADEQUATE FOR PLANT COOLDOWN	17
32	Go To Appropriate Post-SG Tube Leak Cooldown Procedure	18

5. Conclusion

The supporting analysis for SGTL abnormal guideline demonstrates that it provides appropriate guidance for recovery for a SG tube leak. Summary of operator actions, major development points, and a very detailed background information for each step was discussed for SGTL guideline to determine plant specific applicability.

REFERENCES

[1] Westinghouse Owner Group, “Background Information For WOG Abnormal Response Guideline, ARG-3: Steam Generator Tube Leak,” Westinghouse, April 2005.
[2] “Final Safety Analysis Report for Kori-3/4,” Westinghouse, Korea Electric Power Corporation, 1994.