RETRAN ANALYSIS OF SONGS 2 REACTOR

COOLANT SYSTEM FLOW MEASUREMENTS

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INTRODUCTION AND SUMMARY

Southern California Edison Company conducted the test of reactor coolant system (RCS) flow measurements at the San Onofre Nuclear Generating Station, Unit 2 (SONGS 2) in the Summer of 1982. The test was initiated by tripping the pumps in various combinations, and measurements of RCS flow were made. These measurements are used to evaluate the response of the system to a loss of reactor coolant flow and to demonstrate that the RCS flow coastdown is consistent or conservative with respect to safety analysis. A SONGS 2 RETRAN-02 model was developed to simulate the flow test. The main purpose of performing RETRAN calculations for this test is to benchmark the SONGS 2 RETRAN model against plant measurement data.

Several utilities had performed RETRAN analysis of the same test and compared the calculations with the test flow data and vendor calculations. Their results show good agreement only in the early phase of the coastdown. However, the pump speed, which is one of the most important parameters used to check the pump modeling, comparisons of their RETRAN calculated values with test data are not made. The results of our RETRAN predictions compared with flow coastdown test data show that the RETRAN values for reactor core flow gave an excellent agreement during the entire transient, and comparisons of the RETRAN calculated pump speed with the test data indicate a very good agreement in the first 10 seconds of transient.
GENERAL DESCRIPTION OF SONGS 2 RCS FLOW TEST

The SONGS 2 consists of a reactor vessel, two parallel heat transfer loops, each containing one steam generator and two reactor coolant pumps (RCPs), and a pressurizer connected to one of the hot legs, Figure 1. The RCS was initially heated up to hot standby conditions of 545.0 ± 0.5°F and 2250 ± 15 psia. Pressurizer level was maintained at 33% and four RCPs were running. During the coastdown conditions, pressure in both steam generators was held at approximately 1000 psia and water level in both steam generators was maintained at approximately 69%. Pressurizer level control was in automatic mode to maintain water level in pressurizer.

RCS flow coastdown measurements were performed for both steady state and coastdown conditions by tripping the appropriate reactor coolant pump(s) for collection of coastdown data. These data primarily are RCP speeds and differential pressures. The locations of pressure taps used for RCS flow measurement are shown in Figure 1. In accordance with a single failure criterion the performed tests are categorized as follows:

4/4 Case - Loss of 4 pumps to simulate a simultaneous loss of electrical power

2/4 Case - Loss of 2 opposite pumps to simulate a pump bus failure

1/4 Case - Loss of 1 pump to simulate a trip breaker open.

METHODS OF FLOW DETERMINATION

The flow through each running pump was determined by reading the manufacturer (Byron Jackson) supplied pump head-flow curves. Corrections on these curves were made to account for coolant density at the test conditions. The loop flow for the case of 4/4 pump coastdown was determined by using the general form of Darcy equation as follows:

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\text{Fraction of Initial Loop Flow} = \sqrt{\frac{\Delta P(t)}{\Delta P(0)}}
\]

where \(\Delta P(0)\) = the measured pump differential pressure before trip, \(\Delta P(t)\) = the measured pump differential pressure after trip.