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March 28, 1979

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulations
Washington, D. C. 20555

Attention: Mr. John F. Stolz, Chief
Lightwater Reactors Branch 1
Division of Project Management

Gentlemen:

SUBJECT: CAORSO SAFETY RELIEF VALVE DISCHARGE - SUMMARY OF RESULTS AND PRELIMINARY OBSERVATIONS, MARCH 1979

Transmitted herewith are 20 copies of the preliminary observations of the Caorso single valve and multi-valve in plant testing.

The Caorso single valve discharge test report is scheduled for transmittal to the NRC during the second quarter of 1979. The Caorso multi-valve data is being reduced and the final report is scheduled for the forth quarter of 1979.

If you have any questions, please contact the undersigned.

Very truly yours,

L. J. Sobon

L. J. Sobon, Manager
BWR Containment Licensing

LJS:pab/394

Enclosures

cc: C. J. Anderson, NRC
H. C. Brinkmann, Mark II Owners Group
H. Chau, Mark II Owners Group
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CAORSO SAFETY/RELIEF VALVE DISCHARGE

SUMMARY OF RESULTS

AND PRELIMINARY OBSERVATIONS

MARCH 1979

LETTER REPORT

CAORSO SAFETY/RELIEF VALVE DISCHARGE SUMMARY OF RESULTS AND PRELIMINARY OBSERVATIONS

I. Introduction

This letter report presents a summary of preliminary observations and conclusion based on in-plant safety/relief valve (SRV) discharge tests that were performed at the Caorso Nuclear Plant in Italy, as a part of the Mark II Containment Supporting Program. These tests were conducted in conjunction with normal plant startup testing to provide in-plant measurements of loads imposed on suppression pool boundaries and submerged structures, containment structures and on nuclear steam supply system components as a result of main steam safety/relief valve actuations.

The first phase of testing that was performed in July and August of 1978 included single valve first and subsequent actuation tests. The second phase of testing that was performed during January and February of 1979 included low reactor pressure and leaky single valve actuation tests, multiple valve actuation tests, and an extended blowdown of a single valve.

II. Objective of Tests

The objective of the Caorso SRV test program is to obtain SRV discharge test data applicable to Boiling Water Reactor (BWR) plants utilizing SRV discharge line quencher devices.

The specific areas of interest addressed by this test program are:

A. Suppression pool boundary pressures
B. Containment dynamic response
C. SRV discharge line clearing and reflood transients
D. Quencher structural response
E. Suppression pool thermal mixing
F. Submerged structure loads
G. Containment liner and downcomer vent structural response

The data obtained from the test program will be used for confirmation and/or improvement of the Mark II Dynamic Forcing Function Report (DFFR) SRV loads methodologies and in follow-up tasks associated with confirmation, revision and/or development of models for predicting SRV discharge loads.

III. Overview of Test Program

One hundred four SRV actuations were performed at the Caorso plant. A summary of types and number of tests performed during each phase of testing are as follows:

Phase 1:

Test Condition	Number of Valve Actuations
Cold pipe (CP), normal water leg (NWL), single valve first actuation (SVA) valve A	17
Warm pipe (WP), depressed water leg (DWL), consecutive valve actuation (CVA), 10-inch vacuum breaker valve A	5
Warm pipe (WP), depressed water leg (DWL), consecutive valve actuation (CVA), 5-inch vacuum breaker valve A	4
Hot pipe (HP), depressed water leg (DWL), consecutive valve actuation (CVA), 10-inch vacuum breaker valve A	8
Hot pipe (HP), depressed water leg (DWL), consecutive valve actuation (CVA), 5-inch vacuum breaker valve A	4
Warm pipe (WP), elevated water leg (EWL), consecutive valve actuation (CVA), 10-inch vacuum breaker valve A	4

Phase I (Cont'd):

Test Condition	Number of Valve Actuations
Hot pipe (HP), elevated water leg (EWL), consecutive valve actuation (CVA), 10-inch vacuum breaker valve A	4
Cold pipe (CP), normal water leg (NWL), single valve actuation (SVA) valve F	2
Cold pipe (CP), normal water leg (NWL), single valve actuation (SVA) valve E	2
Cold pipe (CP), normal water leg (NWL), single valve actuation (SVA) valve U	2
TOTAL:	52

Phase II:

Test Condition	Number of Valve Actuations
Cold pipe (CP), normal water leg (NWL), single valve first actuation (SVA) valve A	4
Cold pipe (CP), normal water leg (NWL), single valve first actuation (SVA) valve U	1
Warm pipe (WP), consecutive valve actuation (CVA), 2 10-inch vacuum breakers valve U	2
Hot pipe (HP), consecutive valve actuation (CVA), 2 10-inch vacuum breakers valve U	2

Phase II (Cont'd):

Test Condition	Number of Valve Actuations
Warm pipe (WP), consecutive valve actuation (CVA) 10-inch vacuum breaker valve A	4
Hot pipe (HP), consecutive valve actuation (CVA) 10-inch vacuum breaker valve A	8
Leaky valve, single valve first actuation, valve A	5
Leaky valve, consecutive valve actuation 10-inch vacuum breaker valve A	8
Low pressure, single valve first actuation, valve A (800, 600, 400, 200, 100, and 50 psia)	6
Multiple valve actuation, valves A, F	2
Multiple valve actuation, valves A, F, E	1
Multiple valve actuation, valves A, F, E, U	6
Multiple valve actuation, valves B, C, D, L	1
Multiple valve actuation, valves A,B,D,H,K,L,R,V	1
Single valve extended blowdown, valve A	1
	52

Final test reports summarizing the detailed evaluation of results of test data will be issued for each phase of Caorso testing. The current plans are for issue of a final report on the first phase of testing in May, 1979, followed by a final report on the second phase of testing in December, 1979.

IV. Preliminary Results Summary

A. Phase I

Preliminary evaluation of the Phase I test data shows that test data 1) exhibits excellent repeatability and consistency; and 2) generally compares well with or are below predictions; or 3) are well within allowable limits where acceptance limits rather than pretest predictions were established.

Specifically, the following preliminary observations were noted:

(1) The observed pool boundary pressures were lower than predicted using the DFFR methodology. The maximum positive and maximum negative pool boundary pressure observed during single valve first and subsequent actuations were +4.8, -4.3 psid and +8.0, -5.7 psid, respectively. The corresponding mean predicted and 90-90 confidence boundary pressures using the DFFR methodology for the tested conditions were +8.5, -6.1 psid and +12.1, -7.8 psid, respectively for single valve first actuations and +14.8, -8.9 psid and +23.1, -11.3 psid respectively for single valve subsequent actuations.

(2) Preliminary power spectral density analyses indicate that the predominant quencher bubble oscillation frequencies are in the range of 5 to 11 hz. This corresponds to the same expected range for quencher bubble oscillation frequency specified in the DFFR.

(3) The pressure-time attenuation of the pool boundary pressures appeared to be more rapid than that specified by the DFFR methodology.

(4) Pool boundary pressure dropped more with distance than specified by the DFFR methodology.

(5) SRV discharge line piping pressure agreed well with predictions made using the GE SRV discharge line clearing model. The maximum pressure observed in the discharge line piping for first and subsequent SRV actuations were 285 psig and 330 psig, respectively.

(6) The observed SRV discharge line reflood transient agreed well with predictions made using the GE SRV discharge line reflood model and the effects of vacuum breaker size on the reflood transient were confirmed. The maximum reflood level in the discharge line observed for single 10-inch vacuum breaker tests was 6 feet above normal water level. For tests with simulated 3-inch and 5-inch vacuum breakers, maximum reflood levels of 21 to 24 feet and 15 feet above normal water level, respectively, were observed.

(7) All dynamic stresses measured on the quencher and at the discharge line inlet to the quencher were less than 6300 psi, which is significantly below ASME code allowables.

(8) Observed building responses were on the order of a factor of 25 below allowables. The predominant response frequencies were above 20 hz and significant responses lasted only about 0.4 sec.

(9) All strains measured on the containment floor and side wall were significantly less than predicted.

(10) Bending strains measured on the instrumented downcomer vent were significantly less than predicted.

B. Phase II

Data reduction for the second phase of testing is scheduled to begin in March, 1979. However, several of the notable observations based on preliminary analysis of the real-time data are as follows:

(1) Retests of single valve actuations appeared to reconfirm the preliminary findings of the first phase of testing.

(2) The maximum pool boundary pressures recorded during any of the 4-valve multiple actuation tests was +6.0, -4.8 psi compared to the DFFR pretest predicted mean and 90-90 confidence values of +9.9, -6.9 psid and +14.0, -8.5 psid respectively. The maximum pool boundary pressures recorded during the 8-valve multiple actuation test was +5.3, -4.8 psid compared to the DFFR pretest predicted mean and 90-90 confidence values of +11.7, -7.7 and +17.0, -10.0 psid respectively. It was further observed that the boundary pressures did not appear to increase, even when all valves actuated within as little as 21 milli-seconds for a two-valve and a four-valve test.

(3) Actuations of leaking SRV's generally appeared to result in slightly lower positive and slightly greater negative pool boundary pressures for first actuations than the corresponding non-leaky valve actuation cases. For subsequent valve actuations, leaking SRV's appeared to result in slightly higher positive and negative pool boundary pressures than the corresponding non-leaking subsequent valve actuation cases.

(4) All measured strains on the quencher, quencher inlet nozzle, downcomer vent and containment liner were of approximately the same magnitude as for the phase I tests.

(5) The extended (13 minutes, 6 seconds) blowdown test of SRV "A" resulted in a local temperature near the quencher ranging from 10°F to 20°F above the bulk (average) pool temperature.

V. Conclusion

A valid data base has been established for SRV Quencher performance over a wide range of operating conditions including single and multiple valve actuations.

A preliminary assessment of the available Caorso test data indicates that, in general, observations either compare well or are conservatively bounded by test predictions based on existing design load methodology.