BIG ROCK POINT PLANT

ANALYSIS OF RING SPRAY LINE BREAK

WITH FEEDWATER ADDITION

General Electric Company
April 28, 1976

Introduction

Consumers Power Company has asked General Electric Company to respond to an NRC request which states in part as follows:

> "Provide an analysis of the ECCS performance which properly demonstrates that in the event of a break in the core ring spray line, the feed-water system and the flow through the core spray nozzle will reliably provide sufficient core cooling water unless adequate spray distribution of the nozzle has been demonstrated."

This analysis shows that sufficient core cooling water is provided under the conditions described below.

Description of the Analysis

A complete severance of the ring core spray line just outside of the reactor pressure vessel was assumed. Immediately after this hypothetical event, coolant from the region above the core will flow backwards through the thirty-six(1)* spray nozzles, around the ring-shaped sparger, down the riser pipe which connects the vessel nozzle with the ring sparger, and out the vessel nozzle through the broken pipe into containment.

Each of the type 1/2 G1590 nozzles has a flow orifice which is 7/32" in diameter(2). This orifice limits backward flow through each nozzle in the event of the ring spray line break. The total orifice area of all 36 nozzles is 0.009392 ft^2, or 1.35 in^2. It is assumed that critical flow is established at these orifices after the break, and that the approved Moody Critical Flow model in the SAFE code determines the break flow rate.

Note that earlier analyses of the ring spray break, in the absence of data on the 36 spray nozzles, had used a critical flow area of 0.03903 ft^2 or 5.63 in^2, which corresponded to the spray line flow cross-sectional area at the vessel nozzle. Use of the correct flow-limiting area in this analysis predicts a slower depressurization transient than was predicted in earlier analyses.

*Numbers in parentheses refer to references at the end of this report.

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The elevation of the break was similarly corrected to the level of the lowest spray nozzle instead of the level of the spray line vessel nozzle as used in earlier analyses. The new elevation is 4.33 ft. above the top of the core; the old elevation was 3.77 ft.

Feedwater Addition

In modelling the behavior of the feedwater pumps during the ring spray line LOCA, conditions which could cause feed pump trips were considered. These conditions include: a trip on low suction pressure, which could result from a low hotwell level or a condensate pump trip; or a trip on high current, which could result from runout flow.

Since any of these conditions could cause a feed-pump trip following a ring spray break, and since the exact time of such a trip is not known, a bounding assumption was made: the feed-pumps trip at the time of the break. Following trip, the feed-water flow coasts down to zero in one second, as was assumed in earlier analyses.

Re-establishment of feed flow would require operator action. It was further assumed that the operator restarted one of the two feed-pumps 10 minutes after the LOCA, and that full flow from the operating feed-pump is attained 10 seconds after restart. Thereafter the operator regulates feed flow at the normal (pre-LOCA) value until the normal steam drum water level is regained. The temperature of the feed-water delivered to the reactor vessel following feed-pump restart is taken as 100°F, in accordance with a previous analysis[3].

Single Failure Consideration

Prior to making computer runs, it was decided that the worst single failure would be one of the four Reactor Depressurization System (RDS) valves failing to open, in accordance with the previous analysis of the ring spray line break(4). However, the results of the analysis indicate that the RDS does not actuate; hence postulating a single failure in this system does not affect the active systems, which are the nozzle core spray and the feedwater systems. A single failure could be postulated in either of these systems. Such a single failure would completely disable either system, not merely degrade the system. Since the basis of this analysis as stated in the NRC request (see page 1) implies that credit may be taken for flow through both the nozzle spray and feedwater systems, no further single failure was postulated in this analysis.

Results

Following a ring spray line break, the liquid level in the primary system is predicted by the SAFE code as shown in Figure 1. The minimum level is

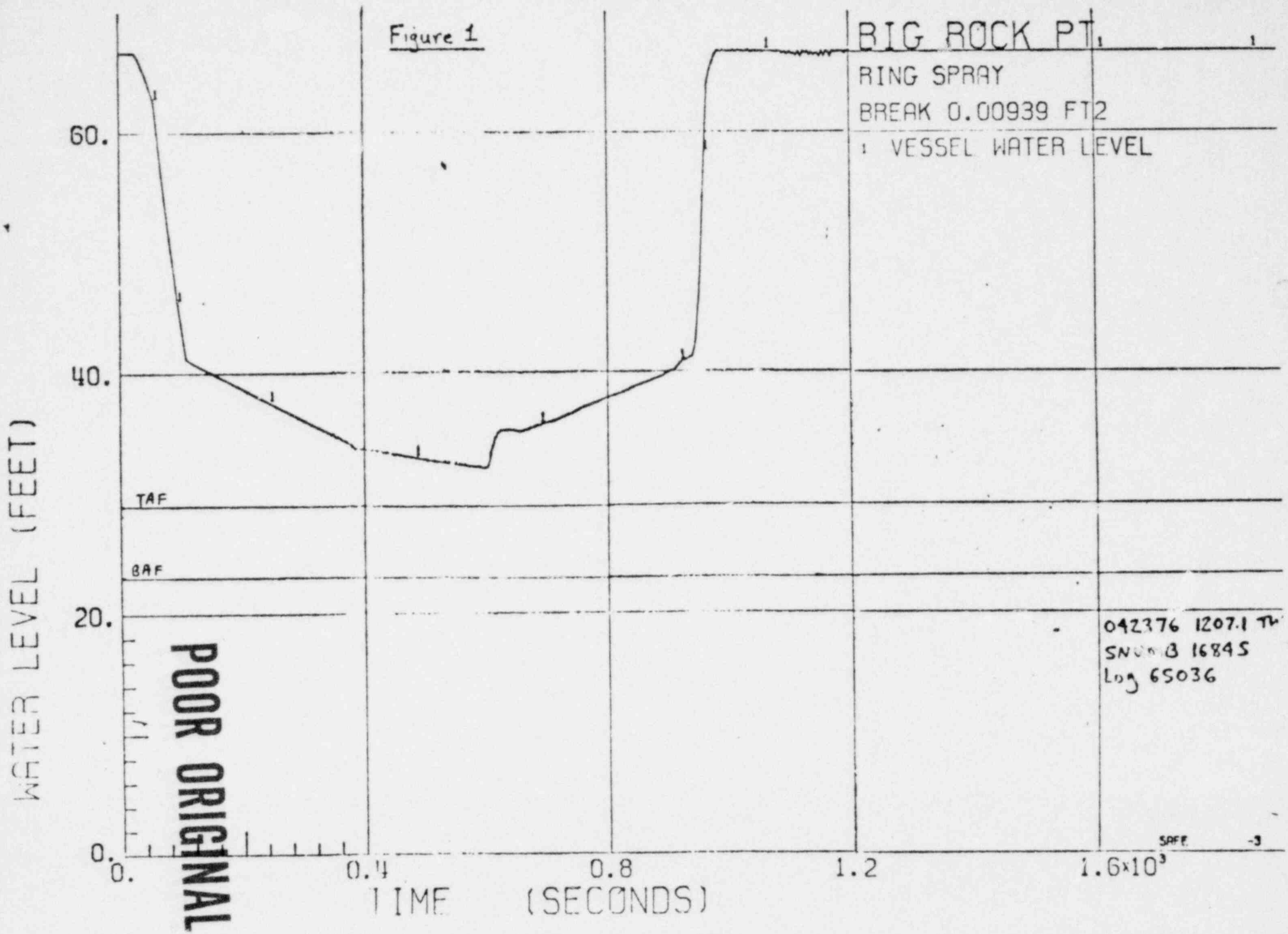

Figure 1

POOR ORIGINAL

31.98 feet at 600 seconds, just before the feed-pump is restarted. Since the top of the core is at 28.78 feet, there is at least 3.20 feet of water above the core during this LOCA.

Because the core is kept covered with liquid, there is no heatup phase to this LOCA, and cladding temperatures remain close to their operating values. It is concluded that sufficient core cooling is provided by the feedwater system in the event of a break in the core ring spray line.

References

1. General Electric drawing of the ring spray sparger, No. 212E456.

2. GE internal memo by KH Sun, "Summary of Existing Information for GE Domestic BWR/1 Core Spray System", March 31, 1976.

3. Submittal from Consumers Power Company to the USAEC dated June 28, 1974; Figure 1.

4. Submittal from Consumers Power Company to the USNRC dated July 25, 1976; Appendix A, Table 4.

NRC FORM 195
(2-76)

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Ralph B. Sewell

DATE OF DOCUMENT 5-10-76

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