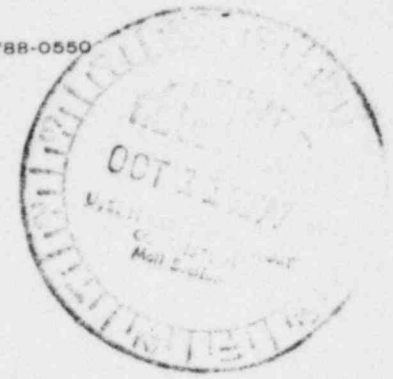
Consumers
Power
Company

General Offices: 212 West Michigan Avenue, Jackson, Michigan 49201 • Area Code 517 788-0550

October 5, 1977



Director of Nuclear Reactor Regulation
Att: Mr Don K Davis, Acting Branch Chief
Operating Reactors Branch No 2
US Nuclear Regulatory Commission
Washington, DC 20555

DOCKET 50-155, LICENSE DPR-6 -
BIG ROCK POINT PLANT - REDUNDANT
CORE SPRAY: TOP ENTRY STEAM

By letter dated September 19, 1977, Consumers Power Company submitted an evaluation of the adequacy of the redundant core spray system at Big Rock Point based on actual bundle spray flows and bundle evaporation rates. This evaluation used measured spray flow data for bottom only and top and bottom combined steam entry. The top only steam entry mode was excluded because the proportion of top entry steam to total steam flow that existed for the combined steam entry tests was thought to conservatively bound that which would be expected in a LOCA. It should be noted that between 36% and 41% of all steam supplied in the combined steam entry tests entered at the top of the test facility vessel. To justify the exclusion of top only entry steam, all breaks considered in the 10 CFR 50, Appendix K, analysis as submitted by letter dated July 25, 1975, have been evaluated correlating the results of the reference analysis with the SAFE code to determine whether or not the proportion of top entry steam would exceed that which actually existed for the combined steam entry tests.

Based on this evaluation, it is concluded that in the event of a LOCA the fraction of top entry steam would not exceed that which actually existed in the top and bottom combined steam entry tests.

Table 1 provides a tabulation of time of rated spray, water levels at time of rated spray and drum emptying times for the range of breaks considered in the Appendix K analysis. Based on this tabulation, it is possible to place each of the breaks into one of three categories. The first category is composed of those breaks in which the pressure vessel, the drum and the recirculation piping are essentially empty at the time of rated spray. The second category is composed of those breaks in which there is some water in vessel and the downcomers at the time of rated spray. The third category is composed of those breaks in which there is water in the drum at the time of rated spray.

Category 1

For breaks in this category, the primary system is essentially empty at the time of rated spray and, hence, the only source of steam is from the core through the evaporation of spray water. Since the core is the only source of steam, it is necessary to determine the amount of steam rising through the core as compared to that which flows backward through the pumps, up the downcomers, through the steam drum and down the risers. During normal operation, the pressure drop through the core is less than one quarter of that around the remainder of the primary loop. With the recirculation pumps stopped as was assumed in the Appendix K analysis, and without two-phase flow (ie, only steam would be flowing through the system), the pressure drop through the core would be even smaller in comparison to the pressure drop through the primary piping. Hence, for this break category, it can be concluded that at least two times as much steam would rise through the core as would flow backward through the primary piping and enter via the risers, and thus no more than 33% of the total amount of steam generated would be top entry.

Category 2

For breaks in this category (ie, steam line, feed-water line, ring spray line, and small pump suction line breaks), the lower plenum and the downcomers are partially filled at the time of rated spray. In this case, all steam generated in the core as a result of evaporation of spray water would flow upward through the core and none would be available for top entry. However, as the system depressurizes, the water lying in the downcomers would flash and thus provide a source of top entry steam.

The SAFE runs indicate that for all breaks in this category some water in the lower plenum and downcomers will be saturated at all times during the transient. Following the time of rated spray and until very late in the transient (past the time of PCT), the rate of energy addition to the saturated downcomer fluid from the hot piping is generally 2 to 10 times lower than the rate of energy addition to the saturated lower plenum fluid from the vessel lower head and internals. Therefore, the flashing rate in the lower plenum would be at least 2 times that in the downcomers, thus no more than 33% of total steam generated would be top entry. Late in the transient, the rate of energy addition to the saturated lower plenum fluid continues to exceed that to the saturated downcomer fluid but by a lesser amount. However, at this point in the transient, the flashing rate in the downcomers is approximately the same as the rate of evaporation of spray water in the core; hence, the amount of top entry steam would continue to be no more than 33% of the total amount of steam being generated in the system.

Category 3 (Riser Break)

In the case of the riser break, the steam drum is not empty at the time of rated spray; therefore, significant amounts of steam would be generated in the drum by flashing. However, due to the location of this break, as long as the primary system is depressurizing, most of the steam generated in the drum will flow out of the break instead of into the reactor vessel. In fact, the primary system continues to depressurize well past 67 seconds, at which time the drum empties. In addition, because the break is above the core, the direction of steam flow must be upwards through the core.

TABLE 1

Break	Time of Rated Spray (T_{spray}) (Seconds)	Vessel Level at T_{spray}* (Feet)	Drum/Downcomer Level at T_{spray}* (Feet)	Time Drum Empties (Seconds)
DBA	20.4	<1.0	<1.0	1.0
0.8 x DBA	21.79	<1.0	<1.0	1.2
0.6 x DBA	24.26	<1.0	<1.0	1.5
1.0 Ft^2	36.87	<1.0	<1.0	3.0
0.5 Ft^2	55.07	<1.0	<1.0	5.0
0.25 Ft^2	98.17	<1.0	<1.0	8.0
0.10 Ft^2	155.90	<1.0	<1.0	12.0
0.05 Ft^2	209.83	3.5	1.5	15.0
0.025 Ft^2	306.35	21.0	~15.0	19.0
0.008 Ft^2	649.70	24.5	~16.0	22.0
Downcomer	24.06	3.5	<1.0	1.2
Riser	30.08	25.3	69.0	67.0
Feedwater	112.23	24.5	~15.0	36.0
Recirc Discharge	21.33	<1.0	<1.0	1.3
Ring Spray	347.08	24.0	16.5	212.0
Steam Line	85.02	26.5	~15.0	64.0

*Level = 0 ft at bottom of pump suction piping.
= 62 ft at bottom of steam drum.
= 25.86 ft at core midplane.
= 65 ft at drum midplane.

Once the drum has emptied, the only source of top entry steam would be the flashing of water in the downcomers. The SAFE run indicates that between the time the drum empties and the vessel depressurization ceases (115 seconds), the rate of energy addition to the saturated water in the vessel lower plenum is at least twice the rate of energy addition to saturated water in the downcomers. Once the depressurization ceases, the rate of energy addition to the saturated water in the lower plenum continues to exceed the rate of energy addition to the saturated water in the downcomers but by a lesser amount. However, after 115 seconds, the rate of core spray water evaporation would be about the same as the steaming rate in the downcomers; hence again it can be concluded that the amount of top entry steam would be no more than 33% of the total amount of steam generated in the system.

Thus, Consumers Power Company concludes that under any postulated LOCA conditions at Big Rock Point the percentage of steam classified as top entry is bounded by the combined entry steam tests conducted at the Bartow, Florida test facility. Further, it is expected that this response adequately alleviates staff concerns relating to this issue.

David A Bixel
Nuclear Licensing Administrator

CC: JGKeppler, USNRC

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TO: Mr. Don K. Davis

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Jackson, Michigan 49201
David A. Bixel

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DESCRIPTION: Consists of additional information in regard to ltr dtd. 09/19/77 concerning evaluation of the adequacy of the redundant core spray system at Big Rock Point based on actual bundle spray flows and bundle evaporation rates... w/att table 1

3p + 1p

ENCLOSURE

PLANT NAME: BIG ROCK POINT

jcm 10/11/77

40 ENCL*

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FOR ACTION/INFORMATION

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