UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO REACTOR AUXILIARY BUILDING EMERGENCY EXHAUST SYSTEM

CAROLINA POWER & LIGHT COMPANY

SHEARON HARRIS NUCLEAR POWER PLANT, UNIT 1

DOCKET NO. 50-400

1.0 INTRODUCTION

By letter dated September 23, 1995, as amended October 10, 1995, the licensee for Shearon Harris Nuclear Power Plant, Unit 1 (SHNPP) proposed changes to the Final Safety Analysis Report (FSAR) which would revise the design basis for the reactor auxiliary building (RAB) emergency exhaust system. The original dose assessments in the FSAR assumed that any leakage outside the containment from the emergency core cooling system (ECCS) following a loss-of-coolant accident (LOCA) would be filtered by the safety-related RAB emergency exhaust system. However, the final plant design resulted in portions of the ECCS recirculation equipment being located outside the boundaries served by the RAB emergency exhaust system. Therefore, any postulated leakage from this equipment may not be filtered by the emergency exhaust system, thus potentially increasing the radiological consequences of a postulated LOCA. The approach used by the licensee to resolve this issue was to reanalyze the post-LOCA dose assessments using an administrative limit on external leakage from ECCS equipment outside the RAB emergency exhaust system boundary.

The staff evaluation consists of the review of the licensee's submittal associated with (1) the administrative limit on the amount of leakage assumed in the reanalysis of the dose calculations, and (2) the radiological consequence assessment of the postulated ECCS leak rates from ECCS' equipment outside the RAB emergency exhaust system boundary.

2.0 EVALUATION

2.1 Administrative limit on amount of leakage assumed in the reanalysis of the dose calculations.

In performing the new dose assessment, the licensee assumed that there was one gallon per minute (gpm) total continuous ECCS leakage, with two gallons per hour (gph) outside the RAB emergency exhaust system boundary established as an administrative limit and the remainder (approximately 0.97 gpm) inside the boundary. In the event the 2 gph (0.033 gpm) cumulative limit is exceeded, the administrative controls require that the leakage rate be reduced to within the limits within 24 hours or be in at least hot standby within the next 6 hours and in cold shutdown within the following 30 hours. The staff's review of this new limit of 2 gph was based mainly on the capability to detect such leakage rates and whether the assumed limit was reasonable with respect to the total amount of leakage expected from the system. For analysis purposes, it has been conservatively assumed by the licensee that all of the

reactor coolant system (RCS) unidentified leakage is from the ECCS. Further conservatism is added for dose calculation purposes. In the dose calculations, the licensee has assumed that these leak rates are double the allowable value, i.e., 4 gph outside the boundary and 2 gpm total.

In accordance with the SHNPP's Administrative Controls TS 6.8.4, a leakage reduction program (per TMI Item III.D.1.1 of NUREG-0737) is already in place which includes the ECCS equipment outside containment. TS 6.8.4 requires integrated leak rate tests at refueling cycle intervals or less. Additional surveillance requirements (SRs) specifically addressing only the ECCS equipment outside the exhaust system boundary have also been proposed as part of the new administrative controls to ensure the 2 gph limit is not exceeded. The new SRs require the areas outside the RAB exhaust system boundary, excluding the filter room, that contain components in the ECCS recirculation flow path pressure boundary to be inspected for indications of external leakage at least every 72 hours. The 72 hours is consistent with the TS requirements for the RCS inventory balance to determine the total RCS leakage rate. Components in the filter room (chemical and volume control system [CVCS] filters) must be inspected for indications of external leakage at least every 31 days. The filter room is normally posted as a locked high radiation area and leakage sources are minimal; the filter housing is welded to the pipe and contains only a single flange and there are only 12 valves in the room. The 31-day inspection interval for the filter room is reasonable based on operating experience and considering it is a high radiation area and contains a minimal amount of equipment. Any noticeable leakage found while performing these SRs is required to be measured or estimated to ensure total leakage is within the limit. The new SRs also specify that these portions of the ECCS shall be leak tested in accordance with the leakage reduction program requirements at refueling (TS 6.8.4) intervals or less.

The staff considers the assumed value of 1 gpm total ECCS leakage outside the containment to be reasonable and conservative because it is consistent with the amount of RCS unidentified leakage rate allowed by the TS. Unidentified leakage beyond this value requires the plant to be placed in a mode where the TS limit no longer applies, i.e., Mode 5 or 6. The leakage reduction program required by TS 6.8.4 has an acceptance criterion of no identifiable leakage for the leakage test performed at least every refueling outage. Based on these requirements, the staff concludes that a 1 gpm assumption for total ECCS leakage outside containment is reasonable and conservative and, therefore, acceptable.

The 2 gph (or 0.033 gpm) limit for the pressure retaining portions of the ECCS that are outside the boundary of the RAB emergency exhaust system is consistent with the amount of total ECCS leakage the licensee assumed in its original licensing analysis. Hence, there is a logical basis for the assumed value of 2 gph since plant operating history at SHNPP has shown that leakage for the entire system has been known to be below this value. The 2 gph is also sufficiently large so as to not result in unnecessary shutdowns, is readily detectable by inspection, and small enough to not exceed radiological limits. It is considered readily detectable because virtually all portions of the ECCS outside the exhaust system boundary are pressurized during normal plant operation. Since the pressurizing fluid is borated water, even the

smallest leaks generally leave traces of boron after evaporation. Therefore, any potential leakage paths should be detected during the required inspections. Also, all portions, except the CVCS filter rooms, are covered by the normal operator rounds (the leakage reduction program requires leakage checks during normal operator rounds) and any noticeable leaks would likely be detected between the required inspection intervals of 72 hours. Because the 2 gph is consistent (higher than) with the actual overall leak rates experienced in the past, is bounded by the no identifiable leakage criterion of the leakage reduction program, and is readily detectable via scheduled inspections, the staff concludes that it is an acceptable leak rate limit for the ECCS equipment outside the RAB exhaust system boundary.

2.2 Radiological consequence assessment of the postulated ECCS leak rates from ECCS' equipment outside the RAB emergency exhaust system boundary.

The original dose assessments in the FSAR assumed that any leakage outside the containment from the ECCS following a LOCA would be filtered by the safety-related RAB emergency exhaust system. However, the final plant design resulted in portions of the ECCS recirculation equipment being located outside the boundaries served by the RAB emergency exhaust system. Therefore, all of the postulated leakage from this equipment may not be filtered by the emergency exhaust system, thus potentially increasing the radiological consequences of a postulated LOCA. The approach used by the licensee to resolve this issue was to reanalyze the post-LOCA dose assessments using an administrative limit on external leakage from ECCS equipment outside the RAB emergency exhaust system boundary.

During the recirculation mode of the ECCS operation following a LOCA, the sump water is circulated outside containment to the auxiliary building for cooling and reinjection via the ECCS or containment spray system. For SHNPP, any leakage outside the containment (other than leakage from outside the boundaries served by the RAB emergency exhaust system) from the ECCS operation following a LOCA would be filtered by the safety-related RAB emergency exhaust system.

In performing the new dose consequence reassessment, the licensee assumed that there will be one gpm continuous ECCS leakage following a LOCA, with 0.03 gpm (2 gph) outside the RAB emergency exhaust system boundary and the remainder (0.97 gpm) inside the boundary. The licensee established 0.03 gpm leakage as an administrative limit. In the event the 0.03 gpm limit is exceeded, the administrative controls require that the leakage rate be reduced to within the limits within 24 hours or be in at least hot standby within the next 6 hours and in cold shutdown within the following 30 hours.

As stated above, the staff's review of this new limit of 0.03 gpm was based mainly on the capability to detect such leakage rate and whether the assumed limit was reasonable with respect to the total amount of leakage expected from the system. The staff has concluded that the 0.03 gpm leak rate limit for the ECCS equipment outside the RAB emergency exhaust system boundary is reasonable and detectable, and that the licensee has adequate administrative controls in place to detect the leakage and to take necessary actions to either reduce the leakage to below the limit or bring the plant to cold shutdown.

The staff also performed an independent radiological consequence assessment as a result of design basis LOCA at the SHNPP site boundaries assuming ECCS leakage rates of twice the administrative limit of 0.03 gpm (0.06 gpm outside the boundary) and 2 gpm total continuous ECCS leak rate in accordance with Standard Review Plan Section 15.6.5, Appendix B. The staff also accepted the 2 percent iodine flashing factor proposed by the licensee since the ECCS fluid at the residual heat removal (RHR) heat exchanger outlet will be less than 200 F° following the start of recirculation. The portion of the ECCS recirculation piping that is located outside of the RAB emergency exhaust system boundary is downstream of the RHR heat exchanger.

The staff previously considered, in the Shearon Harris Safety Evaluation Report (NUREG-1038), the following two potential fission-product leakage pathways from the primary containment to the environment: (1) containment leakage, and (2) leakage from ECCS system outside containment. In this evaluation, the staff performed radiological consequence assessment for item (2) above only since the changes to the FSAR proposed by the licensee do not affect the containment leakage contribution. In previous evaluation, the staff assumed a total of 2 gpm leakage from the ECCS recirculation piping and all leakages are filtered by safety-related RAB emergency exhaust system prior to release to the environment.

The assumptions and parameters used in this evaluation are listed in Table 1. The resulting calculated doses are 7 rem to the thyroid at the exclusion area boundary (EAB), 21 rem to the thyroid at the low population zone (LPZ), and 3 rem to the thyroid for control room operators. The resulting total doses including containment leakage pathway contribution (previously calculated in Section 15.6.5.2 of NUREG-1038) are still within the dose acceptance criteria as set forth in 10 CFR Part 100 and in GDC 19 (see Table 2).

Table 1
Assumptions and Parameters

Reactor Power	2900 Mwt
Percent radioiodine core inventory in containment sump water	50
Iodine flashing traction from ECCS fluid	2 percent
Radioiodine chemical forms (percent)	
Elemental	91
Organic	4
Particulate	5
Sump water temperature	230 F°
ECCS fluid temperature at RHR heat exchanger outlet	200 F°
ECCS leakages	
Within RAB emergency exhaust system	2.0 gpm
Outside of RAB emergency exhaust system	0.06 gpm
ECCS area filter efficiencies (percent)	
Elemental	95
Organic	95
Particulate	95

Atmospheric dispersion factors (second per cubic meters)	
0 to 2 hour EAB	2.9E-4
0 to 8 hour LPZ	6.8E-5
8 to 24 hour LPZ	4.6E-5
1 to 4 day LPZ	1.9E-5
4 to 30 day LPZ	5.5E-6
Control room relative concentrations (second per cubic meters)	
0 to 8 hour	7.9E-3
8 to 24 hour	6.0E-3
1 to 4 day	1.8E-3
4 to 30 day	4.2E-4
Iodine protection factor	496
Control room geometry factor	21
Dose conversion factors	ICRP Report 30

Table 2
Radiological Consequences
of
Design Basis Loss of Coolant
(rem)

	EAB		LPZ	
	Thyroid	Whole Body	Thyroid	Whole Body
Containment Leakage(1)	75	1.8	77	<1
ECCS Leakage	7	<1	21	<1
Total	82	<3	98	<1

(1) Table 15.1, NUREG-1038, "Safety Evaluation Report related to Operation of Shearon Harris Nuclear Power Plant, Units 1 and 2," November 1983.

Control Room Doses
(rem)

	Thyroid	Whole Body
Containment leakage	11	<1
ECCS Leakage	3	<1
Total	14	<1

3.0 CONCLUSION

Based on the above evaluation, the staff concludes: (1) that the 2 gph leak rate limit for the ECCS equipment outside the RAB emergency exhaust system boundary is reasonable and detectable, (2) that the licensee has adequate administrative controls in place to detect the leakage limit, and (3) that the proposed revisions to the SHNPP FSAR (Enclosure 2 to the licensee's letter HNP-95-083) are acceptable. The bases for the staff's acceptance are that the distances to the exclusion area and LPZ boundaries are still sufficient with 0.06 gpm unfiltered and 2 gpm filtered ECCS leakages to provide reasonable assurance that the calculated radiological consequence of a postulated design basis LOCA will meet the dose acceptance criteria as set forth in 10 CFR Part 100 and in GDC 19. The licensee also has committed to take necessary actions to either reduce the leakage to below the limit or bring the plant to cold shutdown.

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