



UNITED STATES
NUCLEAR REGULATORY COMMISSION

REGION II
101 MARIETTA ST., N.W., SUITE 3100
ATLANTA, GEORGIA 30303

Report No. 50-261/81-10

Licensee: Carolina Power and Light Company
411 Fayetteville Street
Raleigh, NC 27602

Facility Name: H. B. Robinson

Docket No. 50-261

License No. DPR-23

Inspection at H. B. Robinson site near Hartsville, South Carolina

Inspector: John R. Wray 4/10/81
J. R. Wray Date Signed

Approved by: C. M. Hooley 4/10/81
C. M. Hooley, Acting Section Chief Date Signed
Technical Inspection Branch
Engineering and Technical Inspection Division

SUMMARY

Inspected on March 2-4, 1981

Areas Inspected

This special, announced inspection involved 22 inspector-hours onsite reviewing the licensee's evaluation of whole body doses received by personnel working inside steam generators during 1980.

Results

Of the area inspected, three violations were identified (failure to perform an adequate survey or evaluation; exceeding quarterly whole body dose limit; and failure to maintain and preserve survey records).

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REPORT DETAILS

1. Persons Contacted

Licensee Employees

H. B. Starkey, Jr., General Manager
*B. H. Webster, Manager - Environmental and Radiation Control (Corporate)
*D. S. Crocker, E&RC Supervisor
J. Pettigout, Senior ALARA Specialist
B. MacCready, E&RC Engineer
D. Gainey, RC&T Foreman
E. Paine, Engineer

Other Organizations

F. E. Lesko, Senior Principal Engineer, Proto-Power Management Corporation

NRC Resident Inspectors

S. Weise, Resident Inspector
J. Skolds, Senior Resident Inspector - V. C. Summer

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on March 4, 1981 with those persons indicated in paragraph 1 above. The licensee representatives acknowledged the violations and indicated that all individuals whose dose records had been upgraded will be notified pursuant to 10 CFR 19.13 whether or not their revised exposure exceeded regulatory limits.

3. Licensee Action on Previous Inspection Findings

Not inspected.

4. Unresolved Items

Unresolved items were not identified during this inspection.

5. Summary of Events

During review of the external radiation exposure control program while conducting the special Health Physics Appraisal inspection on January 26 - February 6, 1981, the appraisal team examined individual exposure records, radiation survey data, and personnel monitoring techniques related to steam

generator tube plugging operations in 1980. Survey data showed that non-uniform and complex radiation fields existed in both hot and cold leg sections of each steam generator (SG). Personnel radiation monitoring consisted of thermoluminescent dosimeters (TLDs) and self-reading pocket dosimeters (PDs) enclosed in plastic bags and attached to the workers' chests. A licensee representative acknowledged that an evaluation of the survey data did not generate sufficient concern to warrant use of extra dosimetry in the area of the worker's head and gonads. The inspector stated that based on review of the available information, it appeared workers may have received a significantly greater whole body dose than previously recorded by dosimetry worn on their chest. On February 10, 1981 a Confirmation of Action Letter was issued to Carolina Power and Light documenting the licensee's commitment to reevaluate the radiation dose received by individuals who made entries into the steam generators during 1980.

The licensee contracted a consulting firm to (a) determine if the recorded exposure data was adequate; (b) determine the most appropriate method for evaluating whole body exposure if the recorded data was not adequate; and (c) develop correction factors from existing data as appropriate. The consultant's evaluation indicated that the exposure data recorded by the dosimetry worn by workers while inside SG channel heads did not reflect the whole body exposure actually received. The licensee concluded that available records could be used to develop correction factors for adjustments of recorded exposure data to properly reflect the actual whole body dose.

On February 19, the licensee notified the NRC regional office that preliminary calculations indicated two employees had received whole body occupational doses greater than 3 rems in a calendar quarter. These calculations were based on correction factors developed from extensive channel head survey data. The whole body dose recorded by personnel dosimetry worn on the chest during steam generator entries was adjusted for exposures which could have affected portions of the whole body other than the chest.

An inspector reviewed the licensee's calculations and methodology used in adjusting recorded doses. Licensee records indicated that 86 contract and station employees made steam generator channel head entries in 1980. Using the method developed by their consultant and incorporating comments by the inspector, the licensee concluded that the calculated dose for three individuals in 1980 exceeded 3 rems in one calendar quarter. One individual received a total whole body dose of 3.054 rems in the first calendar quarter and two individuals received occupational doses of 3.124 rems and 3.257 rems in the third calendar quarter. The adjusted dose of a fourth individual, who had worked first at H. B. Robinson and then at Southern California Edison Company's San Onofre plant, disclosed that although his separate exposures at these two facilities did not exceed regulatory limits, his total occupational whole body dose during the second calendar quarter was greater than 3 rems. No calculated occupational dose was more than 3.5 rems

in one calendar quarter and no individual exceeded established annual or lifetime exposure limits.

On March 30, 1981, CP&L management met with Region II management to discuss these overexposures and concerns about the exposure control program at the plant. During this meeting the violations were discussed and the enforcement sanctions available to the NRC were disclosed to the licensee.

6. Surveys and Dosimetry

During 1980 four separate outages occurred involving steam generator maintenance work. The inspector reviewed with licensee representatives the available survey data of SG channel heads for each outage. Dose rate survey information was taken with both TLDs and portable radiation survey instruments. It included data at nine different points inside each channel head taken in accordance with health physics procedure HP-12, "Steam Generator Inspection and Maintenance". The nine points consisted of 3 points near the tubesheet, three general area points near mid level, and three points along the lower areas of the bowl. Licensee representatives stated that their evaluation of the data performed prior to the initial steam generator entry of each outage concluded that dose rates were constant and relatively uniform. As a result, only chest worn personnel dosimeters were authorized. A review of the data shows that dose rates at the tube sheet and at the bottom of the bowl were up to 60% and 140% greater than at mid-level respectively where chest worn dosimeters normally would be located during a jump. The inspector informed the licensee that failure to perform an adequate survey or evaluation of the radiation hazard incident to work inside the steam generators such that appropriate personnel monitoring devices were not provided to measure the dose received by worker's heads and gonads while inside the steam generators was a violation of 10 CFR 20.201 (50-261/81-10-01).

The inspector noted that a revision to HP-12 in January 1981, made the use of head and gonad dosimeters mandatory during future SG entries. This revision was in response to a Westinghouse letter recommending multi badging of workers in non-uniform radiation fields. The inspector concluded that the licensee, once informed of the potential for extremity exposures during steam generator entries, did act expeditiously to correct program inadequacies and provided measures to prevent future violations of regulatory dose limits. Although the licensee did act on his own volition to prevent recurrence, he did not reevaluate past exposure records until requested by the NRC.

7. Methodology

As a result of their reevaluation of SG survey data, the licensee concluded that exposure data recorded by chest-worn dosimetry did not reflect the whole body exposure actually received. The inspector discussed with licensee representatives the method used to adjust personnel exposure records.

This method was based on correction factors developed from the available survey data. The inspector was informed that alternate methods which were considered included computer modeling of the channel head environment and collection of empirical data during subsequent SG entries. The inspector agreed with the licensee that neither of these alternate methods would have produced significantly different results. Computer modeling would have required extensive generalizations and simplifications and depended on the same survey data used in developing the correction factors employed. Empirical data would have been difficult to correlate to past doses because of significant changes in the source term from one outage to another.

The approach employed was possible due to the availability of the extensive dose rate maps and detailed SG entry logs. The entry log included for each jump the duration, the TLD number, and the dose received as recorded by pocket dosimeter. For each survey performed in each channel head, the highest ratio between tube sheet and general area dose rates or channel head bowl and general area dose rates was determined. Ratios of dose rates from TLD surveys inside SG were equivalent to ratios obtained by portable radiation survey instruments. The inspector concluded from discussions with licensee representatives and observations of a simulated SG channel head survey conducted at the licensee's mock-up facility that the distance between survey points at the tubesheet and general area, and channel head bowl and general area were approximately 24 inches. The head and gonads are approximately 18 inches from the chest. The licensee assumed that the chest TLD was located in the general area and irradiated at dose rates recorded in this area on the survey maps. Since the distance between each survey point is greater than the distance between the chest and the head or gonads, the licensee reduced the highest ratios obtained by 25% in a linear manner. The inspector agreed that a linear reduction is conservative compared to the dose reduction with distance from a finite plane source.

The inspector questioned the assumption that the chest worn TLD was positioned in the general area and the potential for self-body shielding of the chest area that would not occur for areas near the head or gonads. The SG mock-up was used to review body positions for the various job activities including installation and removal of nozzle covers and tubesheet templates, tube marking, and eddy current equipment and tube plugging operations. The inspector concluded from personal observations and reenactments of SG activities that the chest worn TLD could be assumed to have been positioned in the general area of the SG channel head with no significantly different results obtained. It was noted that the worst ratio between survey points was calculated, modified and applied to the total recorded occupational dose without regard for the amount of time spent in this worst position. The inspector also concluded that no significant self-body shielding of the chest worn TLD would have occurred.

The inspector questioned the potential dose to portions of the body other than the head or gonads and from beta radiation. Based on the extensive survey maps, it was concluded that the hand and foot dose limit of 18 3/4

rems per quarter was not exceeded. Results of several TLD badges used in survey map preparations showed insignificant beta dose contribution. Protective clothing and respiratory protection requirements of HP-12 imply that the least protected parts of the skin is the skin on the face which, for each jumper, is shielded by at least a bubble hood with approximately 70 mg/sq cm density thickness. The inspector concluded that beta dose and dose to portions of the body other than the trunk, head or gonads do not appear to be of concern. However, it is recommended that the licensee formalize their evaluation techniques, calculations, and conclusions on beta, skin, extremity, and lens of the eye exposures during SG channel head work (50-261/81-10-02).

Once the adjusted ratios were determined, the dose received in each SG channel head, as measured by the chest TLD, was multiplied by the appropriate adjusted ratio. In those cases where the dose reported on a single TLD was received in separate SG channel heads as well as elsewhere onsite, the pocket dosimeter readings for each jump were used to determine how much dose was received in each channel head. The adjusted SG dose was added to other onsite dose and any prior offsite dose to determine the total quarterly whole body dose. This calculation was performed for each individual who entered the SG channel heads in 1980 using the correction factors listed in Table 1. All adjusted doses per jump were summed to determine the reported total quarterly occupational dose.

The calculations indicated that one individual received a total whole body dose of 3.054 rems in the first calendar quarter and two individuals received occupational doses of 3.124 rems and 3.257 rems in the third calendar quarter. The inspector informed the licensee that failure to limit the total quarterly occupational dose of each individual to 3 rems was a violation of 10 CFR 20.101 (50-261/81-10-03).

8. Record Retention

During the review of SG survey data for each outage, the inspector noticed that no dose rate information was available for the hot leg sections of all three steam generators for the September/October segment of the refueling outage. The plant shut down in August at which time complete surveys of all SG were performed. Entries were made pursuant to health physics procedure HP-12 until late August when each SG was secured for fuel shuffling operations. Following this evolution, the SGs were reopened to complete tube plugging operations. Based on discussions with licensee personnel and observation of other survey records, the inspector was convinced that complete surveys had been retaken on or before September 17, 1980, prior to additional channel head entries. However, only the survey maps for the cold leg sections of all three SG were retained on file. The inspector informed the licensee that failure to maintain survey records for the retention period specified in 10 CFR 20.401 was a violation (50-261/81-10-04).

9. Training

The inspector discussed the type and amount of training administered to workers prior to SG entries. The cognizant licensee representative stated that use of the mock-up steam generator is extensive. Dress out procedures are adhered to during practice jumps. Spare equipment is used to simulate job activities in the training environment. Photographs of the tube sheet plugging pattern are reviewed with appropriate personnel when needed. The licensee acknowledged that no written record is maintained of this specialized job training. The inspector stated that although it appears that no requirement exists for special job training record retention, the licensee should develop and maintain records of all special training activities (50-261/81-10-05).

10. Conclusions

The licensee's entry log, extensive survey data and administrative exposure limits for SG workers helped mitigate the severity of adjusted doses and limit the number of actual overexposure events. The entry log contained information on each SG channel head entered including the duration of each entry, the TLD number of each jumper, and the dose he received as recorded by pocket dosimeter. Survey maps contained dose rate information at nine points inside the channel heads. Administrative exposure controls consisted of strict dose limits at which a worker's TLD must be processed or above which a worker could not be further exposed. TLDs are processed at approximately 1000 mrem and 2000 mrem. No individual is permitted to enter the SG if his cumulated quarterly whole body dose is above 2500 mrem. The maximum exposure allowed per jump based on survey data and stay time calculations is normally 50% of the difference between his existent dose and 2500 mrem. Normally no individual is permitted to jump a SG if his quarterly dose would exceed 2500 mrem if he received 200 mrem during that jump. As a result, correction calculations indicated that of 86 workers who entered SGs in 1980, 14 individuals received whole body doses greater than 2500 mrem in one calendar quarter. Of these, six employees received greater than 2750 mrem. Three of these six exceeded 3000 mrem in one calendar quarter. No occupational whole body dose for 1980 was greater than 3257 mrem in one calendar quarter. The inspector concluded that no safety or health hazard exists at the level of the doses involved.

TABLE 1

ADJUSTED RATIOS
STEAM GENERATOR

	A		B		C	
	Hot Leg	Cold Leg	Hot Leg	Cold Leg	Hot Leg	Cold Leg
1) March	1.5	1.91	--	--	1.42	2.05
2) April	1.0	1.32	1.0	1.25	1.04	1.04
3) July	1.38	1.42	--	--	--	--
4) August	1.38	1.38	1.38	1.19	1.38	1.15
September	1.12*	1.12	1.45	1.25	1.50	1.25

*Adjusted ratios obtained by assuming equivalent relative change of dose rates in H/L as had occurred in C/L.