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NUCLEAR REGULATORY COMMISSION
REGION II
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ENCLOSURE 3

Report Nos.: 50-325/88-33, 50-324/88-33

Licensee: Carolina Power and Light Company
P. O. Box 1551
Raleigh, NC 27602

Docket Nos.: 50-325, 50-324 License Nos.: DPR-71, DPR-62

Facility Name: Brunswick

Inspection Conducted: September 19-23, 1988

Team Leader: for C Bassett 1/11/89
T. R. Collins Date Signed

Team Members: C. H. Bassett
R. B. Shortridge

Accompanying Personnel: C. M. Hosey

Approved by: C M Hosey 1/11/89
C. M. Hosey, Section Chief Date Signed
Division of Radiation Safety and Safeguards

SUMMARY

Scope: This was a special, announced assessment in the area of the licensee's program to maintain occupational exposures as low as reasonably achievable (ALARA).

Results: The licensee currently has in place most of the elements required for an adequate ALARA program. Program strengths, noted during the inspection, included source term reduction efforts, good general radiation worker knowledge of ALARA concepts, and including exposure goal performance as a part of all plant managements' annual performance appraisal. However, increased support and involvement of management is required if the program is to be fully successful. Weaknesses were also identified in the ALARA program that should be addressed to ensure that the collective annual personnel radiation dose is reduced to the maximum extent possible. These weaknesses were as follows:

- Management direction in achieving established goals, Paragraphs 3.c and d.
- Establishing challenging annual exposure goals, Paragraph 3.d.
- Total number of personnel onsite with measurable exposure, Paragraph 4.c.

- Effectiveness of the audit program, Paragraph 7.
- Effectiveness of the ALARA Sub-Committee, Paragraph 3.a.
- Personnel exposures received resulting from rework, Paragraph 4.b.
- Man-hour estimation for each job, Paragraph 3.b.
- Dose acquired under general RWP's that does not receive specific ALARA review, Paragraph 4.d.

Within the areas inspected, no violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

B. Altman, Manager, Maintenance
*A. Cheatham, Manager, Environmental and Radiological Control (E&RC)
B. Cierpiot, Instrument and Control Foreman
J. Harness, Plant manager
A. Hegler, Operations Supervisor
B. Helme, Manager, Technical Support
P. Howe, Vice President, Brunswick Nuclear Project
D. Hunt, System Engineer
J. Kelly, Construction Coordinator
B. Kitchen, Maintenance Supervisor
*R. Mayton, Principal Health Physicist (Corporate)
*B. Meyer, Principal Health Physics Specialist (Corporate)
*R. Morgan, Plant Manager (Robinson)
*A. Poland, Project Specialist,. Radaition Control
S. Power, Brunswick Engineering and Support Unit
M. Shaw, Operations Shift Foreman
*R. Smith, Manager, Environmental and Radiological Control (Robinson)
*R. Starkey, Vice President, Brunswick Nuclear Project
J. Terry, ALARA Coordinator
J. Titrington, Operations Principal Engineer
R. Warden, Instrument and Control Supervisor
*B. Webster, Manager, Health Physics (Corporate)
M. Worth, Technical Support Supervisor

Other licensee employees contacted included engineers, technicians, maintenance, and office personnel.

Nuclear Regulatory Commission

W. Levis, Resident Inspector
W. Ruland, Senior Resident Inspector

*Attended exit interview

2. Background (83528/83728)

For the period 1974-1987, Brunswick Units 1 and 2 have exceeded the national average in collective dose for Boiling Water Reactors (BWRs) 11 out of 12 years. The average collective dose for all BWRs for this period is 829 person-rems per reactor over 312 plant-years of operation. Four BWR units had cumulative average exposures which exceeded the BWR cumulative average exposure by 50% or more. Brunswick Units 1 and 2 ranked third on the list with an average exposure of 1340 person-rem.

In 1980, Carolina Power and Light (CP&L) formally implemented their ALARA Program. Procedures were developed at Brunswick incorporating all elements of ALARA in-plant operations. In 1983, a person-rem budgeting procedure was issued which established methods for developing plant exposure budgets and General Employee Training (GET) was upgraded to emphasize ALARA concepts. Also Brunswick chose to perform weld overlays for piping that was cracking due to intergranular stress corrosion instead of replacing the piping. Weld overlays, intergranular stress corrosion cracking (IGSCC), non-destructive testing and weld crown reduction have been (and continue to be) major contributors to collective exposure at the station.

In 1985, a task force comprised of CP&L personnel was formed to propose a Radiation Exposure Reduction Program. The goal of the program was to lower personnel dose at CP&L facilities to within industry standards. The key elements of the program were to improve supervisor responsibility and accountability in radiation safety, personnel dose reduction; and radwaste volume reduction.

Increased emphasis was placed on exposure accountability in 1986. For 1987, each unit (department) was charged with the responsibility for their dose goals. Unit goals for 1987 were approved by unit managers and submitted to the ALARA coordination group. An annual collective dose goal for 1987 was established at 1,700 person-rem. Later that year Brunswick experienced a refueling outage for Unit 1 which lasted 20 days. The refueling portion of the outage was completed with the lowest person-rem (46) of any previous refueling effort; however, 1,118 person-rem were expended during the overall outage. The major contributor to the collective dose during the outage was weld overlay work (212.5). In addition, 27 person-rem was due to added work from 13 projects that were not identified during outage planning or were not in the original scope of work for the outage. A factor which allowed Brunswick to reduce exposure for this outage from what it might have been, was the chemical decontamination of the reactor recirculation piping. The decontamination cost 28 person-rem to perform but saved a postulated 864 person-rem.

The annual collective dose goal for 1988 was set at 1540 person-rem. Unit 2 refueling outage was completed on April 28, 1988, with the expenditure of 1016.7 person-rem, 109.5 above the goal of 852 person-rem. In addition, 55.2 person-rem were expended on additional work not included in outage planning. The major contributors to dose for this outage were Mechanical Stress Improvement Process (MSIP) work, weld overlays, ISGCC, and Non-Destructive Examinations (NDE). Although recommended by health physics (HP), a dilute chemical decontamination of the recirculation piping system was not performed to reduce exposure during the outage.

Table 1 shows a comparison of Brunswick collective annual dose with that of average BWR collective annual dose.

TABLE 1

Comparison of Brunswick's Annual Collective Dose with the Average Collective Dose for Commercial Boiling Water Reactors.

Year	BWR Average Dose per Reactor (Rem)	Brunswick's Dose Per Reactor (Rem)
1976	549	326
1977	828	1,119
1978	604	1,004
1979	733	1,302
1980	1,136	1,935
1981	980	1,319
1982	940	1,396
1983	1,056	1,738
1984	1,003	1,630
1985	735	1,402
1986	875	955
1987	521	709

3. Program To Maintain Radiation Exposures ALARA (83528/83728)

The following procedures, which implement the station ALARA program, were reviewed by the inspectors:

AI-52	ALARA Subcommittee Activities and Responsibilities
AI-53	ALARA Project Evaluation
BSP-8	Brunswick Nuclear Project Radiation Exposure Budgeting
BSP-30	ALARA Suggestion Awareness Program
E&RC-0230	Issue and Use of Radiation Work Permit
E&RC-4100	ALARA Program
E&RC-4100.1	ALARA Review of Plant Modifications
E&RC-4100.2	ALARA Review of Plant Procedures
E&RC-4100.4	ALARA Problem Reports
E&RC-4150	Use of Temporary Shielding for Personnel Exposure Reduction

a. Organization

The licensee's ALARA organization consisted of a permanent staff of an ALARA project specialist, reporting to the Manager of Environmental and Radiological Control, two senior ALARA Specialists, one ALARA Specialist, and one ALARA technician. The inspectors reviewed the staff members' experience level and qualifications and determined that they met the technician qualification requirements of ANSI 3.1 and that each person had extensive applied HP experience.

The licensee established an ALARA Subcommittee in 1981 as a standing subcommittee of the Plant Nuclear Safety Committee (PNSC). The primary function of the ALARA Subcommittee was to act as an advisory group on plant ALARA related topics to the PNSC, and to identify opportunities to reduce personnel dose. The membership evolved from 13 members in 1983 to 16 members in 1988, that included a chairman, secretary, and 14 members from major station departments. The committee routinely meets monthly to review and discuss plant ALARA related topics. The inspectors noted that with the exception of the chairman, vice chairman and secretary that new ALARA subcommittee members are appointed annually.

The inspectors determined the following based on a review of ALARA Subcommittee meeting minutes (1983-1987) and discussions with licensee representatives:

- The current status of collective dose was discussed at the meetings but not to the extent that would result in concerns and recommendations necessary for the PNSC to become involved in reducing collective dose.

- Other than HP, managers of station departments rarely attended ALARA subcommittee meetings.

- ALARA subcommittee members were working level personnel by design (to better address dose reduction in detail), but could not make commitments for the departments they represented.

- ALARA Problem Report Items are frequently carried for periods of up to six years.

The inspectors concluded that the effectiveness of the ALARA Subcommittee could be improved by direct participation and support by plant management and supervision.

b. Work Reviews

Licensee procedure, AI-53, ALARA Project Evaluation, Revision 0, dated April 28, 1987, required a pre-job review to be completed when the initial exposure for the work activity under consideration was estimated to be equal to or greater than one person-rem. The procedure required that the pre-job review be reviewed and signed by the person responsible for the job, by his foreman or coordinator, by the appropriate system engineer and by an (E&RC) ALARA Specialist or his designee. Those activities that were projected to have an exposure estimate equal to or greater than ten person-rem were required to be reviewed and signed by the responsible person's subunit supervisor as well. For jobs with an estimated exposure equal to or greater than 25 person-rem, a further review and signature was required by the unit manager whose originator planned the work and initiated the pre-job review.

The means used to determine what level of review was required was the ALARA Project Review form. The job originator completed the form indicating the estimated number of man-hours required to complete the work as well as the work location and a description of the work to be performed. The form was then reviewed by an ALARA Specialist who estimated the person-rem to be expended, checked the historical file to determine what person-rem had been expended in the past on similar jobs, and developed an exposure goal for the job. Following completion of these estimates, the appropriate level of review was determined and the reviews and signatures would be obtained as required.

Procedure AI-53 also required a post-job review of all projects or activities which required the completion of a pre-job review. The post-job review consisted of holding a meeting to critique the job and the exposure expended. Those required to attend included, at a minimum, the individual responsible for the work and an ALARA Specialist. Any information or recommendations that would aid in future projects were to be documented in the Post-job Review section of the ALARA Project Review form.

Those jobs with actual exposures equal to or greater than 10 person-rem or less than 10 person-rem but exceeding the goal by 2 person-rem were required to be reviewed and signed by the subunit supervisor. Projects with actual exposures equal to or greater than 25 person-rem or greater than 10 person-rem but deviating from the original goal by plus or minus 25 percent were required to be reviewed and signed by the unit manager as well as the ALARA Subcommittee Chairman. From the post-job reviews, the ALARA group compiled job history files for major jobs as well as for unusual jobs which required the expenditure of a significant amount of dose.

The inspectors reviewed selected ALARA Project Review forms containing pre-job and post-job reviews performed during 1987 and 1988, and verified that the required information concerning man-hours, person-rem and problems or recommendations noted during the jobs were documented. The required reviews had been performed. The inspector determined that lessons learned during previous jobs of a similar nature were reviewed and considered during the ALARA review of jobs being planned for the future. It was also determined that, during 1987, 84% of the station's dose had undergone review and was expended during work that had been preplanned.

During the review of the ALARA Project Review forms, it was also noted that, in two-thirds of the forms reviewed, the total number of actual man-hours worked, the total number of actual person-rem received or both varied by more than fifty percent from the estimates that had been established prior to commencement of the respective jobs. The inspectors discussed these discrepancies with representatives of the ALARA group. They indicated that some of the situations in question had involved jobs in which the scope of work

had changed or were jobs with which the personnel performing the work were not familiar. Because no mechanism existed by procedure, and in order to retain the original data for comparison, the estimates for man-hours and/or person-rem had not been changed but had been left as originally stated.

The causes for the differences in the estimates versus the actual totals had been outlined in the post-job portion of the review form. As stated above, the reasons for the discrepancies were generally listed as changes in job scope or personnel being unfamiliar with the work being performed. In further discussions with licensee representatives, it was noted that a major problem was that the man-hour estimates received from the job supervisors were usually too high and included time not spent by the workers in a radiation area.

In reviewing the causes for differences in the estimates and the actual totals including area dose rates and man-hour estimates, the inspectors determined that the man-hour estimates appeared to be the major contributor. The many discrepancies of greater than 50% between the estimated and the actual man-hours/person-rem indicated that the licensee's method of estimation of such important data needed to be improved and that some method needed to be developed to allow revision of the estimates once they had been established. The licensee acknowledged the need for an improved method and stated that they would reassess the current process.

c. Radiation Dose Goals

Licensee Procedure BSP-8, Brunswick Nuclear Project Radiation Exposure Budgeting, Revision 2, dated November 29, 1986, described the process used by the licensee to develop and establish goals for the units and subunits at the facility. The procedure required first and second line supervisors to establish and maintain person-rem goals for their respective work groups/projects. The procedure also required these supervisors to be responsible for exercising good work control and work practices to achieve the goals. In practice, each subunit's ALARA Subcommittee representative was used for this task and, in turn, made use of the ALARA group's experience, historical files, and expertise. Within thirty days of the end of the calendar year, each unit manager then compiled the subunits' exposure goals and developed an overall goal for the next year. The goal was submitted to the Manager, E&RC for review.

The procedure required the Manager E&RC, to review the goals or budgets and ensure that all potential exposure was accounted for, to ensure that the estimates or goals were adequate and challenging yet achievable, and to identify ways of possibly reducing exposures and compiling a site goal. The final site exposure goal, following any necessary adjustments, was then required to be signed by the facility Vice President and tracked. E&RC reported on the progress of actual versus budgeted exposures by each subunit.

The subunit managers were required to conduct a review of actual versus budgeted exposure at the end of each calendar quarter. If the actual versus budgeted exposure total varied by more than 25% for the quarter, the manager was required to submit a report through the chain of command to the facility Vice President identifying the major reasons for the variance and actions taken, if any, to reduce or limit radiation exposures.

For 1988, the facility's exposure goal had been set at 1540 person-rem based on the original anticipated normal and outage operations. The licensee indicated, however, that they would probably not meet the established goal for 1988 based on added work scope. Licensee representatives did anticipate that they would be able to meet their goal for 1989 which had been set at what they felt the approximate national exposure average for BWRs would be for that year. Also, based on the future anticipated work load, the licensee was projecting that they would be able to continue to meet the BWR national average thereafter except during those years when a double refueling outage occurred.

d. Management of Collective Dose

The inspectors interviewed supervisors and managers to determine the methods used to manage dose reduction. Based on those reviews, the inspectors determined the primary method used was to review dose reports issued by the ALARA group. The inspectors reviewed the weekly, monthly, and quarterly ALARA dose reports used by management. The dose information contained in the weekly and monthly reports did not appear to contain sufficient detail to inform a manager or supervisor of their performance against a goal. Based on those reviews, the inspectors determined that the dose information contained in the weekly and monthly reports were not in enough detail to inform a manager or supervisor of their performance against a goal. The quarterly report did contain sufficient information for goal tracking but was not timely to allow managers and supervisors to manager dose on a daily/weekly basis.

In comparing the various units' weekly and monthly dose expenditures versus dose projections, it appeared that management made no mid course corrections to attempt to bring expended dose back in line with the projected dose once the projection had been exceeded. During the ALARA program assessment, the inspector did not observe or review any management initiatives or directions to recover from being over the dose projections. It appeared that, although the ALARA group was concerned about collective dose, there was little concern among managers about being over dose "budget." One reason for this was the fact that some units were always under budget and that would balance the station's overall expended dose with the dose goal.

A review of the station's annual collective dose goals and performance against those goals, as shown in Table 2, demonstrated

that the site collective doses were generally below the established annual goals. Following a review for the work performed and the station's performance, it appeared that the station's goals were not always challenging and the site goal was substanitally above the national average for BWRs.

TABLE 2

Brunswick Performance Against Established Dose Goals

	83	84	85	86	87
Annual Collective Site Exposure Goal	5,600	3,660	2,500	2,000	1,700
Annual Collective Site Exposure	3,475	3,260	2,804	1,909	1,419
National Average for BWRs	2,112	2,006	1,470	1,750	1,042

The inspectors discussed with licensee management representatives whether or not contractors were held accountable for achieving established dose goals. The inspectors were informed that specific contractors were not held accountable for person-rem expended on assigned tasks. The inspectors stated that contractors should be held accountable for doses received since contractor dose is a major contributing factor toward the annual total collective dose. Modifying the program to make contractors accountable for achieving dose goals should be benefical in reducing the station's annual doses.

e. Job History Files

The inspectors discussed with licensee representatives the historical data maintained for review when planning radiological work. Prior to 1984, the licensee maintained a log book of ALARA numbers assigned to specific jobs with estimated exposure greater than one person-rem. The dose was tracked by ALARA number on the specified projects. In 1984, the licensee initiated a system of maintaining folders on each project with estimated exposure greater than one person-rem. In 1987, the Procedure AI-53, ALARA Project Evaluation, was approved which required the use of the ALARA Project Review form. The form, as noted previously, included the pre-job and post-job review documentation as well as documentation of estimated and actual person-rem and man-hours, problems encountered during the job and notes from meetings held and lists of attendees. These data, along with other notes concerning the specific job and related information, were placed in files in the ALARA group's work area.

The licensee's computer data base system, Radiological Information Management System (RIMS), had also been employed to maintain

historical data and provide a means of ALARA review. An ALARA control number was assigned to each job to be tracked and this number was cross referenced with the Radiation Work Permit (RWP) number assigned to the job. Using the ALARA review mode of RIMS, a job originator could enter the ALARA tracking number of a previous project (similar to the one currently being planned) into the computer. The person would then be provided with information on the previous work including the job location, modification number of trouble ticket number (if used), the job description and estimated/actual man-hours and person-rem. Other related information could be reviewed by using the RWP review mode.

The inspectors reviewed selected job history files that were being maintained in the ALARA office. The inspectors noted that the files contained information that would be useful in planning other jobs of a similar nature. The inspector also reviewed the licensee's post outage reports that had been written and issued following the previous nine outages. These had been used to document historical data concerning radiological work. It was noted that the post outage reports were generally very definitive and identified the problems encountered during the course of the work. The inspector also noted that the majority of the recommendations made by the ALARA group in the post outage reports were included as action items in pre-outage planning. However, no formal program or requirement existed to ensure that the recommendations made by the ALARA group be included in pre-outage planning. The licensee acknowledged this and indicated that they would consider developing a means of formalizing this process.

f. Hold Program

Through a review of the procedure outlining the RWP program, E&RC-0230, Issue and Use of Radiation Work Permit, Revision 016, dated June 17, 1988, the inspector noted that specified ALARA reviews were required during the preparation of an RWP. However, there was no requirement to place any type of a hold or review on the work covered by the RWP when the exposure for the job began to approach or actually exceed the estimated dose projected for the job. The licensee indicated that, although no formal requirement existed in the procedure, jobs were often reviewed when the exposure estimates were approached. This occurred because the ALARA group tracked the exposures daily and the ALARA personnel were aware of those jobs that were approaching or exceeding the estimates. Also, notification was often given to the ALARA group by the HP technician covering the work who was aware of the exposure status of the job and was concerned about it. On occasion a concerned worker or supervisor would notify the ALARA group of the exposure status or exposure rates encountered at the work site. The licensee indicated that this was not always a formal review but usually involved at least a review by one of the ALARA Specialists.

The inspectors also reviewed the function of a committee that had been established to control and reduce exposures during outage periods. In early 1987, an Outage Radiation Exposure Review Committee was established to review any plant modification, project, task or other activity that had an assigned "exposure budget" for which the exposure budget was going to be exceeded according to analysis of the exposure tracking and trends. The Manager, E&RC was to notify the chairman of the committee whenever exposure trending data indicated that an exposure budget would likely be exceeded without corrective action being taken. The chairman would then call a committee meeting to review the project and determine what corrective actions needed to be taken.

In reviewing the activity of this committee, the inspectors determined that it had met only once since its inception to consider an exposure budget problem. Since that time, the Manager, E&RC had handled the exposure problems informally without involving the committee chairman or the committee. The Manager, E&RC also indicated that, since the station's expended dose is generally reciewed daily during management meetings, there was little need to convene a committee meeting.

The licensee acknowledged the lack of a hold program to review the status of jobs approaching or exceeding the exposure estimates and the lack of action by the review committee. The licensee indicated that a hold program and activation of the review committee would be assessed and implemented if warranted.

4. Performance (83528/83728)

In discussions with the inspectors, the licensee stated that outage durations, a large number of people with measurable exposure, and work added to outages after the completion of outage planning contributed to the collective dose exceeding the national average.

a. Outage Duration and Addition of Outage Scope

Both the Outage Manager and Manager of Planning and Scheduling stated in interviews, that the length of outages and the addition of work to outage scope after outage planning was complete were two areas that were contributors to the high annual collective exposure. The licensee has taken action to minimize the late addition of design change packages or modification work by setting a deadline prior to an outage. Currently no additional work, except for safety items, will be performed in an outage that is proposed later than six months prior to the outage start date, without the Outage Project Director or Vice President of Brunswick Nuclear projects'approval. Planning and scheduling efforts have been increased in the area of carrying forward lessons learned from previous outages. Action items based on previous outage problems were assigned to individuals and progress tracked daily for completion prior to the outage start date. The

Outage Manager stated that outage work has been divided into projects and assigned to unit project managers for the upcoming outage. Ninety-six projects will be divided among 10 to 15 unit project managers who will report to a manager for coordination. In addition, the use of mockup training has been increased to improve performance on the job. The licensee stated that the Unit 1 refueling outage, to begin in November 1988, was scheduled for a 10 week duration. Table 3 shows the licensee's program since 1983 for reducing outage duration and person-rem resulting from the late addition of outage scope. (The table also shows the person-rem resulting from rework which is dicussed in Paragraph 4.b.)

TABLE 3

Outage	Duration Weeks	Additional Scope Person-rem	Rework Person-rem
Unit 1 Condenser/Refueling	31	150.65	-
Unit 2 Condenser/Refueling	30	-	-
Unit 1 IGSCC/Weld Overlay	6	-	27.18
Unit 2 PT Outage	2	8.15	-
Unit 1 Refueling	29	584.3	Unquantifiable
Unit 1 Refueling	16	26.8	Unquantifiable
Unit 2 Refueling	16	55.2	Unquantifiable

b. Unnecessary Dose Resulting From Rework

Inspection Report Nos. 50-325/85-39 and 50-324/85-39 dated January 1986, reported that, based on interviews with plant personnel, maintenance rework was a significant contributor to the facilities' external exposure. The licensee agreed to evaluate the finding and it was carried as inspector followup item (IFI) 50-325/85-39-01. In a subsequent inspection (Inspection Report Nos. 50-325/87-28 and 50-324/87-28), the inspector's review of the IFI noted that the licensee had not effectively addressed the IFI. This inspection carried the IFI as 50-325/87-28-02.

The inspectors attempted to quantify the amount of unnecessary exposure due to rework through review of licensee outage reports and through discussions with licensee representatives and management. However, due to the failure of the licensee to implement a rework tracking program, no quantification of such data could be made. The manager, E&RC stated that his department had attempted to track rework but was not able to identify rework in sufficient detail to do so. The inspectors found that some departments' definition of rework was that any number of repairs or removal/reinstallations may take place on a system, but, these repairs were not considered rework until after the system was tested and further repairs were needed. Table 3 shows the amount of dose resulting from rework when it could

be quantified. The inspectors determined that corrective actions sufficient to reduce unnecessary exposure resulting from rework cannot be taken until cooperation is received from all departments in order to identify rework (as defined from an exposure standpoint) and a formal system implemented to track rework.

c. Number of Personnel With Measurable Dose

The inspectors reviewed the data concerning the number of people with measurable dose at Brunswick for the period 1983 through 1987. In 1983, the ALARA Subcommittee minutes 83-03 reported that Brunswick site had badged more workers than any other United States nuclear facility for four consecutive years (since 1979). NUREG-0713, Volume 7, Occupational Radiation Exposure at Commercial Nuclear power Reactors and Other Facilities 1985, Table 4.7a shows five year totals of workers with measurable doses (greater than 100 millirem) for the years 1981 through 1985. Brunswick Unit 2 had 23,516 workers with measurable dose while the next closest total for a BWR was 16,696 for that period.

Licensee management stated that the number of people with measurable dose was high and that efforts were in progress to reduce the number of people entering the radiologically controlled area. Two work groups were involved in this effort. Brunswick Engineering Support Unit, a group that is responsible for engineering modifications, would be moved to Raleigh Corporate Headquarters, and the Brunswick Construction Contractor group would be deleted in March of 1989. Licensee progress in reducing the number of people with measurable dose is shown on Table 4 as well as the percent of difference above the industry norm for BWRs. As can be seen for the years 1983 through 1987, Brunswick had approximately 153% more workers with measurable dose than the industry norm for a typical BWR.

TABLE 4

Comparison of Brunswick with Industry Norms for Average Number of Personnel with Measurable Dose Per Reactor

	1983	1984	1985	1986	1987
Number of Personnel with Measurable Dose	2,601	2,540	2,025	1,685	1,526
BWR Industry Average of Personnel with Measurable Dose	1,287	1,522	1,366	1,264	1,269
Percent of Industry Norm	202	166	148	133	120

d. General Radiation Work Permits

Through discussions with licensee representatives, the inspectors determined that the method used to track radiation exposure by means of individual job or task had been revised several times. The licensee was continually trying to refine the method of tracking dose in order to better be able to determine where the dose was being expended. From these discussions and reviews of previous outage reports, it was determined that this was, in general, the case. However, it was noted that, during the previous three outages and during the outage that was in progress, there was one category where dose was not tracked in a manner that would facilitate determination of dose expenditure per activity. In these four cases approximately 10% of the total dose expended during the outages had been assigned to "general area" activities. The licensee indicated that these activities included such things as housekeeping, restocking of protective clothing bins, general area tours and other non-specific activities. Another category that accounted for approximately 10% of the dose used during the outages was "support activities."

The inspectors indicated that this was a significant amount of dose and that this dose was not receiving any type of an ALARA review. The licensee acknowledged this fact and indicated that they would evaluate the impact of this and the need for future review.

e. NUREG/CR-4254

The inspectors reviewed NUREG/CR-4254, Occupational Dose Reduction and ALARA at Nuclear Power Plants: Study on High Dose Jobs, Radwaste Handling and ALARA Incentives, dated April 1985, with licensee ALARA personnel. NUREG/CR-4254 contains data on dose experienced throughout the industry for typical high dose jobs. The inspectors compared the licensee's exposure history for several of those jobs described in the NUREG as indicated in the following table:

TABLE 5

Brunsiwick Dose Summary for High Dose Jobs

Job	Unit	85	86	87	88	NUREG/ CR-4254 Avg
Snubber Inspection and Repair	1	18		28		290
	2		27		24	
In Service Inspection	1	45		31		150
	2		61		--	
CRD, Rebuild Replacement	1	47		7		60
	2		27		9	

Insulation Replacement	1	58		35		44
	2		55		43	
Plant Decontamination	1	51		16		37
	2		41		23	
RHR System Repair/Maint.	1	58		25		34
	2		87		8	
Reactor Assg/Disssg.	1	49		46		24
	2		82		65	
MSIV Insp./Repair	1	9		0.4		20
	2		14		3	
Instrumentation Repair/Calib.	1	87		64		15
	2		69		--	
TIP/SRM/IRM/PRM Calib./Repair/Maint.	1	12		22		11
	2		9		13	
Turbine	1	-		8		6
	2		6	13		

The inspectors determined that for most of the jobs reviewed, the licensee's dose performance compared favorably with the industry averages indicated in NUREG/CR-4254 (1974-1984 data).

5. Dose Reduction Initiatives (83527/83728)

The following dose reduction initiatives performed by the licensee resulted in the following estimated person-rem savings as indicated below:

a. Shielding

Year	Temporary Shielding Request (TSR)	NET Person-REM Savings
° 1983	68	35
° 1984	97	53
° 1985	144	133
° 1986	66	159
° 1987	79	87
	454	467

b. Chemical Decontamination

° Unit 2 Reactor Water Cleanup System (RWCU) - 221 Person-Rem Saved in 1984

- Unit 2 Reactor Recirculation System (RRS) - 1355 Person-Rem Saved in 1986
- Unit 2 RWCU System - 52 Person-Rem Saved in 1986
- Unit 1 RRS - 864 Person-Rem Saved in 1987

c. Reduced Turbine Building Operating Surveillance

- Reduced Person-Rem by 5 Person-Rem/month

d. Control Rod Drives (CRDs)

- Testing of CRDs to eliminate unnecessary rebuilds reduced person-Rem by 20 Person-Rem/Outage

e. Training/Mock-Ups

- Types - CRDs, reactor recirc suction nozzles, jet pump riser bio-shield windows, valves and valve operators
- Estimated Person-Rem Savings

Unit 1 1983 Outage - 730
Unit 2 1984 Outage - 75
Unit 1 1985 Outage - 140
Unit 2 1986 Outage - 95
Unit 1 1987 Outage - 100

f. Chemistry Controls

During the period from 1983 through 1987, the licensee has effectively managed reactor coolant chemistry in both units to keep reactor water conductivity at or below Administrative or Technical Specification limits. This program has been partly successful by operating at least one of the Reactor Water Clean-Up pumps during power operations to maintain reactor coolant chemistry. Reactor coolant chemistry has not been a factor in increased collective person-rem exposure during the assessment period of 1983 through 1987.

g. Fuel Integrity

During the period from 1983 through 1987, the licensee effectively managed fuel integrity in both units by enhanced chemistry controls. The licensee implemented a fuel integrity monitoring and chemistry measurement evaluation program which included allowable levels of dose equivalent I-131 (DEI) in the Primary Coolant System. The DEI was monitored on a daily basis, under equilibrium and transient conditions, with respect to the technical specification limit of one microcurie per gram (1 uCi/gm). This was accomplished by monitoring

daily iodine isotopic concentrations in the primary coolant system, based on measurements performed by station chemists, and calculating the DEI.

During refueling outages, the licensee performed an analysis of each fuel assembly that was suspected of having fuel degradation. After these tests were performed (wet sipping) and the fuel assembly had been determined to be defective, the entire fuel assembly was replaced by a new fuel assembly known not to be defective. All of the fuel assemblies that were determined to be defective were later reconstituted by replacement of individual fuel pins.

6. Interviews (83528/83728)

a. Employee Interviews

Licensee employees were interviewed to assess their knowledge, involvement, and perspective of the utility's ALARA Program. An ALARA questionnaire was prepared prior to the inspection and was utilized during each interview to ensure that each employee's ALARA awareness and involvement was evaluated uniformly.

The employee questionnaire was prepared to evaluate the employee's knowledge of ALARA goals, concepts, policies and procedure documents; individual responsibilities, personal doses and personal dose limits; the employees involvement in special ALARA training, communication with co-workers and supervision, and participation in the ALARA suggestion program; and the employees' perspective on how to improve the ALARA program, what events or conditions have caused increased personnel doses, and what events or conditions had helped reduce personnel doses.

(1) Employees

All employees interviewed entered the RCA on a daily to weekly basis depending on plant conditions.

(2) Knowledge of ALARA Program

Each of the employees interviewed was familiar with the basic ALARA concepts taught in the GET program and knew that they had a basic responsibility for implementing the utility's ALARA program by performing tasks in a manner consistent with the utility's ALARA policy. In general the employees knew their current radiation exposure and their exposure limit. The employees generally were aware of where the ALARA requirements originated and what documents described the ALARA program objectives. Most of the employees interviewed knew that each of their sections had an ALARA goal, but generally were unaware of the goal that was established. However, the employees did know

that they could find out these section goals from the ALARA staff.

(3) ALARA Program Involvement

The majority of employees interviewed had not received any ALARA training other than given in the GET course. A majority of those interviewed had received some informational ALARA training on jobs requiring ALARA pre-job planning and on-the-job training. The employees reported frequent discussions of ALARA objectives on major jobs during outages with co-workers and supervisors. The employees also reported good communications with the ALARA and HP staffs. Only a small fraction of employees interviewed had participated in the formal ALARA suggestion program. Other employees reported that they had made suggestions to supervisors informally and had not used the formal ALARA suggestion program believing it was only for "significant ALARA suggestions."

(4) Perspective

Most of the employees had suggestions on how the ALARA Program could be improved. The suggestions included better planning and scheduling of work to ensure appropriate equipment and tools were readily available to perform tasks expeditiously. The majority of employees had opinions on things that had contributed to decreases and increases in personnel exposures. Employees believed that the following actions had contributed to exposure reductions: use of temporary shielding, special tools, permanent shielding, chemical decon, flushing of various system components and lines, and decontamination of contaminated areas within the RCA. Employees believed that the following actions had contributed to increases in personnel exposures: poor maintenance planning and scheduling in the past, weld overlays of recirculation pipe in the drywell, use of unqualified contract personnel, and use of too many personnel onsite entering the RCA.

b. Management Interviews

Licensee managers and supervisors were interviewed to assess their knowledge of the utilities' ALARA Program. An ALARA questionnaire for managers and supervisors was prepared prior to the inspection and was utilized during each interview to ensure each manager's and supervisor's ALARA awareness and involvement that was evaluated uniformly. The questionnaire was prepared to evaluate the manager's or supervisor's knowledge of ALARA goals, concepts, policies and procedure documents, individual responsibilities, personal exposure, and personal exposure limits; the manager's or supervisor's involvement in special ALARA training, communication with coworkers and supervision, and participation in the ALARA suggestion program;

and the manager's or supervisor's perspective on how to improve the ALARA program, what events or conditions have caused increased personnel exposures, and what events or conditions has helped reduce personnel radiation exposures.

(1) Managers and Supervisors

All individuals interviewed entered the RCA on a weekly to monthly basis depending on plant conditions.

(2) Knowledge of ALARA Program

Each of the individuals interviewed was familiar with the basic ALARA concepts taught in the GET program and knew that they had a basic responsibility for implementing the utilities ALARA program by performing a task in a manner consistent with the utility's ALARA policy. In general, the managers and supervisors interviewed knew what their current radiation exposure was and what the exposure limit was for their departments. The managers and supervisors had a good understanding on where the ALARA requirements originated and what corporate and plant documents described the ALARA program objectives. All of the managers and supervisors interviewed knew what their departments ALARA goals were.

(3) ALARA Program Involvement

The majority of the managers and supervisors interviewed had not received any ALARA training other than that given in the GET course. Each department had a dedicated individual to serve on the ALARA Sub-Committee, which met on a monthly basis or as appropriate. The ALARA Sub-Committee members represented their departments in discussions of ALARA objectives for major outage jobs. None of the managers or supervisors interviewed had participated in the formal ALARA suggestion program. However, generally most of the managers or supervisors interviewed were aware of the number of ALARA suggestions submitted by their departments in the past or current year. These ALARA suggestions were usually submitted by the departments' Sub-Committee members and not by plant employees.

(4) Perspective

All managers and supervisors interviewed had suggestions on how the ALARA program could be improved. The suggestions included better scheduling and planning of work to ensure appropriate equipment and tools were readily available and continue to increase the awareness of the ALARA concept to all levels of plant personnel. These methods could be through GET retraining, departmental training, non-licensed training or through the Advanced Radiation Worker Training (ARWT) Program. The ARWT

program was in the process of being revised and was to be implemented in the first half of 1989.

The majority of managers and supervisors had opinions on things that had contributed to decreases and increases in personnel exposures. Individual managers and supervisors interviewed believed that the following actions had contributed to exposure reductions: use of temporary shielding, permanent shielding, reduced work activities in high radiation areas, chemical decon and flushing of various systems components and lines, reduction of contaminated areas within the radiological controlled area, use of reach rods on specific systems and reducing refueling outage durations.

Individual managers and supervisors interviewed believed that the following actions had contributed to increases in personnel exposures: poor maintenance planning and scheduling in the past, forced outages, weld overlays of recirc pipe inside the drywell, repetitive work or rework of specific jobs, number of personnel on site entering the RCA, duration of outages, and failure to manage dose on a daily basis to stay within budgeted goals.

7. Internal Audits and Assessments (83528/83728)

The inspectors reviewed annual audits of the site Radiation Control Program for the years 1983 through 1988. The purpose of the annual audit by Corporate Quality Assurance group was to assess the adequacy and effectiveness of the E&RC program through review, evaluation, and verification of implementation of the Plant Operating Manual, Technical Specifications, Final Safety Analysis Report, and Corporate Quality Assurance Program. Only one audit addressed the ALARA Program in any detail but did not result in any comments or recommendations. The inspectors found in general that the audits were not in sufficient depth and did not result in identifying radiological, technical issues for correction, for ALARA program improvement. Licensee management representatives acknowledged the inspectors concerns and stated that the audit and assessment program would be reviewed and evaluated to assess the effectiveness of ALARA programmatic problems.

8. Training (83528/83728)

The inspectors reviewed the licensee's program for ensuring that all employees received training in ALARA beyond that given in basic GET. Both the ALARA group and the site non-licensed training group were involved in giving various types of ALARA training. The ALARA group provided input for the training given to engineers onsite and provided ALARA-related training as requested for the QA/QC group. The ALARA group also sponsored all types of mock-up training such as in the use of: 1) cutting equipment, welding equipment and QC inspections of highly irradiated

components, 2) shielding, 3) glove bag/containments, and 4) mock-up training in the maintenance/repair of various valves, snubbers and motors.

The site non-licensed training organization had been tasked with and had completed including ALARA topics and training into all aspects of the training given by the group. This included the instruction furnished under the Craft and Technical Development Program. The inspector reviewed lesson plans for training offered in radiological control, chemistry, mechanical maintenance, electrical maintenance, and instrumentation and control activities and verified that ALARA topics/training were mentioned as required.

The inspectors also toured the licensee's practical factor training areas. One area was equipped with a mock-up of the underside of the reactor vessel and was used to train personnel in the proper method to remove a control rod drive mechanism. Another area housed various motors, valves, piping systems, snubbers, and valve operators for training purposes. Another training area had been equipped with large sections of piping on which cutting or welding equipment could be set up and operated for training purposes. The inspectors determined that the licensee should be able to provide adequate mock-up and classroom training.

The inspectors also reviewed the status of the licensee's advanced GET III training program with licensee representatives. This program had been suspended in 1987 for evaluation. A discussion of what the new training program is scheduled to include and when it is scheduled to begin is found in Enclosure 2, Paragraph 6.

9. Conclusions (83528/83728)

The inspection revealed that the licensee appears to have in place most of the elements of an adequate dose reduction program. However, the licensee's past performance has been less that adequate and the effectiveness of the implementation of the recent initiatives remains to be seen. In the past, lack of management support and involvement in ALARA, conflicting operational priorities, and unforeseen work items have caused major problems for the ALARA program. Increased licensee management support and involvement will be required to lower the licensee's collective station dose to be consistent with the national average for BWRs. The following significant issues were identified during the inspection and should be addressed by the licensee to increase the effectiveness of their ALARA program:

a. Increased management support and involvement is needed in the ALARA Program (Paragraphs 3.c and d) (50-325/88-33-01).

b. Annual exposure goals are not challenging and should be established at or below the industry norm (Paragraph 3.d) (50-325/88-33-02).

c. The number of personnel with measurable exposure is consistently higher than the industry norm (Paragraph 4.c) (50-325/88-33-03).

d. The audit program is not resulting in ALARA program improvements (Paragraph 7) (50-325/88-33-04).

e. A mechanism should be established to require additional ALARA reviews prior to exceeding dose projections (Paragraph 3.f) (50-325/88-33-05).

f. The ALARA Subcommittee meetings have not been well attended by members or management (Paragraph 3.a) (50-325/88-33-06).

g. Exposures resulting from rework has not been adequately indentified and tracked (Paragraph 4.b) (50-325/88-33-07).

h. The process of estimating man-hours needed to perform a job are frequently overestimated and result in discrepancies between estimates and active man-hour worked (Paragraph 3.b) (50-325/88-33-08).

i. A significant amount of exposure is accumulated under general radiation work permits and therefore, not receiving specific ALARA review (Paragraph 4.d) (50-325/88-33-09).

10. Exit Interview (30703)

The inspection scope and findings were summarized on October 5, 1988, with those persons indicated in Paragraph 1. The inspectors described the areas inspected and discussed in detail the inspection findings (see Paragraph 9). The licensee acknowledged the inspection findings and took no exceptions. The licensee did not identify as proprietary any of the material provided to or reviewed by the inspectors during the inspection.