STEAM GENERATOR REPAIR PROGRAM

FOR THE

SURRY POWER STATION

UNIT NO. 1

FINAL REPORT

(RADIOLOGICAL PROGRESS REPORT - NO. 5)

FOR THE PERIOD

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VIRGINIA ELECTRIC AND POWER COMPANY

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1.0 INTRODUCTION

The Steam Generator Repair Program (SGRP) for Surry Power Station, Unit No. 1, commenced on September 14, 1980 and was completed on June 30, 1981. This Final Progress Report contains information on the radiological effects of the SGRP, and on the measures taken to maintain these effects "as low as reasonably achievable" (ALARA). Much of the information presented has been obtained from earlier radiological progress reports submitted periodically during the repair program.

The following report sections provide an assessment of the occupational radiation exposure expended, the dose reduction techniques employed and their effectiveness, and the radioactive effluents and solid waste generated during the repair program. An assessment of the surveillance activities associated with onsite storage of the old steam generator lower assemblies is also provided.

This final report has been prepared pursuant to the license conditions issued under Amendment No. 47 to the operating license for Surry, Unit No. 1 and, as such, completes and fully satisfies the requirements set forth in those conditions.

2.0 OCCUPATIONAL RADIATION EXPOSURES

2.1 General

Occupational exposure to radiation is considered to be the major radiological effect of the SGRP. As such, this aspect of the project underwent an extensive evaluation during the planning phase to provide realistic estimates of the amounts of personnel radiation exposure (manrem) which would be required to perform each of the tasks involved. These estimates were based upon the anticipated labor requirements (manhours) and the average radiation dose rates in the work area, and were presented in summary form in Table 5.3-1 of the report entitled "Steam Generator Repair Program", dated August 17, 1977 and amendments thereto, hereafter referred to as the SGRP Report.

Prior to commencement of the project, a program was established to assess the actual exposures received by personnel during the repair effort. This program was designed to provide data compatible with the detail and format of the exposure summary presented Table 5.3-1 of the SGRP Report, thereby permitting valid comparisons between estimated and actual expenditures. This section discusses the implementation of that program and provides an evaluation of the occupational exposure information compiled during the repair effort.

2.2 Evaluation of Exposure Data

The exposure assessment program referred to above was basically designed to utilize daily worker exposure data, as recorded by self-reading pocket dosimeters, in conjunction with contractor supplied, worker task data to determine task-related manrem expenditures. The worker task data was standardized to system of discrete work packages (called Engineering Task Assignments) which was developed during the project planning phase. The use of this system to categorize exposure related work facilitated the process of compiling an accurate breakdown of the collective exposure expended on the many tasks performed.

2.3 Description and Format of Exposure Data

Table 1 presents a summary of the occupational radiation exposure expended during the repair effort, the exposure related labor expenditures, and the original estimated expenditures. The following comments are provided for clarification and should be considered when reviewing the data presented.

(a) Additional tasks performed during the repair program which were not listed in Table 5.3-1 of the SGRP Report have been included in Table 1. Similarily, exposures received by personnel performing functions not directly attributable to any specific, pre-defined task have been listed separately. Expenditures reported for these "Additional Tasks" and "Unassigned Personnel Categories" were allocated to a particular phase based upon the major activities being performed at the time they were incurred.

(b) For each phase (except Phase V), separate subtotals are provided for: (i) the "pre-defined tasks" and (ii) the "additional tasks and unassigned personnel categories". Page 1 of Table 1 provides a summary of the "pre-defined tasks" subtotals for each phase and a summation of the "additional tasks and unassigned personnel categories" subtotals for all phases. The Project Totals are also shown on Page 1 of the table.

2.4 Conclusions and Observations

(a) The total occupational radiation exposure expended during the repair program for Unit No. 1 was approximately 15%, or 309 manrem, below the exposure estimate of 2,067 manrem.

(b) During the repair effort, no worker assigned to the SGRP received radiation exposure in excess of the federal standards specified in 10CFR20.

(c) The actual labor expenditures (manhours) reported in Table 1 exceed, in most cases, the estimates made during the project planning phase. This is largely attributed to the fact that peripheral and support activities performed in conjunction with a specific task have been included in the assessment of actual expenditures. The labor estimates developed prior to commencement of work were directed primarily toward providing a basis for evaluating the task exposure estimates and were not intended to consider or anticipate these additional activities.

3.0 APPLICATION OF ALARA PRINCIPLES

3.1 General

This section summarizes the specific techniques and practices which were employed during the repair effort in order to maintain occupational exposures to radiation "as low as reasonably achievable" (ALARA). Where the available data permits, the following evaluations include a quantitative assessment of the manrem savings which can be attributed to the technique used. Additional information on these techniques and how they relate to the overall steam generator replacement activities can be found in the SGRP Report.

3.2 Initial Containment Cleanup

After shutdown and the removal of all fuel from the reactor, a general cleaning of the containment interior was performed to remove loose radioactive contamination in the work areas and thereby reduce the potential for airborne contamination during subsequent activities. Additional cleaning and debris removal was performed after the biological shield walls and steam generator insulation were removed. The exposure received by personnel involved in these initial cleaning activities totaled approximately 58 manrem. The benefit, in terms of manrem savings, is difficult to quantify, however, the following observations give some indication as to the favorable results obtained.

(a) The use of respiratory protection devices, with their inherent degrading effect on worker efficiency, was rarely required, except as a localized precautionary measure for specific cutting and grinding activities.

(b) An extensive whole body counting program, to monitor workers for internal radioactivity, and the use of "Friskers" and portal monitors, to detect radiation on body surfaces, identified no instances of significant internal or external personnel contamination during the repair program.

The worker's ability to perform tasks more efficiently, and thus complete them more quickly, undoubtedly resulted in a reduction of the time spent in radiation areas. Considering the large number of workers involved even a small reduction in individual exposure times can produce significant savings in total manrem. The initial cleanup effort and the maintenance of good radiological working conditions are thus considered successful ALARA techniques.

3.3 Temporary Shielding

The use of temporary shielding can be attributed with significant reductions in personnel radiation exposure for the SGRP. A separate work package was devoted to the design and installation of shielding and frequent evaluations were performed to identify improved methods and new applications.

The lower steam generator cubicles received the most extensive application of shielding during the repair effort and thus the work performed in these areas benefitted most directly from its use. Piping and components located in the cubicles were shielded to achieve minimum exposure levels prior to the start of cutting and removal activities. After cutting of the reactor coolant piping, shield plugs were installed in the steam generator and pipe openings to reduce radiation "streaming". During the installation phase, additional shielding of the exposed reactor coolant pipe ends was performed, by placing specially fabricated bags containing lead beads inside the pipe and lead "blankets" on the outside surfaces. The removal and installation of miscellaneous piping located within the cubicles also received a significant shielding effort utilizing lead blankets and sheet lead "curtains".

Detailed radiation surveys were performed frequently and have provided a basis for evaluating the effectiveness of temporary shielding in achieving net reductions in personnel exposure. Survey data obtained prior to and after shielding installation permits the calculation of average dose rate reduction factors for appropriate tasks, and thereby an assessment of manrem savings. Three tasks

involving significant personnel exposure have been considered in this assessment.

(a) Cutting and removal of reactor coolant piping is reported in Table 1 as requiring the expenditure of about 77 manrem. Contact exposure rate measurements obtained during surveys has shown that an average dose rate reduction factor of 6 was achieved by shielding of this pipe. Using this factor and the actual exposure value for the task, a postulated expenditure of about 462 manrem would have been required to complete the task without the benefit of shielding. An assumed savings of 385 manrem can thus be credited.

(b) The removal of miscellaneous piping located in the steam generator cubicles accounted for the expenditure of approximately 14 manrem. Shielding applied to this pipe provided an average dose rate reduction factor of 5. Thus, without shielding 70 manrem would have been required to complete the task. A savings of 56 manrem is credited.

(c) The installation of reactor coolant piping involved several major activities inside the generator cubicles. Included were pipe end refurbishment and fit-up and welding of new coolant pipe sections. In Table 1, the installation of reactor coolant piping is reported to have required a total expenditure of 234 manrem. Survey data indicates that shielding performed for these activities was effective in reducing dose rates by a factor of 6, and thus resulted in a savings of 1,170 manrem.

Totaling the exposure savings calculated for the above three tasks results in an overall savings of about 1,611 manrem attributable to the use of temporary shielding. The exposure "cost" incurred during installation of shielding is listed in Table 1 as approximately 64 manrem. A comparison of these "benefits" and "costs" provides a clear indication of the value of this technique in maintaining occupational exposures ALARA.

3.4 Steam Generator Water Level

In the early stages of the SGRP, the water in the secondary system was maintained at a level covering the steam generator tube bundles in order to fully utilize its shielding quality. The high water level was maintained until the lower portion of the steam generator was ready to be removed from the containment, at which time it was drained to remove the extra weight. The shielding effect of this water has historically provided an approximate 10 to 1 dose rate reduction for the area of the steam generator above the tubesheet. This reduction factor was substantiated by actual survey results obtained during the removal phase and can be used to assess the effectiveness of this technique for several appropriate tasks.

(1) Removal of Insulation (upper shell, mainsteam and feedwater piping)
(2) Cut and Remove Steam Generator Upper Shell
(3) Cutting of Mainsteam and Feedwater Piping
(4) Disassembly of Steam Generator Supports
(5) Removal of Steam Generator Level Instruments and Blowdown Piping.

All of these tasks were performed in areas where the shielding effect of the steam generator water was beneficial. The total exposure received for these five tasks was approximately 23 manrem. The observed dose reduction factor of 10 thus translates into a postulated exposure savings of 207 manrem. Since practically no exposure "costs" were required to utilize this technique, its contribution to the ALARA program is obvious.

3.5 Plasma-Arc Cutting Equipment

In order to remove the steam generator lower shells from the containment, sections of the reactor coolant piping were cut and removed. A plasma-arc cutting torch was chosen as the means for performing these cuts. Plasma-arc has high cutting speed and produces good cut quality for pipe reinstallation. The high cutting rate was a primary factor in this choice since faster cutting means

reduced exposure times. During the evaluation of this task, alternate methods such as mechanical cutting and other flame cutting techniques were considered. These alternatives were estimated to require 1 to 4 hours per cut, as compared to 15 to 20 minutes for plasma-arc. In actual use, most of the reactor coolant pipe cuts were performed in approximately 20 minutes with the plasma-arc torch. Equipment set-up times were estimated to be about the same for all methods considered, since all would require special track mounting to maintain the close tolerances necessary for fit-up of new reactor coolant pipe.

The exposure savings attributable to the use of plasma-arc equipment could not be assessed, since the total manrem reported for the cutting of reactor coolant piping include significant contributions from equipment set-up and pipe removal. However, this technique has proven valuable in reducing exposure times and its use is consistent with the ALARA committment.

As a result of improvements made in the plasma arc cutting equipment prior to the Unit 1 outage, the cutting of the reactor coolant piping was accomplished with a total expenditure of 77 manrem. This compares to the Unit 2 outage in which 214 manrem was expended for this operation.

3.6 Temporary Containments and Ventilation

To a large degree, the initial containment cleanup and decontamination minimized the need for extensive use of temporary containments such as tents and glove boxes to control the spread of contamination. However, in areas where significant cutting and grinding work was performed on highly contaminated piping and components, temporary containments were constructed and effectively utilized.

The most significant application of this technique was made in the lower steam generator cubicles, where the removal of reactor coolant and miscellaneous piping was performed. In Unit No. 1, the lower cubicle for each steam generator was totally enclosed to

transform the entire room into a single containment. Portable ventilation units continuously withdrew air from these enclosures through appropriate filters whenever cutting or grinding operations were in progress. Personnel working inside the cubicles were required to wear respiratory protection equipment during these operations, and until the ventilation flow effectively reduced the airborne radioactivity to acceptable levels.

Additional tent enclosures were constructed in various locations to provide controlled work areas for pipe cutting, component refurbishment and equipment decontamination. Portable, filtered ventilation was provided to these enclosures as appropriate.

The benefits observed for these ALARA techniques were threefold.

(a) The use of small glove boxes for individual pipe cuts was eliminated. These devices required considerable time and exposure to install and remove, and during the Unit 2 SGRP were found in many cases to be counter-productive to ALARA due to this fact.

(b) The use of temporary containments, especially as applied to the lower steam generator cubicles, largely eliminated delays and interference with work being performed in adjacent areas while cutting and grinding of contaminated piping was in progress.

(c) The overall potential for airborne contamination and problems associated with contamination control was minimized by effective use of temporary containments and portable ventilation.

3.7 Mock-up Training

The installation of reactor coolant piping represented the most significant task performed during the repair effort with regard to occupational exposure. While the shielding techniques described earlier were effective in reducing the radiation exposure rates

associated with this task, the use of mock-ups to train the workers involved can be credited with providing reductions in exposure times. Welders, pipe-fitters, riggers and laborers all received extensive training in the activities to be performed by "dry runs" in full scale piping mock-ups. Completion times were noticeably reduced as the simulated activities were repeated to maximize each worker's familiarity with the actual job situation. Quantifying the exposure savings which have been realized through the use of mock-up training has not been attempted here, however, the inherent benefits of reducing exposure times for this major task were of significant importance to the ALARA program.

3.8 Videotape

As part of the Unit 2 outage a consultant was retained to videotape and take 35mm slides of the major activities during the project. This documentation was then edited into a one hour videotape which was used as a training aid to familiarize workers with the steam generator replacement program. The actual exposure savings which can be attributed to use of this videotape are difficult to quantify, however, the desired effect was to familiarize workers with the job and the environment in which it was to be performed, thereby eliminating a period of familiarization inside the containment.

3.9 Reactor Coolant Piping

For the Unit 2 SGRP, the old reactor coolant pipe sections were reused. In Unit 1, new reactor coolant pipe elbows were installed. This eliminated the task of decontaminating reactor coolant pipe sections, which required the expenditure of approximately 42 manrem during the Unit 2 repair effort. Additionally, during the Unit 2 outage, three sections of reactor coolant piping were removed from each loop. Based on experience gained in Unit 2, it was determined that removal of only two pieces of pipe would still allow an acceptable fitup to be achieved during reinstallation. This fact, in addition to the acquired familiarity with reinstallation of reactor coolant piping, is estimated to account for an additional savings of 95 manrem.

3.10 General Techniques and Practices

In addition to the specific dose reduction techniques described thus far, it is important to note the more general procedures and practices which were implemented prior to and during the repair effort to assure adequate control of occupational radiation exposure and to maintain this exposure ALARA. A brief description of each is given below.

(a) A comprehensive Health Physics program was implemented to provide adequate control and surveillance of the radiation hazards associated with each task. This program included the use of Radiation Work Permits (RWP's) to familiarize workers with the specific radiological hazards involved and proper protective measures to be taken in the performance of their work. The successful implementation of this program is evidenced by the excellent radiation protection record which was achieved.

(b) An extensive training program was conducted to provide adequate instruction in the biological effects of radiation exposure, radiation protection practices and applicable federal regulations to all personnel involved in the steam generator replacement activities. Training for specific tasks, using mock-ups, photographs or "dry runs" was conducted where appropriate.

(c) The use of discrete "Work Packages" provided a mechanism to assure adequate preplanning and review of specific tasks, with special emphasis on minimizing radiation exposures to the personnel involved.

(d) Special tools and equipment, designed to minimize personnel exposure times by increasing worker efficiency and providing remote handling capability were utilized where practicable.

(e) A consultant was retained to compile an extensive photographic and video-tape documentary of the entire steam generator replacement project for Unit No. 2. Components, equipment and work areas involved in the major tasks were photographed in detail to record significant events as the tasks progressed from start to completion. Video-tapes were used to record actual operations where complex procedures or equipment was used, or where the activity was repetitive in nature. This documentation was of significant benefit in training and retraining of personnel for the Unit No. 1 Steam Generator Replacement Project.

(f) General work area cleanup and debris removal was performed periodically to avoid buildups and maintain good radiological working conditions. Decontamination of tools, equipment and components was also performed when necessary to facilitate handling and transfer. These efforts resulted in cleaner and safer work areas and minimized the potential for radioactive airborne contamination throughout the repair effort.

(g) Early in the project, "rest areas" were designated inside the containment to accommodate workers during idle periods. The rest areas were located where exposure levels were minimum (less than 5 mR/hour) and were well posted for identification. Effective utilization of rest areas was continually emphasized to workers in order to minimize unnecessary exposure.

Although quantitative assessments could not be performed for these "general" techniques, all have been of significant value in contributing to the overall ALARA program for the steam generator replacement project.

4.0 RADIOACTIVE EFFLUENTS AND SOLID WASTE

4.1 General

Radioactive liquid and gaseous effluents, and radioactively contaminated solid wastes generated during the SGRP for Unit No. 1 are summarized in Table 2. A description of each category is given below.

4.2 Airborne Releases

Airborne releases during the repair effort originated primarily from the initial purging of containment following shutdown, and continuous ventilation thereafter. This was necessary to maintain a negative pressure while the equipment hatch was open. These releases were processed through appropriate filter banks to minimize the concentration of airborne particulates released to the environment. The relative isotopic distributions observed for airborne releases is presented in Table 2C.

4.3 Liquid Releases

The major contributor to liquid effluent releases attributed to the SGRP was the disposal of laundry waste water. The activities and relative distributions of the major isotopes released in liquid effluents is presented in Table 2B.

4.4 Solid Radioactive Waste

The solid radioactive waste generated during the repair effort consisted of: (i) contaminated insulation, structural materials, and components not intended for reuse, (ii) solidified liquids used for decontamination, and (iii) contaminated paper waste, disposable protective clothing and contamination control materials.

5.0 STEAM GENERATOR STORAGE BUILDING SURVEILLANCE

The Steam Generator Storage Building was reopened in November of 1980 to receive the steam generator lower assemblies removed from Unit No. 1. The building was subsequently closed and resealed, and a periodic surveillance program was resumed. Average contact exposure rates measured on the outside of the building are less than 0.1 mR/hr, as anticipated, and the building HEPA filters continue to show no detectable radioactivity. It is apparent, however, that some pathway for water intrusion into the building still exists; as shown by periodic checks of the collection sump level. Additional sealing work is planned to correct this condition.

6.0 CONCLUSIONS

The following general conclusions have been made based on the information contained within this report.

(a) The total exposure (manrem) expended during the repair effort on Unit 1 was significantly less than the original estimate established prior to the project, and represents a considerable exposure savings when compared to the Unit No. 2 total. The ALARA techniques described in Section 3, and the benefit of prior experience gained during the Unit No. 2 SGRP are attributable as the major factors in this success.

b) Radioactive liquid effluents were below the total release estimate presented on page 9.A.5-5 of the SGRP Report and, as expected, were less than 1% of that normally encountered during station operation.

(c) Radioactive gaseous effluents released during the repair program were comparable to, but less than the estimates established in the SGRP Report on page 9.A.8-7. The reported noble gas releases occurred as a normal result of the defueling operation. Radioiodine releases were comparable to the estimated value and gradually decreased to undetectable quantities due to their short half-lives. Radioactive particulate and tritium releases were lower than but comparable to the estimated quantities.

(d) Solid radioactive waste generation for the Unit No. 1 repair program exceeded the volume and activity estimates set forth on page 9.A.9-2 of the SGRP Report, as was the case for Unit No. 2.

(e) Surveillance data obtained thus far indicates the following with respect to onsite storage of the old steam generator lower assemblies.

(i) Radiation levels measured at the outside wall of the storage building are less than 0.1 mR/hr on contact. This is less than the estimated level presented on page 9.A.16-3 of the SGRP Report. Therefore, the resulting radiation level at the site boundary will be less than 0.0001 mR/hr, as anticipated.

(ii) Samples of the building HEPA filters have contained no detectable radioactive particulates; an indication that clean and stable airborne conditions exist within the building.

(iii) Water intrusion into the building is still occurring and additional sealing is necessary to correct this situation.

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
STEAM GENERATOR REPLACEMENT ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

	PHASE DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
I	Shutdown and Preparatory Activities	39,021	45,424	596.27	194.786
II	Removal Activities	57,422	142,783	559.6	396.511
III	Installation Activities	74,195	402,013	448.23	811.531
IV	Post Installation and Startup Activities	62,650	91,518	427.54	150.589
V	Steam Generator Storage Activities	300	937	35.0	8.079
	SUBTOTAL	233,588	682,675	2,066.64	1,561.496
	Additional Tasks and Unassigned Personnel Categories	------	109,452	-------	197.319
	PROJECT TOTALS	233,588	792,127	2,066.64	1,758.815

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE I-SHUTDOWN AND PREPARATORY ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Erect Equipment Hatch * Temporary Exposure	264	------	0.4	-------
Prepare and Load Test Polar Crane	210	463	1.05	1.285
Open Equipment Hatch **	156	------	0.23	-------
Defueling and Fuel Storage	585	2,863	11.7	23.503
Install Reactor Vessel Cavity Cover	130	753	1.3	1.915
Installation of Jib Cranes	1,838	3,492	9.19	5.479
Disassemble Manipulator Crane	58	629	1.74	1.533
Install Steam Generator Transport System	572	3,948	2.86	6.953
Removal of Biological Shield Wall	1,296	916	19.44	2.298
Disassemble Shroud Cooling System	150	601	3.0	1.228

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE I-SHUTDOWN AND PREPARATORY ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Cutting of Crane Wall at Hatch Opening	432	586	2.16	1.208
Installation of Temporary Ventilation System	50	106	0.05	0.053
Temporary Scaffolding	7,500	4,846	75	14.786
Temporary Lighting and Power	5,200	2,174	26.25	2.162
Cleanup and Decon	9,000	14,920	135	57.975
Polar Crane Operator	1,500	198	4.5	0.137
Shielding	3,600	2,045	270	64.315
H.P., Q.A.	6,480	6,884	32.4	9.956
PHASE I SUBTOTAL	39,021	45,424	596.27	194.786

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE I-SHUTDOWN AND PREPARATORY ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
ADDITIONAL TASKS				
Installation of Service Air System	------	627	-------	2.198
Work Platform Modification	------	1,939	-------	0.752
Protection of Containment Components	------	1,289	-------	6.158
UNASSIGNED PERSONNEL CATEGORIES				
Project Supervision and Administration	------	Not Reported	-------	8.471
SUBTOTAL (ADDITIONAL TASKS & PERSONNEL CAT.)	------	3,855	-------	17.579
PHASE I PROJECT TOTAL	39,021	49,279	596.27	212.365

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE II - REMOVAL ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Removal of Insulation (lower shell, RC Piping)	720	1,647	28.8	14.000
Removal of Insulation (upper shell, mainsteam and feedwater piping)	864	959	12.96	5.354
Removal of Miscellaneous Piping	72	1,288	1.8	13.896
Set Up Steam Generator Girth Cut Equipment	1,152	90	28.8	0.208
Cut and Remove Steam Generator Upper Shell	330	5,529	8.25	9.173
Cutting of Reactor Coolant Piping	2,982	7,181	149.1	76.682
Cutting of Mainsteam and Feedwater Piping	1,428	1,399	7.14	2.391
Disassembly of Steam Generator Supports	792	6,988	15.84	55.120
Removal of Moisture Separation Equipment	396	5,333	1.98	9.402
Refurbish Steam Generator Upper Shell	9,246	12,990	46.23	10.884

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE II - REMOVAL ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Removal of Steam Generator Level Instruments and Blowdown Piping	135	1,472	4.05	6.389
Removal of Steam Generator Lower Shell	1,575	4,341	31.5	22.870
Temporary Scaffolding	7,500	13,611	75.0	40.919
Temporary Lighting and Power	5,250	5,356	26.25	4.451
Cleanup and Decon	17,000	44,732	85.0	88.604
Polar Crane Operator	1,500	2,365	4.5	2.428
H.P., Q.A.	6,480	27,502	32.4	33.740
PHASE II SUBTOTAL	57,422	142,783	559.6	396.511
ADDITIONAL TASKS				
Material Handling, Equipment Maintenance, and Miscellaneous Construction Activities	------	24,484	-------	35.868

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE II - REMOVAL ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
UNASSIGNED PERSONNEL CATEGORIES				
Project Supervision and Administration	------	Not Reported	-------	19.379
SUBTOTAL (ADDITIONAL TASKS & PERSONNEL CAT.)	------	24,484	-------	55.247
PHASE II PROJECT TOTAL	57,422	167,267	559.6	451.758

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE III - INSTALLATION ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Steam Generator Lower Shell Installation	1,926	12,250	9.63	25.888
Installation of Reactor Coolant Piping	6,768	31,365	67.68	233.771
Steam Generator Girth Weld	5,400	15,791	27.0	12.341
Installation of Main Steam Piping	3,735	7,036	18.68	3.335
Installation of Feedwater Piping	2,700	6,418	13.5	2.997
Installation of Blowdown and Miscellaneous Piping	1,782	16,051	17.82	93.686
Install Steam Generator Level Instruments	2,592	8,297	12.96	10.525
Installation of Insulation	11,562	1,024	57.81	6.531
Temporary Scaffolding	7,500	28,757	75.0	91.674
Temporary Lighting and Power	5,250	11,805	26.25	6.477

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE III - INSTALLATION ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Cleanup and Decon	17,000	172,542	85.0	221.466
Polar Crane Operator	1,500	9,225	4.5	4.863
H.P., Q.A.	6,480	81,452	32.4	97.977
PHASE III SUBTOTAL	74,195	402,013	448.23	811.531
ADDITIONAL TASKS				
Material Handling, Equipment Maintenance, and Miscellaneous Construction Activities	------	67,539	-------	70.694
UNASSIGNED PERSONNEL CATEGORIES				
Project Supervision and Administration	------	Not Reported	-------	33.876
SUBTOTAL (ADDITIONAL TASKS & PERSONNEL CAT.)	------	67,539	-------	104.570
PHASE III PROJECT TOTAL	74,195	469,552	448.23	916.101

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE IV - POST INSTALLATION AND STARTUP ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Install Biological Shield Wall	3,240	2,772	16.2	4.822
Repair Crane Wall Opening	473	95	2.37	0.080
Install Steam Generator Recirculation and Transfer System	9,000	12,771	90.0	33.756
Remove Reactor Cavity Cover	130	161	0.65	0.375
Install Reactor Cavity Coaming	240	1,665	1.2	2.692
Reassemble Manipulator Crane	1,176	1,572	23.25	1.783
Remove Steam Generator Transport System	425	47	2.12	0.014
Reassemble Shroud Cooling System	576	2,610	11.52	3.055
Hydrostatic Tests	75	2,923	0.38	7.447
Refueling	585	600	11.7	2.158

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE IV - POST INSTALLATION AND STARTUP ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Temporary Scaffolding	7,500	5,937	75.0	17.956
Temporary Lighting and Power	5,250	2,379	26.25	1.302
Cleanup and Decon	17,000	36,104	85.0	41.078
Polar Crane Operator	1,500	1,845	4.5	0.918
Painting	9,000	3,478	45.0	14.869
H.P., Q.A.	6,480	16,559	32.4	18.284
PHASE IV SUBTOTAL	62,650	91,518	427.54	150.589
ADDITIONAL TASKS				
Material Handling, Equipment Maintenance, and Miscellaneous Construction Activities	------	13,574	-------	13.007

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE IV - POST INSTALLATION AND STARTUP ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
UNASSIGNED PERSONNEL CATEGORIES				
Project Supervision and Administration	------	Not Reported	-------	6.916
SUBTOTAL (ADDITIONAL TASKS & PERSONNEL CAT.)	------	13,574	-------	19.923
PHASE IV PROJECT TOTAL	62,650	105,092	427.54	170.512

TABLE 1
PERSONNEL RADIATION EXPOSURE SUMMARY
PHASE V - STEAM GENERATOR STORAGE ACTIVITIES
SURRY POWER STATION - UNIT NO. 1

TASK DESCRIPTION	ESTIMATED LABOR (MANHOURS)	ACTUAL LABOR EXPENDED (MANHOURS)	ESTIMATED EXPOSURE (MAN-REM)	ACTUAL EXPOSURE EXPENDED (MAN-REM)
Steam Generator Storage Activities	300	937	35.0	8.079

TABLE NOTATION

* The Equipment Hatch Temporary Enclosure used for the Unit No. 1 SGRP was the same structure used for Unit No. 2 previously. Thus, no fabrication was involved and erection required only lifting and placement. Insignificant labor and exposure were expended for this task.

** Labor and Exposure expenditures for this task were included in other task totals. (Primarily "Defueling and Fuel Storage"). Labor and Exposure estimates are included in the Subtotal Values.

TABLE 2
SURRY POWER STATION
STEAM GENERATOR REPLACEMENT PROJECT
REPORT OF RADIOACTIVE EFFLUENTS

YEAR: 1980

I. LIQUID RELEASES		UNITS	September	October	November	December
		Curies				
Isotope: Released	MPC µCi/ml					*
I-131	3×10^{-7}		5.96E-5	4.93E-5	2.25E-3	*
I-132	8×10^{-6}		*	*	*	*
I-133	1×10^{-6}		*	1.73E-6	1.32E-5	3.47E-7
I-134	2×10^{-5}		*	*	*	*
I-135	4×10^{-6}		*	*	*	*
Cs-134	9×10^{-6}		3.01E-4	8.32E-4	2.48E-2	2.58E-4
Cs-137	2×10^{-5}		1.04E-3	2.38E-3	3.35E-2	8.08E-4
Co-57	4×10^{-4}		*	*	1.89E-6	3.57E-7
Co-58	9×10^{-5}		5.73E-4	3.01E-3	1.36E-2	8.60E-4
Co-60	3×10^{-5}		1.10E-3	5.72E-3	1.81E-2	3.48E-3
Mn-54	1×10^{-4}		3.36E-5	1.11E-4	2.78E-3	4.45E-5
Na-24	3×10^{-5}		*	1.17E-3	6.29E-3	*
Cr-51	2×10^{-3}		1.99E-4	4.87E-4	1.14E-4	*
Fe-59	5×10^{-6}		*	*	*	*
Nb-95	1×10^{-4}		1.11E-5	5.68E-5	3.66E-5	1.23E-5
Sb-124	2×10^{-5}		*	*	1.20E-6	*
Sb-125	1×10^{-4}		*	3.86E-5	7.50E-7	1.44E-6
Zn-65	1×10^{-4}		*	*	2.60E-6	*
Zr-95	6×10^{-5}		*	*	*	*
Mo-99	4×10^{-5}		*	*	*	*
Ru-103	8×10^{-5}		*	1.89E-6	*	*
Xe-133	3×10^{-6}		8.66E-5	4.74E-4	1.85E-2	3.68E-6
Xe-135	3×10^{-6}		*	7.48E-5	2.41E-3	*
Xe-133m	3×10^{-6}		*	1.15E-5	*	*
Ar-41	3×10^{-6}		*	8.38E-7	*	*
Ag-110m	3×10^{-5}		*	*	*	*
Ni-63	3×10^{-5}		4.01E-5	1.41E-3	1.15E-3	1.00E-3
Fe-55	8×10^{-5}		1.16E-4	1.12E-2	*	*
Ce-144	1×10^{-6}		*	*	*	*
Tc-99m	3×10^{-3}		*	*	1.77E-7	*
Ce-141	9×10^{-5}		*	9.08E-7	*	*
Volume of Liquid to Discharge Canal		Liters	6.70E+4	5.89E+5	1.16E+6	4.76E+5

* Not Detected

TABLE 2
SURRY POWER STATION
STEAM GENERATOR REPLACEMENT PROJECT
REPORT OF RADIOACTIVE EFFLUENTS

YEAR: 1980

II. AIRBORNE RELEASES

Isotopes Released:	UNITS Curies	September	October	November	December
(a) Particulates					
Cs-134		3.12E-6	1.22E-6	*	2.73E-6
Cs-137		9.07E-6	1.76E-5	3.66E-5	2.21E-5
Cr-51		4.42E-5	1.65E-5	*	*
Co-58		2.63E-5	5.02E-5	1.65E-5	1.94E-5
Co-60		3.49E-5	5.95E-5	5.97E-5	6.27E-5
Mn-54		*	*	*	*
Fe-59		*	*	*	*
Cs-138		*	1.01E-4	*	*
Rb-88		*	5.24E-5	*	*
(b) Halogens					
I-131		1.78E-3	6.15E-4	7.90E-4	1.74E-5
I-132		4.73E-6	*	*	*
I-133		2.12E-6	2.31E-5	4.03E-5	1.31E-6
I-134		*	*	*	*
I-135		*	*	*	*
					*
(c) Gases					
Xe-133		4.44E+2	*	5.26E+1	*
Xe-133m		5.22E0	*	*	*
Xe-135		7.89E0	*	*	*
Kr-85m		3.21E-1	*	*	*
Kr-85		*	*	*	*
Kr-87		*	*	*	*
Kr-88		*	*	*	*
Ar-41		*	*	*	*
Xe-131m		*	*	*	*
H-3		7.08E-1	2.15E-1	6.97E-2	5.62E-2

* Not Detected

TABLE 2
SURRY POWER STATION
STEAM GENERATOR REPLACEMENT PROJECT
REPORT OF RADIOACTIVE EFFLUENTS

YEAR: 1980

III. SOLID RADIOACTIVE WASTE DISPOSAL

	Units	September	October	November	December
Isotopes Released:	Curies				
(a) Total Amount of Solid Waste Packaged	FT^3	0	3.94E+3	6.30E+3	1.64E+4
(b) Estimated Total Activity	Curies	0	1.45E+0	1.82E+1	8.54E+0
(c) Date of Shipment and Disposition		0	All to Barnwell, S.C.	All to Barnwell, S.C.	All to Barnwell S.C.
			10-15-80	11-3-80	12-1-80 (2)
			10-21-80	11-4-80	12-2-80 (2)
			10-23-80	11-6-80	12-3-80 (2)
			10-28-80	11-7-80 (2)	12-4-80 (2)
			10-30-80	11-10-80	12-5-80 (2)
				11-12-80	12-8-80
				11-13-80	12-11-80(2)
				11-14-80	12-12-80
				11-18-80(2)	12-15-80
				11-19-80	12-16-80
					12-17-80
					12-18-80
					12-19-80
					12-22-80
					12-30-80(2)

TABLE 2
SURRY POWER STATION
STEAM GENERATOR REPLACEMENT PROJECT
REPORT OF RADIOACTIVE EFFLUENTS

YEAR: 1981

I. LIQUID RELEASES		UNITS	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
		Curies						
Isotope: Released	MPC µCi/ml							
I-131	3×10^{-7}		1.32E-6	*	*	*	*	*
I-132	8×10^{-6}		*	*	*	*	*	*
I-133	1×10^{-6}		*	*	*	*	*	*
I-134	2×10^{-5}		*	*	*	*	*	*
I-135	4×10^{-6}		*	*	*	*	*	*
Cs-134	9×10^{-6}		4.01E-4	6.00E-4	2.10E-4	9.41E-4	5.21E-4	3.88E-3
Cs-137	2×10^{-5}		1.49E-3	1.60E-3	9.02E-4	1.83E-3	1.28E-3	6.14E-3
Co-57	4×10^{-4}		8.28E-7	1.27E-5	1.52E-7	9.09E-7	1.37E-6	2.32E-6
Co-58	9×10^{-5}		1.69E-3	6.50E-4	2.28E-4	1.94E-3	2.27E-3	1.96E-3
Co-60	3×10^{-5}		7.64E-3	4.30E-3	2.45E-3	7.08E-3	6.88E-3	1.20E-2
Mn-54	1×10^{-4}		1.81E-4	5.00E-5	7.28E-6	9.02E-5	1.81E-4	1.84E-4
Na-24	3×10^{-5}		*	2.00E-4	*	*	*	*
Cr-51	2×10^{-3}		2.21E-5	*	*	*	2.89E-5	*
Fe-59	5×10^{-5}		*	*	*	*	*	*
Nb-95	1×10^{-4}		3.07E-5	4.80E-6	1.61E-6	5.86E-6	1.91E-5	9.38E-6
Sb-124	2×10^{-5}		*	*	*	*	*	*
Sb-125	1×10^{-4}		2.13E-6	2.30E-4	3.63E-5	1.03E-4	1.13E-5	2.35E-5
Zn-65	1×10^{-4}		*	1.25E-6	*	*	3.54E-6	5.39E-6
Zr-95	6×10^{-5}		*	*	*	*	*	*
Mo-99	4×10^{-5}		*	*	*	*	*	*
Ru-103	8×10^{-5}		*	*	*	*	*	*
Xe-133	3×10^{-6}		5.91E-6	1.00E-3	*	*	*	*
Xe-135	3×10^{-6}		*	1.00E-4	*	*	*	*
Xe-133m	3×10^{-6}		*	1.00E-6	*	*	*	*
Ar-41	3×10^{-6}		*	*	*	*	*	*
Ag-110m	3×10^{-5}		*	*	*	*	2.12E-5	*
H-3	3×10^{-3}		1.00E-6	4.10E-7	*	2.03E-4	8.75E-4	4.87E-4
Fe-55	8×10^{-6}		*	*	*	1.77E-3	*	2.34E-2
Ce-144	1×10^{-6}		1.31E-5	*	*	*	*	*
Tc-99m	3×10^{-3}		*	*	*	*	*	*
Ce-141	9×10^{-5}		*	*	*	*	*	*
Volume of Liquid to Discharge Canal		Liters	7.40E+5	8.00E+5	9.02E+5	8.45E+5	7.29E+5	6.16E+5

* Not Detected

TABLE 2
SURRY POWER STATION
STEAM GENERATOR REPLACEMENT PROJECT
REPORT OF RADIOACTIVE EFFLUENTS

YEAR: 1981

II. AIRBORNE RELEASES

	UNITS	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Isotopes Released:	Curies						
(a) Particulates							
Cs-134		1.69E-5	*	1.06E-6	5.09E-6	4.86E-6	4.92E-6
Cs-137		1.15E-4	7.13E-6	1.35E-5	2.39E-5	2.04E-5	2.43E-5
Cr-51		*	*	*	*	*	*
Co-58		2.82E-4	*	*	5.58E-5	3.31E-5	1.46E-6
Co-60		5.44E-4	1.24E-4	3.64E-5	2.69E-4	4.00E-4	5.63E-5
Mn-54		1.92E-5	*	*	*	*	4.97E-7
Fe-59		*	*	*	*	*	*
Cs-138		*	*	*	*	*	*
Rb-88		*	*	*	*	*	*
Nb-95		*	*	3.36E-6	*	*	1.05E-6
(b) Halogens							*
I-131		2.15E-6	*	*	*	*	*
I-132		*	*	*	*	*	*
I-133		*	*	*	*	*	*
I-134		*	*	*	*	*	*
I-135		*	*	*	*	*	*
							*
(c) Gases							*
Xe-133		*	*	*	*	*	*
Xe-133m		*	*	*	*	*	*
Xe-135		*	*	*	*	*	*
Kr-85m		*	*	*	*	*	*
Kr-85		*	*	*	*	*	*
Kr-87		*	*	*	*	*	*
Kr-88		*	*	*	*	*	*
Ar-41		*	*	*	*	*	*
Xe-131m		*	*	*	*	*	*
H-3		5.80E-2	3.33E-2	3.97E-2	7.20E-1	1.57E+0	7.07E-1

* Not Detected

TABLE 2
SURRY POWER STATION
STEAM GENERATOR REPLACEMENT PROJECT
REPORT OF RADIOACTIVE EFFLUENTS

YEAR: 1981

III. SOLID RADIOACTIVE WASTE DISPOSAL

	Units	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Isotopes Released:	Curies						
(a) Total Amount of Solid Waste Packaged	FT^3	7.48E+3	1.01E+4	1.07E+4	4.27E+3	4.29E+3	4.10E+3
(b) Estimated Total Activity	Curies	6.32E+0	9.34E-1	2.21E+0	1.12E+0	5.30E+0	9.29E-1
(c) Date of Shipment and Disposition		Barnwell, S.C.	Barnwell, S.C.	Barnwell, S.C.	Barnwell, S.C.	Barnwell, S.C.	Barnwell, S.C.
		1-6-81	2-3-81	3-2-81	4-2-81	5-5-81	6-5-81
		1-8-81	2-4-81	3-3-81	4-4-81	5-7-81	6-9-81
		1-9-81	2-5-81	3-6-81	4-9-81	5-13-81	6-11-81
		1-13-81	2-6-81	3-10-81	4-21-81	5-14-81	6-16-81
		1-14-81	2-10-81	3-11-81	4-24-81	5-19-81	6-26-81
		1-15-81	2-12-81	3-16-81	4-28-81	5-21-81	
		1-20-81	2-13-81	3-17-81		5-26-81	
		1-21-81	2-16-81	3-19-81		5-27-81	
		1-26-81	2-18-81	3-20-81			
			2-20-81	3-23-81			
			2-20-81	3-26-81			

TABLE 2A
EFFLUENT RELEASE AND SOLID WASTE
COMPARISON SUMMARY
STEAM GENERATOR REPLACEMENT PROJECT
SURRY POWER STATION - UNIT NO. 1

LIQUID EFFLUENTS

	Total Estimated Releases	Total Actual Releases	Total 1977 Liquid Releases
Volume (gal.)	2.3×10^{6}	1.8×10^{6}	1.4×10^{8}
Activity (Ci)	0.344	0.259	67.67

GASEOUS EFFLUENTS

Isotope	Estimated Release/Unit During SGRP (Ci)	Actual Release During Unit No. 1 SGRP (Ci)	Average Six Month 1977 Release/Unit (Ci)
Noble Gases	Negligible	510	7400
Iodines	4.53×10^{-3}	3.27×10^{-3}	0.24
Particulates	3.12×10^{-3}	2.70×10^{-3}	1.4×10^{-4}
Tritium	8.49	4.18	120

SOLID WASTE

	Estimated Quantities	Actual Quantities
Volume (ft^3)	26,236	67,580
Activity (Ci)	18.9	45.0

TABLE 2B
EFFLUENT RELEASE ISOTOPIC DISTRIBUTIONS
STEAM GENERATOR REPLACEMENT PROJECT
SURRY POWER STATION - UNIT NO. 1

LIQUID EFFLUENTS

Isotope	Total Activity Released (Ci)	Percent of Total Activity
Co-60	6.88×10^{-2}	27
Cs-137	5.10×10^{-2}	20
Fe-55	3.65×10^{-2}	14
Cs-134	3.27×10^{-2}	13
Co-58	2.68×10^{-2}	10
Xe-133	2.01×10^{-2}	8
Na-24	7.66×10^{-3}	3
Ni-63	5.17×10^{-3}	2
Mn-54	3.66×10^{-3}	1
Xe-135	2.59×10^{-3}	1
I-131	2.36×10^{-3}	< 1
All Others	1.59×10^{-3}	< 1
Total	2.59×10^{-1}	100

TABLE 2C
EFFLUENT RELEASE ISOTOPIC DISTRIBUTIONS
STEAM GENERATOR REPLACEMENT PROJECT
SURRY POWER STATION - UNIT NO. 1

GASEOUS EFFLUENTS

Isotope	Total Activity Released (Ci)	Percent of Total Activity
Noble Gases		
Xe-133	496.6	97
Others	13.4	3
Total	510.0	100
Iodines		
I-131	3.20×10^{-3}	98
Others	7.16×10^{-5}	2
Total	3.27×10^{-3}	100
Particulates		
Co-60	1.65×10^{-3}	61
Co-58	4.85×10^{-4}	18
Cs-137	2.90×10^{-4}	11
Cs-138	1.01×10^{-4}	4
Cr-51	6.07×10^{-5}	2
Others	1.16×10^{-4}	4
Total	2.70×10^{-3}	100