January 20, 1979

Docket Nos. 50-280
and 50-281

Mr. W. L. Proffitt
Senior Vice President - Power
Virginia Electric and Power Company
Post Office Box 26666
Richmond, Virginia 23261

Dear Mr. Proffitt:

The Commission has issued the enclosed Amendment Nos. 47 and 46 to Facility Operating License Nos. DPR-32 and DPR-37 for the Surry Power Station, Unit Nos. 1 and 2. These amendments are in response to your submittals dated August 17, 1978, as supplemented.

The amendments approve the steam generator repair program for the Surry Power Station, Units 1 and 2 and provide license conditions related to the repair operations.

Copies of our Environmental Impact Appraisal and the Notice of Issuance are also enclosed. Our Safety Evaluation supporting these amendments was issued on December 15, 1978.

Sincerely,

A. Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors

Enclosures:
1. Amendment No. 47to DPR-32
2. Amendment No. 46 to DPR-37
3. Environmental Impact Appraisal
4. Notice of Issuance

cc: w/enclosures
See next page

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| DSE:EP-1 | DSE:EP-1 | RAD | DSE:AD:EP |
|---|---|---|---|
| SSKirslis | RLBallard | RMurphy | VMoore |
| 12/21/78 | 12/26/78 | 12/26/78 | 12/27/78 |

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NRC FORM 318 (9-76) NRCM 0240

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555
January 20, 1979

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and 50-281

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790129 012 3

cc: Mr. Michael W. Maupin
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Board of Supervisors of Surry
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

VIRGINIA ELECTRIC AND POWER COMPANY

DOCKET NO. 50-280

SURRY POWER STATION, UNIT NO. 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 47
License No. DPR-32

1. The Nuclear Regulatory Commission (the Commission ) has found that:

   A. The facility will operate in conformity with the application, the provisions of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   C. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   D. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, Facility Operating License No. DPR-32 is hereby amended by adding a new paragraph 3.G as follows:

   3.G Steam Generator Repair Program

   (1) The Surry Power Station Steam Generator Repair Program for Unit No. 1 is approved.

   (2) During the steam generator repair program the following conditions shall be met:

7901290127

(a) All fuel shall be removed from the reactor pressure vessel and stored in the spent fuel pool.

(b) The temporary containment and ventilation systems shall be operating for all cutting and grinding operations involving components with removable radioactive contamination >2200 DPM per 100 $cm^2$.

(c) The health physics program and procedures which have been established for the steam generator repair program shall be implemented.

(d) Progress reports shall be provided at 60 day intervals from the start of the repair program and due 30 days after close of the interval with a final report provided within 60 days after completion of the repair. These reports will include:

   (i) A summary of the occupational exposure expended to date using the format and detail of Table 5.3-1 of the report entitled "Steam Generator Repair Program".

   (ii) An evaluation of the effectiveness of dose reduction techniques as specified in Chapter 6 of the report entitled "Steam Generator Repair Programs" in reducing occupational exposures.

   (iii) An estimate of radioactivity released in both liquid and gaseous effluents.

   (iv) An estimate of the solid radioactive waste generated during the repair effort including volume and radioactive content.

(3) Sixty days prior to fuel loading, the program for preoperational testing and startup shall be submitted for NRC review.

3. This license amendment is effective as of the date of its issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

D. G. Eisenhut, Acting Assistant
Director for System and Projects
Division of Operating Reactors

Date of Issuance: January 19, 1979

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

VIRGINIA ELECTRIC AND POWER COMPANY

DOCKET NO. 50-281

SURRY POWER STATION, UNIT NO. 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 46
License No. DPR-37

1. The Nuclear Regulatory Commission (the Commission ) has found that:

   A. The facility will operate in conformity with the application, the provisions of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   C. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   D. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, Facility Operating License No. DPR-37 is hereby amended by adding a new paragraph 3.G as follows:

   3.G Steam Generator Repair Program

   (1) The Surry Power Station Steam Generator Repair Program for Unit No. 2 is approved.

   (2) During the steam generator repair program the following conditions shall be met:

(a) All fuel shall be removed from the reactor pressure vessel and stored in the spent fuel pool.

(b) The temporary containment and ventilation systems shall be operating for all cutting and grinding operations involving components with removable radioactive contamination >2200 DPM per 100 $cm^2$.

(c) The health physics program and procedures which have been established for the steam generator repair program shall be implemented.

(d) Progress reports shall be provided at 60 day intervals from the start of the repair program and due 30 days after close of the interval with a final report provided within 60 days after completion of the repair. These reports will include:

(i) A summary of the occupational exposure expended to date using the format and detail of Table 5.3-1 of the report entitled "Steam Generator Repair Program".

(ii) An evaluation of the effectiveness of dose reduction techniques as specified in Chapter 6 of the report entitled "Steam Generator Repair Programs" in reducing occupational exposures.

(iii) An estimate of radioactivity released in both liquid and gaseous effluents.

(iv) An estimate of the solid radioactive waste generated during the repair effort including volume and radioactive content.

(3) Sixty days prior to fuel loading, the program for preoperational testing and startup shall be submitted for NRC review.

3. This license amendment is effective as of the date of its issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

D. G. Eisenhut, Acting Assistant
Director for System and Projects
Division of Operating Reactors

Date of Issuance: January 19, 1979

ENVIRONMENTAL IMPACT APPRAISAL

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

LICENSE NOS. DPR-32 AND DPR-37

VIRGINIA ELECTRIC AND POWER COMPANY

SURRY POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-280 AND 50-281

# STEAM GENERATOR REPAIR AT SURRY POWER STATION

## 1.0 Proposed Action

Virginia Electric and Power Company (VEPCO) proposes to repair the six degraded steam generators in Units 1 and 2 of the Surry Power Station by replacing the lower assembly of each steam generator.

## 2.0 Background

### 2.1 History of Tube Degradation in Steam Generators

Since the Surry Units began generating power in 1972 and 1973, they have experienced a history of excessive tube degradation in the steam generators, resulting in the present condition in which approximately 24% of the tubes in Unit 1 and about 21% of the tubes in Unit 2 have been plugged to prevent the transfer of radioactivity from the primary coolant to the steam system.

The tube degradation is ascribed to a corrosion-related phenomenon called "denting," which involves the buildup of corrosion products in the crevices between the Inconel-600 heat exchanger tubes and the carbon steel tube support plates. As the corrosion product volume expands, the tubes are "dented," and occasionally develop leaks. The plugging of the damaged steam generator tubes affects the thermal and hydraulic performance of the steam generators. The degradation and resultant plugging of the tubes is continuing, and will soon result in serious and expensive operating restrictions such as derating. Another consequence of the tube degradation is the increased occupational exposure to radiation received by workers during the augmented inspection and plugging operations required on the steam generators because of their degraded condition.

The licensee's proposal to eliminate the tube degradation problem is described in detail in Reference 1, "Steam Generator Repair Program, Surry Power Station, Units 1 and 2," consisting of the original submittal dated August 17, 1977, with revisions dated December 2, 1977; April 21, June 2, June 13, June 30, September 1, October 25, and November 10, 1978. In order to provide the NRC staff with an independent basis for evaluating the radiological impacts associated with the repair of degraded steam generators at large pressurized water reactors (PWRs), we have contracted with Battelle Pacific Northwest Laboratories (PNL) to perform a generic radiological assessment of the steam generator repair and disposal operations. This assessment has been published in an NRC report,[2] NUREG/CR-0199, "Radiological Assessment of Steam Generator Removal and Replacement."

Information useful to the environmental review was also obtained from the NRC staff's Safety Evaluation Report (SER)[3] on the repair project, particularly the sections evaluating (1) the measures to reduce corrosion, (2) the As Low As is Reasonably Achievable (ALARA) considerations, and (3) the radiological consequences of postulated accidents.

## 3.0 Description of the Proposed Repair Method

A drawing showing the principal parts of a typical steam generator is presented in Figure 1. Figure 2 shows the regions where the main cuts are proposed to remove the degraded steam generator. It shows also the radiation levels in these regions. A brief description of VEPCO's proposed repair procedure follows.

In preparation for the repair of the steam generators in Surry Unit No. 2, all of the fuel will be removed from the reactor core and placed in the spent fuel pool. Then one of the three steam generators will be cut out of the reactor system. Present plans are to cut through the inlet and outlet reactor coolant piping, and through the steam line piping and feedwater piping. The steam generator wall will be cut on the transition zone between the lower assembly and the larger diameter upper shell assembly. The upper assembly will be lifted off and stored inside the containment vessel. The lower assembly will be lifted by crane from its support, tipped on its side, and transported out of the containment through the equipment hatch. It will then be transported to the concrete vault where it will be stored until the station is decommissioned. The replacement lower assembly will be transported into the containment and placed on its support. The old upper assembly, after some refurbishment, and the new lower assembly will be welded together in the field. The piping mentioned above will be welded to the repaired steam generator.

The same procedure will be followed for the other two steam generators. It is anticipated that the unit will be out of service for about six months. After Unit No. 2 is back in service, Unit No. 1 will be shut down to commence repairs on its steam generators.

A number of changes (see Sections 2.3 through 2.7 of Reference 1) have been made in the materials, the design and the operating procedure for the replacement steam generators to assure that the corrosion and denting problems will not recur. Among the more important of these changes are (1) using All-Volatile-Treatment chemistry control in the secondary system from the beginning of operation, (2) using corrosion resistant SA240 Type 405 ferritic stainless steel rather than carbon steel for the support plate material, (3) thermally treating the Inconel 600 heat exchanger tubes for better corrosion resistance,

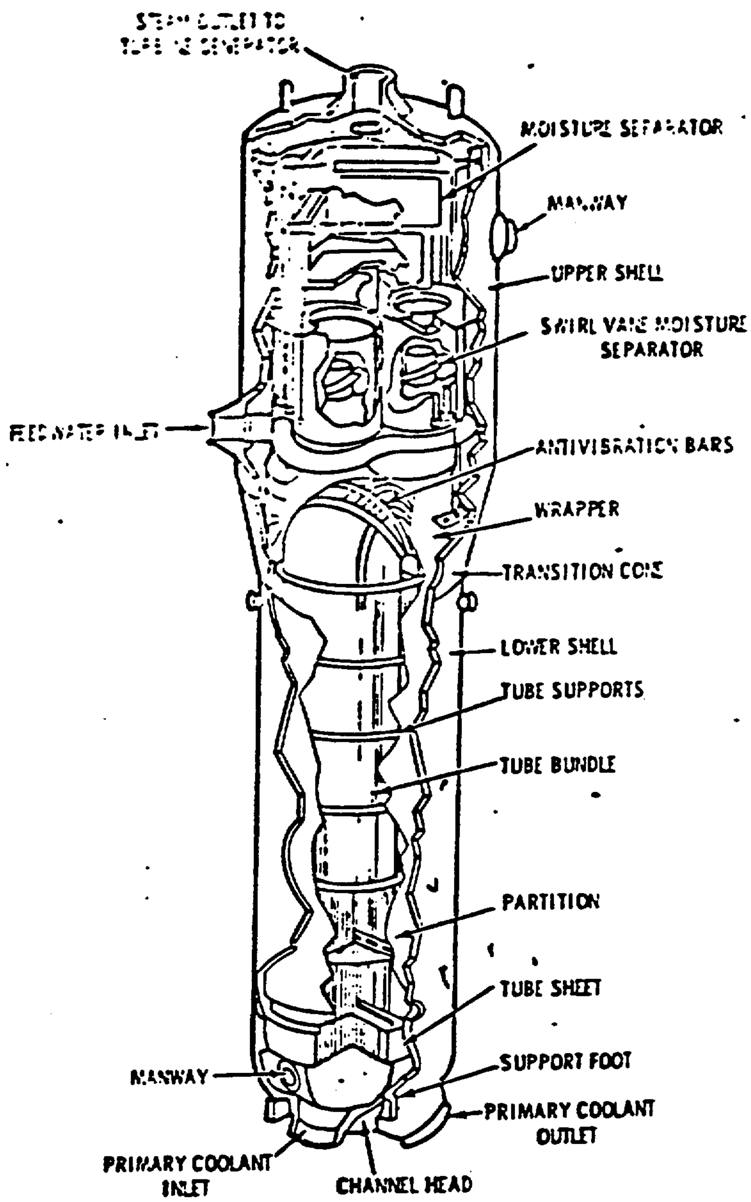


FIGURE 1. Typical Steam Generator

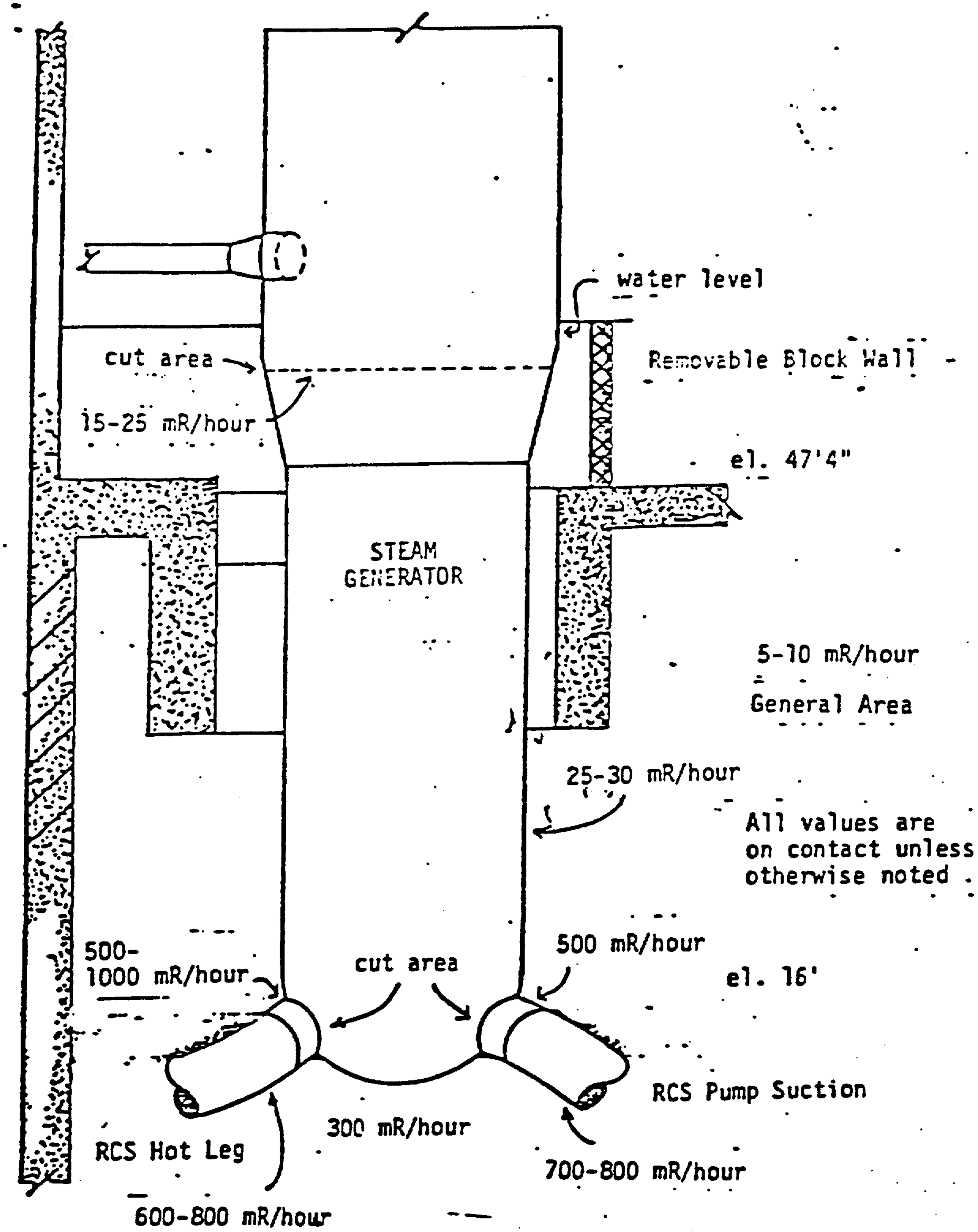


FIGURE 2
TYPICAL RADIATION LEVELS AROUND STEAM GENERATORS
WITH PRIMARY SIDE DRAINED AND SECONDARY SIDE AT
72% LEVEL

and (4) using a broached hole pattern with a quatrefoil design in the support plates rather than separately drilled flow holes to minimize the accumulation of corrosion products where the tubes pass through the plates. The staff's review of the expected effects of the proposed changes is presented in detail in the introductory section of the SER[3] for the repair project. We have concluded in the SER that the new steam generator design incorporates features to eliminate the potential for the various forms of tube degradation observed to date.

The licensee proposes to store the six degraded steam generator lower assemblies for the life of the plant in an above-ground concrete structure with walls about 3 feet thick. The structure will be sealed against water intrusion, but will be provided with an internal sump to collect any water which may get in by means such as condensation. Ventilation to allow for thermal expansion and contraction of the air inside the structure will be provided through high efficiency particulate air filters. Several removable 2-inch plugs will be provided to permit the conduct of radiation surveys without entering the structure.

The method of ultimate disposal will be decided when the reactor itself is scheduled for decommissioning.

## 4.0 Environmental Impacts of Steam Generator Repair Project

### 4.1 Radiological Assessment

#### 4.1.1 Occupational Exposure

The generic radiological assessment of steam generator repair, prepared for the NRC by PNL and reported in NUREG/CR-0199, provides an upper bound estimate of the occupational doses and off-site radiological releases associated with the repair of steam generators at a large PWR. The conservatisms in PNL's methods of assessment, described below, provide the opportunity to reduce occupational doses for the repair operations in specific cases considerably below the generic estimates in NUREG/CR-0199.

The PNL generic estimates of occupational exposure (man-rem) were derived by multiplying maintenance activity man-hours by exposure rates (rem/hour) for the repair activities. Maintenance activities were developed by PNL as a composite of the work descriptions for removal and replacement of the steam generators at Surry and Turkey Point as determined by VEPCO and Florida Power and Light Company. Man-hour estimates for each activity were developed by PNL based on prior experience with similar activities, using standard estimating techniques. Exposure rates were based on information from several sources including data from measurements made at several operating

PWRs including the Surry Units. PNL usually selected exposure rate values on the high end of the range of values measured at the several plants.

The generic estimate of the total collective occupational whole body dose for the repair of three steam generators was presented in NUREG/CR-0199 as a range of values, 3380 to 5840 man-rem. Both ends of this range were conservatively estimated and represent upper bound values. The upper value, 5840 man-rem, was estimated assuming no credit for dose saving techniques. The lower value, 3380 man-rem, was estimated taking credit only for three dose reduction methods: (1) shielding by raising the steam generator water level, (2) using a limited amount of remote tooling, and (3) increasing the source-to-receiver distance. VEPCO's total estimate of 2070 man-rem per unit included not only these dose reduction measures but also measures such as additional temporary lead shielding, local decontamination, pre-job planning and pre-job training. The dose reduction procedures proposed by VEPCO are discussed in more detail in our SER.[3]

In view of the above discussion, the lower end of the generic range, 3380 man-rem, is the appropriate estimate for comparison with VEPCO's estimate of 2070 man-rem per unit. A summary comparing VEPCO's estimates with our generic estimates in NUREG/CR-0199 for the four main phases of the project is given in Table 4.1.

Table 4.1
Comparison of Occupational Collective Whole Body Dose Estimates

| Phase | NRC Generic Estimate Dose, man-rem/unit | VEPCO Estimate Dose, man-rem/unit |
|---|---|---|
| Preparation | 450-810 | 599 |
| Removal | 1100-1700 | 559 |
| Installation | 1800-330 | 877 |
| Storage | 30 | 35 |
| Total | 3380-5840 | 2070 |

The discrepancies between the detailed estimates are accounted for by the same factors discussed above for the total estimates. VEPCO's calculations of doses used commonly accepted practices for calculating doses and took into account the dose reduction measures proposed to maintain doses As Low As Reasonably Achievable (ALARA), including local decontamination, temporary lead shielding, pre-job planning, pre-job training and use of remote tools where practicable. In Section 6 of Reference 1, VEPCO has documented its consideration of the guidance with regard to ALARA issues in Regulatory Guide 8.8, Revision 2.[4] We have reviewed VEPCO's treatment of ALARA issues in detail in Section 4 of the SER.[3] We concluded that VEPCO's efforts to maintain occupational doses ALARA during the repair effort are reasonable.

In summary, the above discussion shows that the differences between the lower generic estimate (3380 man-rem per unit) and VEPCO's estimate (2070 man-rem per unit) can be reconciled by (1) the use of lower dose rates measured at Surry in the VEPCO estimate and (2) the use of more dose reducing measures by VEPCO than in the generic estimate. We therefore conclude that VEPCO's estimate of 2070 man-rem is a more realistic estimate than 3380 man-rem for the repair of the steam generators in one Surry unit. Consequently, in the remainder of this appraisal, we have used 2070 man-rem per unit as the occupational dose for the steam generator repair work at Surry.

To put into perspective the occupational doses to be incurred in repairing steam generators, it is helpful to compare these doses (1) with those expected from the normal operation of nuclear plants, (2) with the projected long-term man-rem saving resulting from steam generator repair and (3) with the doses from major maintenance operations at other plants.

Although the AEC was starting to compile occupational exposure estimates for nuclear power plant operation at the time that the Surry 1 and 2 FES was prepared in 1972, such exposures were not specifically considered in the Surry 1 and 2 FES.

In recent environmental statements, we have estimated an annual occupational dose of about 500 man-rem per nuclear unit, averaged over the life of the plant (30-40 years). This value is based on the average of annual doses received at operating plants. In 1977, the average occupational dose per unit for light water reactors in the United States was 570 man-rem.[5] The doses ranged from 87 to 3142 man-rem per reactor unit, with major maintenance during the year accounting for the larger values. Occasional large doses associated with major maintenance, such as the 2070 man-rem dose per unit for the proposed steam generator repair, will occur. NRC regulations require that measures be taken to keep these doses ALARA.

In 1975, 1976 and 1977, workers at Surry Units 1 and 2 received whole body doses of 638 man-rem,[1] 1287 man-rem[1] and 1410 man-rem,[6] respectively, during the inspection and plugging of degraded steam generator tubes. The total occupational doses for the two units were 1649 man-rem in 1975, 3163 man-rem in 1976, and 2416 man-rem in 1977.[5] These doses are higher than the 570 man-rem per year average for U.S. light water reactors in 1977. As mentioned at the end of Section 3, we concluded in the SER that the proposed repair would eliminate the potential for the kinds of the tube degradation observed to date. Based on our experience with plants without severe denting problems and the staff conclusion regarding corrosion reduction, doses due to the inspection and plugging of degraded tubes would be markedly reduced, and we conclude that occupational exposure after the repair will be reduced by hundreds of man-rem per year for the two units. This would result in total occupational exposures at Surry approaching more closely the national average value for light water reactors (570 man-rem per unit in 1977). We further conclude that the dose savings of hundreds of man-rem per year would over a period of years tend to offset the immediate one-time dose of 2070 man-rem for repairing the three steam generators in each unit.

VEPCO has estimated that the after-repair occupational dose for the inspection and repair of degraded steam generator tubes will be reduced to 25 man-rem per year for the two Surry units. Although the 25 man-rem per year appears to be a reasonable number for Regulatory Guide 1.83 inspections, we have conservatively estimated a higher value of 100 man-rem per year to account for additional inspections which may be performed to check the initial performance of the improved steam generators and to correspond more closely to recent industry experience.

The saving of occupational exposure resulting from the repair effort may be estimated by subtracting the estimated annual dose after repair from the observed annual dose before repair. The doses of 1287 man-rem in 1976 and 1410 man-rem in 1977 are considered representative of exposures related to steam generator operation before repair. The 638 man-rem dose in 1975 is not representative of operation with degraded steam generators because significant tube degradation was not observed in Unit I until September 1975 and in Unit II until January 1976. Subtracting the after-repair dose of 100 man-rem from the before-repair range of 1287 to 1410 man-rem leads to a saving of 1187 to 1310 man-rem per year. At these rates of saving, the 4140 man-rem cost of the repair would be offset in 3 to 4 years.

Operating experience at the Surry plant over the last three years demonstrates that the steam generators can continue to operate with the degraded tubes plugged, but frequent inspection and plugging as performed during the last three years would be required to assure that the integrity of the steam generators would be maintained. At the current rate of tube plugging, about 3% per year, it is the staff's judgment that, with continued inspections and plugging, the Surry units could continue to operate for some period and, even if reduced power were required, the economic balance would favor continued operation of the units, as opposed to decommissioning the reactors. On the other hand, continued degradation of the integrity of a major component such as steam generators, results in continued small reductions in overall safety margins.

This potential has been carefully considered on the basis of the results of each inspection over the past three years. While these margins remain acceptable, any continued degradation would require continued careful assessment to assure that degradation does not become excessive.

In summary, the staff has drawn the following conclusions regarding occupational radiation exposure. VEPCO's estimate of 2070 man-rem per unit for the repair of the steam generators is reasonable. This dose falls within the range of annual occupational doses which have been observed in recent years. Our review in the Safety Evaluation Report[3] concludes that VEPCO is taking the necessary steps to insure that occupational doses will be maintained ALARA. Finally, the renovation of the steam generators will lead to occupational dose reductions of hundreds of man-rem per year. These dose savings over a period of several years will outweigh the immediate large one-time dose resulting from the repair operation. The individual risks associated with the exposures involved in the repair program will be controlled and limited so as not to exceed the limits set forth in 10 CFR Part 20 for occupational exposure. These limits assure that the hazard to any exposed individual is extremely small.

Even should there be an incremental 2000 man-rem per reactor increase in occupational exposure, the increased risk of premature fatal cancer induction is predicted to be less than one event (e.g., 0.2 events risk estimation from data for the population as a whole as given in the BEIR report)[14]. The increased risk of this exposure on genetic effects to the ensuing five generations is also predicted to be less than one event (e.g., 0.5 events risk estimation from data for the population as a whole as given in the BEIR report). For a selected population such as is likely for the exposed workers involved in the repair program consisting principally of males in the age ranges from 20 to 40, these risks would tend to be somewhat less.

For the foregoing reasons, the Staff concludes that the environmental effect due to occupational radiation exposure is not significant.

### 4.1.2 Public Radiation Exposure

Our independent analysis of the gaseous and liquid releases of radioactivity from the plant site during the steam generator repair project is based in large part on the generic report,[2] NUREG/CR-0199, prepared by Pacific Northwest Laboratories for the NRC. The estimates of releases in this report are upper bound values, based on conservatively high estimates for each type of release.

Table 4.2

Radioactive Effluents from Surry Station

| | Steam Generator Repair | | Operating Experience | | FES |
|---|---|---|---|---|---|
| Type of Radioactive Effluent | VEPCO Release Estimates (Ci/Unit) | NUREG/ CR-0199 Release Estimates (Ci/Unit) | Surry 1976 Average Releases (Ci/Unit) | Surry 1977 Average Releases (Ci/Unit) | Annual Average Release Estimates (Ci/Unit/Yr) |
| GASEOUS | | | | | |
| Noble Gases | - | - | 9600 | 9510 | 3360 |
| Halogens (Iodines) | 0.0045 | included in particulates | 0.27 | 0.24 | 0.92 |
| Particulates | 0.0031 | 0.0001 | 0.041 | 0.001 | - |
| Tritium | 8.5 | - | 19 | 44 | - |
| LIQUID | | | | | |
| Mixed fission & activation products | 0.35 | 0.14 | 17 | 3.8 | 53 |
| Tritium | 0.1 | 190 | 390 | 204 | 1000 |

Similar estimates of the gaseous and liquid effluents during the repair were made by VEPCO in Reference 1. These estimates were based on the specific equipment design and procedures to be used at the Surry plant. Table 4.2 presents the NUREG/CR-0199 estimates[2] and VEPCO's estimates[1] of the radioactive effluents which will be released as a result of the repair effort. Table 4.2 also presents Surry's reported average radioactive effluent releases for 1976[12] and 1977,[6] and the annual average radioactive effluent release estimates presented in the Surry FES.[7] Table 4.2 shows that the releases estimated by VEPCO and the generic report for the repair effort are much lower (except for the airborne particulates) than the Surry 1976 and 1977 releases and the FES annual average estimates. For airborne particulates, the VEPCO estimates of releases are in the same range as or lower than the 1976 and 1977 releases in Table 4.2. The Surry FES[7] does not present numerical estimates of airborne particulate and tritium releases. However, airborne particulates and tritium are small dose contributors compared to radioiodine and noble gases for the highest dose pathways of exposure to individuals in the general public. Therefore, the conclusions regarding dose consequences presented in the FES are still valid.

The VEPCO estimates of gaseous releases from the repair effort are larger than the NRC generic estimates because the VEPCO values include the releases from fuel unloading and reloading, which are much larger than the gaseous releases from the rest of the repair operation. VEPCO's figures are based mainly on experience at Surry with refueling operations. The refueling releases were not included in the NUREG/CR-0199 estimate, since the utility normally would plan to carry out the steam generator repair during a scheduled shutdown for refueling. For the other gaseous releases such as those from pipe cutting, VEPCO used commonly accepted calculational methods, for example in calculating the kerf for each cut and in assuming that all radioactive material adhering to the inner cut surface would become airborne. Therefore, we conclude that VEPCO's estimates of gaseous releases, including those from the fuel handling operations, were carried out in an acceptable manner and represent reasonable estimates.

In Table 4.2, the estimates for liquid releases of tritium vary widely because VEPCO plans to store the primary reactor coolant water for re-use, whereas the generic (NUREG/CR-0199) estimate assumes that the coolant is discharged after processing for nuclides other than tritium. The VEPCO estimate for the release of mixed fission and activation products is larger than the generic estimate because the latter did not include the releases of the secondary coolant nor the local decontamination solutions. Both estimates included the activities in laundry waste water. VEPCO based its estimates of releases from the laundry waste water and secondary coolant on past measurements of these sources at Surry. VEPCO used commonly accepted methods to calculate the releases from local decontamination solutions. Based on these several considerations, we conclude that the licensee has made reasonable estimates of the radioactive liquid effluents during the repair effort, and that these estimates correspond, as well, to our own best estimates.

Our estimates of dose to individuals and to the population as a whole in the area surrounding the Surry site are based on the radioactive effluents which VEPCO estimated for the repair effort (summarized in Table 4.2) and on the calculational methods presented in Regulatory Guides 1.109, 1.111 and 1.113.[11,9,8] We conclude that offsite individuals will receive doses from the repair effort of the same order or less than the annual dose consequences presented in the FES.[7] The doses to the population within 50 miles will be less than 5 man-rem to the thyroid or total body from liquid effluents, and less than 2 man-rem to the thyroid or total body from airborne effluents. Every year the same population (about 2 million) will receive a total body dose of more than 100,000 man-rem from the natural background radiation in the vicinity of Surry (0.065 rem per year).[13] Thus, the population total body dose from the repair effort is less than 0.01% of the annual dose due to natural background. On these bases, we conclude that the doses to individuals in unrestricted areas and to the population within 50 miles due to gaseous and liquid effluents from the repair project will not be environmentally significant.

VEPCO has estimated that the repair effort will generate 740 cubic meters of solid waste per unit containing 19 curies of radioactivity.[1] Based on the information presented in NUREG/CR-0199, we estimate that 2300 cubic meters of solid waste containing 37 curies of radioactivity will be generated per unit.[2] Our estimate is higher than the licensee's estimate because we assumed that all of the radioactivity in the solutions from main coolant pipe decontamination would be solidified. Neither of these estimates include the radioactivity on the inside surfaces of the old steam generators. In 1976 and 1977, Surry generated an annual average of 370 cubic meters of solid waste per unit containing 310 curies per unit of radioactivity.[6 2] The amount of radioactivity in the wastes from the repair effort will be about ten percent of this average annual production during operation. Since the solid wastes represent an impact which is a small part of the impact from solid wastes from normal operation, we conclude that the radiological impact is not environmentally significant.

On the basis of long term onsite storage of the degraded steam generators until the reactors are decommissioned, there will be essentially no radioactive effluents from the generators for 30 years. Final disposal at that time will result in small offsite gaseous and liquid radioactive releases, because a large fraction of the radioactive nuclides in the steam generators will have decayed in 30 years.

The stored steam generators will present a source of direct and scattered radiation. We estimate that each steam generator will contain about 2700 Ci of radioactivity including 720 Ci of Cobalt-60, the principal contributor to direct dose. This is based on the estimate of the contamination of steam generator primary side surfaces given in NUREG/CR-0199.[2] The staff estimated a dose rate of less than 0.0001 milli-rem per hour at the nearest site boundary due to this activity. An individual spending an entire year at this location would receive less than 1 milli-rem of radiation exposure. This dose would be approximately halved every 5 years because of the decay of the principal contributing activity, Co-60. VEPCO made a similar calculation and reached the same conclusion. Since this dose represents roughly one percent of the annual dose from natural background,[12] the staff concludes that the direct dose impact to the public from the stored generators will be minimal and not environmentally significant.

The repair effort will return the plant to the design condition on which our evaluation in the FES[7] was based. Therefore, we conclude that the estimates of routine releases of radioactivity and the potential doses to the public from those effluents after the repair will remain as presented in the FES.

Since our estimates of radioactive effluents from Surry during normal operation after the repair effort are about the same or lower than those effluents presented in the FES,[7] we conclude that the impact on biota other than man will be no greater than that impact presented in the FES.

In summary, the offsite doses resulting from the steam generator repair will be less than those from recent plant operation since the expected releases of radioactive material as a result of the repair effort will be less than the releases from normal operation. These doses are comparable to doses presented in the FES[7], and small compared to the annual doses from natural background radiation. Therefore the radiological impact of the repair project to the public will not significantly affect the human environment.

## 4.2 Economic Costs of Steam Generator Repair

VEPCO has estimated that, over the life of the plant, the proposed steam generator repair project will result in a net dollar savings of at least $125,000,000 compared with the cost of continued operation of the existing steam generators, with an optimistic assumed scenario of tube plugging and derating. The cost of purchasing and installing the steam generator lower assemblies and associated activities is estimated at about $66,000,000 for the two units.

The cost of onsite storage and final disposal of the six degraded lower assemblies is expected to be about $1,000,000. The estimate for replacement power during the outage for repair is about $66,000,000. The total project cost is therefore about $133,000,000.

The cost of replacement power during the outage is based on the higher fuel costs of coal, oil and gas-fired units which VEPCO would press into service to replace the power lost by the shutdown of one of the Surry Units. The VEPCO estimate of $66,000,000 based on differential fuel costs is reasonable in view of the total value of the replacement power: 822,500 kW x 0.6 capacity factor x 360 days x 24 hours/day x $.04/kWhr = $183,000,000. VEPCO's estimate of $66,000,000 corresponds to a fuel differential cost of about $0.014/kW hr between fossil-fired plants and a nuclear plant. We consider this differential cost estimate reasonable.

The VEPCO estimated net saving of $125,000,000 is based largely on the cost of replacement power due to derating. We assessed the reasonableness of this estimate by comparing it to the cost of replacement power if both units had to be derated. The cost would be about $360,000,000 after 10 years of derating at an assumed rate of 3% per year (the current rate of tube degradation is greater than 3% per year). Therefore, VEPCO's estimate that $125,000,000 would be saved over the life of the plant even after spending $133,000,000 for the steam generator repair is conservative.

The VEPCO estimate of $1,000,000 for final disposal of the degraded steam generators assumes onsite storage for 30 years followed by sectioning and shipment to a licensed burial facility for low-level waste. This estimate is not out of line when compared to recent estimates[10] for the decommissioning of complete reactors by dismantlement after a cooling period (about $30,000,000).

This consideration of costs does not take into account the continuing costs of tube inspection and plugging services, nor the costs of possible future modifications to control corrosion, if the repair is not done. It also does not consider the cost of the current lack of reliability and availability. In 1976, Surry Unit 1 was offline for 36 days and Unit 2 for 139 days for tube inspection and plugging. In 1977, the outage times for tube inspection and plugging were 50 days for Unit 1 and 70 days for Unit 2.

In Section 5, the economic and other impacts of alternative methods of repairing the steam generators will be compared.

## 4.3 Non-Radiological Environmental Costs

The non-radiological impacts of the repair project on the environment are small compared to those of building and operating the reactors. These small costs include the commitment of about one acre of land on the site for the storage of the degraded steam generators for the life of the station. There will be some noise generated by onsite equipment and a small effect on local traffic by approximately 125 construction workers per shift, but these effects will be insignificant.

The material costs of the proposed action will include about 1350 tons of carbon steel, 48 tons of stainless steel, 3000 cubic yards of concrete. These quantities are about 2% of the quantity of steel and about 8% of the concrete used in the original construction of the plant.

## 4.4 Environmental Impact of Postulated Accidents

As is discussed in our SER,[3] the design and plant operating parameters which are relevant to accident analyses will not change as a result of the steam generator repair effort. Therefore, the assessment of the environmental impact of postulated accidents presented in the final environmental statements for Surry Units 1 and 2 will be unchanged and remain valid. However, there are a few types of accidents which are possible due to the operations involved in the repair effort.

One such postulated accident is the rupture of the Reactor Water Storage Tank by a crane drop. The bounds of the radiological consequences of this accident were discussed in the FES[7] for Surry Unit 2 under the heading -"Release of liquid waste contents."

A second type of postulated accident related to the repair effort would involve the dropping and rupture of a removed steam generator outside the reactor containment while it was being transported to the storage vault. This accident would involve the rupture of the steel covers which will have been welded over each of the steam generator cuts to prevent the spread of the neutron-activated corrosion products adhering to the inner surfaces. The method used to assess the radiological consequences of a rupture which could release contamination on the primary side surfaces to the atmosphere is described in the SER.[3] To obtain a more realistic estimate for the purpose of evaluating the environmental impact, we used an atmospheric dispersion factor of $1.6 \times 10^{-4}$ seconds per cubic meter. On this basis, we concluded that this accident would result in a dose of 0.06 rem to the lungs of an individual at the site boundary.

The dose consequences of a drop accident inside containment would be lower since the containment ventilation system would reduce the radioactivity released to the environment.

In summary, we concluded that the consequences of postulated accidents from the repair operation would be not environmentally significant.

## 5.0 Impacts of Alternatives

The basic choices of future action regarding the tube degradation problem are (1) repair of the degraded steam generators, (2) continuation of the present mode of operation, with increasing costs in plant efficiency and occupational exposure, and (3) shutdown of the Surry Units 1 and 2, and replacement by generating plants of different design. VEPCO opted for repairing the degraded steam generators, with changes in design, materials and operating procedures calculated to eliminate the tube denting problem.

In the absence of methods to arrest or greatly reduce denting, the continuation of operation for an extended period in the present mode is impractical. With tube degradation and plugging continuing at the present rate, the units would soon be required to operate at lower power. VEPCO has estimated the cost of replacement power, based on fuel differential costs, to be about $180,000 per day for the shutdown of a unit. Consequently, the cost of derating the Surry units would be high. Also, the man-rem cost of occupational exposure during inspection and plugging of tubes would continue to be high, resulting in a dose higher than 4140 man-rem in 3 or 4 years. Laboratory test programs on the denting phenomenon are currently underway to define the corrosion process more precisely and to develop preventive measures such as corrosion inhibitors. While the combination of steam generator secondary side cleaning and corrosion inhibitors is being studied by some utilities to combat denting in its early stages, the denting phenomenon at Surry is too advanced for such measures to be practical. Therefore, VEPCO cannot count on a greatly reduced future rate of tube degradation to justify continuing the present mode of operation.

The option of shutting down the Surry station and replacing it with a plant of different design is easily shown to be much more costly than that of repairing the steam generators. VEPCO estimates (Section 5.5.1.3 of Reference 1) that the capital cost of new nuclear units with improved steam generators would be about $2.7 billion dollars and would require about 12½ years to build. New fossil units would cost about $1.2 billion and require about 8 years to build. (We consider the coal estimate low; capital cost for a coal-fired plant is usually about 80% of that for a nuclear plant.) Florida Power and Light Company made a similar comparison for repairing the steam generators in Turkey Point Units 3 and 4. Their estimate was about $77/kW for the proposed steam generator repair operation, compared to $224/kW for gas turbine units, $1059/kW for a coal-fired plant, and $1448/kW for a nuclear plant of improved design. Although the Turkey Point estimates are in different terms, the cost comparison again overwhelmingly favors the repair option. For these reasons, the plant replacement option is not economically feasible. In addition, there would be significant environmental impacts from such a large scale construction operation. The most practical overall option is therefore to repair the degraded steam generators.

In the remainder of this section, we shall consider the radiological and economic costs of several alternative ways of repairing and disposing of the degraded steam generators. An important item in estimating economic costs is the cost of replacement power during unit outage. VEPCO's cost estimate of $66,000,000 for the power needed during the 180 day outage of each unit corresponds to a replacement power cost of nearly $200,000 per unit per day of outage.

## 5.1 Decontamination

VEPCO has estimated (Section 5.5.2.1 of Reference 1) that chemical decontamination of the steam generators before cutting would result in a net saving of 300 to 400 man-rem per unit in occupational exposure. However, it would cost about 1.5 months in additional outage of each unit. Replacement power for this additional outage would cost about $9,000,000. In addition, about 200,000 gallons of radioactive waste would be produced.

VEPCO also considered mechanical decontamination of the inner surfaces of the steam generator, but estimated that the occupational exposure during the decontamination operation would exceed the later saving in dose to workers.

Based on our knowledge of the limited experience of the nuclear industry in large scale, high volume chemical decontamination of reactor coolant systems, we can make the following statements. Most importantly, decontamination would add significant expense and time delays to the repair effort, including the cost of replacement power during those time delays. There is a degree of uncertainty about the compatibility of the decontamination fluid with materials in the coolant system. The research and testing which would be required to provide adequate assurance of material compatibility to obtain our approval to decontaminate would adversely impact on the cost and schedule of this repair effort. While the lower dose rates resulting from decontamination would reduce occupational dose during the repair operations, occupational radiation doses received during the decontamination effort itself would partially offset the dose reduction. Decontamination would not remove the radioactivity inside tubes which are plugged. Large volumes of contaminated fluids would be produced and require processing. That processing would incur further costs and occupational dose. In summary, we conclude that the costs of decontamination including costs due to time delays would outweigh the dose savings. Therefore, the use of large scale decontamination in this repair effort is not a viable option.

5.2 Retubing of Existing Steam Generators

The retubing operation would involve (1) removing the upper or dome portion of the steam generator, (2) removing the lower assembly internals and tubes, (3) replacing the latter with state-of-the-art internals and tubes, and (4) refurbishing the upper internals, and (5) welding the dome back in place. VEPCO has estimated (Section 5.5.1.2 of Reference 1) that the cost of this operation in both dollars and occupational exposure would be higher than the proposed replacement of the complete lower assembly. VEPCO further points out that shop fabrication of new lower assemblies would provide more positive assurance that the quality of the repaired generators was acceptable.

On the other hand, the staff is aware of recent developments by Westinghouse in the technology of in-place refurbishment which show some promise of reducing unit outage and personnel exposure below the values for VEPCO's proposed repair method. However, at this time not enough information is available for us to make a detailed assessment of the retubing alternative.

A detailed proposal for our review is expected in the near future. If our assessment is favorable, in-place retubing may be an alternative for steam generator repairs in the future. However, in the time frame contemplated for the proposed licensing action, this is not considered to be an available alternative to the proposed action.

5.3 Replacement of the Entire Steam Generator

For this alternative, a construction opening in the containment wall about 20 feet wide and 40 feet high would be required, since the upper assembly of the steam generator could not pass through the existing equipment hatch. The personnel exposure for this alternative would be about the same as for the proposed repair, because essentially the same high-dose operations will be required in each case. Elimination of the cut across the diameter of each steam generator results in only a small saving of radiation exposure. The capital costs are estimated to be about 15% higher. The principal cost difference is due to an estimated additional outage of about 100 days per unit for the alternative. This corresponds to an additional requirement of about $40,000,000 worth of replacement power during the repair of both units, calculated at the rate of about $180,000 per day of outage per unit. For these reasons, the staff concludes that VEPCO's proposed repair method is preferable.

## 5.4 Alternate Disposal Methods

In the Appendix to NUREG/CR-0199[2] the radiological costs of several alternative methods for the disposal of the degraded steam generators are evaluated. The results of this analysis are summarized in Table 5.1.

Table 5.1 Steam Generator Disposal Alternatives

| Option | Approximate Man-Rem per Steam Generator | Approximate Airborne Release Ci per Generator |
|---|---|---|
| Long-term[a] storage (including surveillance) with intact shipment | 10 | Negligible[b] |
| Long-term[a] storage with cut-up and shipment | 16 | 0.005 |
| Shorter-term storage with cut-up - at 5 yr | 230 | 0.026 |
| - at 15 yr | 60 | 0.015 |
| Immediate intact shipment | 2.4[c] | Negligible[b] |
| Immediate cut-up and shipment by rail/truck - no decontamination | 580 | 0.042 |
| Immediate cut-up and shipment by rail/truck - with chemical decontamination | 270 | 0.010 |

[a] 30 to 40 years

[b] Since the steam generator will be sealed before it is removed from containment, no release of radioactive material is expected during the repair operation.

[c] Estimates for short-term storage followed by intact shipment would be only slightly larger than this, perhaps 5 man-rem.

It is seen that the options involving intact shipment would have the lower radiological costs; but intact shipment is possible only by barge and at present there is no licensed burial ground with facilities for off-loading an entire lower assembly from a barge.

The next best alternative, radiologically, would be long-term storage of the generators onsite until the reactors are decommissioned, followed by sectioning and shipment at that time. This is the plan proposed by VEPCO.

Immediate cut-up and shipment to a burial facility would involve a substantial cost in occupational exposure, even after chemical decontamination. Comparing Tables 5.1 and 4.2, it is seen that the airborne releases from the segmenting operation would be larger than those from the rest of the repair effort.

The two disposal alternatives considered by VEPCO (Section 5.5.2.2 of Reference 1) were immediate intact barge shipment and near-term sectioning for off-site disposal. The estimated economic and radiological costs are given in Table 5.2 for the disposal of six steam generators.

Table 5.2 Costs of Alternate Disposal Methods (VEPCO)

| Method | Cost, dollars | Exposure[a], man-rem |
|---|---|---|
| On-site Storage With Final Disposal at Decommissioning | 1,000,000 | 80 |
| Intact Barge Shipment | 1,200,000 to 1,500,000 | 200 |
| Near-term Sectioning | 1,700,000 | 1000 to 2000 |

[a]Note that these doses are for six lower assemblies. The estimates in Table 5.1 are for one lower assembly.

According to the VEPCO estimates, the proposed disposal method of on-site storage with final disposition at the time of plant decommissioning should result in the least cost in dollars and in radiation exposure. The staff agrees that the proposed disposal method costs less in radiation exposure than alternatives available at present. The proposed onsite storage leaves open the option of intact barge shipment in the event that a burial ground with adequate off-loading facilities becomes available.

## 6.0 Basis and Conclusion for not Preparing an Environmental Impact Statement

We have reviewed the proposed steam generator repair action and have reached the following conclusions.

(1) The proposed replacement of the lower assemblies of the steam generator is the best available option, from both the radiological and economic standpoints, for eliminating the tube degradation problem.

(2) The one time occupational exposure of 2070 per unit is larger than the average annual occupational exposure associated with the operation of a nuclear power plant. However, such occupational exposures or larger exposures would be incurred in a few years by continued operation at Surry even absent the proposed action. In the long run the proposed action will cause occupational exposures at an operating Surry facility to be reduced on a long term cumulative basis as well as on an annual basis. Therefore it does not appear that there will be a substantial increase in occupational radiation exposure caused by the work authorized.

We have reviewed the dose reduction measures to be used by the applicant and conclude that the doses would be ALARA. We have also considered the health effects resulting from such exposure and concluded that these are not significant.

(3) The new steam generator design incorporates features which will eliminate the potential for the various forms of tube degradation observed to date.

(4) The restoration would restore the generators to the condition evaluated in the FES and would result in an occupational dose saving of hundreds of man-rem per year, because there would be a marked reduction in the amount of tube inspection and tube plugging required to keep the generators in acceptable operating condition.

(5) Offsite doses resulting from the steam generator repair will be less than those from recent plant operations, comparable to doses presented in the FES[7], and small compared to the annual doses from natural background radiation. Therefore, the offsite doses will not be significant.

On the basis of the foregoing analysis, the staff concludes that the proposed steam generator repair action will not significantly affect the quality of the human environment.

We have reviewed this proposed facility modification relative to the requirements set forth in 10 CFR Part 51 and the Council of Environmental Quality's Guidelines, 40 CFR 1500.6. We have determined that the proposed license amendment will not significantly affect the quality of the human environment. Therefore, the staff has found that an environmental impact statement need not be prepared, and that pursuant to 10 CFR 51.5(c), the issuance of a negative declaration to this effect is appropriate.

## REFERENCES


1. Steam Generator Repair Program, Surry Power Station, Unit Nos. 1 and 2, Virginia Electric and Power Company, August 17, 1977, and revisions dated December 2, 1977; April 21, June 2, June 13, June 30, September 1, October 25, and November 10, 1978.

2. NUREG/CR-0199, "Radiological Assessment of Steam Generator Removal and Replacement," G. R. Hoenes, D. A. Waite, and W. D. McCormack, Pacific Northwest Laboratories, June 1978.

3. Safety Evaluation Report for the Surry Power Station Steam Generator Replacement, U. S. Nuclear Regulatory Commission, December 1978.

4. Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be As Low As is Reasonably Achievable", (Revision 2), U.S. Nuclear Regulatory Commission.

5. NUREG-0482, "Occupational Radiation Exposure at Light Water Cooled Power Reactors 1977," L. J. Peck, U. S. Nuclear Regulatory Commission, November 1978.

6. "Annual Operating Report of Surry Power Station for 1977," Virginia Electric and Power Company.

7. "Final Environmental Statement related to the operation of Surry Power Station, Unit 2," U. S. Nuclear Regulatory Commission, June 1972.

8. Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," U. S. Nuclear Regulatory Commission.

9. Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," (Revision 1), U. S. Nuclear Regulatory Commission.

10. NUREG/CR-0130, "Technology, Safety and Cost of Decommissioning a Reference Pressurized Water Reactor," R. I. Smith, G. J. Konzek and W. E. Kennedy, Jr., Pacific Northwest Laboratories, June 1978.

11. Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," (Revision 1), U.S. Nuclear Regulatory Commission.

12. NUREG-0367, "Radioactive Material Released from Nuclear Power Plants (1976)," T.R. Decker, U.S. Nuclear Regulatory Commission, March 1978.

13. NCRP No. 45, "Natural Background Radiation in the United States," National Council on Radiation Protection and Measurements, 1975.

14. "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation", (BEIR Report), National Academy of Sciences, November 1972, Reprinted July 1974.

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-280 AND 50-281

VIRGINIA ELECTRIC AND POWER COMPANY

NOTICE OF ISSUANCE OF AMENDMENTS TO FACILITY

OPERATING LICENSES

AND NEGATIVE DECLARATION

The U.S. Nuclear Regulatory Commission (the Commission) has issued Amendment Nos. 47 and 46 to Facility Operating License Nos. DPR-32 and DPR-37, issued to Virginia Electric and Power Company for operation of the Surry Power Station Unit Nos. 1 and 2 (the facilities) located in Surry County, Virginia. These amendments are effective as of the date of issuance.

The amendments approve the steam generator repair program for the Surry Power Station, Units 1 and 2 and provide license conditions related to the repair and post-repair operations.

The amendments comply with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations. The Commission has made appropriate findings as required by the Act and the Commission's rules and regulations in 10 CFR Chapter I, which are set forth in the license amendments. Notice of Proposed Issuance of Amendments to Facility Operating Licenses in connection with

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this action was published in the FEDERAL REGISTER on October 27, 1977 (42 FR 56652). No request for hearing was filed in response to that notice.

The Commission has prepared an environmental impact appraisal for the license amendments and has concluded that an environmental impact statement for this particular action is not warranted because the action will not significantly affect the quality of the human environment.

For further details with respect to this action, see (1) Amendment Nos. 47 and 46 to DPR-32 and DPR-37, (2) the Commission's related Safety Evaluation dated December 15, 1978 and (3) the Commission's Environmental Impact Appraisal. All of these items are available for public inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C. and at the Swem Library, College of William and Mary, Williamsburg, Virginia. A copy of items (1), (2) and (3) may be obtained upon request addressed to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Division of Operating Reactors.

Dated at Bethesda, Maryland this 20th day of January 1979.

FOR THE NUCLEAR REGULATORY COMMISSION

A. Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors