NOV 12 1976

Docket No. 50-325

Carolina Power & Light Company
ATTN: Mr. J. A. Jones
Executive Vice President
Engineering, Construction, and Operations
336 Fayetteville Street
Raleigh, North Carolina 27602

Gentlemen:

BRUNSWICK STEAM ELECTRIC PLANT, UNIT 1 - ISSUANCE OF AMENDMENT TO OPERATING LICENSE

The Nuclear Regulatory Commission has issued the enclosed Amendment No. 1 to Facility Operating License No. DPR-71. Amendment No. 1 is effective as of the date of issuance. Facility Operating License No. DPR-71, as amended, shall expire at midnight, February 7, 2010.

In accordance with the Commission's Supplemental Statement of General Policy of November 5, 1976 (41 F.R. 49898, November 11, 1976), the staff has determined in the enclosed Environmental Assessment, that use of revised values for reprocessing and waste management would not tilt the cost-benefit balance for the Brunswick plant against issuance of a full power operating license.

We have completed our review of the Unit 1 Startup Program dated November 5, 1976, and find that the overall Program is acceptable as indicated in Enclosure 1. The exceptions indicated in Enclosure 1 must be resolved for startup tests numbers 20 Feedwater System (heater loss), 22 Main Steamline Isolation Valves (full isolation), 24 Turbine Stop Valve Trip and 25 Generator Load Rejection, and the information requested in Enclosure 1 provided for our evaluation. Since we recognize that additional time will be required to develop this information, we have included a license condition 2.G requiring that the acceptance criteria requested in Enclosure 1 be provided for our evaluation prior to proceeding beyond Test Condition 3 in the power ascension program provided in the Final Safety Analysis Report for Brunswick Units 1 and 2.

Accordingly, Amendment No. 1 to License No. DPR-71 authorizes the Carolina Power & Light Company to operate the Brunswick Steam Electric Plant, Unit 1, at a reactor core power level of 2436 megawatts thermal (one hundred percent of the rated core thermal power), subject to the above condition.

OFFICE	DPM:LWR 4	DPM:LWR 4	OELD	EP	DPM/AD/LWR	DPM/D
SURNAME	Service Powell/pav	SAVarga	Mitchell		DVassallo	RBoyd
DATE	11/12/76	11/12/76	11/12/76	11/12/76	11/12/76	11/12/76

Form AEC-318 (Rev. 9-53) AECM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1974-526-166

A copy of the related FEDERAL REGISTER notice is also enclosed.

Sincerely,

Original Signed by
Roger S. Boyd

Roger S. Boyd, Director
Division of Project Management
Office of Nuclear Reactor Regulation

Enclosures:
1. Evaluation of Proposed Changes to the Startup Test Program
2. Amendment No. 1 to DPR-71
3. FEDERAL REGISTER Notice
4. Environmental Assessment

ccs: See page 3

OFFICE ➤						
SURNAME ➤						
DATE ➤						

cc w/enclosure:
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Raleigh, North Carolina 27603

Mr. W. A. Kopp, Jr., Chairman
Board of County Commissioners of
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Bolivia, North Carolina 28422

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OFFICE ➤						
SURNAME ➤						
DATE ➤						

EVALUATION OF PROPOSED CHANGES TO

THE STARTUP TEST PROGRAM FOR BRUNSWICK UNIT NO. 1

In letters to the Commission dated September 2, 1976 and November 5, 1976 the Carolina Power & Light Company proposed several modifications to their Startup Test Program for Brunswick Unit No. 1. These modifications included changes for several of the startup tests, in test objectives, methods, and acceptance criteria from what was previously described in the FSAR. The licensee's stated reasons for proposing these modifications were: experience gained in the startup of Brunswick Unit No. 2; the NSS Supplier's, General Electric Company, recommendations; and Licensing and regulatory requirement changes. The staff has evaluated these modifications and has concluded that the startup test program is acceptable with the following exceptions:

1. The acceptance criteria for the feedwater heater loss test (STI 20) should be modified to establish that plant performance will be in accordance with performance predicted for the actual test condition. Acceptance criteria for error bands or limits from predicted performance for selected parameters and their bases should also be submitted to provide assurance that any differences between predicted and actual performance will not compromise plant safety.
2. The acceptance criteria for main steam isolation valve closure test at Test Condition 6 (STI 22) should be modified to establish that plant performance will be in accordance with performance predicted for the actual test conditions. Acceptance criteria for error bands or limits from predicted performance for selected parameters and their

bases should also be submitted to provide assurance that any differences between predicted and actual performance will not compromise plant safety.

3. The acceptance criteria for the turbine trip at Test Condition 3 and the generator load rejection trip at Test Condition 6 (STI 24 and 25) should be modified to establish that plant performance will be in accordance with performance predicted for the actual test conditions. Acceptance criteria for error bands or limits from predicted performances for selected parameters and their bases should also be submitted to provide assurance that any differences between predicted and actual performance will not compromise plant safety.

November 11, 1976

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

CAROLINA POWER & LIGHT COMPANY

DOCKET NO. 50-325

BRUNSWICK STEAM ELECTRIC PLANT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

License No. DPR-71
Amendment No. 1

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

   A. The application for license filed by Carolina Power & Light Company (the licensee) complies with the standards and requirements 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 and all required notifications to other agencies or bodies have been duly made;

   B. Construction of the Brunswick Steam Electric Plant, Unit 1 (facility), has been substantially completed in conformity with Construction Permit No. CPPR-68 and the application, as amended, the provisions of the Act and the rules and regulations of the Commission;

   C. The facility will operate in conformity with the application, as amended, the provisions of the Act, and the rules and regulations of the Commission;

   D. There is reasonable assurance: (i) that the activities authorized by this operating license can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the rules and regulations of the Commission;

   E. The licensee is technically and financially qualified to engage in the activities authorized by this operating license in accordance with the rules and regulations of the Commission;

   F. The licensee has satisfied the applicable provisions of 10 CFR Part 140, "Financial Protection Requirements and Indemnity Agreements," of the Commission's regulations;

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

H. After weighing the environmental, economic, technical, and other benefits of the facility against environmental and other costs and considering available alternatives, the issuance of amendment No. 1 Facility Operating License No. DPR-71, subject to the conditions for protection of the environment set forth in Facility Operating License No. DPR-71 is in accordance with 10 CFR Part 51 (and with former Appendix D to 10 CFR Part 50) of the Commission's regulations and all applicable requirements of 10 CFR Part 51 (and former Appendix D to 10 CFR 50) have been satisfied; and

I. The receipt, possession, and use of source, byproduct, and special nuclear material as authorized by this amended license will be in accordance with the Commission's regulations in 10 CFR Part 30, 40, and 70, including 10 CFR Section 30.33, 40.32, 70.23 and 70.31.

2. Accordingly, the license is amended by: (1) a change to Paragraph 2.C.(1), and (2) the addition of Paragraph 2.F., 2.G, and 2.H.

2.C.(1) Maximum Power Level

The licensee is authorized to operate the facility at steady state reactor core power levels not in excess of 2436 megawatts thermal.

2.F. In accordance with the requirement imposed by the October 8, 1976, order of the United States Court Appeals for the District of Columbia Circuit in Natural Resources Defense Council v. Nuclear Regulatory Commission, No. 74-1385 and 74-1586, that the Nuclear Regulatory Commission "shall make any licenses granted between July 21, 1976 and such time when the mandate is issued subject to the outcome of the proceedings herein," the license issued herein shall be subject to the outcome of such proceedings.

2.G. This license is issued upon the condition that the license shall provide to and obtain approval from the Commission of acceptance criteria for Startup Test Program tests numbers 20 "Feedwater System (heater loss)," 22, "Main Steamline Isolation Valves (full isolation)", 24 "Turbine Stop Valve Trip" and 25 "Generator Load Rejection" prior to proceeding beyond Test Condition 3 in the power ascension program provided in the Final Safety Analysis Report.

2.H. This license amendment is effective as of the date of issuance. Facility Operating License No. DPR-71, as amended, shall expire at midnight, February 7, 2010.

FOR THE NUCLEAR REGULATORY COMMISSION

Original Signed by
Roger S. Boyd
Roger S. Boyd, Director
Division of Project Management
Office of Nuclear Reactor Regulation

Date of Issuance:

NOV 12 1976

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NO. 50-325

CAROLINA POWER & LIGHT COMPANY

NOTICE OF ISSUANCE OF AMENDMENT TO FACILITY OPERATING LICENSE

Notice is hereby given that the U.S. Nuclear Regulatory Commission (the Commission) has issued Amendment No. 1 to Facility Operating License No. DPR-71, issued to Carolina Power & Light Company for the Brunswick Steam Electric Plant, Unit 1, located in Brunswick County, North Carolina. Amendment No. 1 authorizes the licensee to operate the facility at full power subject to approval by the Commission of acceptance criteria in the power ascension program before proceeding beyond Test Condition 3.

In accordance with the Commission's General Statement of Policy (41 F.R. 34707, August 16, 1976), Carolina Power & Light Company was issued Facility Operating License No. DPR-71 on September 8, 1976, authorizing operation of Brunswick Steam Electric Plant, Unit 1, at a reactor core power level not to exceed 24.36 megawatts thermal (1 percent) for testing purposes, limited to cumulative fuel exposure of 300 megawatt days. Subsequently, the Commission issued Supplemental General Statement of Policy (41 F.R. 49898, November 11, 1976) which concluded that full-power licensing of light water reactors may be resumed on a conditional basis using existing fuel cycle impact values (Table S-3) for reprocessing and waste management, provided the revised values presented in the Commission's notice of proposed rulemaking of October 8, 1976 (41 F.R. 45849) were also examined to determine the effect on the cost-benefit balance for operating the plant. This examination has been performed

by the Commission staff and is set forth in the "Environmental Assessment, Brunswick Steam Electric Plant, Unit 1, Fuel Cycle Considerations." The assessment concludes that use of such revised values would not tilt the cost-benefit balance against issuance of the operating license.

The amendment complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and requlations. 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 amendment. The Commission has also made appropriate findings which are set forth in the license regarding the environmental impacts associated with operation of the facility . Amendment No. 1 also includes the condition that the license is subject to the outcome of the proceedings in Natural Resource Defense Council v. NRC (D. C. Circuit), July 21, 1976), Nos. 74-1385 and 74-1586.

Amendment No. 1 is effective as of the date of issuance. Facility Operating License No. DPR-71, as amended, shall expire at midnight, February 7, 2010. This action completes the licensing action encompassed in the "Notice of Consideration of Issuance of Facility Operating Licenses and Opportunity for Hearing; Notice of Hearing Pursuant to 10 CFR Part 50, Appendix D, Section B, dated October 27, 1972.

For further information see: A copy of (1) Facility Operating License No. DPR-71, complete with Technical Specifications (Appendices "A", "A-Prime", and "B"); (2) the "Negative Declaration Regarding Issuance of a Limited Facility License DPR-71, Brunswick Steam Electric Plant, Unit 1", (3) the "Environmental Impact Appraisal of Issuance of Fuel Loading, Criticality Low-Power Testing Operating License for Brunswick Steam Electric Plant, Units 1 and 2"; (4) the report of the Advisory Committee on Reactor Safeguards, dated December 11, 1973: (5) the Office of Nuclear Reactor Regulation's Safety Evaluation Report dated November 1973, and Supplements thereto dated January 31, 1974, December 23, 1974, December 27, 1974, and September 1976, respectively; (6) the Final Safety Analysis Report and amendments thereto; (7) the applicant's Environmental Report dated June 15, 1973, and supplements thereto; (8) the Final Environmental Statement dated January 1974; (9) Amendment No. 1 to License No. DPR-71; (10) and the "Environmental Assessment, Brunswick Steam Electric Plant, Unit 1, Fuel Cycle Consideration." These items are available for public inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D. C., and the Southport-Brunswick County Library, 109 W. Moore Street, Southport, North Carolina 28461. Single copies of items (1), (2), (3), (4), (5), (8)

(9) and (10) may be obtained upon request addressed to the United States Nuclear Regulatory Commission, Washington, D. C. 20555, Attention: Director, Division of Project Management.

Dated at Bethesda, Maryland, this 12th day of November, 1976.

FOR THE NUCLEAR REGULATORY COMMISSION

Original signed by
Steven A. Varga
Steven A. Varga, Chief
Light Water Reactors Branch No. 4
Division of Project Management

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

ENVIRONMENTAL ASSESSMENT

DOCKET NO. 50-325

BRUNSWICK STEAM ELECTRIC PLANT UNIT 1

FUEL CYCLE CONSIDERATIONS

On July 21, 1976, the United States Court of Appeals for the District of Columbia Circuit decided in Natural Resources Defense Council v. NRC that the NRC's final fuel cycle rule (39 FR 14188) was inadequately supported by the record insofar as it treated two aspects of the fuel cycle -- the impacts from reprocessing of spent fuel and radioactive waste management. The decision generally complimented other aspects of the Commission's survey underlying Table S-3.

In response to the Court decisions, the Commission issued a General Statement of Policy (41 FR 34707, August 16, 1976). In that statement, the Commission announced its intention to reopen rulemaking proceedings on the environmental effects of the fuel cycle to supplement the existing record with regard to reprocessing and waste management, to determine whether the rule should be amended, and if so, in what respect. The Commission directed the staff to prepare a well-documented supplement to WASH-1248 to establish a basis for identifying environmental impacts associated with fuel reprocessing and waste management activities that are attributable to the licensing of a model light water reactor (LWR). The NRC staff issued NUREG-0116, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle in October 1976 for this purpose.

On November 5, 1976 the Commission issued a Supplemental General Statement of Policy regarding the licensing of nuclear power plants as related to the analysis of fuel cycle environmental impacts. The Commission concluded that licensing of light water reactors may be resumed on a conditional basis using existing Table S-3 values for reprocessing and waste management, provided the revised values presented in the Commission's Notice of Proposed Rulemaking of October 18, 1976 were also examined to determine the effect on the cost-benefit balance for constructing or operating the plant.

This assessment briefly describes the impacts of Table S-3 values as they apply to Brunswick Unit 1. These values were considered by the Atomic Safety and Licensing Board in its Initial Decision of December 26, 1974, 8 AEC 1144, authorizing continuation of CPPR-67 and CPPR-68 for Brunswick Steam Generating Plant Units 1 and 2. This assessment also specifically considers the revised values for reprocessing and waste management in its determination of effects on the cost-benefit balance as presented in the FES for Brunswick.

The natural resource uses identified in Table S-3, i.e., land, water, fossil fuel, and radiological and non-radiological effluents, have been evaluated for the plant fuel cycle activities. The attached Table 1 presents a summary of these potential fuel cycle environmental impacts for Brunswick Unit 1 based on Table S-3 and compares them, where appropriate, with those environmental impacts directly related to the operation of Brunswick Unit 1 as identified in the FES of April 1973.

The approximate total annual fuel cycle land use commitment associated with the operation of Brunswick Unit 1 is 56 acres. This consists of about 52 acres which are temporarily committed and 4 acres which are

permanently committed. The land use commitment for fuel cycle operations over 30 years represents less than half the overall land requirement of 5,766 acres for operation of the power plant during its expected 30 year electrical production lifetime. The annual land requirement of 56 acres for fuel cycle operation is comparable to that used by a small coal-fired power plant of approximately 75 MWe capacity.

The annual total water usage and thermal output associated with the fuel cycle for Brunswick Unit 1 are respectively about 9,293 millions of gallons and 2,759 billions of BTU's. The corresponding annual water use and thermal output at Brunswick Unit 1 assuming an 80% capacity factor are respectively 273,000 millions of gallons and 58,265 billions of BTU's. Thus, the approximate 3% and 5% increases in water use and thermal loading respectively, for fuel cycle operations are low percentages of actual plant values.

Electrical energy is required during various phases of the fuel cycle process. This electrical energy is usually produced by the consumption of fossil fuel at conventional power plants. It is estimated that approximately 260,000 MW-hours of energy will be utilized annually in the fuel cycle for Brunswick. This represents less than 5% of the annual net electrical output of Brunswick Unit 1 at an 80% capacity factor. It represents an annual consumption of about 94,000 MT of coal, along with the corresponding gaseous and particulate chemical effluents which are equivalent to those produced by a small 37 MWe coal-fired plant operating for a year.

Liquid chemical effluents produced by the fuel cycle process constitute a potential for adverse environmental impacts but such constituents are present in dilute concentrations and need only a small amount of additional dilution by receiving bodies of water to reach levels below permissible standards. The amount of dilution water needed for various constituents are: ammonia -493 cfs, nitrate - 16 cfs, and fluoride - 57 cfs. Tailings solutions resulting from the fuel cycle represent an insignificant effluent to the environment.

Solids are produced principally during the milling process in the fuel cycle and are not released in significant quantities to create an impact upon the environment.

Radioactive effluents released to the environment estimated to result from the reprocessing and waste management activities or other phases of the fuel cycle process are set forth in Table 1. It is estimated that the overall gaseous dose commitment to the U. S. population from the fuel cycle for a 1000 MWe reference reactor would be approximately 250 man-rem per year. This is approximately .001% of the average natural background dose of approximately 21,000,000 man-rem[1] to the U. S. population. Based on Table S-3 values the additional dose commitment to the U. S. population from radioactive liquid effluents due to fuel cycle operations would be approximately 260 man-rem per year for a 1000 MWe reference reactor. The fuel cycle dose commitment for Brunswick Unit 1 would be somewhat less than that given for the reference reactor, since it has a net generating capacity of 821 MWe.

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[1] Based upon a natural background dose rate of 100 mrem/yr.

The overall estimated involuntary dose commitment to the U. S. population from radioactive gaseous and liquid releases due to the fuel cycle is approximately 500 man-rem per reference reactor year. This is higher than the small involuntary dose to the public from operating Brunswick Unit 1, approximately 25 man-rem. However, the occupational dose from the fuel cycle is comparable to the estimated occupational total dose commitment associated with operation and maintenance of the reactor, some 500 man-rem. The overall effect of such exposure will be extremely small and may not be detectable against natural background radiation exposure levels.

Both high and low level radioactive solid waste produced during fuel cycle operations are to be buried at licensed repositories and are not released to the environment.

In the original fuel cycle rule, the environmental impacts for fuel cycle activities necessary for the support of an LWR were summarized in Table S-3 as shown in 10 CFR 51.20 and presented in the attached Table 2. As indicated,this environmental assessment is based on fuel cycle parameters set forth in Table S-3 as well as modifications to it. Table 2 presents a summary of environmental considerations of the uranium fuel cycle as originally contained in Table S-3 together with the modifications given in the proposed rulemaking notice of October 18, 1976, and presented in NUREG-0116. Principal changes include those in the categories of land use, chemical effluents, iodine releases, Carbon-14 releases, and buried solids.

The following describes the differences between the impacts described in Table S-3 as it was originally promulgated in 10 CFR 50.21 and the

change in certain impacts resulting from the revised assessment of reprocessing and waste management considerations in NUREG-0116. The land commitment reflected in NUREG-0116 is slightly larger than that presented in the original Table S-3. The original estimates were smaller by some 30 acres per reference reactor year in temporarily committed land and about 3 acres per year in permanently committed land for waste disposal. This does not constitute a significant change.

Hydrogen chloride has been included in NUREG-0116 as a gaseous chemical effluent, resulting from incineration of plastics in the waste management systems. The amount is a small fraction of other acid gas effluents from the fuel cycle discussed in both Table S-3 and NUREG-0116. No significant impact is attributable to the change.

There have been increases in NUREG-0116 in the estimated Carbon-14, Iodine and Tritium release rates. However, the principal addition in radioactive gaseous effluents is the dose estimate of 110 man-rem for the release of Carbon-14. These additional releases will add some 150 man- rem to the gaseous U. S. dose commitment of 250 man-rem as determined with Table S-3. The total gaseous and liquid involuntary dose commitment to the U. S. population utilizing revised source term data presented in NUREG-0016 is comparable to the approximate 500 man-rem dose evaluated with Table S-3.

The substitution of a "throw away" cycle would increase the dose commitment accumulated to the year 2000 for the reprocessing and waste management portions of the fuel cycle. This is due principally to increased occupational exposure during fuel storage. These effects amount to some 12,000 man-rem total to the year 2000 and would have

only a small effect on the overall population dose commitment. Furthermore, they may not be detectable against the natural background exposure during this 25 year period of some 2-3 rem for every member of the general public.[2]

There is an increase to the transportation dose commitment presented in Table S-3. The revised transportation dose value of some 2.5 man-rem is based upon refined calculational assumptions and modeling techniques. This dose is not considered significant in comparison to the natural background dose.

There has been an increase in the quantity of buried radioactive waste material (both high level and transuranic). These wastes are placed in the geosphere and are not released to the biosphere and no radiological environmental impact is expected from such disposal. Table S-3 did not include either the disposal of high level or transuranic wastes nor low-level wastes from reactors which were buried.

The fuel cycle effects presented in Table S-3 as discussed above are sufficiently small so that, when they are superimposed upon the other environmental impacts assessed with respect to operation of the reactor, the changes in the overall environmental impact from operation of Brunswick Unit 1 are not substantial. Taking the impacts into account, the staff has concluded that the overall cost-benefit balance previously developed in the Brunswick FES remains unaltered and, therefore, on balance, the full power operating license should be granted.

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[2] As a result of increased requirements for new source material due to a "throw away" cycle, estimated releases from mining and milling would be increased. This, in turn, would increase the estimated dose commitment for the total fuel cycle by some 600 man-rem per reference reactor year. Although this is larger than the dose commitment due to other elements of fuel cycle, it is still small compared to the natural background exposure level of some 21,000,000 man-rem per year.

In accordance with the Commission's directive contained in the Supplemental General Statement of Policy, the staff has also assessed as set forth above, the effect of using the revised chemical processing and waste storage values set forth in the Commission's Notice of Proposed Rulemaking of October 18, 1976, on the cost-benefit balance for the Brunswick facility. These changes, as discussed above, are so small that there is no significant change in impact from that associated with the effects presented in Table S-3 and, accordingly, the use of the revised values would not tilt the cost-benefit balance against issuance of the license.

Table 1

Fuel Cycle Environmental Impacts
vs.
Plant Operating Environmental Impacts

Natural Resource Use	Fuel Cycle Impacts per AFR[a] (WASH-1248 Table S-3)	Fuel Cycle Impacts per Year for the Plant[b]	Plant Operating Impacts per Year
Land (Acres)			
Temporarily Committed	63	52	5706)*
Undisturbed Area	45	37	741)*
Disturbed Area	18	15	4965)*
			)
Permanently Committed	4.6	3.8	60)*
Overburden Moved (millions of MT)	2.7	2.2	
Water (millions of gal.)			
Discharged to air	156	128	
Discharged to water bodies	11,040	9,064	342,054
Discharged to ground	123	101	
Total Water	11,319	9,293	342,054
Fossil Fuel			
Electrical energy (thousand MW-hr.)	317	260	
Equivalent coal (thousand MT)	115	94	
Natural Gas (million scf)	92	76	
Effluents			
Chemicals (MT)			
Gases (MT)			
SO_x	4,400	3,612	
NO_x	1,177	966	
Hydrocarbons	13.5	11.1	
CO	28.7	23.6	
Particulates	1,156	949	
Other Gases			
F^-	0.72	0.59	
HCl	-		

*Over Plant Operating Lifetime

Table 1 (Continued)

Natural Resource Use	Fuel Cycle Impacts per AFR (WASH-1248 Table S-3)	Fuel Cycle Impacts per Year for the Plant	Plant Operatin Impacts per Year
Effluents (Cont'd.)			
Liquids			
$SO_4^=$	10.3	6.9	30.4
NO_3^-	26.7	21.9	
Fluoride	12.9	10.6	
Ca^{++}	5.4	4.4	
Cl^-	8.6	7.1	
NA^+	16.9	13.8	14.6
NH_3	11.5	9.4	
Tailings Solutions (thousands)	240	197	
Fe	0.4	0.3	
Solids	91,000	74,711	0.075
Radiological (curies)			
Radiological (curies)			
Gases (including entrainment)			A total of approx 11,000 Ci/yr of Noble Gases
Rn-222	74.5	61.2	
Ra-226	0.02	.02	
Th-230	0.02	.02	
Uranium	0.032	.026	
Tritium (thousands)	16.7	13.7	
Kr-85 (thousands)	350	287	0.550
I-129	0.0024	.002	0.064
I-131	0.024	.02	
Fission Products	1.0	0.8	
Transuranics	0.004	0.003	
C-14	-		
Liquids			A total of approx 5 Ci/yr excluding Tritium
Uranium & Daughters	2.1	1.7	
Fission & Activation Products	-		
Ra-226	0.0034	0.0028	
Th-230	0.0015	0.0012	
Th-234	0.01	0.008	
Tritium (thousands)	2.5	2.1	.02
Ru-106	0.15	0.12	0.0012

Table 1 (Continued)

Natural Resource Use	Fuel Cycle Impacts per AFR (WASH-1248 Table S-3)	Fuel Cycle Impacts per Year for the Plant	Plant Operatin Impacts per Year
Effluents (Cont'd)			
Radiological (curies) (Cont'd)			
Solids (buried onsite)[c]			
Other than high level (shallow)	601	493	
TRU & HLW (deep)	-		
Thermal (Billions of Btu)	3,360	2,759	72,831
Transportation (man-rems)			
Exposure of workers and general public	0.334	0.274	2.83

[a] AFR is an annual fuel requirement which is equivalent to operating a 1000 MWe reactor at 80% of its maximum capacity for one year.

[b] Fuel cycle impacts normalized to 821 MWe output of Brunswick Unit No. 1.

[c] Not released to the environment.

Table 2

Summary of Environmental Considerations
For Uranium Fuel Cycle Normalized to
Model LWR Reference Reactor Year[a]

Natural Resource Use	Total	
	WASH-1248[b]	NUREG-0116[c]
Land (Acres)		
Temporarily Committed	63	94
Undisturbed Area	45	73
Disturbed Area	18	22
Permanently Committed	4.6	7.1
Overburden Moved (millions of MT)	2.7	2.8
Water (millions of gal.)		
Discharged to air	156	159
Discharged to water bodies	11,040	11,090
Discharged to ground	123	124
Total Water	11,319	11,373
Fossil Fuel		
Electrical energy (thousand MW-hr.)	317	321
Equivalent coal (thousand MT)	115	117
Natural Gas (million scf)	92	124
Effluents		
Chemical (MT)		
Gases (MT)		
SO_x	4,400	4,400
NO_x	1,177	1,190
Hydrocarbons	13.5	14
CO	28.7	29.6
Particulates	1,156	1,154
Other Gases		
F^-	0.72	0.67
HCl	-	0.14

Table 2 (Continued)

Natural Resource Use	Total	
	WASH-1248	NUREG-0116
Effluents (Cont'd.)		
Liquids		
$SO_4^=$	10.3	9.9
NO_3^-	26.7	25.8
Fluoride	12.9	12.9
Ca^{++}	5.4	5.4
Cl^-	8.6	8.5
NA^+	16.9	12.1
NH_3	11.5	10.0
Tailings Solutions (thousands)	240	240
Fe	0.4	0.4
Solids	91,000	91,000
Radiological (curies)		
Gases (including entrainment)		
Rn-222	74.5	74.5
Ra-226	0.02	0.02
Th-230	0.02	0.02
Uranium	0.032	0.034
Tritium (thousands)	16.7	18.1
Kr-85 (thousands)	350	400
I-129	0.0024	1.3
I-131	0.024	0.83
Fission Products	1.0	0.021
Transuranics	0.004	0.024
C-14	-	24
Liquids		
Uranium & Daughters	2.1	2.1
Fission & Activation Products	-	5.9E-6
Ra-226	0.0034	0.0034
Th-230	0.0015	0.0015
Th-234	0.01	0.01
Tritium (thousands)	2.5	-
Ru-106	0.15	-

Table 2 (Continued)

Natural Resource Use	Total	
	WASH-1248	NUREG-0016
Effluents (Cont'd)		
Radiological curies) (Cont'd)		
Solids (buried onsite)[d]		
Other than high level (shallow)	601	5,300
TRU & HLW (deep)	-	1.1E+7
Thermal (billions of Btu)	3,360	3,462
Transportation (man-rems)		
Exposure of workers and general public	0.334	2.46

[a]Reference Reactor Year (RRY) is a 1000 MWe reactor operating at 80% of its maximum capacity for one year. An RRY is equivalent to an Annual Fuel Requirement as used in WASH-1248 dated April 1974.

[b]Table S-3 values.

[c]Revised Table S-3 values.

[d]Not released to the environment.

SOURCES: Environmental Supply of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle, NUREG-0116, October 1976.

Environmental Survey of the Uranium Fuel Cycle, WASH-1248, April 1974.

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