NEI 07-11 [Revision 0]

Generic Template Guidance for Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors

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Nuclear Energy Institute

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EXECUTIVE SUMMARY

NEI 07-11, *Generic Template Guidance for Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors, Revision 0*, provides a generic approach for use in support of design certification (DC) and combined license (COL) applications to demonstrate compliance with the regulatory requirement to perform a cost-benefit analysis for radwaste systems (10 CFR 50, Appendix I, Section II.D). The document reflects contemporary NRC guidance, including Regulatory Guide 1.206, "COL Applications for Nuclear Power Plants (LWR Edition)," and industry-NRC discussions regarding the applicable standard review plan sections. A main objective of this report is to assist in expediting NRC review and issuance of the combined license.

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GENERIC TEMPLATE GUIDANCE FOR COST-BENEFIT ANALYSIS FOR RADWASTE SYSTEMS FOR LIGHT-WATER-COOLED NUCLEAR POWER REACTORS

1 INTRODUCTION

This template guidance report provides a generic approach for use in support of design certification (DC) and combined license (COL) applications to demonstrate compliance with the regulatory requirement to perform a cost-benefit analysis for radwaste systems (10 CFR 50, Appendix I, Section II.D) and provide reasonable assurance that all items of reasonably demonstrated technology have been incorporated into radwaste systems to maintain doses to members of the public as low as is reasonably achievable (ALARA).

The approach included in this report utilizes methods endorsed in NRC regulatory guidance and proposes "thresholds," in terms of estimated collective radiation dose to members of the public within a 50-mile radius of proposed nuclear power plants, below which further cost-benefit analysis is not necessary (i.e., using the criteria prescribed in regulation of $1,000 per person-rem for total body or thyroid dose). The proposed thresholds are derived from an analysis of the liquid and gaseous waste treatment system augments listed in NRC Regulatory Guide 1.110.

Conformance by applicants with the threshold values presented in this report is neither required nor intended. The threshold values reflect the results of a conservative, "bounding" analysis and serve as generic thresholds below which no further analysis by DC or COL applicants is necessary to meet the requirement. Specifically, the threshold values do not represent proposed limits or standards, but merely indicate where further analysis using applicant-specific information may be warranted.

2 REGULATORY REQUIREMENT AND GUIDANCE

2.1 REGULATORY REQUIREMENT – 10 CFR 50, APPENDIX I, SECTION II.D

The regulatory requirement for performing a cost-benefit analysis for radwaste systems at light-water-cooled nuclear power reactors is contained in 10 CFR 50, Appendix I, Section II.D, as follows:

> "In addition to the provisions of paragraphs A, B, and C above, the applicant shall include in the radwaste system all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit return, can for a favorable cost-benefit ratio effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor. As an interim measure and until establishment and adoption of better values (or other appropriate criteria), the values $1000 per total body man-rem and $1000 per man-thyroid-rem (or such lesser

values as may be demonstrated to be suitable in a particular case) shall be used in this cost-benefit analysis."

2.2 REGULATORY GUIDANCE

Regulatory guidance on acceptable methods and criteria for performing a cost-benefit analysis of radwaste systems to demonstrate compliance with 10 CFR 50, Appendix I, Section II.D, is included in USNRC Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants," NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," and RG 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors." Relevant guidance from these documents is included below to provide a single consolidated set of applicable guidance for users of this report.

2.2.1 Regulatory Guide 1.206, Section C.I.11 – Radioactive Waste Management

2.2.1.1 Section C.I.11.2.1, Design Bases for Liquid Radwaste Treatment Systems

"Within this evaluation, the applicant should provide a site-specific cost-benefit analysis for reducing population doses due to liquid effluents, pursuant to Appendix I to 10 CFR Part 50 and in accordance with the guidance in Regulatory Guides 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Plants," and 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," and NUREG/CR-4013, "LADTAP II—Technical Reference and User Guide." If this guidance is not followed, describe the specific alternative methods used. More specifically, show that the proposed systems contain all items of reasonably demonstrated technology that, when added to the system in order of diminishing cost-benefit return, can, for a favorable cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor. State all assumptions and describe the calculation methods used, including all supporting references."

2.2.1.2 Section C.I.11.3.1, Design Bases for Gaseous Radwaste Treatment Systems

"The applicant should provide an evaluation showing the capability of the proposed systems to control releases of radioactive materials to within the numerical design objectives of Appendix I to 10 CFR Part 50. Within this evaluation, provide a site-specific cost-benefit analysis for reducing population doses due to gaseous effluents, in compliance with Appendix I to 10 CFR Part 50, and in accordance with the guidance in Regulatory Guides 1.110 and 1.111 and NUREG/CR-4653, "GASPAR II—Technical Reference and User Guide." If this guidance is not followed, describe the specific alternative methods used. More specifically, show that the proposed systems contain all items of reasonably demonstrated technology that, when added to the system in order of diminishing cost-benefit return, can, for a favorable cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor. State all assumptions and describe the calculation methods used, including all supporting references."

2.2.2 NUREG-0800, Chapter 11 – Radioactive Waste Management

2.2.2.1 Chapter 11.2, Liquid Waste Management System and Chapter 11.3, Gaseous Waste Management System

Note: Chapters 11.2 and 11.3 contain equivalent guidance regarding cost-benefit analysis of liquid and gaseous waste management systems, respectively. For efficiency, the excerpts shown are from Chapter 11.2 only (for liquid waste management systems). References to the corresponding sections in Chapter 11.3 (gaseous waste management systems) are included in brackets at the end of each excerpt.

Chapter 11.2 – SRP Acceptance Criterion 1.B:

"In addition to 1.A, 1.B, and 1.C, above, the LWMS should include all items of reasonably demonstrated technology that, when added to the system sequentially and in order of diminishing cost-benefit return, for a favorable cost-benefit ratio, can effect reductions in dose to the population reasonably expected to be within 80 km (50 mi) of the reactor. Regulatory Guide 1.110 provides an acceptable method for performing this analysis." [See Chapter 11.3, SRP Acceptance Criterion 1.D, for comparable guidance for evaluating gaseous waste treatment systems.]

Chapter 11.2 – Technical Rationale Item 2:

"Appendix I to 10 CFR Part 50 provides numerical guidance on design objectives to meet the requirements that radiation doses caused by radioactive materials in effluents released to unrestricted areas be kept ALARA. Sections II.A and II.D of Appendix I relate to the numerical guides for dose design objectives, limiting conditions for operation, and controls to meet the ALARA criterion for liquid effluents. Regulatory Guides 1.109 and 1.113 provide acceptable methods for performing dose analyses to demonstrate that the LWMS design results in doses caused by releases of radioactive materials from each reactor comply with Appendix I dose objectives.

Regulatory Guide 1.110 provides an acceptable method of performing cost-benefit analysis to demonstrate that the LWMS design includes all items of reasonably demonstrated technology for reducing cumulative population doses from releases of radioactive materials from each reactor to ALARA levels.

Meeting the requirements of Sections II.A and II.D of Appendix I to 10 CFR Part 50 provides assurance that the limits for radiation doses to a maximally exposed offsite individual from liquid effluents specified in Section II.A and the acceptance criterion for cost-benefit analysis specified in Section II.D for meeting the ALARA objective will be met." [See Chapter 11.3, Technical Rationale Item 7, for comparable guidance for evaluating gaseous waste treatment systems.]

Chapter 11.2 – Evaluation Findings Item 2: "The applicant has met the requirements of Section II.D of Appendix I to 10 CFR Part 50 with respect to meeting the ALARA criterion. The staff has considered the potential effectiveness of augmenting the proposed LWMS using items of reasonably demonstrated technology and has determined that further effluent treatment will not effect reductions in cumulative population doses reasonably expected within an 80-km (50-mi) radius of the reactor at a cost of less than $1000 per man-rem or man-thyroid-rem." [See Chapter 11.3, Evaluation Findings Item 2.C, for comparable guidance for evaluating gaseous waste treatment systems.]

2.2.2.2 Chapter 11.4, Solid Waste Management System

Chapter 11.4 – Technical Rationale Item 2:

"The review should determine whether performance meets or exceeds that noted in NRC guidance, standard DCs, industry standards, or topical reports. The NRC guidance includes NUREG-0016 or NUREG-0017 and Regulatory Guide 1.112, as they relate to the use of acceptable methods for calculating radionuclide concentrations in process streams and annual effluent releases, and Regulatory Guide 1.110, as it relates to performing cost-benefit analysis in reducing cumulative population doses by using available technology."

Chapter 11.4 – Evaluation Findings Item 3:

"The applicant has fulfilled the requirements of Section II.D of Appendix I to 10 CFR Part 50 with respect to meeting the ALARA criterion. The staff has considered the potential effectiveness of augmenting the proposed SWMS using items of reasonably demonstrated technology and has determined that further waste treatment will not effect reductions in cumulative population doses reasonably expected within an 80-kilometer (50-mile) radius of the reactor at a cost of less than $1000 per man-rem or man-thyroid-rem."

2.2.3 Regulatory Guide 1.110, Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors

RG 1.110 outlines a method for performing the required cost-benefit analysis of nuclear power plant radwaste systems and provides fixed and variable cost values for estimating the total annual costs for various liquid and gaseous radwaste treatment system augments. The costs presented consider the direct equipment cost and the costs of building space, supportive services, maintenance, interest, and operating as well as other costs generally considered in analyzing capital and operating costs in power plant estimating.

The Regulatory Position in the guide stipulates the following:

1. The cost-benefit analysis should consider the reduction in release of radioactive material from all effluent pathways. Liquid and gaseous radwaste system augments considered in the analysis should be selected in order of diminishing cost-benefit returns.

2. All costs are given in terms of 1975 dollars (as is the $1,000 per man-rem cost with which they are compared). Allowances for inflation after 1975 should not be factored into the cost estimates.

3. The method of calculation described in Appendix A and the parameters presented in Appendix B of this guide are acceptable to the NRC staff for performing the cost-benefit analysis.

4. The method of calculation described in Appendix A and the parameters presented in Appendix B of this guide are acceptable to the NRC staff for performing the cost-benefit analysis.

In support of the cost-benefit analysis, the applicant should provide a complete evaluation, in methodology used, components considered, and all assumptions and parameters used. Information to be submitted by the applicant is described in Appendix C to this guide.

3 ANALYSIS

3.1 APPROACH

Collective doses for populations within a 50 mile radius of currently operating nuclear power plants are extremely low, ranging from 0.0015 to 16 person-rem total dose from combined liquid and gaseous pathways, as evaluated by the USNRC in the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (NUREG-1437). Preliminary data provided by near-term COL applicants indicate that the collective doses for populations within a 50 mile of proposed plants will be comparable to those for operating plants. The estimated low population doses associated with proposed new nuclear power plants support a generic approach for use by DC and COL applicants to demonstrate compliance with the regulatory requirement for performing a cost-benefit analysis for radwaste systems (Section II.D of Appendix I to 10 CFR Part 50).

The generic approach presented in this report includes a bounding analysis that evaluates the most favorable cost-benefit-ratio options for both liquid and gaseous radwaste treatment systems, using the methodology prescribed in Regulatory Guide 1.110. The results of the analysis are used to propose "threshold values," below which no further analysis by an applicant is necessary to demonstrate compliance with the regulatory requirement. The threshold values, presented in terms of annual person-rem, represent the lowest-cost radwaste system augments, given in terms of total annual costs in dollars, divided by the regulatory criteria of $1,000 per person-rem prescribed in Appendix I to 10 CFR Part 50.

In order to be "bounding," the analysis utilizes reasonably conservative assumptions in determining the cost factors from RG 1.110. This approach produces the least-cost values for each of the liquid and gaseous radwaste treatment system augments included in Regulatory Guide 1.110. After ranking the augments by cost, the lowest-cost augments for liquid and gaseous radwaste treatment systems, respectively, are selected to determine the threshold values that are presented in this report.

It should be noted that the analysis employs a highly conservative assumption that the respective radwaste treatment system augment reduces the effluent and estimated dose for that pathway by 100% (i.e., reduces the estimated pathway dose to zero). This is a hypothetical construct for the purpose of a bounding analysis and obviously, no such "perfect" radwaste treatment system exists in practice. Less restrictive, but still conservative, thresholds may be derived by developing and applying more realistic effluent/dose reduction factors in regard to the respective radwaste treatment system augments.

3.2 Methodology and Assumptions

3.2.1 Methodology

Cost-benefit analysis threshold values (CBA-TV) proposed in this report are derived for each of the lowest-cost options for liquid and gaseous radwaste treatment systems. The CBA-TV is calculated for each as follows:

CBA-TV (person-rem) = Total Annual Cost ($) / $1,000 per person-rem

The methodology given in Regulatory Guide 1.110 for determining the Total Annual Cost (TAC) for each radwaste treatment system augment is as follows:

TAC = Annual Fixed Cost (AFC) + Annual Operating Cost (AOC) + Annual Maintenance Cost (AMC), where:

AFC = Total Capital Cost (TCC) x Capital Recovery Factor (CRF), where:

TCC = Total Direct Cost (TDC) x Indirect Cost Factor (ICF), where:

TDC = Direct Cost of Eqpt/Mat'ls (DCEM) + Adjusted Labor Cost (ALC), where:

ALC = Direct Labor Cost (DLC) x Labor Cost Correction Factor (LCCF)

3.2.2 Assumptions

Some of the parameters used in calculating the Total Annual Cost are fixed and are given for each radwaste treatment system augment listed in Regulatory Guide 1.110, including the Annual Operating Cost (AOC), Annual Maintenance Cost (AMC), Direct Cost of Equipment and Materials (DCEM), and Direct Labor Cost (DLC).

Other parameters are variable and are determined by the user, including the following:

Capital Recovery Factor (CRF) – This factor is taken from a table in Regulatory Guide 1.110 and reflects the cost of money for capital expenditures. A cost-of-money value of 7% per year is assumed in the analysis in this report, consistent with the "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NUREG/BR-0058). From the table in regulatory Guide 1.110, this equals a Capital recovery Factor of 0.0806.

Indirect Cost Factor (ICF) – This factor takes into account whether the radwaste system unitized or shared (in the case of a multi-unit site). It is assumed that the radwaste system for the analysis in this report is a unitized system at a 2-unit site, which equals an Indirect Cost Factor of 1.625.

Labor Cost Correction Factor (LCCF) – This factor takes into account the differences in relative labor costs between geographical regions. A factor of 1 (the lowest value) is assumed in the analysis in this report.

The value of $1,000 per person-rem is prescribed in the regulation.

As noted above, in determining the threshold values, it is assumed that the respective radwaste treatment system augment is a "perfect" system that reduces the effluent and dose by 100%.

4 RESULTS

The results of the analysis are tabulated in the tables in Appendix A to this report. The respective gaseous and liquid radwaste treatment system augments are listed from highest annual cost to lowest annual cost for each.

The lowest-cost option for gaseous radwaste treatment system augments is the Steam Generator Flash Tank Vent to Main Condenser at $6,320/year, which yields a threshold value of 6.32 person rem.

The lowest cost option for liquid radwaste treatment system augments is a 10,000 gallon Tank at $16,830/year, which yields a threshold value of 16.83 person-rem.

5 CONCLUSION

For light-water reactors, applications with dose estimates less than the following values would not need to perform any further cost-benefit analysis to demonstrate compliance with 10 CFR 50, Appendix I, Section II.D:

6.32 person-rem whole body or thyroid dose from gaseous effluents

16.83 person-rem whole body or thyroid dose from liquid effluents

6 REFERENCES

6.1 10 CFR 50, Appendix I, Section II.D

6.2 USNRC Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants"

6.3 USNRC Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors"

6.4 NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Sections 11.2, 11.3, and 11.4

6.5 NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission"

6.6 NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants"

Cost Benefit Analysis For Radwaste Systems Light-Water Cooled Nuclear Power Reactors Work Sheet

FPC Region	3	1	IS Type Radwaste System Single Unit or Multi-Unit (Shared Rad Waste Systems)?	N	1.625	Cost Of Money	7.00%
		# Unitized Rad Waste Systems Multi- Unit Sites (i.e. if N above)		2	Capital Recovery Factor		8.06%
		Number of Units		2			

Gaseous Radwaste Augments													Gaseous Waste Management System		
Augments	Equipment/ Material Cost	Labor Cost(LC)	LC Correction Factor	Corrected Labor Cost	Total Direct Cost (TDC)	Indirect Cost Factor	Total Capital Cost (TCC)	Annual Fixed Cost	Annual Operating Cost (AOC) Per Unit	Annual Operating Cost (AOC)	Annual Maintenance Cost (AMC)	Total Annual Cost (TAC)	AP-1000	ESBWR	AREVA
Turbine Building Chilled Water HVAC System	614	374	1	374	988	1.625	1605.5	129.38	49	98	20	198.38			
BWR Offgas Recombiner	553	255	1	255	808	1.625	1313.0	105.81	3	6	20	128.81			
PWR Hydrogen Recombiner	419	147	1	147	566	1.625	919.8	74.12	4	8	10	88.12			
Clean Steam to Turbine Glands	81	215	1	215	296	1.625	481.0	38.76	24	48	4	66.76			
Desiccant Dryer	218	176	1	176	394	1.625	640.3	51.60	3	6	6	60.60			
30,000 cfm Charcoal/HEPA Filtration System (If in Auxiliary Building)	157	51	1	51	208	1.625	338.0	27.24	9	18	18	54.24			
30,000 cfm Charcoal/HEPA Filtration System (If in Turbine Building)	152	41	1	41	193	1.625	313.6	25.27	9	18	18	52.27			
Clean Steam to Steam Valves 2-1/2" and Less Than 24"	183	55	1	55	238	1.625	386.8	31.17	3	6	12	46.17			
Clean Steam to Steam Valves 24" and Larger	137	110	1	110	247	1.625	401.4	32.35	3	6	4	39.35			
15,000 cfm Charcoal/HEPA Filtration System (If In Auxiliary Building)	97	31	1	31	128	1.625	208.0	16.76	7	14	9	32.76			
15,000 cfm Charcoal/HEPA Filtration System (If In Turbine Building)	93	26	1	26	119	1.625	193.4	15.58	7	14	9	31.58			
Charcoal Vault Refrigeration	116	38	1	38	154	1.625	250.3	20.17	4	8	3	27.17			
15,000 cfm HEPA Filtration System (If In Auxiliary Building)	52	16	1	16	68	1.625	110.5	8.90	6	12	2	16.90			
15,000 cfm HEPA Filtration System (If In Turbine Building)	49	14	1	14	63	1.625	102.4	8.25	6	12	2	16.25			
PWR Air Ejector Charcoal/HEPA Filtration Unit	14	10	1	10	24	1.625	39.0	3.14	4	8	2	9.14			
3-Ton Charcoal Absorber	53	14	1	14	67	1.625	108.9	8.77	0	0	0	8.77			
Main Condenser Vacuum Pump Charcoal/HEPA Filtration System	40	8	1	8	48	1.625	78.0	6.29	0.4	0.8	1	7.69			
1000 cfm Charcoal/HEPA Filtration System	28	10	1	10	38	1.625	61.8	4.98	2	4	0.6	7.58			
600-ft3 Gas Decay Tank	33	24	1	24	57	1.625	92.6	7.46	0	0	0	7.46			
Steam Generator Flash Tank Vent to Main Condenser	19	14	1	14	33	1.625	53.6	4.32	1	2	1	6.32			

All Cost Are In $1,000s And Annual Cost Are In $1,000s/Year   Population Doses Are In Units Of Man-REM

Liquid Radwaste Augments

Liquid Radwaste Augments													Liquid Waste Management System		
Augments	Equipment/ Material Cost	Labor Cost(LC)	LC Correction Factor	Corrected Labor Cost	Total Direct Cost (TDC)	Indirect Cost Factor	Total Capital Cost (TCC)	Annual Fixed Cost	Annual Operating Cost (AOC) Per Unit	Annual Operating Cost (AOC)	Annual Maintenance Cost (AMC)	Total Annual Cost (TAC)	AP-1000	ESBWR	AREVA
50 gpm Evaporator (BWR Dirty Waste)	655	233	1	233	888	1.625	1443.0	116.29	169	338	30	484.29			
30 gpm Evaporator (BWR Dirty Waste)	540	223	1	223	763	1.625	1239.9	99.92	169	338	30	467.92			
15 gpm Evaporator (BWR Dirty Waste)	386	201	1	201	587	1.625	953.9	76.87	169	338	30	444.87			
50 gpm Evaporator (Condensate Polisher Chemical Waste)	655	233	1	233	888	1.625	1443.0	116.29	114	228	30	374.29			
30 gpm Evaporator (Condensate Polisher Chemical Waste)	540	223	1	223	763	1.625	1239.9	99.92	114	228	30	357.92			
15 gpm Evaporator (Condensate Polisher Chemical Waste)	386	201	1	201	587	1.625	953.9	76.87	114	228	30	334.87			
50 gpm Evaporator (PWR Dirty Waste)	655	233	1	233	888	1.625	1443.0	116.29	50	100	30	246.29			
30 gpm Evaporator (PWR Dirty Waste)	540	223	1	223	763	1.625	1239.9	99.92	50	100	30	229.92			
400 gpm Demineralizer (PWR Turbine Bldg. Drains Waste)	102	44	1	44	146	1.625	237.3	19.12	95	190	5	214.12			
200 gpm Demineralizer (PWR Turbine Bldg. Drains Waste)	94	35	1	35	129	1.625	209.6	16.89	95	190	5	211.89			
100 gpm Demineralizer (PWR Turbine Bldg. Drains Waste)	64	31	1	31	95	1.625	154.4	12.44	95	190	5	207.44			
15 gpm Evaporator (PWR Dirty Waste)	386	201	1	201	587	1.625	953.9	76.87	50	100	30	206.87			
50 gpm Demineralizer (PWR Turbine Bldg. Drains Waste)	43	29	1	29	72	1.625	117.0	9.43	95	190	5	204.43			
400 gpm Demineralizer (BWR Dirty Waste)	102	44	1	44	146	1.625	237.3	19.12	88	176	5	200.12			
200 gpm Demineralizer (BWR Dirty Waste)	94	35	1	35	129	1.625	209.6	16.89	88	176	5	197.89			
100 gpm Demineralizer (BWR Dirty Waste)	64	31	1	31	95	1.625	154.4	12.44	88	176	5	193.44			
50 gpm Demineralizer (BWR Dirty Waste)	43	29	1	29	72	1.625	117.0	9.43	88	176	5	190.43			
50 gpm Evaporator (detergent Waste)	655	233	1	233	888	1.625	1443.0	116.29	20	40	30	186.29			
30 gpm Evaporator (Detergent Waste)	540	223	1	223	763	1.625	1239.9	99.92	20	40	30	169.92			
400 gpm Precoat Filter	202	112	1	112	314	1.625	510.3	41.12	53	106	10	157.12			
15 gpm Evaporator (Detergent Waste)	386	201	1	201	587	1.625	953.9	76.87	20	40	30	146.87			
100 gpm Precoat Filter	108	56	1	56	164	1.625	266.5	21.48	53	106	10	137.48			
400 gpm Demineralizer (PWR Steam Generator Blowdown)	102	44	1	44	146	1.625	237.3	19.12	25	50	5	74.12			
200 gpm Demineralizer (PWR Steam Generator Blowdown)	94	35	1	35	129	1.625	209.6	16.89	25	50	5	71.89			
100 gpm Demineralizer (PWR Steam Generator Blowdown)	64	31	1	31	95	1.625	154.4	12.44	25	50	5	67.44			
50 gpm Demineralizer (PWR Steam Generator Blowdown)	43	29	1	29	72	1.625	117.0	9.43	25	50	5	64.43			
400 gpm Demineralizer (PWR Dirty Waste)	102	44	1	44	146	1.625	237.3	19.12	18	36	5	60.12			
200 gpm Demineralizer (PWR Dirty Waste)	94	35	1	35	129	1.625	209.6	16.89	18	36	5	57.89			

Augments	Equipment/ Material Cost	Labor Cost(LC)	LC Correction Factor	Corrected Labor Cost	Total Direct Cost (TDC)	Indirect Cost Factor	Total Capital Cost (TCC)	Annual Fixed Cost	Annual Operating Cost (AOC) Per Unit	Annual Operating Cost (AOC)	Annual Maintenance Cost (AMC)	Total Annual Cost (TAC)	AP-1000	ESBWR	AREVA
400 gpm Deminerlizer BWR 2nd Waste Demineralizer in Series	102	44	1	44	146	1.625	237.3	19.12	15	30	5	54.12			
100 gpm Demineralizer (PWR Dirty Waste)	64	31	1	31	95	1.625	154.4	12.44	18	36	5	53.44			
200 gpm Deminerlizer BWR 2nd Waste Demineralizer in Series	94	35	1	35	129	1.625	209.6	16.89	15	30	5	51.89			
50 gpm Demineralizer (PWR Dirty Waste)	43	29	1	29	72	1.625	117.0	9.43	18	36	5	50.43			
100 gpm Deminerlizer BWR 2nd Waste Demineralizer in Series	64	31	1	31	95	1.625	154.4	12.44	15	30	5	47.44			
50 gpm Demineralizer BWR 2nd Waste Demineralizer in Series	43	29	1	29	72	1.625	117.0	9.43	15	30	5	44.43			
2 gpm Reverse Osmosis	100	38	1	38	138	1.625	224.3	18.07	7	14	9	41.07			
400 gpm Demineralizer (PWR Clean Waste)	102	44	1	44	146	1.625	237.3	19.12	5	10	5	34.12			
200 gpm Demineralizer (PWR Clean Waste)	94	35	1	35	129	1.625	209.6	16.89	5	10	5	31.89			
100 gpm Demineralizer (PWR Clean Waste)	64	31	1	31	95	1.625	154.4	12.44	5	10	5	27.44			
50 gpm Demineralizer (PWR Clean Waste)	43	29	1	29	72	1.625	117.0	9.43	5	10	5	24.43			
Evaporator Distillate Demineralizer	36	24	1	24	60	1.625	97.5	7.86	5	10	2	19.86			
20 gpm Cartridge Filter	13	11	1	11	24	1.625	39.0	3.14	7	14	1	18.14			
10,000 gal Tank	55	43	1	43	98	1.625	159.3	12.83	1	2	2	16.83			

All Cost Are In $1,000s And Annual Cost Are In $1,000s/Year   Population Doses Are In Units Of Man-REM

USER INPUT VALUES	CALCULATED VALUES	DATA FROM REGULATORY GUIDE 1.110

	FPC Region	3

FPC Region	Labor Cost Corrections	Value To Be Returned For Caculation On Primary Work Sheet
1	1.6	0
2	1.5	0
3	1	1
4	1.4	0
5	1.1	0
6	1.2	0
7	1.3	0
8	1.2	0
Labor Cost Correction Factor		1