12.2 Radiation Sources

12.2.1 Contained Sources

12.2.1.1 Source Terms

With the exception of the vessel and drywell shields, shielding designs are based on fission product and activation product sources consistent with Section 11.1. For shielding, it is conservative to design for fission product sources at peak values rather than an annual average, even though experience supports a lower annual average than the design average (Reference 12.2-1). It should be noted that activation products, principally N-16, control shielding calculations in most of the primary system. In areas where fission products are significant, conservative allowance is made for transient decay while at the same time providing for transient increase of the noble gas source, daughter product formation and energy level of emission. Areas where fission products are significant relative to N-16 include: (1) the condenser offgas system downstream of the steam jet air ejector; (2) liquid and solid radwaste equipment; (3) portions of the CUW System; and (4) portions of the feedwater system downstream of the hotwell, including condensate treatment equipment.

For application, the design sources are grouped first by location and then by equipment type (e.g., Reactor Building, core sources). The following paragraphs represent the source data in various pieces of equipment throughout the plant. General locations of equipment are shown in the general plant arrangement drawings of Section 1.2. Specific Acceptance Criterion II.6 of Section 12.2 provides that, in addition to the location of contained sources, their approximate size and shape be shown. Though this has not always been included, the source strength or concentration has been provided in Chapter 12 tables and detailed geometry has been provided in Table 12.2-1 for the reactor and in Chapter 5 for the main steam. In Chapter 12 the reactor water concentrations were used to develop sources in equipment containing reactor water or steam.

12.2.1.2 Reactor, Radwaste, and Turbine Building Sources

The information in this section is divided into two categories: (1) the reactor vessel sources (Subsection 12.2.1.2.1) and (2) the sources in the remaining areas (Subsections 12.2.1.2.2 through 12.2.1.3). Included in these areas are the sources from the Radwaste Building (Subsection 12.2.1.2.6) and the Turbine Building (Subsection 12.2.1.3). Table 12.2-5 presents an overview of the radioactive sources found in the ABWR excluding the reactor pressure vessel. This table is divided into four sections. The first section lists all major radioactive sources, the table which provides the source term information for the component, and the figure in Section 12.3 (or Chapter 1) in which the component location is shown along with coordinates for the component. In addition, the approximate geometry of the component is supplied. This geometry, in most cases, is only approximate and represents a generic application as compared to specific details for a vendor-supplied component. The second section of Table 12.2-5 gives for each component the estimated source distribution in each component. Again, this is estimated and will depend on final design parameters with vendor-specific application. The third section of Table 12.2-5 lists room dimensions and wall thicknesses for each component. This data is taken from the arrangement drawings and represents minimal values. Part four of Table 12.2-5 lists pipe chases, the major pipe routing through these chases, and piping data. Only chases carrying significant radioactive sources are listed.

Some areas of the plant show shielded areas without any designation to any radioactive component. These are primarily areas found around the primary containment boundary. For example, in Figure 12.3-5, at coordinate (RF,R4) a shielded area is shown with breakdown walls without any designated component. This area represents shielded penetration areas for nonradioactive components and can be cross referenced to Figure 1.2-13. Reference to Figure 1.2-13a shows electrical penetrations from the primary containment into the shielded area at (RF,R4) on Figure 12.3-5.

12.2.1.2.1 Reactor Vessel Sources

12.2.1.2.1.1 Radiation from the Reactor Core

12.2.1.2.1.1.1 General

The information in this section defines a reactor vessel model and the associated gamma and neutron radiation sources. This section is designed to provide the data required or calculations beyond the vessel. The data selected were not chosen for any given program, but were chosen to provide information for any of several shield program types. In addition to the source data, calculated radiation dose levels are provided at locations surrounding the vessel. These data are given as a potential check point for calculations by shield designers.

12.2.1.2.1.1.2 Physical Data

Table 12.2-1 presents the physical data required to form the model in Figure 12.2-1. This model was selected to contain as few separate regions as possible to adequately portray the reactor. Table 12.2-1 provides nominal dimensions and material volume fractions for each boundary and region in the reactor model. To describe the reactor core, Table 12.2-1 provides thermal power, power density, core dimensions, core average material volume factions and reactor power distributions. The reactor power distributions are given for both radial and axial distributions. These data contain uncertainties in the volume regions near the edge of the core. The level of uncertainties for these regions is estimated at 20%.

12.2.1.2.1.1.3 Core Boundary Neutron Fluxes

Table 12.2-2 presents peak axial neutron multigroup fluxes at the core equivalent radius. The core-equivalent radius is a hypothetical boundary enclosing an area equal to the area of the fuel bundles and the coolant space between them. The peak axial flux occurs adjacent to the portion of the core with the greatest power. While the flux within any given energy group is not known within a factor of 2, the total calculated core boundary flux is estimated to be within ±50%.

12.2.1.2.1.1.4 Gamma Ray Source Energy Spectra

Table 12.2-3 presents average gamma ray energy spectra thermal per watt of reactor power in both core and non-core regions. In Table 12.2-3, part A, the energy spectra in the core are presented. The energy spectra in the core represent the average gamma ray energy released by energy group in J/cm^3/s/MW thermal. The energy spectra in J/s/MW thermal/cm^3 can be used with the total core power and power distributions to obtain the source in any part of the core.

The gamma ray energy spectra include the fission gamma rays, the fission product gamma ray and the gamma rays resulting from inelastic neutron scattering and thermal neutron capture. The total gamma ray energy released in the core is estimated to be accurate to within ±10%. The energy release rate above 0.96 pico J may be in error by as much as a factor of ±2.

Table 12.2-3, part B, gives a gamma ray energy spectrum in J/s/W in spent fuel as a function of time after operation. The data were prepared from tables of fission product decay gamma fitted to integral measurements for operation times of 10^8 s, or approximately 3.2 years. To obtain shutdown sources in the core the gamma ray energy spectra are combined with the core thermal power and power distributions. Shutdown sources in a single fuel element can be obtained by using the gamma ray energy spectra and the thermal power the element contained during operation.

Table 12.2-3, part C, gives the gamma ray energy spectra in the cylindrical regions of the reactor from the core through the vessel. The energy spectra are given in terms of J/cm^3/ s/W at the inside surface and outside surfaces of the region. This energy spectrum, multiplied by the core thermal power, is the gamma ray source. The point on the inside surface of the region is the maximum point within the region. In the radial direction, the variation in source intensity may be approximated by an exponential fit to the data on the inside and outside surfaces of the region. The axial variation in a region can be estimated by using the core axial variation. The uncertainty in the gamma ray energy spectra is due primarily to the uncertainty in the neutron flux in these regions. The uncertainty in the neutron flux is estimated to vary from approximately ±50% at the core boundary to a factor of ±3 at the outside of the vessel. The calculations were carried out with voids beyond the vessel.

12.2.1.2.1.1.5 Gamma Ray and Neutron Fluxes Outside the Vessel

Table 12.2-4 presents the maximum axial neutron and gamma ray fluxes outside the vessel. The maximum axial flux occurs on the vessel opposite the elevation of the core with the maximum outer bundle power level. This elevation can be located using the data from Table 12.2-1. The fluxes at this elevation are based on a mean radius core and do not show azimuth angle variations. The calculational model for these fluxes assumed no shield materials beyond the vessel wall. The presence of shield materials will significantly alter the neutron fluxes in the lower end of the neutron energy spectrum. The gamma ray calculations include gamma ray sources from all of the cylindrical regions between the center of the core and the edge of the vessel. While the uncertainties in a given energy group flux may be a factor of ±3, the uncertainties in the total integral flux are estimated to be within a factor of two.

12.2.1.2.1.1.6 Deleted

12.2.1.2.2 Radioactive Sources in the Reactor Water, Steam and Offgas

The radioactive sources in the reactor water, steam and offgas are covered and discussed in Chapter 11 (Subsections 11.1.1 through 11.1.4). This material provides the concentrations during normal operation of the radioisotopes in the reactor vessel or leaving the reactor vessel.

12.2.1.2.3 Radioactive Sources in the HPCF and the LPFL Mode of the RHR System

The HPCF and the LPFL take suction from either the condensate storage tank or from the suppression pool. The radiation source in the equipment is the activity of the water transported through the system.

12.2.1.2.4 Radioactive Sources in the Reactor Shutdown Mode of the Residual Heat Removal System

The radioactive sources (Tables 12.2-6 and 12.2-7) in the Residual Heat Removal (RHR) System were calculated for the system operating in the reactor shutdown mode. In this mode, the system recirculates reactor coolant to remove reactor decay heat (Subsection 5.4.7). The RHR System is operated from approximately 2–4 hours after shutdown until the end of the refueling period. The source in the RHR System is the activity in the volume of reactor water contained in the system. This should include the increase of activity as a result of depressurization.

12.2.1.2.5 Radioactive Sources in Reactor Core Isolation Cooling System

The radioactive sources in the Reactor Core Isolation Cooling (RCIC) System were evaluated for the systems operating in the reactor shutdown mode. This system may be utilized during reactor shutdown if the main condenser is unavailable. The system is operated from the time of reactor shutdown for approximately 2 hours until a reactor pressure of 0.345 MPaG is achieved. Below 1.03 MPaG, the RCIC flow decreases. The source in the system is the activity in the volume of reactor water and steam contained in the system.

During routine testing of the system, the source in the equipment is the activity of the steam driving the system turbine. This activity is controlled by N-16. The radiation source data used in the shield design for this system is shown in Table 12.2-8.

12.2.1.2.6 Radioactive Sources in Radwaste Systems

12.2.1.2.6.1 Radioactive Sources in the Reactor Water Cleanup System

The radioactive sources are the result of the activity in the reactor water in transit through the system or accumulation of radioisotopes removed from the water. Components for this system include regenerative and nonregenerative heat exchangers, pumps, valves, filter demineralizers and the backwash receiving tank (Subsection 5.4.8). The accumulated sources in the filter demineralizers, backwash receiving tanks and heat exchangers are given in Tables 12.2-9 through 12.2-12.

The radioactive source is present in the filters and receiving tanks during all modes of operation. Therefore, backwashing capability is provided to remove the residual activity for effective radwaste handling.

12.2.1.2.6.2 Radioactive Sources in Liquid Radwaste System

The Liquid Radwaste System is composed of four subsystems designed to collect, treat and cycle or discharge different categories of waste water (Subsection 11.2.2). The radioactive sources for the components in the systems are provided in Table 12.2-13. The isotopic inventories in the liquid radwaste components were calculated assuming a fission product release rate from the fuel equivalent to that required to produce 3.7 GBq/s of offgas following a 30-min holdup period.

12.2.1.2.6.3 Radioactive Sources in the Gaseous Radwaste System

The gaseous effluent treatment systems are designed to limit the dose to offsite persons from routine station release. The offgases are treated through the use of a catalytic Recombiner and Ambient Temperature Charcoal Adsorption (RECHAR) System (Subsection 11.3.2). The system is designed to handle an annual average noble gas release equivalent to 3.7 GBq/s after a 30-minute delay. The accumulation of gaseous radioisotopes and the solid daughter products resulting from the decay of the noble gases are given in Table 12.2-14. The inventory in the components, evaluated for a 60-year operating time, has been used to accumulate the decay activities. This is sufficient time for most isotopes to reach equilibrium.

12.2.1.2.6.4 Radioactive Sources in the Solid Radwaste System

The Solid Radwaste System provides the capability for solidifying or packaging waste from the other radwaste systems (Subsection 11.4.2). The wastes can be solidified separately by type or source. The final waste is placed in a waste container. The radioactive sources for the components in the system are given in Table 12.2-15.

12.2.1.2.6.5 Radioactive Sources in the Fuel Pool Cleanup System

The radiation source data used in the shield design of the Fuel Pool Cleanup (FPC) System filter demineralizer are given in Table 12.2-16.

12.2.1.2.6.6 Radioactive Sources in the Suppression Pool Cleanup System

The radiation source data used in the shield of the Suppression Pool Cleanup (SPC) System are given in Table 12.2-17.

12.2.1.2.7 Radioactive Sources in Piping and Main Steam Systems

12.2.1.2.7.1 Radioactive Sources in Main Steam System

All radioactive material in the Main Steam System result from radioactive sources carried over from the reactor during plant operation. In most of the components carrying live steam, the source is dominated by N-16. In components where N-16 has decayed, the other activities carried by the steam become significant.

12.2.1.2.7.2 Radioactive Crud in Piping and Steam Systems

The inside surfaces of the piping and all reactor and power systems components become coated with activated corrosion products, commonly called crud. The quantity of crud on the components is dependent on a number of factors, including power history, water quality and fuel experience. The piping and components carrying reactor water are coated with higher levels of crud than piping and components carrying steam.

12.2.1.2.8 Radioactive Sources in the Spent Fuel

The radiation source for spent fuel is given in Subsection 12.2.1.2.1.1.4 (Table 12.2-3) in terms of J/s/W. The design calculation is carried out for a mean element and appropriate decay time.

12.2.1.2.9 Other Radioactive Sources

12.2.1.2.9.1 Reactor Startup Source

The reactor startup source is shipped to the site in a special cask designed with shielding. The source is transferred under water while in the cask and loaded into beryllium containers. This is then loaded into the reactor while remaining under water. The source remains within the reactor for its lifetime. Thus, no unique shielding requirements are required after reactor operation.

12.2.1.2.9.2 Radioactive Sources in the Control Rod Drive System

The control rod drive (CRD) source term data are provided in Table 12.2-18. The CRD System is described in Subsection 3.9.4.

12.2.1.2.9.3 Radioactivity in the Transverse In-Core Probe

The Traversing Incore Probe (TIP) System consists of a probe and a stainless steel cable which is run into and out of the core such that the probe and up to 3.7 m of cable are activated. The probe is described in Subsection 7.7.1.6.1 and is automatically controlled and indexed to its incore position. For maintenance, the probe is manually withdrawn into a shielded assembly area in which a shielded container is used to hold the probe. Both automatic logic control and mechanical stops prevent the probe and activated sections of the cable from withdrawal beyond the shielded room and container. Table 12.2-24 describes the levels of radioactivity expected from the probe and cable. Since there are two specific types of probes (a neutron and a gamma), both types are described in Table 12.2-24.

12.2.1.2.9.4 Radioactivity in the Reactor Internal Pumps

The reactor internal pumps (RIP) are located on the lower exterior portion of the pressure vessel and connect to an impeller located in the pressure vessel. A constant flow of clean water is maintained from the pump into the pressure vessel to minimize contamination of the lower pump housing and components. A complete description of the internal pump is given in Subsection 5.4.1. Contamination of the pump nevertheless occurs primarily on the upper impeller and components and to a lesser extent throughout the water bearing components into the lower pump housing. Table 12.2-25 presents the expected levels of contamination based upon operating experience.

12.2.1.2.9.5 Radioactivity in the Standby Gas Treatment System

The Standby Gas Treatment System (SGTS) is described in Section 6.5. For the determination of the potential activity associated with the operation of the SGTS, the primary containment source term developed in Subsection 12.2.2.1 for Table 12.2-19 was used as the basis for input to the SGTS. Six purges per year were assumed with a SGTS replacement lifetime of five years. The inventory is given in Table 12.2-30.

12.2.1.2.10 Post-accident Radioactive Sources

The ABWR general design criteria limit potential radiation exposure from accidents both to plant personnel and to the public by the use of containment and treatment of accident sources. The following describes those features of the ABWR germane to post- accident radiation sources in the Primary Containment, Reactor Building, Radwaste Building, and the Turbine Building.

The Primary Containment is an inerted steel-lined pressure boundary capable of containing all accident sources with minimal leakage to the environment or other plant areas. Sufficient redundancy in the ECCS and spray systems exists to insure, within a reasonable probability, that this primary boundary will not exceed design criteria. In the case of a degraded core event, additional passive features such as the suppression pool and passive flooder system have been incorporated to flood the containment and scrub airborne fission products. Therefore, for all but the most improbable accident scenarios, radioactive sources from the pressure vessel will be contained in the primary containment.

With respect to the Reactor Building, the overall plant design has divided the Reactor Building into three separate and independent divisions. ECCS components are contained in each division in separate isolated rooms such that the failure of one system in one division will not affect components in another division. Releases of radioactive material either in the form of water or steam (airborne) are contained in and isolated to a large extent in the compartment in which it might occur by the use of watertight doors and process radiation monitors which isolate the

HVAC System from the compartment on a high radiation signal. Divisional separation under such conditions is complete. Sumps are designed to detect and alarm in the event of leaks in excess of 0.063 liter per second. All connections to the Primary Containment not terminating in the Reactor Building meet GDC 54, 55, 56, and 57. Therefore, in the event of an accident involving radioactive sources in the Primary Containment or Reactor Building, such sources would be contained and isolated for further treatment and decontamination.

Likewise, potential releases in the Radwaste Building will be contained by filtering the Radwaste Building atmosphere and sealing any water releases in the building, which is steel-lined to prevent any potential water releases. Such potential releases are discussed in Section 15.7.

The Turbine Building contains no major sources of releasable radioactivity (discounting N-16 because of the 7.7 second half-life) and potential releases are limited to liquid releases of low activity water from the Feedwater and Condenser System. Two other sources exist which contain radioactivity species, but in a form not amenable for release. The potential for accident sources from these two sources (the Offgas System and condenser demineralizers) is reduced due to heavy shielding and compartmentalizing these components.

Estimates on sources and location for limiting design basis events are found in Chapter 15 and sources for degraded core events as a function of probability are found in Chapter 19.

12.2.1.3 Turbine Building Sources

Turbine Building sources are primarily dominated by N-16 in the steam flow from the pressure vessel. The N-16 source results in significant gamma shine from the main steamlines and steam bearing components (turbines, moisture separators, and reheaters) on the order of 0.2 to 0.5 GY/h contact. Estimates of typical BWR sources and gamma shine are given in Reference 12.2-11. Since the geometry of the radiation source is dependent on the exact turbine configuration used, the specific details for the turbines and turbine reheaters are left for construction-specific detail. Tables 12.2-26 through 12.2-28 provide estimates of inventories for the moisture separator, condenser, and condenser demineralizer. The Offgas System is divided into three major components: steam jet air ejector (SJAE), recombiner, and charcoal tanks. The inventory in the SJAE is given in Table 12.2-29, while the inventories in the recombiner and charcoal tanks are given in Table 12.2-14. The Offgas System is more fully described in Subsection 12.2.1.2.6.3.

12.2.2 Airborne and Liquid Sources for Environmental Consideration

This subsection deals with the source and parameters required to evaluate airborne concentrations and liquid releases of radionuclides during normal plant operations for compliance with 10CFR20 and 40CFR190. In addition, specific sources are addressed with regard to airborne contamination in the refueling area under Subsection 12.2.2.3 for evaluation of worker potential doses under 10CFR20. However, for compliance to worker airborne limitations as stipulated in 10CFR20, direct evaluations are not contained in this document.

12.2.2.1 Production of Airborne Sources

Design efforts are directed towards keeping contained all the radioactive material, whether it is in a solid, liquid or gaseous form; however, the unavoidable leaks from process systems and some processes in refueling and decontamination lead to airborne radioactivity.

Leakage of fluids from the process system will result in the release of radionuclides into plant buildings. In general, the noble radiogases will remain airborne and will be released to the atmosphere with little delay via the building ventilation exhaust duct. The radionuclides will partition between air and water to approach equilibrium conditions. Airborne iodines will "plateout" on most surfaces, including pipe, concrete, and paint. A significant amount of radioiodine remains in air or is desorbed from surfaces. Radioiodines are found in ventilation air as methyl iodide and as inorganic iodine, which is here defined as particulate, elemental and hypoiodous acid forms of iodine. Particulates will also be present in the ventilation exhaust air.

The average annual release of I-131 is given in Table 12.2-20. The basis for these releases is as follows:

(1) A calendar year consisting of 300 days of power operations and one refueling/ maintenance shutdown period.

(2) A concentration I-131 in reactor water of 0.085 MBq/kg.

(3) A carryover of I-131 from reactor water to steam of 1.5%.

(4) Forward-pumped heater drains.

(5) A noble gas release rate of 555 MBq at t = 30 min and an I-131 release rate of 3.7 MBq/s at t = 0.

(6) 24 drywell purges per year, 365 hours between each purge.

(7) Meteorology as provided in Subsection 11.3.10.

The airborne radiological releases from building heating, ventilating, and air conditioning and the main condenser mechanical vacuum pump have been compiled and evaluated in References 12.2-3 and 12.2-5.

Based upon the above conditions and values in References 12.2-2 and 12.2-4, airborne releases to the environment are summarized in Table 12.2-21.

Approximately 1.89E08 MBq/plant/yr of noble radiogases are released; one-half of this total is released from the Turbine Building. The total particulate release rate per plant is approximately 9.81E05 MBq/yr; the annual release of Co-60 is less than 1.11E03 MBq.

12.2.2.2 Not Used

12.2.2.3 Airborne Sources During Refueling

The airborne radioactivity during refueling in the containment is expected to be similar to that observed in operating stations. Experience at operating BWRs has shown that airborne radioactivity can result from the water in the reactor cavity exceeding 100°F and flaking of cobalt dioxide (CoO_2) from the dryer and separator if their surfaces are allowed to dry. Other potential airborne sources could occur during vessel head venting and fuel movement. The airborne radioactive material sources resulting from reactor vessel head and internals removal have been determined from operating plant experience. The major radioisotopes found were I-131, Co-60, and Mn-54, with Nb-95, Zr-95, Ru-103, and Ce-144 at moderate concentrations, and with Ce-141, Cs-137, Co-58, and Cr-51 at low concentrations. The radioactive particulates ranged as high as 7.4E-10 MBq/cm^3 and the I-131 as high as 1.48E-09 MBq/cm^3.

To minimize the containment airborne radioactivity contribution due to removal of the reactor pressure vessel head:

(1) The steam dryer and separator surfaces will be kept wet or covered.

(2) The fuel pools are cooled through heat exchangers of large capacity.

(3) The ventilation system on the refueling pool is designed to sweep air from the pool surface and remove a large portion of potential airborne contamination.

12.2.2.4 Average Annual Doses

For compliance with 10CFR50 Appendix I, evaluations have been made to determine average annual doses to unrestricted areas subject to airborne and liquid releases. For airborne dose calculations, isotopic releases were taken from Table 12.2-20 assuming a 0.8 km exclusion boundary. Releases were assumed to be from the plant stack, since all major (Reactor Building, Turbine Building and Radwaste Building) ventilation systems pipe to the stack for normal releases. Since a site meteorology is not definitively defined, a statistical approach was used to evaluate the releases over a series of meteorologies discussed in References 12.2-6 and 12.2-7. Doses were calculated using methodologies and conversion factors consistent with Regulatory Guides 1.109 and 1.111 as implemented in References 12.2-8 and 12.2-9. Results of the airborne evaluations are given in Table 12.2-21. For the ingestion doses given in Table 12.2-21, ingestion values given in Table E-5 of Regulatory Guide 1.109 were used. COL applicants need to update the airborne dose calculations to conform to the as-designed plant and site-specific meteorology (see Subsection 12.2.3 for COL license information).

The evaluations above provide airborne sources and offsite doses for compliance with 10CFR50 Appendix I. For complete evaluations for compliance to 40CFR190, gamma shine evaluations are not contained in this document, since adequate detail for skyshine evaluations from the turbine complex are required in DAC Table 3.2.

12.2.2.5 Liquid Releases

The ABWR is designed not to release radioactive liquid effluents. However, under certain conditions of high water inventory, up to 3.7 GBq per year, excluding tritium, may be released as described in Subsection 11.2.3. These releases are given in Table 12.2-22 and form the basis for estimating doses using methodologies consistent with Regulatory Guide 1.113 as implemented in Reference 12.2-10. The results of the liquid release, assuming dilution factors described in Subsection 11.2.3.2, are shown in the dose evaluation in Table 12.2-23. COL applicants need to update the liquid dose analysis to conform to the as-designed plant and site-specific parameters (see Subsection 12.2.3 for COL license information).

12.2.3 COL License Information

12.2.3.1 Compliance with 10CFR20 and 10CFR50 Appendix I

The COL applicant will re-evaluate the average annual airborne releases and the average annual liquid releases to the environment for the final plant design and site parameters for conformance to 10CFR20 and 10CFR50 Appendix I (Subsections 12.2.2.4 and 12.2.2.5).

12.2.4 References

12.2-1 J.E. Smith, “Noble Gas Experience in Boiling Water Reactors”, Paper No. A-54, presented at Noble Gases Symposium, Las Vegas, Nevada, September 24, 1974.

12.2-2 “Airborne Releases from BWRs for Environmental Impact Evaluations”, NEDO-21159-2 (1977).

12.2-3 American Nuclear Society, ANS-18.1, Table 5.

12.2-4 “Airborne Releases from BWRs for Environmental Impact Evaluations”, NEDO-21159, March 1976.

12.2-5 “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors” (BWR-GALE Code) U.S. NRC NUREG-0016 Rev. 1, January 1979.

12.2-6 I. Hall, et al, Generation of “Typical Meteorological Years for 26 SOLMET Stations”, Sandia National Laboratory Report SAND78-1601 (1978).

12.2-7 D.C. Aldrich, et al, "Technical Guidance for Siting Criteria Development", NUREG/CR-2239 (1981).

12.2-8 E.W. Bradley, "Gamma and Beta Dose to Man from Noble Gas Release to the Atmosphere GEMAN Code." NEDO-25132A, April 1980.

12.2-9 E.W. Bradley and V.D. Nguyen, "Radiation Exposure from Airborne Effluents—the REFAE Code", NEDO-25257, July 1980.

12.2-10 P.P. Standcavage and D.G. Abbott, "Liquid Discharge Doses LIDSR Code", NEDM-20609-01, August 1976.

12.2-11 D.R. Rogers, "BWR Turbine Equipment N-16 Radiation Shielding Studies", GE NEDO-20206, December 1973.

Table 12.2-1a Basic Reactor Data

a.	Reactor Thermal Power	3926 MW
b.	Average Power Density	50.57 W/cm^3
c.	Physical Dimensions	Figure 12.2-1
		Radii (cm)
1.	Core Equivalent Radius	258.13
2.	Inside Shroud Radius	274.955
3.	Outside Shroud Radius	280.035
4.	Inside Vessel Radius—Average	355.6
5.	Outside Vessel Radius—Average	374.015
6.	Shroud Head Inside Radius	568.96
7.	Outside Top Guide Radius	307.34
8.	Inside Radius of Shroud Head Flange	292.1
9.	Outside Radius of Shroud Head Flange	297.18
10.	Vessel Top Head Inside Radius	335.28
11.	Vessel Bottom Head Inside Radius	486.61
		Elevation (cm)
12.	Outside of Vessel Bottom Head	–27.94
13.	Inside of Vessel Bottom Head	0.0*
14.	Vessel Bottom Head Knuckle	164.46
15.	Bottom of Core Support Plate	506.34
16.	Top of Core Support Plate	511.42
17.	Bottom of Active Fuel	534.11
18.	Top of Active Fuel	
	(365.8 cm fuel)	904.95
	(381.0 cm fuel)	915.11

Table 12.2-1a Basic Reactor Data (Continued)

19. Bottom of Top Guide	933.85
20. Top of Fuel Channel	951.63
21. Shroud Head Knuckle	1068.29
22. Inside of Shroud Head	1150.54
23. Outside of Shroud Head	1155.62
24. Normal Vessel Water Level	1342.06
25. Top of Steam Dryer	1747.14
26. Vessel Top Head Knuckle	1770.3
27. Inside of Vessel Top Head	2105.58
28. Outside of Vessel Top Head	2117.01

* Corresponds to TMSL 4950 mm.

Table 12.2-1b Basic Reactor Data—Material Densities* (g/cm^3)

Region	Coolant	UO_2	Zircaloy	304L Stainless
A	0.740	0	0	0.178
B	0.338	0	0	4.35
C	0.318	2.33	0.978	0.056
C-1	0.597	0	0.166	1.70
C-2	0.234	0	1.10	0.255
D	0.240	0	1.00	1.21
E	0.390	0	0	0
F	0.669	0	0	0.200
G	0.036	0	0	0
H	0.740	0	0	0
I	0.740	0	0	0.260

* See Figure 12.2-1 for Location Schematic.

Table 12.2-1c Basic Reactor Data—Typical Core Exposure Distribution

Radial 2 Dimensional Distribution giving axial averaged normalized differential exposure for an equilibrium cycle for a 17 x 17 node.

Node	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1															0.2733	0.3456	0.3564
2												0.2900	0.3680	0.4420	0.6689	0.7918	0.7681
3											0.3918	0.7214	0.7771	0.8530	0.9636	0.9322	1.0265
4								0.2838	0.3825	0.4969	0.8342	0.8860	0.9921	1.0751	1.0184	1.1152	1.0498
5							0.3695	0.6740	0.7584	0.9218	0.9454	1.0714	1.1475	1.0771	1.1977	1.2231	1.2190
6						0.4148	0.6957	0.8268	0.9737	0.9734	1.1057	1.1828	1.1092	1.2400	1.2551	1.1409	1.2561
7					0.3478	0.6818	0.8332	0.9823	0.9649	1.0854	1.1782	1.1157	1.2566	1.2738	1.1512	1.2514	1.1277
8				0.2566	0.5818	0.7993	0.9731	0.9474	0.9985	1.0959	1.0802	1.2358	1.2747	1.1617	1.2710	1.2421	1.1610
9				0.3676	0.7281	0.9539	0.9551	0.9945	0.7311	0.7371	1.1321	1.2413	1.1560	1.2804	1.2610	1.0835	0.8136
10				0.4888	0.9068	0.9613	1.0766	1.0911	0.7359	0.7931	1.1715	1.1308	1.2652	1.2731	1.1346	1.1581	0.7962
11			0.3918	0.8298	0.9381	1.0976	1.1717	1.0761	1.1295	1.1703	1.1130	1.2364	1.2491	1.1335	1.2415	1.2337	1.1632
12		0.2939	0.7256	0.8857	1.0682	1.1781	1.1118	1.2320	1.2383	1.1290	1.2354	1.2277	1.0795	1.1559	1.2306	1.1389	1.2497
13		0.3773	0.7852	0.9963	1.1472	1.1077	1.2541	1.2715	1.1533	1.2624	1.2469	1.0785	0.7808	0.8188	1.0829	1.2347	1.1516
14		0.4730	0.8699	1.0826	1.0800	1.2403	1.2726	1.1598	1.2771	1.2692	1.1303	1.1536	0.8185	0.8222	1.1742	1.2617	1.2700
15	0.2915	0.7258	0.9843	1.0298	1.2012	1.2559	1.1534	1.2696	1.2570	1.1301	1.2357	1.2271	1.0831	1.1725	1.2396	1.1488	1.2616
16	0.3575	0.8158	0.9433	1.1294	1.2213	1.1402	1.2618	1.2398	1.0802	1.1516	1.2235	1.1328	1.2409	1.2553	1.1427	1.2185	1.0967
17	0.3598	0.7786	0.9987	1.1538	1.1125	1.2543	1.2492	1.0797	0.8121	0.7927	1.0730	1.2374	1.2705	1.1566	1.2484	1.2011	0.8127
Sum	1.0089	3.4645	5.6987	8.2204	10.3329	12.0853	13.3778	14.1285	13.4924	14.0089	16.0969	17.1686	16.8688	17.1910	18.5549	18.7215	17.5799

Table 12.2-1d Basic Reactor Data—Typical Core Exposure Distribution—Axial Relative Exposure

Node	Node Mid-Point Elevation (cm) 365.8 cm Fuel	Node Mid-Point Elevation (cm) 381.0 cm Fuel	Relative Exposure
24	892.25	907.17	2.072%
23	877.01	891.30	3.437%
22	861.77	875.42	4.130%
21	846.53	859.55	4.449%
20	831.29	843.67	4.571%
19	816.05	827.80	4.603%
18	800.81	811.92	4.596%
17	785.57	796.05	4.578%
16	770.33	780.17	4.566%
15	755.09	764.30	4.576%
14	739.85	748.42	4.626%
13	724.61	732.55	4.822%
12	709.37	716.67	4.859%
11	694.13	700.80	4.855%
10	678.89	684.92	4.826%
9	663.65	669.05	4.778%
8	648.41	653.17	4.771%
7	633.17	637.30	4.619%
6	617.93	621.42	4.506%
5	602.69	605.55	4.354%
4	587.45	589.67	4.040%
3	572.21	573.80	3.465%
2	556.97	557.92	2.590%
1	541.73	542.05	1.370%
			100%

Table 12.2-2 Core Boundary Neutron Fluxes

Energy Bounds (pJ)	Neutron Flux (neutrons/cm^2-s)
> 4.8E-01	1.1E + 13
1.6E-01 < E < 4.8E-01	2.3E + 13
1.6E-02 < E < 1.6E-01	3.1E + 13
5.53 keV < E < 1.6E-02	1.8E + 13
10 eV < E < 8.9E-04	2.2E + 13
0.683 eV < E < 1.6E-06	2.5E + 13
E < 1.1E-07	9.1E + 13

Table 12.2-3a Gamma Ray Source Energy Spectra— Gamma Ray Sources in the Core During Operation

Energy (E) Bounds (pJ)	Gamma Ray Source pJ/cm^3/s/MWt
E > 1.6E+00	3.7E+02
1.3E+00 < E < 1.6E+00	2.7E+06
9.6E-01 < E < 1.3E+00	3.5E+07
6.4E-01 < E < 9.6E-01	1.8E+08
3.2E-01 < E < 6.4E-01	8.5E+08
1.6E-01 < E < 3.2E-01	9.5E+08
8.2E-02 < E < 1.6E-01	5.0E+08
3.2E-02 < E < 8.2E-02	1.9E+08
E < 3.2E-02	5.3E+07

Table 12.2-3b Gamma Ray Source Energy Spectra— Post-Operation Gamma Sources in the Core* (pJ/W.s)

Energy	Time after Shutdown			
Bounds (pJ)	0 s	1 day	1 week	1 month
9.6E-01				
	1.3E+03	1.6E-01	1.6E+00	1.6E-01
6.4E-01				
	2.9E+03	1.1E+00	7.4E-01	1.6E-01
4.8E-01				
	1.7E+03	9.1E-01	5.9E-01	1.6E-01
4.2E-01				
	2.7E+03	4.6E+01	2.7E+01	1.6E-01
3.5E-01				
	3.4E+03	7.2E+01	6.4E+00	8.0E-02
2.9E-01				
	5.3E+03	5.0E+02	3.4E+02	1.0E+02
2.2E-01				
	5.9E+03	3.7E+02	2.6E+02	1.8E+02
1.4E-01				
	8.2E+03	1.2E+03	6.1E+02	3.4E+02
6.4E-02				
	1.9E+03	2.9E-03	1.4E+02	5.8E+01
1.6E-02				

* Operating history of 3.2 years.

Table 12.2-3c Gamma Ray Source Energy Spectra— Gamma Ray Sources External to the Core During Operation

	Gamma Ray Source pJ/cm^3/s/MWt			
Energy Bounds (pJ)	**Zone H**	**Shroud**	**Zone I**	**Vessel**
E > 1.60	1.9E-07	2.7E-03	4.3E-09	3.0E-07
1.28 < E < 1.60	5.3E-04	41.7	1.2E-05	3.0E-04
0.96 < E < 1.28	0.14	76.9	2.4E-03	3.0E-03
0.64 < E < 0.96	8.3E-04	24.0	1.6E-05	8.2E-04
0.32 < E < 0.64	35.2	17.6	4.6E-02	8.3E-04
0.16 < E < 0.32	4.5E-03	7.7	6.1E-05	3.8E-04
8.2E-02 < E < 0.16	3.7E-03	4.6	5.0E-05	3.3E-04
3.2E-02 < E < 8.2E-02	1.1E-02	1.3	1.9E-04	3.3E-05
E < 3.2E-02	1.3E-04	0.30	2.6E-06	1.5E-05

Table 12.2-4a Gamma Ray and Neutron Fluxes Outside the Vessel Wall— Neutron Fluxes

Energy Bounds (pJ)	Neutron Flux Neutrons/cm^2/s
> 4.8E–01	1.4E+07
1.6E–01 < E < 4.8E–01	4.2E+07
1.6E–02 < E < 1.6E–01	1.7E+08
8.9E–04 < E < 1.6E–02	4.1E+07
1.6E–06 < E < 8.9E–04	6.6E+06
1.1E–07 < E < 1.6E–06	5.3E+06
E < 1.1E–07	1.5E+05

Table 12.2-4b Gamma Ray and Neutron Fluxes Outside the Vessel Wall— Gamma Ray Energy Fluxes

Energy Bounds (pJ)	Gamma Ray Fluxes pJ/cm^2/s
E > 1.6E+00	1.6E+05
1.3E+00 < E < 1.6E+00	2.0E+09
9.6E–01 < E < 1.3E+00	5.3E+09
6.4E–01 < E < 9.6E–01	4.6E+09
3.2E–01 < E < 6.4E–01	6.2E+09
1.6E–01 < E < 3.2E–01	3.5E+09
8.2E–02 < E < 1.6E–01	1.6E+09
3.2E–02 < E < 8.2E–02	1.5E+09
E < 3.2E–02	2.4E+08

Table 12.2-5a Radiation Sources— Radiation Sources

Source Table	For	Drawing	Approximate Geometry
12.2-6	RHR Heat Exchanger	12.3-1	Rt Cylndr (r=0.9m, l=7m)
12.2-8	RCIC Turbine	12.3-1	Rt Cylndr (r=0.5m, l=0.7m)
12.2-9	CUW Filter Demineralizer	12.3-3	2 Tanks, Rt Cylndr (r=0.6m, l=3.3m)
12.2-10	CUW Regen Heat Exchanger	12.3-2	Rt Cylndr (r=0.63m, l=4.9m)
12.2-11	CUW Non-Regen Heat Exchanger	12.3-1	Rt Cylndr (r=0.4m, l=5.5m)
12.2-13a	LCW Collector Tank	12.3-37 & 38	4 Tanks, Rt Cylndr (r=2.74m, l=9.58m)
12.2-13b	LCW Filter/Demin Skid**	12.3-39	Rt Cylndr (r=0.5m, l=1.8m)
12.2-13d	LCW Sample Tank	12.3-37 & 38	2 Tanks, Rt Cylndr (r=2.74m, l=9.58m)
12.2-13e	HCW Collector Tank	12.3-37 & 38	3 Tanks, Rt Cylndr (r=2.74m, l=9.58m)
12.2-13f	HCW Filter/Demin Skid**	12.3-39	Rt Cylndr (r=0.5m, l=1.8m)
12.2-13g	HCW Sample Tank	12.3-37 & 38	Rt Cylinder (r=2.74m, l=9.58m)
12.2-13h	HSD Receiver Tank	12.3-37	Cylinder (r=1.98m, l=4.4m)
12.2-13i	HSD Sample Tank	12.3-38	Cylinder (r=1.98m, l=4.4m)
12.2-13j	Chem Drain Tank	12.3-38	Cylinder (r=0.91m, l=2.6m)
12.2-14	Offgas	12.3-50	Tank 1, Rt Cylndr (r=0.6m, l=7.6m) Tanks 2-9, Rt Cylndr (r=1.1m, l=7.6m)
12.2-29	Steam Jet Air Ejector	12.3-51	Rt Cylndr (r=0.15m, l=4.6m) Rt Cylndr (r=0.76m, l=6.1m) Rt Cylndr (r=0.2m, l=4.6m)
12.2-14	Offgas Recombiner	12.3-51	Rt Cylndr (r=1.4m, l=7m)
12.2-15a	CUW Backwash Receiving Tank	12.3-1	Rt Cylndr (r=2.2m, l=5.7m)
12.2-15b	CF Backwash Receiving Tank	12.3-49	Rt Cylndr (r=2.2m, l=5.7m)
12.2-15c	Phase Separators	12.3-37 & 38	2 Tanks, Rt Cylndr (r=2.3m, l=9.7m)

Table 12.2-5a Radiation Sources— Radiation Sources (Continued)

Source Table	For	Drawing	Approximate Geometry
12.2-15d	Spent Resin Storage Tanks	12.3-37 & 38	2 Tanks, Rt Cylndr (r=2.0m, l=6.6m)
12.2-15l	LW Receiving Tank	12.3-37 & 38	Cylinder (r=1.98m, l=6.6m)
12.2-16	FPC Filter Demineralizer	12.3-3	Rt Cylndr (r=0.7m, l=3.4m)
12.2-17	Suppression Pool Cleanup System*	12.3-3	Rt Cylndr (r=0.7m, l=3.4m)
12.2-18	Control Rod Drive System†	12.3-2	Distributed Source
12.2-24	Traversing Incore Probe	12.3-2	Distributed Source
12.2-25	Reactor Internal Pumps‡	12.3-2	Distributed Source
12.2-25	RIP Heat Exchanger	1.2-3b	Rt Cylndr (r=0.322m, l=2.9m)
12.2-26	Turbine Moisture Separator/Reheater	12.3-52	Rt Cylndr (r=1.8m, l=31.m)
12.2-27	Turbine Condenser	12.3-53	Distributed Source
12.2-28	Condenser Filter/ Demineralizer		
	Filter	12.3-51	3 Tanks, Rt Cylndr(r=1.4m, l=6.1m)
	Demineralizer	12.3-51	6 Tanks, Rt Cylndr(r=1.7m, l=5.1m)
12.2-30	SGTS Filter Train	12.3-7	Surface, (3.66m x 2.54m)ƒ
Applicant	Spent Fuel Storage	12.3-6	See Drawings††

* Suppression pool clean up F/D uses second of Fuel Pool F/D

† Maintenance Facility

†† Applicant to develop spent fuel storage facilities design drawings showing geometry of facilities.

‡ Maintenance Facility, see Figure 1.2-3b Elevation 3000 for drywell location

ƒ Surface area of HEPA and charcoal filter

Table 12.2-5b Radiation Sources—Source Geometry

Component	Assumed Shielding Source Geometry
RHR Heat Exchanger	Homogenous source over volume of heat exchanger
RCIC Turbine	Homogenous source over volume of turbine
CUW Filter Demineralizer	80% of source in first 15 cm, remainder dispersed over volume.
CUW Regen Heat Exchanger	Homogenous source over volume of exchanger
CUW Non-Regen Heat Exchanger	Homogenous source over volume of exchanger
LCW Collector Tank	80% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
LCW Filter/Demin Skid	Homogenous source over volume of skid
LCW Sample Tank	Homogenous source over volume of tank
HCW Collector Tank	Homogenous source over volume of tank
HCW Filter/Demin Skid	Homogeneous source over volume of skid
Offgas	90% of source in first tank in first (upper) 30 cm, rest evenly dispersed. Remaining tanks, homogenous source over tank volume.
Steam Jet Air Ejector*	Homogenous source over volume of ejector
Offgas Recombiner*	Homogenous source over subcomponent††
CUW Backwash Receiving Tank	80% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
CF Backwash Receiving Tank	80% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
Phase Separator	90% non-solubles in slurry on tank bottom, rest evenly dispersed in volume
Spent Resin Storage Tank	Homogenous source over volume of tank
FPC Filter Demineralizer	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Suppression Pool Cleanup System	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
Control Rod Drive System	Exposure dependent, assume evenly dispersed over length of blade
Transverse Incore Probe	Point or line geometry (Table 12.2-24)
Reactor Internal Pumps	Cylindrical source coupled to water bearing components
RIP Heat Exchanger	Homogenous source over volume of exchanger
Turbine Moisture Separator/Reheater	Homogenous source over volume of component
Turbine Condenser	Homogenous source over volume of condenser
Condenser Filter/Demineralizer	

Table 12.2-5b Radiation Sources—Source Geometry (Continued)

Component	Assumed Shielding Source Geometry
Filter	Source evenly dispersed over volume of filter
Demineralizer	90% insolubles in first 15 cm, rest of source evenly dispersed over volume
SGTS Filter Train	90% particulates on HEPA filter, remaining on charcoal filter
Spent Fuel Storage	Applicant***
HSD Receiver Tank	Homogenous source over volume of tank
HSD Sample Tank	Homogenous source over volume of tank
LW Backwash Receiving	Homogenous source over volume of tank
Chem Drain Tank	Homogenous source over volume of tank
HCW Sample Tank	Homogenous source over volume of tank

* Radiation levels in SJAE and recombiner highly dependent upon power level. Actual measurements on SJAE condenser contact dose rate are 2×10^{-3} Gy/h at 100% power and less than 5×10^{-2}m Gy/h at 20% power.

*** Applicant to develop spent fuel storage facilities design drawings showing the shielding source geometry.

†† See Offgas Recombiner Description, Section 11.3, use inventory for preheater, recombiner, condenser and cooler for recombiner inventory for shielding applications.

Table 12.2-5c Radiation Sources— Shielding Geometry in Meters

Component	Room Dimensions			Wall Thickness in Meters*					
	Length	Width	Height	East	West	North	South	Floor	Ceiling
RHR Heat Exchanger	12.6	5.6	5.6	0.8	0.6	0.6	0.6	Ground	0.8
RCIC Turbine	14.6	7.8	5.6	0.8	2	0.6	0.6	Ground	0.8
CUW Filter Demineralizer	2.8	3	7.4	0.8	1	0.8	1	0.5	Hatch
CUW Regen Heat Exchanger	7.7	3.6	6	1.4	1.4	1	1.4†	0.8	0.5
CUW Non-Regen Heat Exchanger	7.4	4.4	5.6	1	1	1	1†	Ground	0.8
LCW Collector Tank (4 Tanks)	16	15	13	0.6	0.6	0.9	0.9	Ground	0.8
LCW Filter/Demin Skid***	10	8	3	0.8	0.8	0.8	0.8	0.8	0.8
HCW Filter/Demin Skid***	10	8	3	0.3	0.3	0.3	0.3	0.3	0.3
LCW Sample Tank (2 Tanks)	7.4	15	13	0.6	0.6	1.2	0.6	Ground	0.8
HCW Collector Tank (3 Tanks - L-Shaped Room)	16	15	13	0.9	0.6	0.9	0.9	Ground	0.8
Offgas	9.1	11	16	1	1	1	1	2.5	1
Steam Jet Air Ejector	9.1	14.2	7	1	1	1	1	1	1
and Recombiner Room									
CUW Backwash Receiving Tank	6.6	7.4	5.6	1	0.8	0.8	1	Ground	0.8
CF Backwash Receiving Tank	5	5	25	1	1	1	1	2.5	Hatch
Phase Separator (2 Tanks - 2 Rooms)	5.4	8.6	13	1.2	1.2	0.6	1.2	Ground	0.8
FPC Filter Demineralizer	3.2	3.2	7.4	0.8	1	0.8	0.8	0.5	Hatch
Suppression Pool Cleanup Sys	3.2	3.2	7.4	0.5	0.8	0.8	0.8	0.5	Hatch
Control Rod Drive System‡	7.6	33.4	5.8	0.6	0.6	0.6	0.6	0.8	0.6
Transverse Incore Probe	4	7.3	2.7	1	1	1	1	Mezz	0.6
Reactor Internal Pumps**	8.2	8.5	5.8	0.6	0.6	0.6	0.6	0.8	0.6

Table 12.2-5c Radiation Sources— Shielding Geometry in Meters (Continued)

Component	Room Dimensions			Wall Thickness in Meters*					
	Length	Width	Height	East	West	North	South	Floor	Ceiling
RIP Heat Exchanger	Primary Containment								
Turbine Moisture Sep/Reheater	12.4	47.6	8.5	1	1	1	1	1	1
Turbine Condenser	14.2	36	25	3.5	2.5	1	1	2.5	Turbine
Condenser Filter	5	21.1	8	2.5†	1	1	1	1	Hatch
Condenser Demineralizer	9.8	17.3	9	1	1	1	1.6	1	1
SGTS Filter Train	14.4	5	8.2	0.2	0.5	0.2	0.2	2	0.6
Spent Fuel Storage	9.4	14	4.1	2	2	2	2	2	7.4*ƒ*
HSD Receiver Tank	7.7	7.2	6.2	0.6	0.6	0.6	0.9	Ground	0.6
HSD Sample Tank	7.7	7.2	6.2	0.6	0.6	0.6	0.9	0.6	0.8
LW Backwash Receiving	5.6	8.3	13	0.6	1.2	0.6	1.2	Ground	0.8
Chem Drain Collector Tank	4.4	3.7	3.1	0.6	0.6	0.6	0.6	0.6	0.6
HCW Sample Tank (2 Tanks)	15	7.7	13	0.9	0.6	1.2	0.6	Ground	0.8
Spent Resin Storage Tank									
Tank A	5.2	6.4	10.1	0.9	0.9	0.9	0.9	Ground	0.6
Tank B	5.2	5.2	10.1	0.9	0.9	1.2	0.9	Ground	0.6

* North refers to plant 0 degree orientation, east = 90 degrees

† Moveable Wall

‡ Maintenance Facility

ƒ 7.4m water depth above fuel elements

*** The LCW and HCW Filter Demineralizer Skids, identified as “LRW System Skids”, are vendor provided. The room dimensions provided are approximate since the shield walls will be movable and the final arrangement will depend on the equipment provided.

Table 12.2-5d Radiation Source— Pipe Chase Detail

Pipe Space (PS)	Level	Location	System	Number Pipes	Size*	Source†	Shield Wall Thickness in meters			
							East	West	North	South
RHR(A)	1F	(RC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC	1	168x140	RS	0.6	PC	0.6	0.6
	B1F	(RC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC	1	168x140	RS	0.6	PC	0.6	0.6
			RCIC	1	356X333	SP	0.6	PC	0.6	0.6
	B2F	(RC,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC	1	168x140	RS	0.6	PC	0.6	0.6
			RCIC	1	356X333	SP	0.6	PC	0.6	0.6
	B3F	(RC,RA)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			RCIC	1	168x140	RS	0.6	PC	0.6	0.6
			RCIC	1	356X333	SP	0.6	PC	0.6	0.6
RHR(B)	1F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B1F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B2F	(RD,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6
	B3F	(RE,R2)	RHR	1	273x237	RC	PC	0.6	0.6	0.6
			HPCF	1	334x303	RC	PC	0.6	0.6	0.6

Table 12.2-5d Radiation Source—Pipe Chase Detail (Continued)

Pipe Space (PS)	Level	Location	System	Number Pipes	Size*	Source†	Shield Wall Thickness in meters			
							East	West	North	South
RHR(C)	1F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B1F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B2F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
	B3F	(RE,R6)	RHR	1	273x237	RC	0.6	PC	0.6	0.6
			HPCF	1	334x303	RC	0.6	PC	0.6	0.6
FPC/CUW	2F	(RB,R3)	FPC	2	273x255	1% RC	1.2	1.2	1.2	1.2
	1F	(RB,R3)	FPC	2	273x255	1% RC	1.2	1.2	1.2	1.2
			CUW	1	219x189	RC	1.6	1.2	1.2	1.2
	B1F	(RB,R3)	FPC	2	273x255	1% RC	1.2	1.2	1.2	1.2
			CUW	1	219x189	RC	1.6	1.2	1.2	1.2
	B3F	(RB,R2)	CUW	2	168x140	RC	0.6	0.6	0.8	0.8
MSL/FDW	1F	(RB,R4)	MSL	4	711x640	RS	1.6	1.6	1.6	1.6
			FDW	4	550x480	10% RS‡	1.6	1.6	1.6	1.6
SPCU	B2F	(RC,R2)	SPCU	1	219x203	SP	PC	0.8	0.8	0.8

* Pipe size given as outside diameter in millimeters and inside diameter in millimeters.

† Source is defined by RC= reactor coolant water, see Tables 11.2-2 through 11.2-5. RS is reactor steam, see Tables 11.2-1 and 4. SP=Suppression pool water = 10% RC (normal operations), Reg Guide 1.7 (LOCA conditions).

‡ No N-16 or noble gases in feedwater.

Table 12.2-6 Fission Product Gamma Source Strength in the RHR Heat Exchanger

Energy Bounds (pJ)	Gamma Source (pJ/s)
>6.4E–01	0.0
4.8E–01 – 6.4E–01	3.7E+01
4.2E–01 – 4.8E–01	4.5E+03
3.5E–01 – 4.2E–01	1.3E+04
2.9E–01 – 3.5E–01	2.6E+04
2.2E–01 – 2.9E–01	1.8E+05
1.4E–01 – 2.2E–01	3.7E+05
6.4E–02 – 1.4E–01	5.6E+05
1.6E–02 – 6.4E–02	6.9E+04
0.0 – 1.6E–02	8.7E+02

Table 12.2-7 Fission Product Inventory in the RHR Heat Exchanger 2 Hours After Shutdown

Class	Isotope		Lambda (/h)	Inventory (MBq)
Class 2	I	131	3.59E–03	1.2E+06
	I	132	3.03E–01	1.0E+06
	I	133	3.33E–02	2.7E+06
	I	134	7.91E–01	6.7E+05
	I	135	1.05E–01	2.3E+06
Class 3	RB	089	2.74E 00	2.8E+01
	CS	134	3.84E–05	2.8E+01
	CS	136	2.22E–03	1.9E+01
	CS	137	2.63E–06	7.4E+01
	CS	138	1.29E 00	9.6E+02
Class 5	H	3	6.45E–06	3.1E+03
Class 6	NA	24	4.63E–02	9.6E+03
	P	32	2.02E–03	2.0E+02
	CR	51	1.04E–03	6.3E+03
	MN	54	9.53E–05	7.0E+01
	MN	56	2.69E–01	3.3E+04
	FE	55	3.04E–05	1.0E+03
	FE	59	6.33E–04	3.1E+01
	CO	58	4.05E–04	2.1E+02
	CO	60	1.50E–05	4.1E+02
	NI	63	7.90E–07	1.0E+00
	CU	64	5.42E–02	2.8E+04
	ZN	65	1.18E–04	2.1E+02
	SR	089	5.55E–04	1.0E+02
	SR	090	2.81E–06	7.0E+00
	Y	090	2.81E–06	7.0E+00
	SR	091	7.31E–02	3.7E+03
	SR	092	2.56E–01	7.0E+03
	Y	091	4.93E–04	4.1E+01
	Y	092	1.96E–01	4.4E+03
	Y	093	6.80E–02	3.7E+03

Table 12.2-7 Fission Product Inventory in the RHR Heat Exchanger 2 Hours After Shutdown (Continued)

Class	Isotope		Lambda (/h)	Inventory (MBq)
Class 6 (continued)	ZR	095	4.41E–04	8.1E+00
	NB	095	8.23E–04	8.1E+00
	MO	099	1.05E–02	2.0E+03
	TCM	099	1.05E–02	2.0E+03
	RU	103	7.29E–04	2.1E+01
	RHM	103	7.29E–04	2.1E+01
	RU	106	7.83E–05	3.1E+00
	RH	106	7.83E–05	3.1E+00
	AGM	110	1.16E–04	1.0E+00
	TEM	129	8.65E–04	4.1E+01
	TEM	131	2.31E–02	1.0E+02
	TE	132	8.89E–03	1.0E+01
	BA	140	2.26E–03	4.1E+02
	LA	140	2.26E–03	4.1E+02
	CE	141	8.88E–04	3.1E+01
	CE	144	1.02E–04	3.1E+00
	PR	144	1.02E–04	3.1E+00
	W	187	2.90E–02	3.0E+02
	NP	239	1.24E–02	8.1E+03
Total				**8.0E+06**

Table 12.2-8 Reactor Coolant Concentration Values Entering the RCIC Turbine

Class	Isotope	MBq/g	Class	Isotope	MBq/g
Class1	KRM 083	6.3E–05	Class 6	CR 051	7.4E–07
	KRM 085	1.0E–04		MN 054	8.5E–09
	KR 085	4.1E–07		MN 056	6.7E–06
	KR 087	3.4E–04		FE 055	1.2E–07
	KR 088	3.4E–04		FE 059	3.7E–09
	KR 089	2.1E–03		CO 058	2.4E–08
	XEM 131	3.4E–07		CO 060	4.8E–08
	XEM 133	5.2E–06		NI 063	1.2E–10
	XE 133	1.4E–04		CU 064	3.7E–06
	XEM 135	4.4E–04		ZN 065	2.4E–08
	XE 135	4.1E–04		SR 089	1.2E–08
	XE 137	2.7E–03		SR 090	8.5E–10
	XE 138	1.6E–03		Y 090	8.5E–10
Class 2	I 131	8.9E–06		SR 091	5.2E–07
	I 132	7.8E–05		SR 092	1.4E–06
	I 133	5.9E–05		Y 091	4.8E–09
	I 134	1.3E–04		Y 092	8.1E–07
	I 135	8.5E–05		Y 093	5.2E–07
Class 3	RB 089	7.8E–07		ZR 095	9.6E–10
	CS 134	3.3E–09		NB 095	9.6E–10
	CS 136	2.2E–09		MO 099	2.4E–07
	CS 137	8.9E–09		TCM 099	2.4E–07
	CS 138	1.5E–06		RU 103	2.4E–09
Class 4	N 16	8.9E–01*		RHM 103	2.4E–09
Class 5	H 3	3.7E–04		RU 106	3.7E–10
Class 6	NA 024	1.3E–06		AGM 110	1.2E–10
	P 032	2.4E–08		TEM 129	4.8E–09
					(Continued)

Table 12.2-8 Reactor Coolant Concentration Values Entering the RCIC Turbine (Continued)

Class	Isotope	MBq/g	Class	Isotope	MBq/g
			Class 6 (continued)	TEM 131	1.2E–08
				TE 132	1.2E–09
				BA 140	4.8E–08
				LA 140	4.8E–08
				CE 141	3.7E–09
				CE 144	3.7E–10
				PR 144	3.7E–10
				W 187	3.7E–08
				NP 239	1.0E–06

* Mulitply by 6 if Hydrogen Water Chemistry is in use.

Table 12.2-9 CUW Filter Demineralizer

Source volume= 3.7 m^3

Total MBq 1.94E+08

Halogens		Soluble fission Products		Insoluble fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	2.41E+07	Rb-89	2.82E+04	Y-91	3.66E+05	Na-24	5.01E+06
I-132	3.06E+06	Sr-89	9.40E+05	Y-92	7.37E+05	P-32	1.32E+06
I-133	2.20E+07	Sr-90	7.27E+04	Y-93	1.36E+06	Cr-51	4.99E+07
I-134	2.01E+06	Y-90	7.27E+04	Zr-95	7.41E+04	Mn-54	7.12E+05
I-135	9.52E+06	Sr-91	1.27E+06	Nb-95	7.41E+04	Mn-56	4.44E+06
		Sr-92	9.76E+05	Ru-103	1.73E+05	Co-58	1.87E+06
		Mo-99	4.05E+06	Rh-103m	1.73E+05	Co-60	4.10E+06
		Tc-99m	4.05E+06	Ru-106	3.11E+04	Fe-55	5.41E+06
		Te-129m	3.36E+05	Rh-106	3.11E+04	Fe-59	2.73E+05
		Te-131m	9.27E+04	La-140	2.51E+06	Ni-63	1.03E+07
		Te-132	2.37E+05	Ce-141	2.58E+05	Cu-64	1.22E+07
		Cs-134	1.54E+05	Ce-144	3.09E+04	Zn-65	2.00E+06
		Cs-136	6.44E+04	Pr-143	3.09E+04	Ag-110m	1.00E+04
		Cs-137	4.23E+05			W-187	2.28E+05
		Cs-138	2.07E+05				
		Ba-140	2.51E+06				
		Np-239	1.44E+07				
Total	6.06E+07	Total	2.98E+07	Total	5.85E+06	Total	9.77E+07

Table 12.2-10 Reactor Water Cleanup, Regenerative Heat Exchanger Tube Sides

Class	Isotope	MBq	Class	Isotope	MBq
Class 2	I-131	4.8E+03	Class 6 (Continued)	SR-91	1.1E+03
	I-132	1.7E+04		SR-92	3.1E+03
	I-133	1.6E+04		Y-91	1.1E+01
	I-134	2.8E+04		Y-92	1.8E+03
	I-135	1.9E+04		Y-93	1.1E+03
Class 3	RB-89	1.8E+03		ZR-95	2.2E+00
	CS-134	7.4E+00		NB-95	2.2E+00
	CS-136	5.2E+00		MO-99	5.6E+02
	CS-137	2.0E+01		TCM-99	5.6E+02
	CS-138	3.4E+03		RU-103	5.6E+00
Class 5	H-3	8.5E+02		RHM103	5.6E+00
Class 6	NA-24	2.8E+03		RU-106	8.1E–01
	P-32	5.6E+01		RH-106	8.1E–01
	CR-51	1.7E+03		AGM110	2.8E–01
	MN-54	1.9E+01		TEM129	1.1E+01
	MN-56	1.6E+04		TEM131	2.8E+01
	FE-55	2.8E+02		TE-132	2.8E+00
	FE-59	8.1E+00		BA-140	1.1E+02
	CO-58	5.6E+01		LA-140	1.1E+02
	CO-60	1.1E+02		CE-141	8.1E+00
	NI-63	2.8E–01		CE-144	8.1E–01
	CU-64	8.5E+03		PR-144	8.1E–01
	ZN-65	5.6E+01		W-187	8.5E+01
	SR-89	2.8E+01		NP-239	2.2E+03
	SR-90	1.9E+00			
	Y-90	1.9E+00		**Total**	**1.3E+05**

Table 12.2-11 Reactor Water Cleanup, Non-Regenerative Heat Exchanger Tube Sides

Class	Isotope	MBq	Class	Isotope	MBq
Class 2	I-131	6.3E+03	Class 6 (Continued)	SR-91	1.5E+03
	I-132	2.1E+04		SR-92	4.1E+03
	I-133	2.1E+04		Y-91	1.4E+01
	I-134	3.6E+04		Y-92	2.4E+03
	I-135	2.6E+04		Y-93	1.5E+03
Class 3	RB-89	2.3E+03		ZR-95	2.9E+00
	CS-134	9.6E+00		NR-95	2.9E+00
	CS-136	6.7E+00		MO-99	7.4E+02
	CS-137	2.6E+01		TCM-99	7.4E+02
	CS-138	4.4E+03		RU-103	7.4E+00
Class 5	H-3	1.1E+03		RHM103	7.4E+00
Class 6	NA-24	3.7E+03		RU-106	1.1E+00
	P-32	7.4E+01		RH-106	1.1E+00
	CR-51	2.2E+03		AGM110	3.6E–01
	MN-54	2.6E+01		TEM129	1.4E+01
	MN-56	2.0E+04		TEM131	3.7E+01
	FE-55	3.6E+02		TE-132	3.7E+00
	FE-59	1.1E+01		BA-140	1.4E+02
	CO-58	7.4E+01		LA-140	1.4E+02
	CO-60	1.4E+02		CE-141	1.1E+01
	NI-63	3.6E–01		CE-144	1.1E+00
	CU-64	1.1E+04		PR-144	1.1E+00
	ZN-65	7.4E+01		W-187	1.1E+02
	SR-89	3.6E+01		NP-239	2.9E+03
	SR-90	2.6E+00			
	Y-90	2.6E+00		**Total**	**1.7E+05**

Table 12.2-12 Reactor Water Cleanup, Regenerative Heat Exchanger Shell Side

Class	Isotope	MBq	Class	Isotope	MBq
Class 2	I-131	1.6E+02	Class 6 (Continued)	Y-90	6.7E–03
	I-132	5.6E+02		SR-91	3.7E+00
	I-133	5.6E+02		SR-92	1.0E+01
	I-134	9.3E+02		Y-92	5.9E+00
	I-135	6.7E+02		Y-93	3.7E+00
Class 3	Y-91	3.7E–02		ZR-95	7.4E–03
	RB-89	5.9E+00		NB-95	7.4E–03
	CS-134	2.5E–02		MO-99	1.9E+00
	CS-136	1.7E–02		TCM-99	1.9E+00
	CS-137	6.7E–02		RU-103	1.9E–02
	CS-138	1.1E+01		RHM103	1.9E–02
Class 5	H-3	2.8E+03		RU-106	2.8E–03
Class 6	NA-24	9.6E+00		RH-106	2.8E–03
	P-32	1.9E–01		AGM110	9.3E–04
	CR-51	5.6E+00		TWM129	3.7E–02
	MN-54	6.7E–02		TEM131	9.3E–02
	MN-56	5.2E+1		TE-132	9.3E–03
	FE-55	9.3E–01		BA-140	3.7E–01
	FE-59	2.8E–02		LA-140	3.7E–01
	CO-58	1.9E–01		CE-141	2.8E–02
	CO-60	3.7E–01		CE-144	2.8E–03
	NI-63	9.3E–04		PR-144	2.8E–03
	CU-64	2.9E+01		W-187	2.8E–01
	ZN-65	1.9E–01		NP-239	7.4E+00
	SR-89	9.3E–02			
	SR-90	6.7E–03		**Total**	**5.8E+03**

Table 12.2-13a Liquid Radwaste Component Inventories-LCW Collector Tank

Source volume = 140 m^3

Total MBq: 7.40E+05

Halogens		Soluble Fission Products		Insoluble Fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	2.03E+04	Rb-89	9.42E+01	Y-91	2.97E+04	Na-24	1.29E+04
I-132	8.06E+03	Sr-89	2.11E+03	Y-92	2.32E+03	P-32	2.65E+03
I-133	5.54E+04	Sr-90	2.67E+02	Y-93	2.72E+04	Cr-51	1.04E+05
I-134	5.28E+03	Y-90	2.67E+02	Zr-95	6.03E+03	Mn-54	2.21E+03
I-135	2.50E+04	Sr-91	3.33E+03	Nb-95	6.03E+03	Mn-56	1.17E+04
		Sr-92	2.57E+03	Ru-103	1.38E+04	Co-58	4.43E+03
		Mo-99	8.86E+03	Rh-103m	1.38E+04	Co-60	1.47E+04
		Tc-99m	8.86E+03	Ru-106	2.69E+03	Fe-55	1.09E+04
		Te-129m	7.13E+02	Rh-106	2.69E+03	Fe-59	6.02E+02
		Te-131m	2.25E+02	La-140	1.89E+05	Ni-63	3.79E+04
		Te-132	5.09E+02	Ce-141	2.04E+04	Cu-64	3.17E+04
		Cs-134	4.00E+02	Ce-144	2.66E+03	Zn-65	6.00E+03
		Cs-136	1.35E+02	Pr-143	2.66E+03	Ag-110m	3.01E+01
		Cs-137	1.22E+03			W-187	5.66E+02
		Cs-138	5.46E+02				
		Ba-140	5.04E+03				
		Np-239	3.20E+04				
Total	1.14E+05	Total	6.72E+04	Total	3.19E+05	Total	2.40E+05

Table 12.2-13b Liquid Radwaste Component Inventories-LCW Filter/Demin Skid

Source Volume		1.42 m3					
Total MBq		6.52E+06					
Halogens		Soluble Fission Products		Insoluble Fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	3.64E+05	Rb-89	1.39E+03	Y-91	3.20E+04	Na-24	6.69E+04
I-132	7.31E+04	Sr-89	4.14E+04	Y-92	3.02E+04	P-32	2.56E+04
I-133	2.79E+05	Sr-90	1.36E+04	Y-93	2.03E+04	Cr-51	1.48E+06
I-134	5.55E+04	Y-90	1.36E+04	Zr-95	4.12E+03	Mn-54	9.25E+04
I-135	1.65E+05	Sr-91	1.94E+04	Nb-95	6.09E+03	Mn-56	1.02E+05
		Sr-92	2.24E+04	Ru-103	6.51E+03	Co-58	1.09E+05
		Mo-99	4.79E+04	Rh-103m	6.52E+03	Co-60	7.36E+05
		Tc-99m	4.70E+04	Ru-106	4.30E+03	Fe-55	1.71E+06
		Te-129m	1.13E+04	Rh-106	4.30E+03	Fe-59	1.12E+04
		Te-131m	1.13E+03	La-140	5.22E+04	Ni-63	1.89E+03
		Te-132	2.84E+02	Ce-141	8.48E+03	Cu-64	1.68E+05
		Cs-134	2.94E+04	Ce-144	3.93E+03	Zn-65	2.42E+05
		Cs-136	1.36E+03	Pr-144[2]	3.93E+03	Ag-110m	1.19E+03
		Cs-137	9.41E+04			W-187	2.79E+03
		Ba-137m	8.79E+04				
		Cs-138	5.62E+03				
		Ba-140	4.63E+04				
		Np-239	1.71E+05				
TOTAL	**9.37E+05**	**TOTAL**	**6.55E+05**	**TOTAL**	**1.83E+05**	**TOTAL**	**4.75E+06**

Table 12.2-13c Not Used

Table 12.2-13d Liquid Radwaste Component Inventories-LCW Sample Tank

Source volume = 140 m^3

Total MBq: 5.84E+2

Halogens		Soluble Fission Products		Insoluble Fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	1.82E+01	Rb-89	5.63E-03	Y-91	2.92E+01	Na-24	4.30E+00
I-132	4.35E-01	Sr-89	2.07E+00	Y-92	1.94E-01	P-32	2.49E+00
I-133	2.37E+01	Sr-90	2.67E-01	Y-93	6.43E+00	Cr-51	1.01E+02
I-134	1.09E-01	Y-90	2.67E-01	Zr-95	5.95E+00	Mn-54	2.20E+00
I-135	3.90E+00	Sr-91	7.37E-01	Nb-95	5.95E+00	Mn-56	7.12E-01
		Sr-92	1.64E-01	Ru-103	1.35E+01	Co-58	4.37E+00
		Mo-99	6.54E+00	Rh-103m	1.35E+01	Co-60	1.47E+01
		Tc-99m	6.54E+00	Ru-106	2.68E+00	Fe-55	9.91E+00
		Te-129m	6.95E-01	Rh-106	2.68E+00	Fe-59	5.90E-01
		Te-131m	1.20E-01	La-140	1.76E+02	Ni-63	3.79E+01
		Te-132	3.93E-01	Ce-141	1.99E+01	Cu-64	9.22E+00
		Cs-134	3.99E+00	Ce-144	2.65E+00	Zn-65	5.98E+00
		Cs-136	1.26E+00	Pr-143	2.65E+00	Ag-110m	3.00E-02
		Cs-137	1.22E+01			W-187	2.65E-01
		Cs-138	6.92E-02				
		Ba-140	4.71E+00				
		Np-239	2.25E+01				
Total	4.63E+01	Total	6.25E+01	Total	2.82E+02	Total	1.93E+02

Table 12.2-13e Liquid Radwaste Component Inventories-HCW Collector Tank

Source volume = 140 m^3

Total MBq: 1.80E+04

Halogens		Soluble Fission Products		Insoluble Fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	4.45E+02	Rb-89	2.57E+02	Y-91	5.51E-01	Na-24	4.94E+01
I-132	9.76E+00	Sr-89	5.68E+00	Y-92	4.05E+02	P-32	6.51E+00
I-133	2.57E+02	Sr-90	4.27E+01	Y-93	6.59E+02	Cr-51	6.51E+00
I-134	5.68E+00	Y-90	1.32E-01	Zr-95	7.35E+01	Mn-54	4.04E+01
I-135	4.27E+01	Sr-91	1.87E+02	Nb-95	2.53E+00	Mn-56	2.19E+02
		Sr-92	1.55E+01	Ru-103	7.87E+00	Co-58	9.38E+03
		Mo-99	1.55E+01	Rh-103m	1.50E+01	Co-60	1.50E+02
		Tc-99m	6.96E+00	Ru-106	1.50E+01	Fe-55	1.41E+01
		Te-129m	3.13E+00	Rh-106	3.38E+01	Fe-59	3.79E+02
		Te-131m	2.30E+02	La-140	3.38E+01	Ni-63	8.72E+02
		Te-132	2.30E+02	Ce-141	6.56E+00	Cu-64	7.90E+02
		Cs-134	6.46E+01	Ce-144	6.56E+00	Zn-65	5.40E+01
		Cs-136	1.75E+00	Pr-143	4.05E+02	Ag-110m	2.19E+03
		Cs-137	1.64E+01			W-187	8.47E+01
		Cs-138	5.84E+01				
		Ba-140	1.88E+01				
		Np-239	1.62E+02				
Total	**7.60E+02**	**Total**	**1.32E+03**	**Total**	**1.66E+03**	**Total**	**1.42E+04**

Table 12.2-13f Liquid Radwaste Component Inventories-HCW Filter/Demin Skid

Source Volume	$1.42\ m^3$						
Total MBq	2.02E+04						
Halogens		Soluble Fission Products		Insoluble Fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	1.04E+03	Rb-89	1.80E+00	Y-91	1.05E+02	Na-24	1.76E+02
I-132	1.08E+02	Sr-89	1.34E+02	Y-92	6.03E+01	P-32	7.44E+01
I-133	7.71E+02	Sr-90	4.60E+01	Y-93	4.77E+01	Cr-51	4.45E+03
I-134	6.94E+01	Y-90	4.60E+01	Zr-95	1.32E+01	Mn-54	3.16E+02
I-135	3.36E+02	Sr-91	4.52E+01	Nb-95	2.02E+01	Mn-56	1.55E+02
		Sr-92	3.44E+01	Ru-103	2.05E+01	Co-58	3.60E+02
		Mo-99	1.45E+02	Rh-103m	2.06E+01	Co-60	2.47E+03
		Tc-99m	1.40E+02	Ru-106	1.46E+01	Fe-55	5.69E+03
		Te-129m	3.54E+01	Rh-106	1.46E+01	Fe-59	3.59E+01
		Te-131m	3.20E+00	La-140	1.51E+02	Ni-63	6.40E+00
		Te-132	8.34E-01	Ce-141	2.64E+01	Cu-64	4.27E+02
		Cs-134	1.53E+02	Ce-144	1.34E+01	Zn-65	8.21E+02
		Cs-136	6.13E+00	Pr-144[2]	1.34E+01	Ag-110m	4.10E+00
		Cs-137	4.81E+02			W-187	7.97E+00
		Ba-137m	4.49E+02				
		Cs-138	7.34E+00				
		Ba-140	1.33E+02				
		Np-239	5.09E+02				
TOTAL	**2.32E+03**	**TOTAL**	**2.37E+03**	**TOTAL**	**5.21E+02**	**TOTAL**	**1.50E+04**

Table 12.2-13g Liquid Radwaste Component Inventories-HCW Sample Tank

Source volume = 140 m^3							
Total MBq: 1.81E+00							
Halogens		Soluble Fission Products		Insoluble Fission Products		Activation Products	
Isotope	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**
I-131	2.90E-02	Rb-89	9.29E-07	Y-91	6.90E-03	Na-24	3.38E-04
I-132	1.25E-03	Sr-89	1.75E-02	Y-92	4.99E-06	P-32	1.71E-02
I-133	2.99E-01	Sr-90	1.55E-03	Y-93	4.48E-05	Cr-51	8.22E-01
I-134	2.78E-04	Y-90	1.55E-03	Zr-95	1.42E-03	Mn-54	1.48E-02
I-135	1.57E-02	Sr-91	3.68E-05	Nb-95	1.42E-03	Mn-56	2.03E-05
		Sr-92	4.74E-06	Ru-103	3.09E-03	Co-58	3.60E-02
		Mo-99	7.92E-03	Rh-103m	3.09E-03	Co-60	8.70E-02
		Tc-99m	7.92E-03	Ru-106	6.50E-04	Fe-55	5.47E-02
		Te-129m	5.79E-03	Rh-106	6.50E-04	Fe-59	4.98E-03
		Te-131m	2.92E-05	La-140	3.07E-02	Ni-63	2.19E-01
		Te-132	6.41E-04	Ce-141	4.41E-03	Cu-64	6.05E-04
		Cs-134	5.77E-03	Ce-144	6.42E-04	Zn-65	4.14E-02
		Cs-136	1.43E-03	Pr-143	6.42E-04	Ag-110m	2.07E-04
		Cs-137	1.62E-02			W-187	4.20E-05
		Cs-138	1.65E-07				
		Ba-140	3.07E-02				
		Np-239	1.97E-02				
Total	**3.45E-01**	**Total**	**1.17E-01**	**Total**	**5.36E-02**	**Total**	**1.30E+00**

Table 12.2-13h Liquid Radwaste Component Inventories-HSD Receiver Tank

Source volume= 30.00m^3

Total MBq 1.59E+03

Halogens		Soluble fission Products		Insoluble fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	2.05E+02	Rb-89	3.32E-01	Y-91	2.29E+00	Na-24	4.71E+01
I-132	2.13E+01	Sr-89	5.92E+00	Y-92	5.32E+00	P-32	9.75E+00
I-133	2.25E+02	Sr-90	4.28E-01	Y-93	1.17E+01	Cr-51	3.33E+02
I-134	1.34E+01	Y-90	4.28E-01	Zr-95	4.61E-01	Mn-54	4.23E+00
I-135	7.46E+01	Sr-91	1.07E+01	Nb-95	4.61E-01	Mn-56	3.12E+01
		Sr-92	6.87E+00	Ru-103	1.12E+00	Co-58	1.16E+01
		Mo-99	4.55E+01	Rh-103m	1.12E+00	Co-60	2.41E+01
		Tc-99m	4.55E+01	Ru-106	1.85E-01	Fe-55	4.40E+01
		Te-129m	2.20E+00	Rh-106	1.85E-01	Fe-59	1.74E+00
		Te-131m	1.03E+00	La-140	1.90E+01	Ni-63	6.04E+01
		Te-132	2.59E+00	Ce-141	1.69E+00	Cu-64	1.10E+02
		Cs-134	1.64E+00	Ce-144	1.84E-01	Zn-65	1.19E+01
		Cs-136	8.76E-01	Pr-143	1.84E-01	Ag-110m	5.96E-02
		Cs-137	4.48E+00			W-187	2.41E+00
		Cs-138	1.37E+00				
		Ba-140	1.90E+01				
		Np-239	1.64E+02				
Total	**5.39E+02**	**Total**	**3.13E+02**	**Total**	**4.39E+01**	**Total**	**6.91E+02**

Table 12.2-13i Liquid Radwaste Component Inventories - HSD Sample Tank

Source volume=	30 m^3						
Total MBq	2.43E+01						
Halogens		Soluble Fission Products		Insoluble Fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	3.01E+00	Rb-89	1.87E-04	Y-91	5.02E-02	Na-24	9.40E-01
I-132	1.05E-01	Sr-89	7.41E-02	Y-92	1.23E-01	P-32	1.34E-01
I-133	4.91E+00	Sr-90	5.36E-03	Y-93	1.92E-01	Cr-51	4.38E+00
I-134	2.44E-02	Y-90	5.37E-03	Zr-95	5.88E-03	Mn-54	5.33E-02
I-135	9.12E-01	Sr-91	1.73E-01	Nb-95	6.03E-03	Mn-56	1.62E-01
		Sr-92	3.75E-02	Ru-103	3.39E-03	Co-58	1.48E-01
		Mo-99	8.40E-01	Rh-103m	1.45E-02	Co-60	3.03E-01
		Tc-99m	8.08E-01	Ru-106	2.32E-03	Fe-55	7.54E-01
		Te-129m	2.88E-02	Rh-106	2.32E-03	Fe-59	2.24E-02
		Te-131m	2.21E-02	La-140	2.87E-01	Ni-63	---
		Te-132	4.54E-03	Ce-141	2.21E-02	Cu-64	2.04E+00
		Cs-134	2.08E-02	Ce-144	2.32E-03	Zn-65	1.50E-01
		Cs-136	1.22E-02	Pr-143	2.32E-03	Ag-110m	7.50E-04
		Cs-137	5.62E-02			W-187	5.23E-02
		Cs-138	1.57E-03				
		Ba-140	2.65E-01				
		Np-239	3.15E+00				
TOTAL	**8.96E+00**	**TOTAL**	**5.51E+00**	**TOTAL**	**7.14E-01**	**TOTAL**	**9.15E+00**

Table 12.2-13j Liquid Radwaste Component Inventories - Chemical Drain Tank

Source volume = **4 m^3**

Total MBq **6.52E+00**

Halogens		**Soluble Fission Products**		**Insoluble Fission Products**		**Activation Products**	
Isotope	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**
I-131	3.68E-01	Rb-89	4.10E-03	Y-91	4.93E-03	Na-24	3.56E-01
I-132	2.46E-01	Sr-89	8.15E-03	Y-92	1.36E-01	P-32	1.56E-02
I-133	1.40E+00	Sr-90	5.79E-04	Y-93	1.05E-01	Cr-51	4.91E-01
I-134	1.58E-01	Y-90	5.79E-04	Zr-95	6.45E-04	Mn-54	5.78E-03
I-135	7.61E-01	Sr-91	9.99E-02	Nb-95	6.52E-04	Mn-56	3.53E-01
		Sr-92	7.75E-02	Ru-103	1.60E-03	Co-58	1.62E-02
		Mo-99	1.29E-01	Rh-103m	1.61E-03	Co-60	3.27E-02
		Tc-99m	1.25E-01	Ru-106	2.51E-04	Fe-55	8.15E-02
		Te-129m	3.21E-03	Rh-106	2.51E-04	Fe-59	2.48E-03
		Te-131m	4.92E-03	La-140	3.23E-02	Ni-63	---
		Te-132	6.64E-04	Ce-141	2.46E-03	Cu-64	8.96E-01
		Cs-134	2.24E-03	Ce-144	2.51E-04	Zn-65	1.63E-02
		Cs-136	1.42E-03	Pr-143	2.51E-04	Ag-110m	8.13E-05
		Cs-137	6.06E-03			W-187	1.36E-02
		Cs-138	1.64E-02				
		Ba-140	3.10E-02				
		Np-239	5.14E-01				
TOTAL	**2.94E+00**	**TOTAL**	**1.02E+00**	**TOTAL**	**2.86E-01**	**TOTAL**	**2.28E+00**

Table 12.2-14 Offgas System Inventories*

Isotopic Inventories (megabecquerel) Valid at t = 60 years							
Inventory	Preheater	Recombiner	Condenser	Cooler	Tank 1	Tank 2	Tank 3
BA-137M	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E+01	0.0E+00	0.0E+00
BA-139	0.0E+00	0.0E+00	2.3E+01	2.3E–01	5.6E+02	0.0E+00	0.0E+00
BA-140	0.0E+00	0.0E+00	4.1E–01	0.0E+00	1.7E+00	0.0E+00	0.0E+00
BA-141	0.0E+00	0.0E+00	1.3E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
BA-142	0.0E+00	0.0E+00	1.1E–01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CS-135	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.1E–05	2.9E–08	0.0E+00
CS-137	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E+01	0.0E+00	0.0E+00
CS-138	1.0E+00	1.0E+00	1.4E+03	1.0E+02	2.9E+03	0.0E+00	0.0E+00
CS-139	8.5E+00	8.5E+00	9.6E+03	3.6E+02	5.6E+02	0.0E+00	0.0E+00
CS-140	5.9E+01	4.8E+01	3.2E+04	3.7E+02	1.9E+00	0.0E+00	0.0E+00
CS-141	7.8E–01	6.7E–01	7.0E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CS-142	2.8E–01	2.0E–01	1.7E+00	00.E+00	0.0E+00	0.0E+00	0.0E+00
KR-83M	1.7E+02	7.0E+01	6.3E+03	1.7E+03	7.0E+05	4.8E+05	5.2E+01
KR-85	1.1E+00	4.8E–01	4.1E+01	1.1E+01	6.7E+03	6.7E+04	6.7E+04
KR-85M	2.9E+02	1.2E+02	1.1E+04	3.0E+03	1.6E+06	3.5E+06	7.8E+10
KR-87	9.3E+02	4.1E+02	3.5E+04	9.6E+03	3.5E+06	1.3E+06	1.8E+00
KR-88	9.6E+02	4.1E+02	5.9E+02	4.4E+01	4.8E+06	5.9E+06	1.3E+04
KR-89	5.9E+03	2.4E+03	2.0E+05	4.8E+04	7.0E+05	0.0E+00	0.0E+00
KR-90	1.0E+04	4.1E+03	2.3E+05	3.1E+04	1.3E+04	0.0E+00	0.0E+00
KR-91	5.2E+03	2.0E+03	4.4E+04	5.9E+02	2.0E–01	0.0E+00	0.0E+00
KR-92	7.8E+01	2.3E+01	1.0E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
KR-93	2.4E+00	5.9E–01	1.8E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
KR-94	6.3E–02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
N-13	8.5E–02	3.6E–02	3.1E+00	8.5E–01	4.4E+01	6.7E+00	0.0E+00
N-16	5.9E+01	2.2E+01	4.1E+02	2.8E+00	3.0E–02	0.0E+00	0.0E+00
N-17	2.4E–03	8.5E–04	8.9E–03	2.6E–08	0.0E+00	0.0E+00	0.0E+00
O-19	1.8E+01	7.4E+00	3.7E+02	4.8E+01	5.6E+01	4.8E–02	0.0E+00
RB-88	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.4E+02	4.1E+02	9.3E–01
RB-89	2.8E+00	2.8E+00	4.1E+03	2.5E+02	2.6E+03	0.0E+00	0.0E+00
RB-90	2.7E+01	2.7E+01	2.8E+04	9.3E+02	2.4E+02	0.0E+00	0.0E+00
RB-90M	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.2E+01	0.0E+00	0.0E+00
RB-91	4.1E+01	3.7E+01	1.8E+04	5.6E+01	0.0E+00	0.0E+00	0.0E+00
RB-92	7.8E+00	6.3E+00	1.9E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
RB-93	1.9E–01	1.6E–01	4.4E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Table 12.2-14 Offgas System Inventories* (Continued)

Isotopic Inventories (megabecquerel) Valid at t = 60 years							
Inventory	Preheater	Recombiner	Condenser	Cooler	Tank 1	Tank 2	Tank 3
RB-94	0.0E+00	0.0E+00	8.5E–02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
SR-90	0.0E+00	0.0E+00	4.1E–04	3.2E–06	1.0E+00	0.0E+00	0.0E+00
SR-92	0.0E+00	0.0E+00	5.9E–01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
SR-93	0.0E+00	0.0E+00	2.8E–01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
XE-131M	7.0E–01	3.0E–01	2.7E+01	7.4E+00	6.7E+04	4.4E+05	1.9E+05
XE-133	4.1E+02	1.6E+02	1.5E+04	4.1E+01	3.4E+07	1.4E+08	2.1E+07
XE-133M	1.3E+01	5.6E+00	4.8E+02	1.4E+02	1.1E+06	1.9E+06	2.2E+04
XE-135	1.1E+03	4.4E+02	4.1E+04	1.1E+04	3.6E+07	2.9E+06	0.0E+00
XE-135M	1.3E+03	5.2E+02	4.4E+04	1.3E+04	1.1E+06	0.0E+00	0.0E+00
XE-137	7.0E+03	2.9E+03	2.4E+05	6.3E+04	1.1E+06	0.0E+00	0.0E+00
XE-138	4.4E+03	1.8E+03	1.6E+05	4.1E+04	3.5E+06	0.0E+00	0.0E+00
XE-139	1.0E+04	4.4E+03	2.6E+05	4.1E+04	3.3E+04	0.0E+00	0.0E+00
XE-140	7.0E+03	2.8E+03	9.6E+04	4.8E+03	3.7E+01	0.0E+00	0.0E+00
XE-141	4.1E+00	1.1E+01	4.8E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
XE-142	1.1E+00	2.8E–01	7.8E–01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Y-90	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.5E–01	0.0E+00	0.0E+00
Totals	**5.5E+04**	**2.3E+04**	**1.5E+06**	**2.7E+05**	**8.8E+07**	**1.6E+08**	**7.8E+10**

* Inventory based upon 1.42E–02 m^3/second flow with a noble gas and N–16 mixture taken from Table 11.1-1 and 11.1-4. Inventories are cummulative for 60 years with a 90% availability. For hydrogen water chemistry, multiply the N-16 values by a factor of 6. Inventories are given in Megaeacquerels per tank. Tanks 2 and 3 are charcoal tanks in series subsequent to Tank 1. There are four each of Tanks 2 and 3.

Table 12.2-15a Solid Radwaste Component Inventories CUW Backwash Receiving Tank

Source volume=		**28 m³**					
Total MBq		**1.94E+08**					
Halogens		**Soluble Fission Products**		**Insoluble Fission Products**		**Activation Products**	
Isotope	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**
I-131	2.41E+07	Rb-89	2.82E+04	Y-91	3.66E+05	Na-24	5.01E+06
I-132	3.06E+06	Sr-89	9.40E+05	Y-92	7.37E+05	P-32	1.32E+06
I-133	2.20E+07	Sr-90	7.27E+04	Y-93	1.36E+06	Cr-51	4.99E+07
I-134	2.01E+06	Y-90	7.27E+04	Zr-95	7.41E+04	Mn-54	7.12E+05
I-135	9.52E+06	Sr-91	1.27E+06	Nb-95	7.41E+04	Mn-56	4.44E+06
		Sr-92	9.76E+05	Ru-103	1.73E+05	Co-58	1.87E+06
		Mo-99	4.05E+06	Rh-103m	1.73E+05	Co-60	4.10E+06
		Tc-99m	4.05E+06	Ru-106	3.11E+04	Fe-55	5.41E+06
		Te-129m	3.36E+05	Rh-106	3.11E+04	Fe-59	2.73E+05
		Te-131m	9.27E+04	La-140	2.51E+06	Ni-63	1.03E+07
		Te-132	2.37E+05	Ce-141	2.58E+05	Cu-64	1.22E+07
		Cs-134	1.54E+05	Ce-144	3.09E+04	Zn-65	2.00E+06
		Cs-136	6.44E+04	Pr-143	3.09E+04	Ag-110m	1.00E+04
		Cs-137	4.23E+05			W-187	2.28E+05
		Cs-138	2.07E+05				
		Ba-140	2.51E+06				
		Np-239	1.44E+07				
Total	**6.06E+07**	**Total**	**2.98E+07**	**Total**	**5.85E+06**	**Total**	**9.77E+07**

Table 12.2-15b Solid Radwaste Component Inventories CF Backwash Receiving Tank

Source volume = <u>60</u> m^3

Total MBq: 2.59E+03

Halogens		Soluble Fission Products		Insoluble Fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	0.00E+00	Rb-89	0.00E+00	Y-91	2.06E+02	Na-24	0.00E+00
I-132	0.00E+00	Sr-89	0.00E+00	Y-92	2.63E+02	P-32	0.00E+00
I-133	0.00E+00	Sr-90	0.00E+00	Y-93	4.88E+02	Cr-51	0.00E+00
I-134	0.00E+00	Y-90	0.00E+00	Zr-95	4.21E+01	Mn-54	0.00E+00
I-135	0.00E+00	Sr-91	0.00E+00	Nb-95	4.21E+01	Mn-56	0.00E+00
		Sr-92	0.00E+00	Ru-103	9.45E+01	Co-58	0.00E+00
		Mo-99	0.00E+00	Rh-103m	9.45E+01	Co-60	0.00E+00
		Tc-99m	0.00E+00	Ru-106	1.87E+01	Fe-55	0.00E+00
		Te-129m	0.00E+00	Rh-106	1.87E+01	Fe-59	0.00E+00
		Te-131m	0.00E+00	La-140	1.14E+03	Ni-63	0.00E+00
		Te-132	0.00E+00	Ce-141	1.37E+02	Cu-64	0.00E+00
		Cs-134	0.00E+00	Ce-144	1.85E+01	Zn-65	0.00E+00
		Cs-136	0.00E+00	Pr-143	1.85E+01	Ag-110m	0.00E+00
		Cs-137	0.00E+00			W-187	0.00E+00
		Cs-138	0.00E+00				
		Ba-140	0.00E+00				
		Np-239	0.00E+00				
Total	**0.00E+00**	**Total**	**0.00E+00**	**Total**	**2.59E+03**	**Total**	**0.00E+00**

Table 12.2-15c Solid Radwaste Component Inventories Phase Separator

Source volume=		**100m^3**					
Total MBq		**5.10E+08**					
Halogens		**Soluble Fission Products**		**Insoluble Fission Products**		**Activation Products**	
Isotope	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**
I-131	2.41E+07	Rb-89	8.06E+04	Y-91	1.05E+06	Na-24	1.43E+07
I-132	8.75E+06	Sr-89	2.69E+06	Y-92	2.11E+06	P-32	3.76E+06
I-133	6.28E+07	Sr-90	2.08E+05	Y-93	3.90E+06	Cr-51	1.43E+08
I-134	5.74E+06	Y-90	2.08E+05	Zr-95	2.12E+05	Mn-54	2.03E+06
I-135	2.72E+07	Sr-91	3.63E+06	Nb-95	2.12E+05	Mn-56	1.27E+07
		Sr-92	2.79E+06	Ru-103	4.96E+05	Co-58	5.34E+06
		Mo-99	1.16E+07	Rh-103m	4.96E+05	Co-60	1.17E+07
		Tc-99m	1.16E+07	Ru-106	8.89E+04	Fe-55	1.54E+07
		Te-129m	9.61E+05	Rh-106	8.89E+04	Fe-59	7.81E+05
		Te-131m	2.65E+05	La-140	7.17E+06	Ni-63	2.94E+07
		Te-132	6.78E+05	Ce-141	7.37E+05	Cu-64	3.48E+07
		Cs-134	4.39E+05	Ce-144	8.84E+04	Zn-65	5.71E+06
		Cs-136	1.84E+05	Pr-143	8.84E+04	Ag-110m	2.86E+04
		Cs-137	1.21E+06			W-187	6.50E+05
		Cs-138	5.93E+05				
		Ba-140	7.17E+06				
		Np-239	4.10E+07				
Total	**1.29E+08**	**Total**	**8.53E+07**	**Total**	**1.67E+07**	**Total**	**2.79E+08**

Table 12.2-15d Solid Radwaste Component Inventories Spent Resin Storage Tank

Source volume=		50 m^3					
Total MBq		**5.72E+06**					
Halogens		**Soluble Fission Products**		**Insoluble Fission Products**		**Activation Products**	
Isotope	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**	**Isotope**	**MBq**
I-131	1.48E+06	Rb-89	1.58E+02	Y-91	7.01E+01	Na-24	3.37E+04
I-132	1.53E+05	Sr-89	2.47E+04	Y-92	3.34E+01	P-32	1.43E+04
I-133	1.11E+06	Sr-90	4.45E+03	Y-93	6.21E+01	Cr-51	8.46E+05
I-134	9.88E+04	Y-90	4.45E+03	Zr-95	1.51E+01	Mn-54	3.66E+04
I-135	4.79E+05	Sr-91	8.53E+03	Nb-95	1.51E+01	Mn-56	2.97E+04
		Sr-92	6.52E+03	Ru-103	2.57E+01	Co-58	5.91E+04
		Mo-99	2.75E+04	Rh-103m	2.57E+01	Co-60	2.45E+05
		Tc-99m	2.75E+04	Ru-106	1.12E+01	Fe-55	4.74E+04
		Te-129m	6.52E+03	Rh-106	1.12E+01	Fe-59	6.59E+03
		Te-131m	6.24E+02	La-140	1.73E+02	Ni-63	6.31E+05
		Te-132	1.62E+03	Ce-141	3.32E+01	Cu-64	8.19E+04
		Cs-134	7.28E+03	Ce-144	1.06E+01	Zn-65	9.87E+04
		Cs-136	6.02E+02	Pr-143	1.06E+01	Ag-110m	4.95E+02
		Cs-137	2.35E+04			W-187	1.53E+03
		Cs-138	6.76E+02				
		Ba-140	2.55E+04				
		Np-239	9.69E+04				
Total	**3.32E+06**	**Total**	**2.67E+05**	**Total**	**4.97E+02**	**Total**	**2.13E+06**

Table 12.2-15e Not Used

Table 12.2-15f Not Used

Table 12.2-15g Not Used

Table 12.2-15h Not Used

Table 12.2-15i Not Used

Table 12.2-15j Not Used

Table 12.2-15k Not Used

Table 12.2-15l Radwaste Component Inventories LW Backwash Receiving Tank

Source volume = 50 m^3							
Total MBq: 2.33E+6							
Halogens		Soluble fission Products		Insoluble fission Products		Activation Products	
Isotope	MBq	Isotope	MBq	Isotope	MBq	Isotope	MBq
I-131	1.36E+05	Rb-89	8.72E+01	Y-91	1.92E+04	Na-24	9.75E+03
I-132	5.40E+03	Sr-89	2.31E+04	Y-92	3.22E+03	P-32	1.23E+04
I-133	4.51E+04	Sr-90	3.65E+03	Y-93	2.83E+03	Cr-51	8.47E+05
I-134	3.39E+03	Y-90	3.65E+03	Zr-95	2.42E+03	Mn-54	3.46E+04
I-135	1.74E+04	Sr-91	2.40E+03	Nb-95	3.42E+03	Mn-56	8.54E+03
		Sr-92	1.71E+03	Ru-103	4.19E+03	Co-58	6.27E+04
		Mo-99	1.16E+04	Rh-103m	4.20E+03	Co-60	2.25E+05
		Tc-99m	1.12E+04	Ru-106	1.55E+03	Fe-55	5.43E+05
		Te-129m	6.57E+03	Rh-106	1.56E+03	Fe-59	7.16E+03
		Te-131m	2.02E+02	La-140	2.44E+04	Ni-63	5.84E+02
		Te-132	7.20E+01	Ce-141	5.50E+03	Cu-64	2.33E+04
		Cs-134	8.68E+03	Ce-144	1.50E+03	Zn-65	8.52E+04
		Cs-136	6.80E+02	Pr-144	1.50E+03	Ag-110m	4.62E+02
		Cs-137	2.52E+04			W-187	5.31E+02
		Ba-137m	2.35E+04				
		Cs-138	3.56E+02				
		Ba-140	2.11E+04				
		Np-239	3.86E+04				
Total	**2.08E+05**	**Total**	**1.82E+05**	**Total**	**7.55E+04**	**Total**	**1.86E+06**

Table 12.2-16 FPC Filter Demineralizer

Source Volume =			**20m^3/Batch (Backwash)**								
Total megabecquerel =			**3.77E 06**								
Halogens			**Soluble Fission Products**			**Insoluble Fission Products**			**Activation Products**		
Isotope		**MBq/cm^3**	**Isotope**		**MBq/cm^3**	**Isotope**		**MBq/cm^3**	**Isotope**		**MBq/cm^3**
I	131	4.07E+05	RB	89	7.29E+02	Y	91	1.09E+04	NA	24	6.81E+04
I	132	4.25E+04	SR	89	2.65E+04	Y	92	1.04E+04	P	32	2.75E+04
I	133	3.05E+05	SR	90	2.55E+03	Y	93	1.79E+04	CR	51	1.27E+06
I	134	2.81E+04	Y	90	2.55E+03	ZR	95	2.24E+03	MN	54	242E+04
I	135	1.32E+05	SR	91	1.82E+04	NB	95	1.83E+03	MN	56	6.22E+04
			SR	92	1.34E+04	RU	103	4.88E+03	CO	58	5.81E+04
			MO	99	5.88E+04	RH	103M	4.88E+03	CO	60	1.43E+05
			TC	99M	5.88E+04	RU	106	1.05E+03	FE	55	3.60E+05
			TE	129M	8.99E+03	RH	106	1.05E+03	FE	59	7.62E+03
			TE	131M	1.32E+03	LA	140	4.96E+04	NI	63	3.66E+02
			TE	132	3.43E+02	CE	141	6.77E+03	CU	64	1.69E+05
			CS	134	9.66E+03	CE	144	1.04E+03	ZN	65	6.84E+04
			CS	136	2.32E+03	PR	143	3.96E+02	AG	110M	5.40E+01
			CS	137	2.66E+04				W	187	3.19E+03
			CS	138	3.04E+03						
			BA	140	4.96E+04						
			NP	239	2.03E+05						
Total		**9.15E+05**	**Total**		**4.87E+05**	**Total**		**1.13E+05**	**Total**		**2.26E+06**

Table 12.2-17 Radioactive Sources in the Suppression Pool Cleanup System

Class	Isotope	MBq	Class	Isotope	MBq
Class 2			Class 6 (Continued)		
	I-131	6.7E+02		SR91	4.4E+06
	I-132	2.0E+07		SR92	6.3E+06
	I-133	4.1E+07		Y-091	5.6E+04
	I-134	6.3E+06		Y-092	4.4E+06
	I-135	4.4E+07		Y-093	4.4E+06
Class 3					
	RB-089	6.3E+02		ZR-095	1.1E+04
	CS-134	3.7E+04		NB-095	1.1E+04
	CS-136	2.4E+04		MO-099	2.6E+06
	CS-137	9.6E+04		TCM099	2.6E+06
	CS-138	1.9E+05		RU-103	2.7E+04
Class 6				RHM103	2.7E+04
	NA-24	1.2E+07		RU-106	4.1E+03
	P-32	2.7E+05		RH-106	4.1E+03
	CR-51	8.1E+06		AGM110	1.4E+03
	MN-54	9.6E+04		TEM129	5.6E+04
	MN-56	3.0E+07		TEM131	1.3E+05
	FE-55	1.4E+06		TE-132	1.3E+04
	FE-59	4.1E+04		BA-140	5.6E+05
	CO-58	2.7E+05		LA-140	5.6E+05
	CO-60	5.6E+05		CE-141	4.1E+04
	NI-63	1.4E+03		CE-144	4.1E+03
	CU-64	3.5E+07		PR-144	4.1E+03
	ZN-65	2.7E+05		W-187	3.7E+05
	SR-089	1.3E+05		NP-239	1.0E+07
	SR-090	9.6E+03			
	Y-90	9.6E+03		**Total**	**2.4E+08**

Table 12.2-18a Radioactive Sources in the Control Rod Drive System

Control Rod Drive Radiation Survey Data		
	Gamma Dose Measured at Contact, mSvh	
Component	Before Cleaning	After Cleaning
Seal Housing (Spool Piece)	1.0E–01	0.0E+00
Rotating-ball Spindle	0.0E+00	2.0E–01
Hollow Piston	5.0E–01	2.5E–01
Throttle Bushing	4.0E–01	4.0E–01
Guide Tube	3.0E–01	2.0E–01
Motor/Synchro Assembly	2.0E-02	<1.0E–02
Cylinder Tube/Flange	2.2E+00	2.0E–01

Table 12.2-18b Control Blade Principal Isotopes

Isotopes	MBq/Blade
Cr-51	5.2E+09
Mn-54	3.4E+08
Fe-55	5.9E+09
Co-58m	3.3E+08
Co-60	4.1E+09
Ni-63	1.9E+08
Total	**1.6E+10**

Table 12.2-19 Annual Airborne Releases for Offsite Dose Evaluations (MBq)

Nuclide	R/B	Turbine	Radwaste	Mechanical Vacuum Pump	Turbine Seal	Offgas	Drywell
Kr-83m						2.0E–01	3.1E+01
Kr-85m	5.9E+04	3.7E+05				3.6E+05	1.3E+02
Kr-85					2.6E+02	2.1E+07	2.5E+01
Kr-87	2.9E+04	8.9E+05				1.8E–05	1.2E+02
Kr-88	5.9E+04	1.3E+06				3.2E+03	2.7E+02
Kr-89	2.9E+04	8.5E+06	4.4E+05				3.3E+01
Kr-90							1.2E+01
Xe-131m					2.2E+02	1.9E+06	1.2E+01
Xe-133m						3.1E+03	7.4E+01
Xe-133	1.6E+06	2.2E+06	3.2E+06	1.4E+07	1.1E+05	6.7E+07	4.4E+03
Xe-135m	8.9E+05	5.9E+06	7.8E+06		3.0E+05		3.3E+01
Xe-135	1.9E+06	4.8E+06	4.1E+06	5.6E+06	2.6E+05		1.0E+03
Xe-137	2.6E+06	1.5E+07	1.2E+06				4.8E+01
Xe-138	1.2E+05	1.5E+07	2.9E+04		9.3E+05		1.0E+02
Xe-139							1.5E+01
I -131	1.4E+03	5.6E+03	4.8E+02	2.0E+03	2.4E+01		9.6E+01
I -132	1.2E+04	4.8E+04	4.1E+03	1.7E+04			1.3E+01
I -133	9.3E+03	3.7E+04	3.3E+03	1.3E+04	1.6E+02		9.6E+01
I -134	2.0E+04	8.1E+04	7.4E+03	3.0E+04			8.9E+00
I -135	1.3E+04	5.2E+04	4.4E+03	1.9E+04			4.1E+01
H-3	1.1E+06	1.1E+06			2.2E+05		2.6E+05
C-14						3.4E+05	
Na-24							1.5E+02
P-32							3.4E+01
Ar-41						2.5E+05	
Cr-51	3.4E+01	2.7E+01	2.1E+01				1.2E+03
Mn-54	4.4E+01	1.8E+01	1.2E+02				1.7E+01

Table 12.2-19 Annual Airborne Releases for Offsite Dose Evaluations (MBq) (Continued)

Nuclide	R/B	Turbine	Radwaste	Mechanical Vacuum Pump	Turbine Seal	Offgas	Drywell
Mn-56							1.3E+02
Fe-55							2.4E+02
Fe-59	1.2E+01	3.0E+00	9.3E+00				6.7E+00
Co-58	9.3E+00	3.0E+01	5.9E+00				4.4E+01
Co-60	1.5E+02	3.0E+01	2.1E+02				9.6E+01
Ni-63							2.4E–01
Cu-64							3.7E+02
Zn-65	1.5E+02	1.8E+02	9.3E+00				4.8E+01
Rb-89							1.6E+00
Sr-89	1.5E+00	1.8E+02					2.2E+01
Sr-90	3.0E–01	5.9E–01					1.7E+00
Y-90							1.7E+00
Sr-91							3.7E+01
Sr-92							2.9E+01
Y-91							8.9E+00
Y-92							2.3E+01
Y-93							4.1E+01
Zr-95	3.0E+01	1.2E+00	2.4E+01				1.8E+00
Nb-95	3.0E+02	1.8E–01	1.2E–01				1.6E+00
Mo-99	2.0E+03	5.9E+01	9.3E–02				1.2E+02
Tc-99m							1.1E+01
Ru-103	1.3E+02	1.5E+00	3.0E–02				4.1E+00
Rh-103m							4.1E+00
Ru-106							7.0E–01
Rh-106							7.0E–01
Ag-110m	7.4E-02						6.7E–06
Sb-124	1.5E+00	3.0E+00	2.1E+00				

Table 12.2-19 Annual Airborne Releases for Offsite Dose Evaluations (MBq) (Continued)

Nuclide	R/B	Turbine	Radwaste	Mechanical Vacuum Pump	Turbine Seal	Offgas	Drywell
Te-129m							8.1E+00
Te-131m							2.8E+00
Te-132							7.0E–01
Cs-134	1.4E+02	5.9E+00	7.4E+01				6.3E+00
Cs-136	1.5E+01	3.0E+00					3.0E+00
Cs-137	1.8E+02	3.0E+01	1.2E+02				1.7E+01
Cs-138							6.3E+00
Ba-140	6.7E+02	3.0E+02	1.2E–01				6.7E+01
La-140							6.7E+01
Ce-141	2.7E+01	3.0E+02	2.1E–01				6.3E+00
Ce-144							7.0E–01
Pr-144							7.0E–01
W-187							7.0E+00
Np-239							4.4E+02

Table 12.2-20 Airborne Concentrations

Nuclide	Annual Average Airborne		Maximum Technical Specification (MBq/cm^3)
	Release (MBq/yr)	Concentration (MBq/cm^3)	
Kr-83m	3.1E+01	2.0E–18	5.2E–17
Kr-85m	7.8E+05	4.8E–14	7.4E–13
Kr-85	2.1E+07	1.3E–12	1.3E–12
Kr-87	9.3E+05	5.9E–14	1.6E–12
Kr-88	1.4E+06	8.9E–14	2.4E–12
Kr-89	8.9E+06	5.5E–13	1.5E–11
Kr-90	1.2E+01	7.8E–19	2.1E–17
Xe-131m	1.9E+06	1.2E–13	1.2E–13
Xe-133m	3.2E+03	2.0E–16	3.3E–16
Xe-133	8.9E+07	5.5E–12	4.1E–11
Xe-135m	1.5E+07	9.2E–13	2.4E–11
Xe-135	1.7E+07	1.0E–12	2.8E–11
Xe-137	1.9E+07	1.2E–12	3.1E–11
Xe-138	1.6E+07	1.0E–12	2.5E–11
Xe-139	1.5E+01	9.6E–19	2.6E–17
I-131	9.6E+03	5.9E–16	1.8E–14
I-132	8.1E+04	5.2E–15	1.6E–13
I-133	6.3E+04	4.1E–15	1.2E–13
I-134	1.4E+05	8.9E–15	2.7E–13
I-135	8.9E+04	5.5E–15	1.7E–13
H-3	2.7E+06	1.7E–13	1.7E–13
C-14	3.4E+05	2.2E–14	2.2E–14
Na-24	1.5E+02	9.2E–18	9.2E–18
P-32	3.4E+01	2.2E–18	2.2E–18
Ar-41	2.5E+05	1.6E–14	1.6E–14
Cr-51	1.3E+03	8.1E–17	2.3E–16

Table 12.2-20 Airborne Concentrations (Continued)

Nuclide	Annual Average Airborne Release (MBq/yr)	Annual Average Airborne Concentration (MBq/cm^3)	Maximum Technical Specification (MBq/cm^3)
Mn-54	2.0E+02	1.3E–17	3.5E–16
Mn-56	1.3E+02	8.5E–18	8.5E–18
Fe-55	2.4E+02	1.5E–17	1.5E–17
Fe-59	3.0E+01	1.9E–18	4.4E–17
Co-58	8.9E+01	5.9E–18	8.9E–17
Co-60	4.8E+02	3.1E–17	7.4E–16
Ni-63	2.4E–01	1.5E–20	1.5E–20
Cu-64	3.7E+02	2.3E–17	2.3E–17
Zn-65	4.1E+02	2.5E–17	6.7E–16
Rb-89	1.6E+00	9.6E–20	9.6E–20
Sr-89	2.1E+02	1.3E–17	3.5E–20
Sr-90	2.6E+00	1.6E–19	1.9E–18
Y-90	1.7E+00	1.1E–19	1.1E–19
Sr-91	3.7E+01	2.4E–18	2.4E–18
Sr-92	2.9E+01	1.8E–18	1.8E–18
Y-91	8.9E+00	5.5E–19	5.5E–19
Y-92	2.3E+01	1.4E–18	1.4E–18
Y-93	4.1E+01	2.6E–18	2.6E–18
Zr-95	5.9E+01	3.7E–18	1.1E–16
Nb-95	3.1E+02	1.9E–17	5.9E–16
Mo-99	2.2E+03	1.4E–16	4.1E–15
Tc-99m	1.1E+01	7.4E–19	7.4E–19
Ru-103	1.3E+02	8.5E–18	2.5E–16
Rh-103m	4.1E+00	2.7E–19	2.7E–19
Ru-106	7.0E–01	4.4E–20	4.4E–20
Rh-106	7.0E–01	4.4E–20	4.4E–20

Table 12.2-20 Airborne Concentrations (Continued)

Nuclide	Annual Average Airborne		Maximum Technical Specification (MBq/cm^3)
	Release (MBq/yr)	Concentration (MBq/cm^3)	
Ag-110m	7.4E–02	4.8E–21	1.4E–19
Sb-124	6.7E+00	4.1E–19	1.3E–17
Te-129m	8.1E+00	5.2E–19	5.2E–19
Te-131m	2.8E+00	1.8E–19	1.8E–19
Te-132	7.0E–01	4.4E–20	4.4E–20
Cs-134	2.3E+02	1.4E–17	4.1E–16
Cs-136	2.2E+01	1.3E–18	3.5E–17
Cs-137	3.5E+02	2.2E–17	6.3E–16
Cs-138	6.3E+00	4.1E–19	4.1E–19
Ba-140	1.0E+03	6.7E–17	1.9E–15
La-140	6.7E+01	4.1E–18	4.1E–18
Ce-141	3.4E+02	2.1E–17	6.3E–16
Ce-144	7.0E–01	4.4E–20	4.4E–20
Pr-144	7.0E–01	4.4E–20	4.4E–20
W-187	7.0E+00	4.4E–19	4.4E–19
Np-239	4.4E+02	2.7E–17	2.7E–17

Table 12.2-21 Average Annual Doses from Airborne Releases

Part A	**Doses from Noble Gas Releases (mSv)**							
		Dose						
	Gamma Air	1.3E–02						
	Beta Air	1.7E–02						
	Total Body	1.2E–02						
	Skin	2.7E–02						
Part B	**Inhalation Doses from Particulate Releases (mSv)**							
		Bone	**Liver**	**T body***	**Thyroid**	**Kidney**	**Lung**	**GI-LLI†**
	Adult	6.7E–06	5.8E–06	4.5E–06	2.6E–04	7.1E–06	7.4E–06	5.2E–06
	Teen	9.5E–06	7.0E–06	5.2E–06	3.4E–04	8.8E–06	9.7E–06	5.9E–06
	Child	1.3E–05	7.1E–06	5.6E–06	4.2E–06	8.6E–06	9.0E–06	5.6E–06
	Infant	9.5E–06	5.4E–06	3.8E–06	3.8E–04	5.7E–06	6.3E–06	3.6E–06
Part C	**Ground Shine Doses from Particulates Deposited on Ground (mSv)**							
			T body*	**Skin**				
		Dose	5.7E–04	6.7E–04				
Part D	**Ingestion Doses from Particulate Releases (mSv)**							
	Milk Consumption							
		Bone	**Liver**	**T body***	**Thyroid**	**Kidney**	**Lung**	**GI-LLI†**
	Adult	9.5E–05	3.4E–05	2.6E–05	2.2E–05	2.7E–05	1.8E–05	2.8E–05
	Teen	1.7E–04	6.0E–05	4.5E–05	3.9E–05	4.8E–05	3.3E–05	4.4E–05
	Child	4.2E–04	1.2E–04	1.0E–04	9.2E–05	1.0E–04	8.0E–05	8.6E–05
	Infant	8.1E–04	2.4E–04	2.0E–04	2.0E–04	2.0E–04	1.7E–04	2.2E–04
	Meat Consumption							
		Bone	**Liver**	**T body***	**Thyroid**	**Kidney**	**Lung**	**GI-LLI†**
	Adult	8.7E–05	2.3E–05	2.0E–05	3.7E–04	2.2E–05	1.6E–05	4.1E–05
	Teen	7.3E–05	1.9E–05	1.7E–05	2.7E–04	1.8E–05	1.4E–05	2.7E–05
	Child	1.4E–04	3.2E–05	3.0E–05	4.1E–04	3.1E–05	2.6E–05	3.3E–05
	Leafy Vegetable Consumption							
		Bone	**Liver**	**T body***	**Thyroid**	**Kidney**	**Lung**	**GI-LLI†**
	Adult	5.0E–05	1.8E–05	1.3E–05	29E–03	2.4E–05	6.1E–06	1.9E–05
	Teen	4.6E–05	1.6E–05	1.2E–05	2.3E–03	2.2E–05	5.7E–06	1.4E–05
	Child	8.3E–05	2.4E–05	1.9E–05	3.5E–03	3.0E–05	1.0E–05	1.5E–05
	Produce Consumption							
		Bone	**Liver**	**T body***	**Thyroid**	**Kidney**	**Lung**	**GI-LLI†**
	Adult	2.3E–04	4.7E–05	4.9E–05	1.4E–04	4.2E–05	3.7E–05	6.7E–05
	Teen	3.9E–04	8.0E–05	8.1E–05	2.1E–02	7.1E–05	6.5E–05	9.8E-05
	Child	9.4E–04	1.8E–04	1.9E–04	4.5E–04	1.7E–04	1.6E–04	1.8E–04

* T body—Total Body

† GI–LLI—Gastrointestinal–Lower Large Intestine

Table 12.2-22 Annual Average Liquid Releases

Nuclide	Annual Release (MBq/yr)	Concentration (MBq/ml)
I-131	1.18E+02	4.07E–11
I-132	9.62E+01	3.14E–11
I-133	3.70E+02	1.22E–10
I-134	6.29E+01	2.11E–11
I-135	2.78E+02	9.25E–11
H-3	2.22E+06	7.40E–07
C-14	5.92E+00	1.92E–12
Na-24	1.04E+02	3.40E–11
P-32	6.66E+00	2.22E–12
Cr-51	2.85E+02	9.62E–11
Mn-54	9.62E+01	3.22E–11
Mn-56	1.41E+02	4.81E–11
Co-56	1.92E+02	6.29E–11
Co-57	2.66E+00	8.88E–13
Co-58	3.33E+00	1.11E–12
Co-60	3.37E+02	1.11E–10
Fe-55	2.15E+02	7.03E–11
Fe-59	3.70E+00	1.26E–12
Ni-63	5.18E+00	1.74E–12
Cu-64	2.78E+02	9.25E–11
Zn-65	3.33E+00	1.11E–12
Rb-89	1.63E+00	5.55E–13
Sr-89	4.07E+00	1.29E–12
Sr-90	1.30E+00	4.44E–13
Y-90	1.15E–01	3.70E–14
Sr-91	3.33E+01	1.11E–11
Y-91	4.07E+00	1.33E–12
Sr-92	2.96E+01	9.99E–12
Y-92	2.22E+01	7.40E–12
Y-93	3.33E+01	1.11E–11
Zr-95	3.11E+01	1.04E–11

Table 12.2-22 Annual Average Liquid Releases (Continued)

Nuclide	Annual Release (MBq/yr)	Concentration (MBq/ml)
Nb-95	3.70E+01	1.26E–11
Mo-99	3.07E+01	1.04E–11
Tc-99m	2.96E+01	9.99E–12
Ru-103	6.66E+00	2.26E–12
Rh-103m	3.33E–01	1.11E–13
Ru-106	6.29E+00	2.00E–14
Rh-106	6.29E+00	2.07E–12
Ag-110m	1.22E+01	2.32E-14
Sb-124	1.33E+01	4.44E–12
Te-129m	6.29E–01	2.03E–13
Te-131m	1.26E+00	4.07E–13
Te-132	1.48E–01	4.81E–14
Cs-134	2.26E+02	7.77E–11
Cs-136	1.18E+01	4.07E–12
Cs-137	3.29E+02	1.11E–10
Cs-138	7.03E+00	2.29E–12
Ba-140	2.52E+01	8.51E–12
La-140	6.29E+00	2.11E–12
Ce-141	4.44E+00	1.55E-12
Ce-144	7.03E+01	2.40E–11
Pr-143	4.81E–02	1.63E–14
W-187	3.52E+00	1.18E–12
Np-239	1.15E+02	3.70E–11

Table 12.2-23 Liquid Pathway Dose Analysis (Assuming 5678 L/min Flow and a Dilution Factor of 10)

	Doses mSv/yr				
Pathway	**T Body**	**Skin**	**GI-LLI**	**Thyroid**	**Bone**
Drinking Water					
Adult	2.30E–03	0.00E+00	2.40E–03	4.20E–03	3.70E–04
Teen	1.60E–03	0.00E+00	1.70E–03	2.90E–03	2.60E–04
Child	1.60E–03	0.00E+00	1.70E–03	2.90E–03	2.60E–04
Infant	1.00E–03	0.00E+00	1.10E–03	1.90E–03	1.70E–04
Eating Plants					
Adult	1.30E–03	0.00E+00	3.90E–03	3.20E–04	1.50E–02
Teen	9.50E–04	0.00E+00	3.00E–03	2.50E–04	1.10E–02
Child	4.30E–04	0.00E+00	1.30E–03	1.10E–04	4.90E–03
Eating Invertebrates					
Adult	4.60E–04	0.00E+00	3.60E–03	4.80E–05	7.80E–04
Teen	3.50E–04	0.00E+00	2.80E–03	3.70E–05	6.00E–04
Child	1.60E–04	0.00E+00	1.20E–03	1.60E–05	2.70E–04
Eating Fish					
Adult	2.00E–02	0.00E+00	8.40E–03	1.00E–03	3.90E–02
Teen	1.60E–02	0.00E+00	6.40E–03	7.90E–04	3.00E–02
Child	6.70E–03	0.00E+00	2.70E–03	3.40E–04	1.30E–02
Swimming					
Adult	9.30E–07	1.10E–06	0.00E+00	0.00E+00	0.00E+00
Teen	5.20E–06	6.40E–06	0.00E+00	0.00E+00	0.00E+00
Child	1.10E–06	1.30E–06	0.00E+00	0.00E+00	0.00E+00
Boating					
Adult	2.00E–06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Teen	2.00E–06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Child	1.00E–06	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 12.2-23 Liquid Pathway Dose Analysis (Assuming 5678 L/min Flow and a Dilution Factor of 10) (Continued)

	Doses mSv/yr				
Pathway	**T Body**	**Skin**	**GI-LLI**	**Thyroid**	**Bone**
Sunbathing					
Adult	8.3E–05	9.7E–05	0.0E+00	0.0E+00	0.0E+00
Teen	4.6E–04	5.4E–04	0.0E+00	0.0E+00	0.0E+00
Child	9.6E–05	1.1E–04	0.0E+00	0.0E+00	0.0E+00
Total					
Adult	2.4E–02	9.8E–05	1.8E–02	5.6E–03	5.5E–02
Teen	1.9E–02	5.5E–04	1.4E–02	4.0E–03	4.2E–02
Child	9.0E–03	1.1E–04	6.9E–03	3.4E–03	1.8E–02
Infant	1.1E–03	0.0E+00	1.1E–03	1.9E–03	1.7E–04

Table 12.2-24 Activity Levels of the Transversing In-Core Probe System

	Decay Time (day)	Gy/h @ 1 Meter	Major Isotopes
Gamma Probe			
Sensor	0.00139	0.0561	Mn-56, Al-28, Ti-51
	0.0417	0.032	Mn-56, Na-24, Ni-65
	1.0	0.000133	Mn-56, Na-24, Cu-64
	2.0	0.0000384	Na-24, Co-60, Cr-51
Cable	0.00139	0.535	Mn-56, Mg-27, Ni-65
	0.0417	0.412	Mn-56, Ni-65, Fe-59
	1.0	0.00104	Mn-56, Fe-59, Mn-54
	2.0	0.00018	Fe-59, Mn-54, Cr-51
Neutron Probe			
Sensor	0.00139	0.03382	Mn-56, Al-28, Ti-51
	0.0417	0.02142	Mn-56, Na-24, Ni-65
	2.0	0.0000378	Co-60, Na-24, Co-58
Cable	0.00139	0.451	Mn-56, Mg-27, Ni-65
	0.0417	0.348	Mn-56, Ni-65, Fe-59
	1.0	0.00091	Mn-56, Fe-59, Mn-54
	2.0	0.000189	Fe-59, Mn-54, Co-60

Table 12.2-25 Activity Levels in the Reactor Internal Pump

Component	Level
Impeller	0.04 - 0.24 Gy/h
Upper Motor	4 -12 mGy/h
Motor	0.8 - 3 mGy/h
Lower motor casing	0.7 - 5 mGy/h

Table 12.2-26 Activity in the Turbine Moisture Separator/Reheater

Isotopes	MB/q	Isotopes	MB/q
KR-83M	6.3E+01	NA-24	1.0E+02
KR-85M	1.1E+02	P-32	1.9E+00
KR-85	4.4E–01	CR-51	5.9E+01
KR-87	3.6E+02	MN-54	6.7E–01
KR-88	3.6E+02	MN-56	5.2E+02
KR-89	2.3E+03	FE-55	9.6E+00
KR-90	5.2E+03	FE-59	2.9E–01
KR-91	5.9E+03	CO-58	1.9E+00
XE-131M	3.7E–01	CO-60	3.7E+00
XE-133M	5.2E+00	NI-63	9.6E–03
XE-133	1.6E+02	CU-64	2.9E+02
XE-135M	4.8E+02	ZN-65	1.9E+00
XE-135	4.1E+02	SR-89	9.6E–01
XE-137	2.8E+03	SR-90	6.7E–02
XE-138	1.7E+03	Y-90	6.7E–02
XE-139	5.2E+03	SR-91	4.1E+01
XE-140	5.6E+03	SR-92	1.1E+02
XE-144	1.0E+01	Y-91	3.7E–01
Total	**3.1E+04**	Y-92	6.3E+01
		Y-93	4.1E+01
I-131	7.0E+02	ZR-95	7.8E–02
I-132	6.3E+03	NB-95	7.8E–02
I-133	4.8E+03	MO-99	1.9E+01
I-134	1.0E+04	TC-99M	1.9E+01
I-135	6.7E+03	RU-103	1.9E–01
		RH-103M	1.9E–01
		RU-106	2.9E–02
Total	**2.9E+04**		**1.3E+03**

Table 12.2-26 Activity in the Turbine Moisture Separator/Reheater (Continued)

Isotopes	MB/q	Isotopes	MB/q
RB-89	6.3E+01	RH-106	2.9E–02
CS-134	2.6E–01	AG-110M	9.6E–03
CS-136	1.7E–01	TE-129M	3.7E–01
CS-137	7.0E–01	TE-131M	9.6E–01
CS-138	1.2E+02	TE-132	9.6E–02
Total	**1.8E+02**	BA-140	3.7E+00
		LA-140	3.7E+00
N-16	1.4E+08	CE-141	2.9E–01
		CE-144	2.9E–02
H-3	2.9E+04	PR-144	2.9E–02
		W-187	2.9E+00
		NP-239	7.8E+01
		Total	**1.4E+03**

Table 12.2-27 Activity in the Turbine Condenser

Isotopes	MBq	Isotopes	MBq
KR-83M	9.6E+03	NA-24	1.4E+02
KR-85M	1.7E+04	P-32	2.8E+00
KR-85	6.7E+01	CR-51	8.5E+01
KR-87	5.6E+04	MN-54	1.0E+00
KR-88	5.6E+04	MN-56	7.8E+02
KR-89	2.9E+05	FE-55	1.4E+01
KR-90	2.9E+05	FE-59	4.1E+01
KR-91	8.5E+04	CO-58	2.8E+00
XE-131M	5.6E+01	CO-60	5.6E+00
XE-133M	8.1E+02	NI-63	1.4E–02
XE-133	2.4E+04	CU-64	4.4E+02
XE-135M	7.0E+04	ZN-65	2.8E+00
XE-135	6.3E+04	SR-89	1.4E+00
XE-137	3.6E+05	SR-90	1.0E–01
XE-138	2.4E+05	Y-90	1.0E–01
XE-139	3.4E+05	SR-91	5.9E+01
XE-140	1.3E+05	SR-92	1.6E+02
XE-144	1.4E+02	Y-91	5.6E–01
Total	**2.0E+06**	Y-92	9.3E+01
		Y-93	5.9E+01
I-131	1.0E+03	ZR-95	1.1E–01
I-132	8.9E+03	NB-95	1.1E–01
I-133	7.0E+03	MO-99	2.8E+01
I-134	1.5E+04	TC-99M	2.8E+01
I-135	1.0E+04	RU-103	2.8E–01
Total	**4.2E+04**	RH-103M	2.8E–01
		RU-106	4.1E–02

Table 12.2-27 Activity in the Turbine Condenser (Continued)

Isotopes	MBq	Isotopes	MBq
RB-89	8.5E+01	RH-106	4.1E–02
CS-134	3.7E–01	AG-110M	1.4E–02
CS-136	2.6E–01	TE-129M	5.6E–01
CS-137	1.0E+00	TE-131M	1.4E+00
CS-138	1.7E+02	TE-132	1.4E–01
Total	**2.6E+2**	BA-140	5.6E+00
		LA-140	5.6E+00
N-16	1.4E+07	CE-141	4.1E–01
		CE-144	4.1E–02
H-3	4.4E+04	PR-144	4.1E–02
		W-187	4.4E+00
		NP-239	1.1E+02
		Total	**2.0E+03***

* Includes isotopes from previous page (right hand side)

Table 12.2-28 Activity in the Condenser Demineralizer

Isotopes	Demineralizer MBq	Filter MBq	Isotopes	Demineralizer MBq	Filter MBq
I-129	7.0E–04		SR-92	5.2E+03	
I-131	2.4E+06		Y-91	7.4E+03	1.1E+04
I-132	2.5E+05		Y-91M	4.1E+03	
I-133	1.8E+06		Y-92	5.2E+03	7.4E+03
I-134	1.6E+05		Y-93	5.6E+01	1.4E+04
I-135	8.1E+05		ZR-93	1.2E–04	
Total	**5.4E+06**		ZR-95	3.2E+01	4.4E+03
			NB-95M	1.3E–01	1.8E+01
RB-89	2.7E+02		NB-95	2.4E+01	3.2E+03
CS-134	5.6E+04		MO-99	4.4E+04	
CS-135	7.4E–01		TC-99M	2.3E+04	
CS-136	7.4E+02		TC-99	2.4E–01	
CS-137	2.2E+05		RU-103	2.5E+01	4.8E+03
CS-138	1.1E+03		RH-103M	2.5E+01	4.8E+03
Total	**2.8E+05**		RU-106	3.0E+01	1.3E+03
			RH-106	3.0E+01	1.3E+03
NA-24	2.7E+04		AG-110M	7.4E+00	4.1E+02
P-32	1.2E+04		AG-110	1.0E–01	5.6E+00
CR-51	7.0E+05		TE-129M	1.1E+04	
MN-54	4.1E+04	1.5E+04	TE-129	3.5E+03	
MN-56	1.2E+04	2.2E+04	TE-131M	1.0E+03	
FE-55	1.6E+04	4.4E+05	TE-131	1.1E+02	
FE-59	4.4E+01	7.8E+03	TE-132	1.4E+02	
CO-58	3.0E+04	3.2E+04	BA-137M	2.1E+05	
CO-60	5.2E+05	9.3E+04	BA-140	2.1E+04	

Table 12.2-28 Activity in the Condenser Demineralizer (Continued)

Isotopes	Demineralizer MBq	Filter MBq	Isotopes	Demineralizer MBq	Filter MBq
NI-63	1.6E+03	2.4E+02	LA-140	2.1E+04	3.7E+04
CU-64	6.7E+04		CE-141	3.0E+01	6.3E+03
ZN-65	2.0E+05		CE-144	4.8E+01	2.6E+03
SR-89	2.2E+04		PR-144M	3.6E–01	1.9E+01
SR-90	2.1E+04		PR-144	4.8E+01	2.6E+03
Y-90	2.1E+04		W-187	9.6E+00	2.3E+03
SR-91	1.4E+04		NP-239	8.1E+04	
			PU-239	6.7E+00	
Total	**3.3E+05**		**Total**	**1.4E+07**	**7.2E+05**

Table 12.2-29 Steam Jet Air Ejector Inventory

Isotope	1st Stage Ejector (MBq)	Condenser (MBq)	2nd Stage Ejector (MBq)
Kr-83m	2.5E+01	7.4E+02	7.4E+01
Kr-85m	4.4E+01	1.4E+03	1.4E+02
Kr-85	1.5E–01	4.4E+00	4.4E–01
Kr-87	1.5E+02	4.4E+03	4.4E+02
Kr-88	1.5E+02	4.4E+03	4.4E+02
Kr-89	9.3E+02	2.8E+04	2.8E+03
Kr-90	1.7E+03	5.2E+04	5.2E+03
Kr-91	1.1E+03	3.3E+04	3.3E+03
Kr-92	5.6E+01	1.7E+03	1.7E+02
Kr-93	2.9E+00	8.9E+01	8.9E+00
Kr-94	7.8E–13	2.4E–11	2.4E–12
Kr-95	1.5E–05	4.4E–04	4.4E–05
Kr-97	5.6E–21	1.7E–19	1.7E–20
Total KR	**4.1E+03**	**1.3E+05**	**1.3E+04**
Xe-131m	1.1E–01	3.3E+00	3.3E–01
Xe-133m	2.1E+00	6.3E+01	6.3E+00
Xe-133	5.9E+01	1.8E+03	1.8E+02
Xe-135m	1.9E+02	5.6E+03	5.6E+02
Xe-135	1.6E+02	4.8E+03	4.8E+02
Xe-137	1.1E+03	3.2E+04	3.2E+03
Xe-138	6.7E+02	2.0E+04	2.0E+03
Xe-139	1.7E+03	5.2E+04	5.2E+03

Table 12.2-29 Steam Jet Air Ejector Inventory (Continued)

Isotope	1st Stage Ejector (MBq)	Condenser (MBq)	2nd Stage Ejector (MBq)
Xe-140	1.3E+03	4.1E+04	4.1E+03
Xe-141	3.1E+01	9.6E+02	9.6E+01
Xe-142	1.9E+00	5.6E+01	5.6E+00
Xe-143	8.1E–09	2.5E–07	2.5E–08
Xe-144	4.1E–03	1.2E–01	1.2E–02
Total XE	**5.3E+03**	**1.6E+05**	**9.4E+03**
Noble Gas Totals	**4.1E+03**	**2.8E+05**	**2.8E+04**
N-16*	1.3E+04	4.8E+05	4.8E+04

* Value given is estimated N-16 inventory at 100% power. Value varies in an unknown fashion with power. Based upon operating measurements, the value for N-16 at 20% power is close to zero. Multiply value by a factor of 6 for use with hydrogen water chemistry.

Table 12.2-30 Standby Gas Treatment System Inventory

Isotope	MBq	Isotope	MBq
I-131	5.6E+02	Y-91	3.1E+01
I-132	5.6E+01	Y-92	1.3E+01
I-133	4.1E+02	Y-93	2.5E+01
I-134	3.7E+01	Zr-95	7.0E+00
I-135	18E+02	Nb-95	3.7E+00
		Mo-99	7.4E+01
		Tc-99m	7.0E+00
Na-24	6.3E+02	Ru-103	1.1E+01
P-32	2.7E+02	Rh-103m	1.1E+01
Cr-51	1.6E+04	Ru-106	1.5E+01
Mn-54	2.0E+03	Rh-106	1.5E+01
Mn-56	5.6E+02	Ag-110m	4.1E–06
Fe-55	6.7E+04	Te-129m	1.8E+01
Fe-59	1.3E+02	Te-131m	1.7E+00
Co-58	1.4E+03	Te-132	4.4E–01
Co-60	3.6E+04	Cs-134	2.3E+02
Ni-63	1.7E+01	Cs-136	3.2E+00
Cu-64	2.2E+02	Cs-137	1.2E+03
Zn-65	6.7E+02	Cs-138	3.7E+00
Rb-89	9.3E–01	Ba-140	7.0E+01
Sr-89	7.0E+01	La-140	7.0E+01
Sr-90	1.2E+02	Ce-141	1.3E+01
Y-90	1.2E+02	Ce-144	1.1E+01
Sr-91	2.3E+01	Pr-144	1.1E+01
Sr-92	1.7E+01	W-187	4.1E+00
		Np-239	2.6E+02
Totals	**1.3E+05**		**3.8E+01**
Total			**1.3E+05**

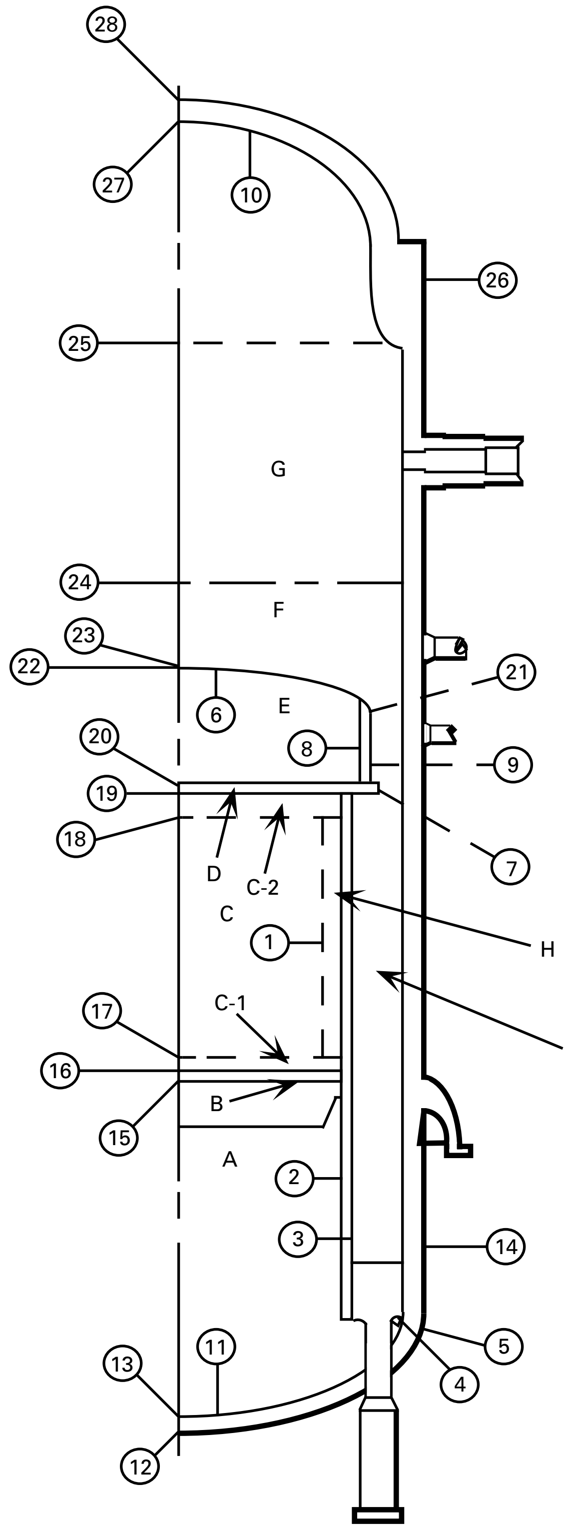

Figure 12.2-1 Radiation Source Model