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Monticello Nuclear Generating Plant
Operated by Nuclear Management Company, LLC

August 22, 2006

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Monticello Nuclear Generating Plant
Docket 50-263
License No. DPR-22

Response to Request for Additional Information Related to License Amendment Request for Full Scope Alternative Source Term

References: 1) NMC letter to NRC, "License Amendment Request: Full Scope Application of an Alternative Source Term," (ADAMS Accession No. ML052640366) dated September 15, 2005.

2) NMC letter to NRC, "Full Scope Alternate Source Term-Supplemental Information," (ADAMS Accession No. ML 061310445) dated April 13, 2006.

During the review of the Monticello application for a Full Scope Alternative Source Term (AST), the Nuclear Regulatory Commission (NRC) provided Nuclear Management Company, LLC (NMC) with questions regarding the application. The questions were transmitted to NMC via e-mails dated June 29, July 13 and August 3, 2006, and were clarified during conference calls held on July 11, July 17 and August 4, 2006.

NMC responses to the questions are included in Enclosures 1, 2 and 3. Enclosure 1 contains the responses to questions regarding the accident dose assessment review. Enclosure 2 contains the responses to questions regarding the meteorology review and Enclosure 3 contains the responses to questions regarding the containment ventilation systems review. As part of this submittal, Enclosure 5 includes reference drawings and one calculation which were previously provided to NRC staff to assist in the technical review.

In addition, MNGP has determined that the sector used for the Control Room elevated release X/Q calculation in CA-04-037 Rev 2 (MNGP AST - CR/TSC Post-Accident Atmospheric Dispersion Analysis) was incorrect. The sector used was Southeast (SE);

the opposite Northwest (NW) sector should have been used. The details and evaluation of this minor error are provided as Enclosure 4.

Summary of Commitments

This letter contains no new or revised commitments.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 22, 2006.

John T. Conway
Site Vice-President, Monticello Nuclear Generating Plant
Nuclear Management Company, LLC

Enclosures (5)

cc: Administrator, Region III, USNRC
NRR Project Manager, Monticello, USNRC
Resident Inspector, Monticello, USNRC
Minnesota Department of Commerce

NRC Question 1a:

What is the basis for the assumed reduction in leakage through the main steam isolation valves (MSIVs) at 24 hours and 72 hours in the loss of coolant accident (LOCA) dose analysis?

NMC Response 1a:

The basis for the reduction in the assumed MSIV leakage rate at 24 hours and 72 hours is plant-specific analysis of the post-LOCA primary containment pressure/temperature profile.

NMC Calculation CA-03-099 Rev 1, "Drywell Temperature and Pressure EQ Profiles", provides drywell pressure and temperature response for EQ purposes. The calculation reviewed data from a variety of scenarios from existing MNGP-specific containment response analyses and determined conservative bounding drywell pressure and temperature values for EQ.

These bounding values were compared with the latest evaluation of containment response (GE-NE-0000-00002-8817-01 Rev. 2, August 2003, documented in USAR Section 5.2), including scaling the GE-NE response from 1775 to 1880 MWt, and determined to be still bounding. Therefore the pressure and temperature values from CA-03-099 were considered to provide a conservative containment response basis for reduction in MSIV and primary containment leakage at 24 and 72 hours, with the exception that the drywell pressure for 0-1 days is assumed to be the design accident pressure of 42 psig, consistent with guidance in RG 1.183 Appendix A Section 3.7 (the drywell peak pressure evaluated in CA-03-099 does not reach this pressure).

Using these post-LOCA pressure/temperature conditions and the critical mass flux (lbm/sec-ft^2) Equation No. 2.60 from Frederick J. Moody, "Introduction to Unsteady Thermofluid Mechanics", the ratio of mass fluxes is calculated for the MNGP pressures and temperatures at times greater than 24 hours post-LOCA for both steam and air assuming an ideal gas (gas properties taken from Table B.6 of Sonntag & Van Wylen, "Introduction to Thermodynamics: Classical and Statistical").

A check of the critical pressure is also performed to determine if DW pressure is less than the critical pressure needed for sonic (critical) flow (Frederick J. Moody, "Introduction to Unsteady Thermofluid Mechanics" Eqn. 2.59). Leakage rates for DW pressures below the critical pressure are not calculated, but would be less than the critical mass flux calculated above.

Results of these critical mass flux ratio calculations, based on the MNGP analyzed LOCA pressure/temperature profile, indicate that the leakage flow rate at 24 hours is reduced to 61% of the design leakage value and is reduced further at 72 hours to 50% of the design leakage value.

[Reference CA-04-038, Rev 0, “MNGP AST – LOCA Radiological Consequence Analysis”: Assumption 3.9 (pg A-22) and Attachment 102, “Pressure Decay - Reduced Leakage Rate.xls”. CA-04-038 Rev 0 and attachments were provided in NMC AST Full-Scope Submittal dated September 15, 2005.]

NRC Question 1b:

The submittal indicates that the reduction in leakage into the main steam lines is consistent with the reduction in primary containment leakage based on the reduction of primary containment pressure. How does the reduction in primary containment pressure lead to a reduction in MSIV leakage?

NMC Response 1b:

For the design basis LOCA (double-ended large pipe break) following the blowdown of the initial RPV/RPS inventory, the long term reactor vessel pressure profile is assumed to be essentially the same as that of the primary containment. Thus, the driving pressure for leakage (Primary, MSIV, Secondary Containment Bypass), is the post LOCA pressure within the primary containment.

NRC Question 2:

Does the LOCA analysis modeling of iodine aerosol deposition in the MSIV leakage pathway account for the preceding removal of aerosols in the primary containment by natural deposition? Discuss MNGP’s interpretation of expected aerosol size distribution behavior over time vs. that assumed by the AEB-98-03 model.

NMC Response 2:

Yes, the iodine aerosol deposition modeling in the MSIV leakage pathway does account for preceding removal of aerosols in primary containment by natural deposition.

The RADTRAD model used for the assessment of LOCA dose via the MSIV leakage pathway assumes 10% Powers – BWR natural deposition correlation within the primary containment volume. MSIV leakage is taken directly from the described primary containment volume.

For the AST LOCA, all activity release from the core is assumed to be released to the primary containment within the first 2-hours post LOCA. Therefore, using the RADTRAD primary containment volume with Powers – BWR natural deposition as the source of MSIV leakage is both justifiable and reasonable.

The model based on AEB-98-03 guidance is intended to be conservative in estimating total deposition based on a deposition velocity statistically determined from drywell expected distributions of aerosol density, diameter, and shape factors. Since the MNGP Main Steam Line (MSL) aerosol deposition model is a

lumped-single volume, there is no aerosol size distribution behavior impact on the model itself as the deposition volume's outlet flow empties directly into the condenser and not into other pipe deposition volumes with deposition rates based on the first volume's exit conditions. Thus, this single-volume model does not permit simulation of deposition induced changes to the initial aerosol size distribution as a function of time for a unit volume of aerosol that transits through the model. Simulation of the physical changes to the aerosol constituents would require a multi-volume model to account for time-dependent changes to control volume characteristics (i.e., loss of mass, redistribution of remaining particles, etc.). However, it is expected that a mechanistic multi-compartment pipe deposition model would yield higher deposition rates as the downstream volumes further remove additional aerosol particles not deposited in upstream volumes. The model, therefore, does not account for the effect of time-dependent aerosol mass depletion through the MSL drain system, the effect of pipe bends, condensation, or other non-uniformities that could stimulate additional droplet growth and enhance aerosol deposition. Ultimately, a realistic expectation might be for a more dilute aerosol consisting of only the smallest particles entering the condenser volume wherein additional depletion effects act on the remaining aerosol.

Thus, the dose consequence predicted from the lumped-single volume MNGP MSL iodine aerosol pipe deposition model is expected to be greater than that expected from a multi-compartment aerosol depletion model that takes into account all or most of the aerosol depletion mechanisms.

[Reference CA-04-038 Rev 0, Section 6.1 (RADTRAD models) and Figure 11]

NRC Question 3a:

Was potential iodine revolatilization accounted for in the modeling of iodine removal for the LOCA MSIV leakage pathway?

<u>NMC Response 3a:</u>

No. Potential revolatilization of iodines was not explicitly incorporated into the LOCA MSIV leakage pathway model. Previous evaluations have shown the revolatilization mechanism to be of minor significance in LOCA dose analysis.

The temperature dependent elemental iodine resuspension rates as reported in J. E. Cline's "MSIV Leakage Iodine Transport Analysis" are orders of magnitude lower than the particulate deposition rates calculated using the methodology in AEB 98-03. Considering the conservative nature of the pipe temperature calculation methodology used (see response to Question 3b), the potential non-conservatism of not incorporating iodine revolatilization is deemed more than compensated.

NRC Question 3b:

Does the piping temperature profile used to determine the aerosol deposition efficiency include heating from aerosols deposited in the piping?

NMC Response 3b:

No. The piping temperature profile analysis performed to support the temperature values used in the LOCA MSIV pathway dose analysis does not explicitly model decay energy from deposited aerosols. However, the analysis performed to generate the temperature profile used to evaluate LOCA dose is very conservative. Boundary conditions were explicitly chosen to maximize heat addition to the piping pathway while heat transfer boundary conditions and heat transfer coefficients were chosen to minimize heat transfer from the piping pathway. Thus, modeled pipe temperatures used in the LOCA MSIV pathway dose analysis are much higher than would be predicted based on a more realistic set of boundary conditions and would more than offset the small contribution to the pipe wall temperature resulting from the decay heat of the deposited material.

Additionally, there are significant conservatisms in the MSL thermal profile model for MNGP:

- The drywell/inside pipe temperature and pressure conditions used are the conservative values determined in MNGP Calculation CA-03-099 discussed in Response 1a above. Room temperatures for the Main Steam Tunnel are assumed at values which bound the room temperatures expected during heat-up post-LOCA.

- The Main Steam Tunnel temperatures are used to model heat transfer to the environment for the entire pipe, with MST room temperatures ranging from 175°F to 126°F. A significant portion of the MSL piping is located in the large condenser bay room. This room is more open and cooler, with an expected high temperature of 130°F.

- The MSL insulation has many penetrations that connect directly to the piping but are not credited as heat losses for calculating the thermal profile. These include branch piping, valve yokes and un-insulated structural pipe supports that act to dissipate heat directly to the surrounding atmosphere. For example, an engineering-science reference table gives a combined natural convection and radiation heat transfer coefficient of 2.25 BTU/hr-ft^2-°F for 100°F mean temperature differential (Ts – Ta) of a 3-inch diameter horizontal cylinder (a size comparable to heavy pipe support tube steel). At a 100°F effective temperature difference, a 1.2 ft^2 surface dissipates 273 BTU/hr, or about 18 inches of cylinder length. This is only a small fraction of the total support structures and attachments combined surface area. Thus, the heat gain to the piping

from deposited iodine decay is greatly exceeded by the heat dissipated through the MSL piping attachments.

- The temperature profile was held constant for the first 12 hours post-LOCA although the model predicts significant temperature decrease during that period. The temperature profile was held constant after 20 days although the model predicts continuing decrease after that time.

When questioned by NRC about effects of heating from deposited iodine species, during review of a submittal made for the Clinton Nuclear Station, Clinton responded that the calculated decay heat value from deposited iodine species is approximately equal to an 80-watt incandescent light bulb, or about 273 BTU/hr. The basis for this value is a 100 scfh leakage flow rate, 100 percent of the iodine species in the leakage flow assumed to be deposited, and the iodine activity of the Clinton source term in curies converted to watts. By comparison, Clinton Nuclear Station has a license rated thermal power (RTP) of 3,473 megawatts and the MNGP LOCA source term assumes a thermal power of 1,880 megawatts. Since the source term is directly proportional to core power, the estimated decay heat for the same leak rate in the MNGP model would be about that of a 43-watt bulb or 147 BTU/hr.

Based on the above discussion and the conservatism in the piping temperature profile used, the effect of any decay heat on pipe inner surface temperature due to iodine decay energy absorption is insignificant to the evaluation of iodine deposition, and also to any re-suspension/re-evolution of deposited iodine.

The GOTHIC model, methodology, and assumptions used in the development of the MSIV pathway piping temperature profile are essentially the same as that used in the Brunswick Steam Electric Plant (BSEP) TS amendment approved on March 6, 2006 (Amendment 239 and 267).

[Reference CA-04-038, Rev 0, Assumption 3.10; CA-05-134, Rev 0, “Post-LOCA Steam Pipe Internal Temperature 30-Day Profile for Radiological Dose Analysis” (incorporates AAC Calculation MNGP-012 Rev 0)].

NRC Question No. 4:

Please provide the control room shine dose calculations, including any diagrams that indicate the location of the source(s) and receptor(s).

<u>NMC Response No. 4:</u>

MNGP Calculation CA-05-130, Rev 0, “Post LOCA Direct Dose to the Control Room from External Sources”, is provided in Enclosure 5. A series of annotated plant drawings is also included as an overall view of the relative positions of the sources and receptors as well as the plant position column numbering referenced in the diagrams in CA-05-130. Supplied drawings: NF-36056-1, Rev H; NF-36057, Rev L; NF-36063, Rev A. (See Enclosure 5)

ENCLOSURE 2
NMC Response to RAI Questions (Meteorology)

NRC Question No. 1:

Section 4, Atmospheric Dispersion, of the March 7, 2006 NRC Regulatory Issue Summary 2006-04 (RIS 2006-04), Experience with Implementation of Alternative Source Terms, states that valid wind direction data in the ARCON96 format should range from 1° to 360°. Fields of "nines" (e.g., 999) should be used to indicate invalid or missing data. The staff notes that the Monticello hourly meteorological data for the 1998-2002 period generally contains fields of nines to indicate invalid data, but also has some zeros in the wind direction and wind speed fields. Are these data (i.e., the zeros) valid data? RIS 2006-04 further states that the jfds used as input to the PAVAN computer code should have a large number of wind speed categories at the lower wind speeds in order to produce the best results (e.g., Section 4.6 of NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations," suggests wind speed categories of calm, 0.5, 0.75,1.0, 1.25,1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0 and 10.0 meters per second). What is the wind speed and designation for calm (e.g., less than 0.5 meters per second based upon instrument thresholds)? The staff is attempting to generate a jfd using these categories and is attempting to input valid data only.

NMC Response No. 1:

For the 43 Meter ARCON96-formatted data provided in the AST Full Scope submittal dated September 15, 2005 (provided as attachments in MNGP Calculation CA-04-037, Rev 2, "MNGP AST - CR/TSC Post-Accident Atmospheric Dispersion Analysis"), not all invalid data was formatted as "99"s since "99"s were entered only for missing data. Therefore, for these data files, wind directions given as "0" should be considered as invalid data per RIS 2006-04. Wind speeds given as "0" may be calm or may be invalid data. Two periods were identified as containing invalid data due to instrument maintenance: June 14-21, 2000 and August 5-8, 2001. All data for all levels for these periods should be considered as invalid.

The 100 Meter ARCON96-formatted data supplied as part of the AST Full Scope Supplemental submittal was formatted with "99"s in all fields where the stability class for that hour was invalid or "0". The periods of invalid data in June 2000 and August 2001 discussed above were formatted as all "99"s.

For wind speed categories, MNGP followed the guidance provided in RG 1.183 Section 5.3 and RG 1.145 Section 1.1, which refer to RG 1.23. RG 1.23 details the binning categories used by MNGP for jfd tables, which are the same categories given in RG 1.21.

The joint frequency distribution tables used as input to PAVAN were generated by the MNGP MIDAS computer code. MIDAS defines calm as 0.3 meters per second or less (less than 0.4 meters per second). This value is consistent with the instrument thresholds over the five-year period of data collection (0.3 m/s through June 2000; 0.1 m/s after).

NRC Question No. 2:

What wind speed values were used as an input to Midas to define the categories in the Monticello wind speed, wind direction and atmospheric stability joint frequency distributions (jfds) for both the Regulatory Guide 1.21 and non-Regulatory Guide 1.21 tables? For example, if two consecutive categories are defined as 4-7 miles per hour (mph) and 8-12 mph, what is the value defining the lower category (e.g., 7 mph, 7.5 mph, 8 mph)?

NMC Response No. 2:

The following wind speed categories were used for the joint frequency distribution tables:

RG 1.21:
Calm, >Calm – 3.5, 3.6 – 7.5, 7.6 – 12.5, 12.6 – 18.5, 18.6 – 24.5, 24.6 – up
Non-RG 1.21:
Calm, >Calm – 3.5, 3.6 – 7.5, 7.6 – 12.5, 12.6 – 18.5, 18.6 – 24.5. 24.6 – 32.5, 32.6 - up

The value defining the lower category for the above example would be 7.5 mph.

NRC Question No. 3:

Please provide the calculations for the atmospheric dispersion factors (χ/Q values) used in the Monticello alternative source term license amendment request for new χ/Q values. Also, provide a site plan generally drawn to scale and showing true North, with postulated release/receptor pairs highlighted.

NMC Response No. 3:

MNGP calculations CA-04-036, Rev 1, "MNGP AST - Offsite Post-Accident Atmospheric Dispersion Analysis," and CA-04-037, Rev 2, "MNGP AST - CR/TSC Post-Accident Atmospheric Dispersion Analysis," determined the atmospheric dispersion factors used in the AST Full Scope LAR dated September 15, 2005. These calculations were provided in their entirety on Disk 2 of the LAR submittal.

A site plan is included in Enclosure 5. The plan is drawn to scale, indicates true North, and shows the release points and receptors assumed in the MNGP radiological analyses.

NRC Question No. 4:

Which χ/Q values were used to model unfiltered inleakage into the control room?

NMC Response No. 4:

X/Q values were chosen to provide the most conservative source for Control Room unfiltered inleakage, Control Room normal ventilation, and Control Room emergency ventilation. For a given release, the limiting X/Q was determined and then used to model all three pathways.

The following pathways to the Control Room were identified by system evaluation:

a. The Control Room intake is used for both normal Control Room ventilation unfiltered intake and Emergency Control Room ventilation filtered intake;

b. The Control Room intake was identified as a likely source of inleakage due to ductwork carrying unfiltered air passing through the Control Room envelope;

c. The Administration Building intake was identified as a source of inleakage since it supplies unfiltered air to rooms adjacent to the Control Room.

Control Room tracer gas habitability testing was performed in June 2004 and confirmed the inleakage sources identified above.

For each release point, dispersion factors were calculated for both the Control Room Intake and the Administration Building intake. The limiting dispersion factor was then chosen for each release point, and was used to model all pathways to the Control Room from that release point (CR normal unfiltered ventilation, emergency filtered ventilation, and unfiltered inleakage).

Reference the individual DBA calculation design inputs which were provided on Disk 2 of the MNGP AST Full Scope LAR submittal (CA-04-038, Rev 0, “MNGP AST - LOCA Radiological Consequence Analysis”; CA-04-039, Rev 0, “MNGP AST - MSLBA Radiological Consequence Analysis”; CA-04-040, Rev 0, “MNGP AST - CRDA Radiological Consequence Analysis”; and CA-04-041, Rev 1, “MNGP AST - FHA Radiological Consequence Analysis”).

NRC Question No. 5:

Do the accident scenarios and generated χ/Q values model the limiting doses considering multiple release scenarios (e.g., including those due loss of offsite power or other single failure)?

NMC Response No. 5:

Yes, multiple release scenarios were considered. The accident doses reported in Enclosure 3 of the NMC AST Full-Scope License Amendment Request dated 9/15/05 include the contributions from the most limiting scenarios.

The LOCA analysis assumes loss of offsite power and single failures as directed by RG 1.183 Section 5.1.2. A positive pressure period is modeled which assumes both LOOP and single failure of a Standby Gas train, during which any releases to the Secondary Containment are then released directly to the environment as a ground release (dispersion coefficient used is RB Nearest Wall). Use of the positive pressure period release followed by an elevated stack release via SBGT is the limiting scenario for releases from the Secondary Containment for the LOCA.

The CRDA analysis includes a release via the steam jet air ejectors directly to the stack with no credit for holdup in the offgas storage system. A failure of radiation monitors to isolate the SJAEs is assumed since the isolation is non-safety-related. The CRDA analysis also considers a release from the isolated condenser. The SJAE release is the limiting scenario for the CRDA.

The FHA analysis assumes a ground-level release from the Reactor Building Vent. In the February 28, 2005 MNGP response to NRC RAIs, multiple release scenarios for the FHA were discussed. This discussion remains relevant for the FHA analysis submitted with the MNGP AST Full Scope LAR. The Reactor Building Vent release is the limiting scenario for the FHA.

NRC Question No. 6:

When assessing meteorological factors that may affect secondary containment drawdown capability, is high wind speed, only, the limiting case (e.g., temperature is not a factor)?

<u>NMC Response No. 6:</u>

The following meteorological factors were addressed in the secondary containment drawdown (or positive pressure period, PPP) calculation: wind speed, relative humidity, and ambient temperature effects.

a. Section 4.3 of Appendix A of Regulatory Guide 1.183 requires consideration of high winds on the secondary containment ability to maintain negative pressure. Specifically, RG 1.183 states that the wind speed to be assumed is "the 1-hour average value that is exceeded only 5% of the total number of hours in the data set." At the 43 meter elevation (1072 ft., representative of the RB), meteorological tower data from 1998 through 2002 used in the radiological consequences analyses indicates that the wind speed exceeds 24 mph only 1.4% of the total sample. Section 5.3.5 of the MNGP USAR indicates that at wind speeds up to 35 mph there is little ex-filtration from the reactor building at –0.25 in WG. Further, the MNGP secondary containment surveillance tests (used to confirm the design inleakage rate used in the drawdown calculation) correct the measured RB pressure for wind conditions. Therefore, no further consideration was given to high wind effects.

b. Atmospheric relative humidity was assumed at 0%. Sensitivity studies demonstrate that this is conservative for PPP calculations.

c. The calculation addresses temperature effects as noted in NRC Information Notice No. 88-76, "Recent Discovery of a Phenomenon Not Previously Considered in the Design of Secondary Containment Pressure Control". Site ambient minimum temperature for both summer and winter operations were based on temperatures exceeded 5% of the time during the AST implementation meteorological data for the years of 1998-2002, in accordance with RG 1.183, Appendix A Section 4.3. The summer and winter low temperatures were 50.9°F and -3.5°F respectively. Inleakage

air temperature and atmospheric pressure conditions (as affected by air density) were adjusted based on these temperatures. Experience in previous PPP calculations indicates that using the lowest boundary condition temperature results in a slightly longer PPP due to air density differences. For the purpose of this calculation, both high and low temperature limits were checked and the lowest temperature limit confirmed to result in a longer design PPP. The PPP calculations were performed at bounding summer and winter conditions and the worst case selected.

Based on the above discussion, ambient temperature was determined to be the limiting factor in the Secondary Containment drawdown assessment.

ENCLOSURE 3
NMC Response to RAI Questions (Containment Ventilation)

NRC Question No. 1:

Question withdrawn by NRC staff.

NMC Response No. 1:

No response required.

NRC Question No. 2:

Question withdrawn by NRC staff.

NMC Response No. 2:

No response required.

NRC Question No. 3:

Please state if the whole system is subject to Inservice Inspection requirements of ASME Boiler and Pressure Vessel Code Section 11 or other plant specific Inservice Inspection program that provides for periodic testing and examination of the condition of the system. Information on the testing of pumps, valves and frequency of test would be useful.

NMC Response No. 3:

The Standby Liquid Control (SLC) system is included in the MNGP Section XI IST program (ADAMS Accession Numbers ML023370107 and ML023370010). As specified in Attachments 7 and 8 of the program plan, tests and testing frequencies are as follows:

- *Pumps*: flow test quarterly; flow, discharge pressure and vibration tests every 2 years.
- *Relief Valves*: tested once per 10 years minimum (group sampling every 48 months).
- *Explosive (squib) valves*: tested once per 10 years minimum (group sampling every 48 months) per IST program; TS requires pathway testing every 24 months (staggered basis) which includes exploding squib.
- *Discharge check valves*: disassembled and inspected once per 8 years minimum, group sampling every RF outage.
- *Containment isolation check valves*: leakage test per App J program (maximum interval of 60 months); tested open and tested closed every RF outage.
- *Injection line manual isolation valve*: position indication test every two years.

NMC has implemented a Risk-Informed In-Service Inspection (RI-ISI) program at MNGP (ADAMS Accession Number ML0202403810). Table 3.1 of the RI-ISI Program identifies the SLC system as within the scope of the program. The actual segments or elements subject to examination for RI-ISI are selected and inspected consistent with the requirements outlined in the program.

NRC Question No. 4

Please clarify the transport of sodium pentaborate from the reactor vessel to the suppression pool after SLC injection. The staff understands that once reactor level is restored after a LOCA, the LPSI pump(s) are switched to suppression pool recirculation and cooling and that reactor vessel level is maintained by the core spray system. This would occur at about 10 minutes after the LOCA. SLC injection may not occur until sometime later (maybe two hours) when the presence of fuel damage is detected. Is the flow supplied by core spray systems sufficient to sweep the sodium pentaborate from the reactor vessel to the suppression pool in a timely fashion? The path of the flow should be considered to assure that it sweeps the whole vessel. The staff is concerned that much of the sodium pentaborate would remain in the reactor vessel and not be available to buffer the suppression pool pH. Other plants have opted to revise procedures to run the LPSI pumps in the injection mode after SLC injection to assure transport to the suppression pool. Would a revision to Monticello's procedures be reasonable?

NMC Response No. 4:

Sodium pentaborate is injected into the reactor vessel through a vertical sparger which is located in the bottom head region, mounted on the inside of the vessel wall and rising up to an elevation about one foot below the core plate. The sparger section has 8 outlet holes 1/4 inch in diameter spaced 6 inches apart and is capped at the top. The sparger serves to aid in initial dispersal of the pentaborate by providing improved distribution. An annotated drawing showing the location of the sparger in the reactor vessel is included in Enclosure 5 (NX-7831-197-1, Rev D, "Reactor Vessel and Internals").

SBLC injection will begin to enter the suppression pool within one hour and all injection will be complete within 2 hours post-accident.

NMC performed a quantitative assessment of the turnover rate within the reactor vessel with respect to sodium pentaborate injection. The volume assumed was the total reactor vessel internal volume up to 2/3 core height minus the volume of the annulus region. Flow assumed was one core spray pump injecting at 2,700 gpm minus the core boiloff rate of 300 gpm for a total of 2,400 gpm.

The assessment demonstrated that the fluid in the reactor vessel turns over at least five times per hour, thus assuring adequate mixing and transport of the sodium pentaborate.

NRC Question No. 5

It is stated in the submittal that the Maintenance rule applies to the isolation check valves and the initiation switch (the two items that were identified as not single failure proof). Does the Maintenance rule apply to other components in the system such as pumps, tanks, heat tracing, relief valves and instrumentation?

NMC Response No. 5:

The SLC system is included in the MNGP Maintenance Rule (MR) Program scope. The SLC system availability and functional failures are tracked. The primary function of the SLC System, as described by the Maintenance Rule System Basis Document, is to bring the reactor to a shutdown condition at any time in the reactor core life even if any or all withdrawn control rods are unavailable for insertion. (Note that this basis will be updated to reflect the AST suppression pool pH control function of SLC when appropriate.)

The MR Program tracks function availability, as opposed to specific component availability. Components necessary to accomplish the specified system function are identified in the site equipment database as Maintenance Rule related. For the SLC system, this includes pumps, pressure accumulators, discharge check valves, squibs, discharge valve to vessel, heat tracing, tank heater, relief valves, containment isolation check valves, and initiation switch. Verification of inclusion in the Maintenance Rule Program for the aforementioned components was performed using the MNGP equipment database. Indication instrumentation and tanks are not within the program scope. All the SLC components in the flow path that are necessary to support injection of sodium pentaborate are within the program scope.

ENCLOSURE 4

X/Q Recalculation Description

NMC has determined that the sector used for the Monticello Control Room elevated release X/Q calculation in CA-04-037 Rev 2 (MNGP AST - CR/TSC Post-Accident Atmospheric Dispersion Analysis) was incorrect. The sector used was Southeast (SE); the opposite Northwest (NW) sector should have been used.

The X/Q was recalculated using the correct sector. Results are given below:

ELEVATED RELEASE χ/Q (sec/m^3) PAVAN-PC CR Intake Location			
Time Period	**χ/Q SE**	**χ/Q NW**	**Difference**
Fumigation	3.37E-04	3.37E-04	No change
0-2 hours	3.73E-06	3.77E-06	+1.1%
0-8 hours	5.62E-07	5.74E-07	+2.1%
8-24 hours	2.20E-07	2.24E-07	+1.8%
1-4 days	2.88E-08	2.90E-08	+0.7%
4-30 days	1.56E-09	1.54E-09	-1.3%

ELEVATED RELEASE χ/Q (sec/m^3) PAVAN-PC Admin Bldg. Intake Location			
Time Period	**χ/Q SE**	**χ/Q NW**	**Difference**
Fumigation	3.59E-04	3.59E-04	No change
0-2 hours	4.02E-06	4.06E-06	+1.0%
0-8 hours	5.63E-07	5.75E-07	+2.1%
8-24 hours	2.13E-07	2.17E-07	+1.9%
1-4 days	2.58E-08	2.60E-08	+0.8%
4-30 days	1.25E-09	1.24E-09	-0.8%

This error does not affect the Control Room ground-level X/Qs calculated in CA-04-037 Rev 2. The EAB/LPZ X/Qs calculated in CA-04-036 Rev 1 (MNGP AST - Offsite Post-Accident Atmospheric Dispersion Analysis) are also unaffected since the proper sectors and sector distances were used in that calculation.

This error occurred because the calculation preparer used the ARCON96 directional convention for input to both the ARCON96 and PAVAN programs when calculating Control Room X/Qs. ARCON96 specifies input as the direction from the receptor to the source, while PAVAN specifies input of the direction (as a sector) from the source to the receptor.

ENCLOSURE 4
X/Q Recalculation Description

The CR elevated X/Q was used as input for dose assessments of the LOCA and CRDA accidents. Conservatively assuming a 2.1% increase in dose:

	Original Dose	New Dose	Change
LOCA*	0.4525 Rem	0.4620 Rem	0.01 Rem
CRDA	1.70 Rem	1.736 Rem	0.04 Rem

*Dose due to elevated release only; ground level release and direct shine doses are unaffected.

Although use of the correct sector would increase the CR elevated X/Qs slightly, the elevated release X/Qs used as input to the LOCA and CRDA calculations remain conservative. Fumigation was assumed for one-half hour during these accidents, and the PAVAN-calculated X/Qs were used for all time periods. Section 3.2.2 of RG 1.194 does not require consideration of fumigation and allows use of modified ARCON96-calculated X/Qs for periods greater than 2 hours, which would result in significantly smaller X/Qs.

Therefore, NMC does not propose to revise the submitted LOCA and CRDA calculations (CA-04-038 Rev 0 and CA-04-040 Rev 0). The Control Room X/Q calculation CA-04-037 Rev 2 will be revised to incorporate the proper sector so that the resulting X/Q is available for use as input to future dose assessments, but will not be resubmitted.

ENCLOSURE 5

Supporting Documents

1. MNGP Calculation CA-05-130, Rev 0, "Post LOCA Direct Dose to the Control Room from External Sources".

2. Drawing NF-36056-1, Rev H, EQUIP LOCATION - OFFICE BLDG PLAN AT ELEV 951'-0".

3. Drawing NF-36057, Rev L, EQUIPMENT LOCATION - REACTOR BLDG. PLANS AT EL.986'-6" & 1001'-2".

4. Drawing NF-36063, Rev A, EQUIPMENT LOCATION - REACTOR BLDG SECTION B-B.

5. MNGP Site Diagram.

6. Drawing NX-7831-197-1, Rev D, Reactor Vessel & Internals.

CALCULATION COVER SHEET Page 1 of ________

Title *Post LOCA Direct Dose to the Control Room From External Sources* CA- *05* - *130* Add. *0*

PART A – (Not Applicable to Vendor Calcs)

Assigned Personnel			
Name (Print)	Signature	Title	Initials

Record of Issues							
Rev	Description	Total Sheets	Last Sheet	Preparer	Verifier	Approval	Approval Date

Verification Method(s)

☐ Review ☐ Alternate Calculation ☐ Test ☐ Other

☐ Technical Review (per 4 AWI-05.08.07 (FP-E-MOD-07))

3087 (DOCUMENT CHANGE, HOLD AND COMMENT FORM) incorporated: ________				
FOR ADMINISTRATIVE USE ONLY	Resp Supv: CNSTP	Assoc Ref: 4 AWI-05.01.25	SR: N	Freq: 0 yrs
	ARMS: 3494	Doc Type: 3042	Admin initials:	Date:

Approved (Signatures available in Master File)

PART B – (Applicable to Vendor Calculations Only)

Vendor Name *Sargent & Lundy* Vendor Calc No: *2005-00480, Rev 0*

Vendor Approval Date: *9/6/05*

☒ Form 3345 or QF-0547 attached.

☒ Safety related? If safety related, attach DIA or reference here. *See Other Comments*

Reviewed by: *Dave Sexton/Mike Aleksey* [signature] *9/7/05*
Print Name Signature Date

Accepted by: *Dennis Zercher* [signature] *9/7/05*
Print Name Eng. Supv. Signature Date

Record of Issues			
Revision	Description	Total No. of Sheets	Last Sheet Number
0	Original Issue		

PART C – Design Basis Data (Complete for all Calculations)

10 CFR50.59 Screening or Evaluation No: *N/A*

Associated Reference(s): *AST LAR*

Does this calculation:	YES	NO	Calc No(s), Rev(s), Add(s)
Supercede another calculation?	☐	☒	
Augment (credited by) another calculation?	☒	☐	*CA-04-038, Rev. 0, Add. 0*
Derive inputs from another calculation?	☒	☐	*CA-03-190, Rev 1, Add 0; CA-04-038, Rev 0, Add 0; CA-04-037, Rev. 2, Add. 0; CA-04-210, Rev. 0, Add. 0; CA-96-039, Rev. 0, Add. 0; and, CA-96-040, Rev. 0, Add. 0.*
Affect the Fire Protection Program per Form 3765?	☐	☒	If Yes, attach Form 3765
Affect piping or supports?	☐	☒	If Yes, attach Form 3544

Approved (Signatures available in Master File)

Affect IST Program Valve or Pump Reference Values, and/or Acceptance Criteria?	☐	☒	If Yes, inform IST Coordinator and provide copy of calculation

List all documents/procedures that are based on this calculation (include revision):

See Future Needs below.

List all plant procedures used to ensure inputs/assumptions/outputs are maintained (include revision):

None - MNGP inputs were other calculations and plant drawings.

What Systems or components are affected?

System Code(s) (See Form 3805):	CDR, EFT, MST, PCT, SBGT, and TOR
Component ID's (CHAMPS Equip):	N/A
DBD Section (if any):	DBD-S.01, S.02, B.02.04, B.04.01, B.04.02, and B.08.13.
Topic Code (See Form 3805):	DBAE
Structure Code (See Form 3805):	ADMIN, PCS, and RB

Approved (Signatures available in Master File)

Other Comments:

Note: This calculation is not incorporated as part of MNGP's design basis until the associated LARs are approved (AST Phase 1 and 2).

Future needs: Update USAR relevant sections and other plant documents in accordance with the MNGP AST Implementation Plan (OTH027371).

This calculation was completed in accordance with the approved project work plan (DIA Equivalent) for the AST Implementation S&L Letter #SLMON-2003-085, and PO38317.

Attachments to this Form 3494 are: Form 3345 (1 page), MNGP AST Project Calculations List (1 page), and S&L Review Comment Form (4 pages).

Approved (Signatures available in Master File)

MONTICELLO NUCLEAR GENERATING PLANT		3345
TITLE:	VENDOR CALCULATION REVIEW CHECKLIST	Revision 3
		Page 1 of 1

CA - 05 - 130
Attachment to Form 3494

The purpose of the review is to ensure that the vendor calculation or analysis complies with the conditions of the purchase order and is appropriate for its intended use. The purpose of the review is not to serve as an independent verification. Independent verification of the calculation or analysis by the vendor should be evident in the document.

The reviewer should use the criteria below as a guide to assess the overall quality, completeness and usefulness of the calculation or analysis. The reviewer is not required to check the vendor's calculations in detail.

See 4 AWI-05.01.25 (CALCULATION/ANALYSIS CONTROL) for guidance. Place initials by items reviewed.

REVIEW

1. Form 3544 (PIPING AND SUPPORT NUMBERING) completed for calculations affecting piping or supports. NA
2. Design inputs correspond to those which were transmitted to the vendor.
3. Assumptions are described and reasonable. Basis for assumptions identified.
4. Applicable codes, standards and regulations are identified and met.
5. Applicable construction and operating experience is considered.
6. Applicable structure(s), system(s), and component(s) are listed.
7. Formulas and equations documented and unusual symbols are defined.
8. Acceptance criteria are identified, adequate and satisfied.
9. Results are reasonable compared to inputs.
10. Source documents are referenced.
11. The calculation is appropriate for its intended use.
12. The calculation complies with the terms of the Purchase Order.
13. Inputs, assumptions, outputs, etc. which could affect plant operation are enforced by adequate procedural controls. List any affected procedures.
None

Completed By: [signature] Date: 9/7/05 9/7/05

3087 (DOCUMENT CHANGE, HOLD AND COMMENT FORM) incorporated:				
FOR ADMINISTRATIVE	Resp Supv: CNSTP	Assoc Ref: 4 AWI-05.01.25	SR: N	Freq: 0 yrs
	ARMS: 3345	Doc Type: 3042	Admin initials:	Date:

Approved (Signatures available in Master File)

MNGP AST Project Calculations List

Calculation No.	Title
MNGP # **S&L #** **AAC #**	**[Applied Analysis Corporation (AAC) performed DBA calculations for the AST project. Sargent & Lundy provided independent verification and documented results in S&L calculations which incorporated the AAC calculations as attachments. The S&L calculations were accepted by MNGP via the vendor calculation control process (4 AWI-05.01.25). Thus each DBA calculation has three numbers – MNGP, S&L, and AAC.** **AAC calculations will reference other AST calculations by their AAC number. This list is provided for proper cross-reference of calculations.]**
03-190 N/A N/A	Design Inputs For Alternate Source Term (AST) Radiological Analysis
04-036 2004-01852 MNGP-001	MNGP AST - Offsite Post-Accident Atmospheric Dispersion Analysis
04-037 2004-02100 MNGP-002	MNGP AST - CR/TSC Post-Accident Atmospheric Dispersion Analysis
04-038 2004-02101 MNGP-003	MNGP AST - LOCA Radiological Consequence Analysis
04-039 2004-02102 MNGP-004	MNGP AST - MSLBA Radiological Consequence Analysis
04-040 2004-02103 MNGP-005	MNGP AST - CRDA Radiological Consequence Analysis
04-041 2004-02104 MNGP-006	MNGP AST - FHA Radiological Consequence Analysis
04-042 2004-02105 MNGP-007	MNGP AST - Post-LOCA pH Analysis
04-210 2004-07600 N/A	Alternative Source Term – Core Isotopic Inventory
05-130 2005-00480 N/A	Post LOCA Direct Dose to the Control Room From External Sources
05-134 2005-06343 MNGP-012	Post-LOCA Steam Pipe Internal Temperature 30-Day Profile for Radiological Dose Analysis

REVIEW COMMENT
Form SOP-0402-03, Revision 7

Project: Monticello Nuclear Generating Plant		Unit: 1
Project No.: 11163-013	Calc. No. 2005-00480	Calc. Rev. 0
Calc. Title: Post LOCA Direct Dose to the Control Room from External Sources		

#	Comment	Resolution
1	Section 2.1, 2nd paragraph. Consider changing the first sentence as follows to more accurately describe the use of AST methods: "The direct dose to the Control Room is based on shielding calculations that assume radiological releases based on the AST methodology…"	Comment will be incorporated as specified.
2	Section 2.1, consistent with recent Limerick RAIs, some discussion on why the selected isotopes are considered conservative for calculating shine should be considered (i.e., why the subset from the 60 isotopes used in RADTRAD were selected and , further, why the 60 isotopes are conservative from ORIGEN as a starting point.)	In order to address this comment, additional computer runs were made to determine the impact on the doses from including additional radionuclides. A total of 250 radionuclides (which represent the elements in Table 5 of RG 1.183) from Attachment A1 of Calculation 2004-07600 where included in the source term. The computer runs are based on an airborne source, representing the activity within the Reactor Building atmosphere, and a liquid source, representing ECCS liquid within piping. For the airborne source, a comparison of the Control Room doses was performed for Source Region 1 in the Reactor Building attributed to primary containment leakage (Tables 29 through 32). Per Table 32, the maximum Control Room dose based on the original 60 radionuclides is 1.735E-01 rem. The Control Room dose at the same location based on 250 radionuclides is 1.779E-01 rem, which represents an increase of 2.6%. For the liquid source, a comparison of the Control Room doses was performed for Pipe Segment A containing ECCS liquid (Tables 55 through 58). Per Table 58, the maximum Control Room dose based on the original 60 radionuclides is 2.730E-01 rem. The Control Room dose at the same location based on 250 radionuclides is 2.861E-01 rem, which represents an increase of 4.8%. These sources were chosen because they represent the majority of the total Control Room dose from external sources. The total dose increase using 250 radionuclides rather than 60 radionuclides will be less than 5 %, which for the largest dose in the Control Room (6.578E-01 rem) is an increase of about 0.03 rem, which is not significant.
3	Table 3. Though only minor changes occurred, Revision 4 of MNGP-002 increased all X/Q values shown in Table 3 except during positive pressure period (PPP). The revised X/Qs should be used in the calculation.	New computer runs will be made to incorporate the updated X/Qs.
4	Table 7. Due to the potential difficulty in tracking control building roof gravel level and	The gravel thickness will be moved from the design input section to the assumptions section.

REVIEW COMMENT
Form SOP-0402-03, Revision 7

Project:	Monticello Nuclear Generating Plant		Unit: 1
Project No.: 11163-013	Calc. No. 2005-00480		Calc. Rev. 0
Calc. Title:	Post LOCA Direct Dose to the Control Room from External Sources		

#	Comment	Resolution
	the apparently limited shielding it provides to the control room, use of gravel should be eliminated as a design input.	Specifically, Assumption 3.2 will be expanded to also include the gravel thicknesses. Attachment B will be used as the basis for the gravel thicknesses in Assumption 3.2. To determine the impact of removing the gravel on the CR doses, additional computer runs were made. These computer runs involve replacing the gravel with air for the Primary Containment Leakage Pathway, Source Region 3 in the Reactor Building (Refueling Floor). This source was chosen because it will have the most impact on the CR dose from removing the gravel on the Control Building roof. Per Table 41, the maximum dose from Source Region 3 with the gravel in place is 2.914E-02 rem. Replacing the gravel with air results in a dose of 3.149E-02 rem at the same location. This represents an 8.1% increase in the dose. Doses at other locations within the CR increase from 5.5% to 9.0% when gravel is not credited. Removing the gravel on the Control Building roof would impact the CR doses attributed to Sources 2 and 3 in the Reactor Building (areas above the Control Building roof) and the TSC filters. To estimate the impact of removing the gravel on the maximum CR dose the following approach is taken. Per Table 111, the maximum total dose is 6.578E-01 rem and occurs in the SW corner of the CR. Per Table 41, the doses in the SW corner of the CR for Reactor Building Sources 2 and 3 from Primary Leakage are 2.781E-03 rem and 4.925E-03 rem, respectively. These doses are increased by 9% to account for no gravel, which results in new doses of 3.031E-03 rem and 5.368E-03 rem, respectively. This results in a delta increase in the maximum dose of 6.930E-04 rem [(3.031E-03 – 2.781E-03) + (5.368E-03 – 4.925E-03)]. Per Table 54, the doses in the SW corner of the CR for Reactor Building Sources 2 and 3 from ESF Leakage are 8.074E-05 rem and 2.744E-04 rem, respectively. These doses are increased by 9% to account for no gravel, which results in new doses of 8.801E-05 rem and 2.991E-04 rem, respectively. This results in a delta increase in the maximum dose of an additional 3.197E-05 rem [(8.801E-05 – 8.074E-05) + (2.991E-04 – 2.744E-04)]. Per Table 97, the TSC filter dose to the SW corner of the CR is 4.707E-09 rem.

CA-05-130, Rev 0
Att. to Form 3494
Page 3 of 4

REVIEW COMMENT
Form SOP-0402-03, Revision 7

Project: Monticello Nuclear Generating Plant		Unit: 1
Project No.: 11163-013	Calc. No. 2005-00480	Calc. Rev. 0
Calc. Title: Post LOCA Direct Dose to the Control Room from External Sources		

#	Comment	Resolution
		This dose is increased by 9% to account for no gravel, which results in a new dose of 5.131E-09 rem. This results in a delta increase in the maximum dose of an additional 4.236E-10 rem (5.131E-09 – 4.707E-09 rem). Summing all additional deltas results in an increase in the maximum dose of 7.25E-04 rem (6.930E-04 + 3.197E-05 + 4.236E-10). Since the increase in dose of 7.25E-04 rem is less than 1 % of the total dose of 6.578E-01 rem, it can be concluded that removing the gravel will result in a negligible increase to the maximum CR dose because the majority of the dose is attributed to Reactor Building Source Region 1 and the ECCS piping which are not impacted by removing the gravel.
5	Assumption 3.1. Consider changing the last sentence as follows: "...released directly to the environment as a ground level release without passing...".	Comment will be incorporated as specified.
6	Section 4.0, page 26, last sentence. Consider deleting this sentence. For calculating RB shine it is stated earlier in the paragraph that PPP releases are ignored. Re-stating here is confusing since it is not ignored in calculating other dose contributors (see Assumption 3.1).	The last sentence on page 26 will be deleted.
7	Section 4.0, page 27, 3rd and 4th paragraphs. For the determination of SGTS, CR, and TSC filter dose contributions and cloud shine, maximum, not minimum SGTS system flow would result in a greater dose contribution to the CR operators. Either the maximum should be used or some discussion included that notes use of minimum is more conservative for overall dose as it allows the "unprocessed" activity a longer resident time in the Reactor Building for contributing to RB direct shine – which is the most significant contributor to operator dose.	Refer to Section 5.1.3 for the SGTS filter activity transport models, Section 5.1.4 for the CR and TSC filters activity transport models, and Section 5.1.5 for the External Cloud activity transport models. Basically, there is no credit taken for holdup of activity within secondary containment. Therefore, activity is release directly from the primary containment or suppression pool directly to the filters or external cloud. The SGTS flow rate is not used in determining the activity buildup on the filters or external cloud. This point will be made clear in the 3rd and 4th paragraphs on page 27.
8	Section 5.1.3, page 44, last paragraph. Setting filter efficiency to 0% during the PPP is not conservative for calculating SGTS filter dose contribution. Some additional discussion should be added to indicate that even though this is not conservative, it results in a higher operator dose because a ground level, unfiltered, release from the RB is assumed for this same time period.	New SGTS filter computer runs will be made in which the filter efficiency during PPP will by set to 100%. It is likely that there will be no change in the dose due to the release timing of the source term and because PPP only last for 3 minutes following the onset of the accident.
9	Section 5.1.5. It should be noted that a maximum SGTS flow rate would result in a higher external cloud dose (versus assuming	Refer to the resolution for Comment #7. Per Section 5.1.5 and Figures 9 and 10, activity from the primary containment and suppression

REVIEW COMMENT
Form SOP-0402-03, Revision 7

Project: Monticello Nuclear Generating Plant		Unit: 1
Project No.: 11163-013	Calc. No. 2005-00480	Calc. Rev. 0
Calc. Title: Post LOCA Direct Dose to the Control Room from External Sources		

#	Comment	Resolution
	the minimum flow from Table 3). A justification for this should be included (i.e., the total dose would drop as less dose would be available for direct shine from Reactor Building airborne activity, which according to Table 111, is a more significant dose contributor for almost all areas of the Control Room – this may require validation).	pool is released to the environment at the primary containment leakage rate and ESF leakage rate, respectively. The SGTS flow rate is not used because there is no credit taken for holdup of activity within secondary containment.
10	Section 5.2.7. To demonstrate the validity of this approach for modeling the control room as a summation of rectangular solid surfaces, a comparison to the use of finite cloud dose model in Section 4.2.7 of R.G. 1.183 should be considered.	The finite cloud dose model presented in Section 4.2.7 of RG 1.183 applies to doses attributed to internal immersion within the control room. The external cloud doses in this calculation are attributed to activity contained within the atmosphere external to the control room, i.e., areas immediately surrounding the control room.
11	Change Reference 7.6 to Revision 1.	Comment will be incorporated as specified.
12	Reference 7.7 (DIT) should be deleted as it has been incorporated in CA-03-190 Rev 1. Items which reference this DIT should be changed to reference 7.6: -- 2nd item in Table 3 (B.14 is updated in CA-03-190 Rev 1) -- 1st item in Table 4 (B.27 is updated in CA-03-190 Rev 1) -- 1st item in Table 5 (B.14 and B.20 are updated in CA-03-190 Rev 1)	Comment will be incorporated as specified. It should be noted that the calculation uses a primary containment leakage rate of 1.1078 wt % per day and a secondary containment bypass leakage rate of 0.0922 wt % per day. These leakage rates were taken from Reference 7.7 (DIT No. 18851 Dated 12/28/04). The primary containment and secondary containment bypass leakage rates as listed in CA-03-190 Rev. 1 are 1.1079 wt % per day and 0.0921 wt % per day, respectively. This change will have a negligible impact on the calculated CR doses.
Reviewed by: A. G. Klazura / A. G. Klazura		Date: 9-6-05

ISSUE SUMMARY

Form SOP-0402-07, Revision 6

DESIGN CONTROL SUMMARY			
CLIENT:	**NMC**	UNIT NO.: **1**	Page No.: **1**
PROJECT NAME:	**Monticello Nuclear Generating Plant**		
PROJECT NO.:	**11163-013**	☒ NUCLEAR SAFETY- RELATED	
CALC. NO.:	**2005-00480**	☐ NOT NUCLEAR SAFETY-RELATED	
TITLE:	**Post LOCA Direct Dose to the Control Room From External Sources**		
EQUIPMENT NO.:			

IDENTIFICATION OF PAGES ADDED/REVISED/SUPERSEDED/VOIDED & REVIEW METHOD			
Original Issue. Performed in Accordance with Project Work Plan 11163-013 and NMC PO # PO38317/P501799. Pages 1-151, A1-A5, B1-B2, C1-C2 (160 Total Pages)		INPUTS/ ASSUMPTIONS ☒ VERIFIED ☐ UNVERIFIED	
REVIEW METHOD:	Detailed	REV.	0
STATUS:	Approved	DATE FOR REV.:	9/6/05
PREPARER	D. L. Marsh / [signature]	DATE:	9-6-05
REVIEWER	A. G. Klazura / [signature]	DATE:	9-6-05
APPROVER	W. J. Johnson / [signature]	DATE:	9/6/05

IDENTIFICATION OF PAGES ADDED/REVISED/SUPERSEDED/VOIDED & REVIEW METHOD			
		INPUTS/ ASSUMPTIONS ☐ VERIFIED ☐ UNVERIFIED	
REVIEW METHOD:		REV.	
STATUS:		DATE FOR REV.:	
PREPARER		DATE:	
REVIEWER		DATE:	
APPROVER		DATE:	

IDENTIFICATION OF PAGES ADDED/REVISED/SUPERSEDED/VOIDED & REVIEW METHOD			
		INPUTS/ ASSUMPTIONS ☐ VERIFIED ☐ UNVERIFIED	
REVIEW METHOD:		REV.	
STATUS:		DATE FOR REV.:	
PREPARER		DATE:	
REVIEWER		DATE:	
APPROVER		DATE:	

NOTE: PRINT AND SIGN IN THE SIGNATURE AREAS

Table of Contents

1.0 Purpose and Scope

The purpose of this calculation is to determine the post LOCA direct doses to the Control Room operator from external radiation sources. These external radiation sources include airborne activity within the Reactor Building, ECCS piping containing suppression pool water activity, Standby Gas Treatment System (SGTS) charcoal filter, Control Room (CR) charcoal filter, Technical Support Center (TSC) charcoal filter, and activity in the atmosphere immediately surrounding the Control Room (External Cloud). The post LOCA source terms used in this analysis are based on the Alternative Source Term (AST) methodology provided in Regulatory Guide 1.183 (Reference 7.2). The Control Room doses in this analysis are calculated based on a core thermal power of 1918 Megawatt-Thermal (MW_{th}).

2.0 Design Input

2.1 Source Term

The total core inventory at time zero post LOCA is listed in Table 1 and obtained from Table No. 5 of Reference 7.3. The activities for Cobalt-58 and Cobalt-60 are obtained from Table 1.4.3.2-3 of Reference 7.12. The core inventory as listed in Table 1 is in units of Curies (Ci) per MW_{th}. Per Item B.1 of Reference 7.6, the stretch power uprate (PU) core thermal power level is 1918 MW_{th}, which includes the 2% increase as specified in Reference 7.11 to account for instrument uncertainty.

The direct dose to the Control Room is based on shielding calculations that assume radiological releases based on the AST methodology provided in Reference 7.2. The core inventory release fractions for the gap release and early in-vessel damage phases are listed in Table 2 and are obtained from Table 1 of Reference 7.2. The timing of the gap release and early in-vessel phases are obtained from Section 3.3 and Table 4 of Reference 7.2. The onset (time following the initiation of the accident) for the gap release phase is 2 minutes with a duration of 30 minutes. The early in-vessel phase immediately follows the gap release phase and has a duration of 1.5 hours. The activity released from the core during each release phase is modeled as a linear increase over the duration of the phase. The chemical form of the radioiodine inventory released from the fuel is obtained from Section 3.5 of Reference 7.2. Of the radioiodine release from the fuel, 95 percent is assumed to be cesium iodide (CsI), 4.85 percent elemental iodine, and 0.15 percent organic iodide. With the exception of elemental and organic iodine and noble gases, fission products are assumed to be in particulate form.

There are three activity leakage pathways considered in this calculation: 1) Primary Containment Leakage, 2) Engineered Safety Features (ESF) System Leakage, and 3) Main Steam Isolation Valve (MSIV)/Secondary Containment Bypass (SCB) Leakage. The relevant design inputs related to the primary containment leakage pathway are listed in Table 3. The relevant design inputs related to the ESF system leakage pathway are listed in Table 4. The relevant design inputs related to the MSIV/SCB leakage pathway are listed in Table 5.

2.2 Shielding Model Dimensions

The Reactor Building dimensions used in the shielding model are listed in Table 6. The Control Building dimensions used in the shielding model are listed Table 7. The relevant ECCS piping dimensions are listed in Table 8. The dimensions used in the shielding model for the SGTS filter are listed in Table 9. The dimensions used in the shielding model for the CR filter are listed in Table 10. The dimensions used in the shielding model for the TSC filter are listed in Table 11.

2.3 Shielding Materials

There are eight materials used in the shielding models. These materials include air, poured concrete, precast concrete panels, corrugated steel sheets, gravel, water, steel, and charcoal. The density of air is taken as 0.001293 g/cm^3 (Page 378 of Reference 7.15). The density of poured concrete is 140 lb/ft^3 or 2.242 g/cm^3 (Table 5.2 of Reference 7.13). There are concrete precast walls along the west side of the TSC which extend to the elevation above the TSC. The density of the precast concrete is conservatively taken as the minimum concrete density (cinder) on Page 43 of Reference 7.14. The mass thickness of cinder concrete is 9 lb/ft^2 based on a thickness of 1 inch. This equates to a density of 1.730 g/cm^3. The corrugated steel sheets are used to model the metal decking on the roof of the Control Building above the Control Room and TSC. The mass thickness of the corrugated steel sheets is 2 lb/ft^2 based on a thickness of 20 gauge (Page 45 of Reference 7.14). Per Page 169 of Reference 7.16, 20 gauge is equivalent to 0.0375 inches. Therefore, the effective density of the corrugated steel sheets is 640 lb/ft^3 or 10.252 g/cm^3. Gravel is used as a shielding material on the Control Building roof above the Control Room and TSC. The mass thickness of gravel is 7 lb/ft^2 based on a thickness of 1 inch (Page 47 of Reference 7.14). Therefore, the density of gravel is 84 lb/ft^3 or 1.346 g/cm^3. Water is used as the fluid within the ECCS piping. The density of water is taken as 1.0 g/cm^3. Steel is used to model the pipe wall for the ECCS piping. Steel is modeled as iron with a density of 7.86 g/cm^3 (Page 17 of Reference 7.17). The SGTS, CR, and TSC filters are modeled as carbon with a density of 0.48 g/cm^3 (Page 12 of Reference 7.7 and Page 11 of Reference 7.8).

2.4 Occupancy Factors

The occupancy factors for individuals in the Control Room are 1.0 for time less than 1 day post LOCA, 0.6 between 1 day and 4 days post LOCA, and 0.4 from 4 days to 30 days post LOCA (Section 4.2.6 of Reference 7.2).

Table 1. Core Inventory

Isotope	Activity, Ci/MW$_{th}$	Isotope	Activity, Ci/MW$_{th}$	Isotope	Activity, Ci/MW$_{th}$
Co-58	1.529E+02	Ru-103	4.14E+04	Cs-136	2.19E+03
Co-60	1.830E+02	Ru-105	2.86E+04	Cs-137	4.84E+03
Kr-85	4.35E+02	Ru-106	1.79E+04	Ba-139	4.72E+04
Kr-85m	6.64E+03	Rh-105	2.74E+04	Ba-140	4.54E+04
Kr-87	1.27E+04	Sb-127	2.88E+03	La-140	4.68E+04
Kr-88	1.78E+04	Sb-129	8.53E+03	La-141	4.30E+04
Rb-86	6.36E+01	Te-127	2.87E+03	La-142	4.15E+04
Sr-89	2.41E+04	Te-127m	3.95E+02	Ce-141	4.30E+04
Sr-90	3.51E+03	Te-129	8.40E+03	Ce-143	3.97E+04
Sr-91	3.02E+04	Te-129m	1.26E+03	Ce-144	3.72E+04
Sr-92	3.29E+04	Te-131m	3.80E+03	Pr-143	3.96E+04
Y-90	3.60E+03	Te-132	3.71E+04	Nd-147	1.73E+04
Y-91	3.13E+04	I-131	2.62E+04	Np-239	5.40E+05
Y-92	3.30E+04	I-132	3.77E+04	Pu-238	1.48E+02
Y-93	3.84E+04	I-133	5.31E+04	Pu-239	1.59E+01
Zr-95	4.37E+04	I-134	5.82E+04	Pu-240	2.10E+01
Zr-97	4.35E+04	I-135	4.97E+04	Pu-241	6.63E+03
Nb-95	4.47E+04	Xe-133	5.32E+04	Am-241	1.03E+01
Mo-99	4.91E+04	Xe-135	2.20E+04	Cm-242 [1]	2.09E+03
Tc-99m	4.30E+04	Cs-134	7.17E+03	Cm-244	1.08E+02

[1] The RUNT-PC radionuclide library does not contain Curium-242 and therefore Curium-242 is not included in the source term. Ignoring Curium-242 will have a negligible impact on the control room dose from external sources because Curium-242 is primarily an alpha emitter.

Table 2. Core Inventory Release Fractions

Group	Elements [1]	Gap Release Phase	Early In-Vessel Phase	Total
Noble Gases	Xe, Kr	0.05	0.95	1.0
Halogens	I, Br	0.05	0.25	0.3
Alkali Metals	Cs, Rb	0.05	0.20	0.25
Tellurium Metals	Te, Sb, Se	0.0	0.05	0.05
Ba, Sr	Ba, Sr	0.0	0.02	0.02
Noble Metals	Ru, Rh, Pd, Mo, Tc, Co	0.0	0.0025	0.0025
Cerium Group	Ce, Pu, Np	0.0	0.0005	0.0005
Lanthanides	La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am	0.0	0.0002	0.0002

[1] Obtained from Table 5 of Reference 7.2.

Table 3. Input Parameters for the Primary Containment Leakage Pathway

Parameter	Value	Reference / Comment
Particulate Natural Deposition Model Within the Drywell	Refer to Section 5.1.1	The equations used in Section 5.1.1 are obtained from Table 2.2.2.1-3 of Reference 7.12 and are based on the 10th percentile.
Primary to Secondary Containment Leakage Rate Time < 24 hours: 24 hours < Time < 74 hours: 74 hours < Time < 30 days:	 1.1078 % / day 0.7151 % / day (Flow Fraction = 0.6455) 0.5539 % / day (Flow Fraction = 0.5)	Section B.14 of Reference 7.6 For the leakage rate reduction factors (i.e. flow fractions) after 24 hours, refer to Reference 7.4. NOTE: the more conservative reduction factors from Revision 1 are used in this analysis.
Positive Pressure Period (PPP), min	5	Section B.18 of Reference 7.6
SGTS Minimum Exhaust Rate, cfm	3150	Section B.21 of Reference 7.6
SGTS Filter Removal Efficiency	85% for elemental and organic iodine 98% for particulate iodine and other particulates	Section B.22 of Reference 7.6
Secondary Containment Volume, ft^3	1.68E+06	Section B.19 of Reference 7.6
Refueling Floor Volume, ft^3	655780.7	Section B.19 of Reference 7.6
Control Room Filter Atmospheric Dispersion Factors, sec/m^3 0 to 2 hours (During PPP): 0 to 2 hours (Post PPP): 2 to 8 hours: 8 to 24 hours: 1 to 4 days: 4 to 30 days:	 1.00E-02 3.73E-06 5.62E-07 2.20E-07 2.88E-08 1.56E-09	 Table 1 of Reference 7.5 Table 8 of Reference 7.5

Table 3. Input Parameters for the Primary Containment Leakage Pathway

Parameter	Value	Reference / Comment
TSC Filter Atmospheric Dispersion Factors, sec/m^3		
0 to 2 hours (During PPP):	1.91E-02	Table 3 of Reference 7.5
0 to 2 hours (Post PPP):	4.30E-06	Table 8 of Reference 7.5
2 to 8 hours:	6.34E-07	
8 to 24 hours:	2.47E-07	
1 to 4 days:	3.18E-08	
4 to 30 days:	1.68E-09	
External Cloud Atmospheric Dispersion Factors, sec/m^3		Taken as the maximum atmospheric dispersion factor for releases from the Reactor Building
0 to 2 hours (During PPP):	1.91E-02	Table 3 of Reference 7.5
0 to 2 hours (Post PPP):	4.30E-06	Table 8 of Reference 7.5
2 to 8 hours:	6.34E-07	
8 to 24 hours:	2.47E-07	
1 to 4 days:	3.18E-08	
4 to 30 days:	1.68E-09	
Maximum CR Outside Air Intake Flow Rate, scfm	1100	Section B.54 of Reference 7.6
Maximum TSC Outside Air Intake Flow Rate (Emergency Ventilation Mode), scfm	1100	Section B.66 of Reference 7.6

Table 4. Input Parameters for the ESF Leakage Pathway

Parameter	Value	Reference / Comment
ESF Leakage Rate, gal/min	1.31	Per Section B.27 of Reference 7.6, the ESF leakage is 1.31 gallons per minute. As specified in Appendix A, Section 5.2 of Reference 7.2, this ESF leakage rate should be doubled. Per Section B.28 of Reference 7.6, the ESF leakage is assumed to start at time zero post LOCA and continue for the full 30 days of the accident.
Iodine Flashing Fraction	0.1	B.31 and B.32 of Reference 7.6
ESF Dilution Volume, ft^3	79745.4	Section B.87 of Reference 7.6
Positive Pressure Period (PPP), min	Same as for Primary Leakage Pathway	Refer to Table 3
SGTS Minimum Exhaust Rate, cfm	Same as for Primary Leakage Pathway	Refer to Table 3
SGTS Filter Removal Efficiency	Same as for Primary Leakage Pathway	Refer to Table 3
Control Room Filter Atmospheric Dispersion Factors, sec/m^3	Same as for Primary Leakage Pathway	Refer to Table 3
TSC Filter Atmospheric Dispersion Factors, sec/m^3	Same as for Primary Leakage Pathway	Refer to Table 3
External Cloud Atmospheric Dispersion Factors, sec/m^3	Same as for Primary Leakage Pathway	Refer to Table 3
Maximum CR Outside Air Intake Flow Rate, scfm	Same as for Primary Leakage Pathway	Refer to Table 3
Maximum TSC Outside Air Intake Flow Rate (Emergency Ventilation Mode), scfm	Same as for Primary Leakage Pathway	Refer to Table 3

Table 5. Input Parameters for the MSIV/SCB Leakage Pathway

Parameter	Value	Reference / Comment
Particulate Natural Deposition Model Within the Drywell	Same as for Primary Leakage Pathway	Refer to Table 3
Secondary Containment Bypass Leakage Rate MSIV Leakage Rate Total for Time < 24 hours: 24 hours < Time < 74 hours: 74 hours < Time < 30 days:	0.0922 %/day (35.2 scfh) 200 scfh 235.2 scfh 64.55% of Total 50% of Total	Section B.14 and B.20 of Reference 7.6 Section B.36 of Reference 7.6 For the leakage rate reduction factors after 24 hours, refer to Reference 7.4. NOTE: the more conservative reduction factors from Revision 1 are used in this analysis.
Condenser Removal Efficiencies for Particulates and Elemental Iodine (i.e., no credit is taken for removal of noble gases or organic iodine by the condenser) Time < 24 hours: 24 hours < Time < 74 hours: 74 hours < Time < 30 days:	 98.6211% 99.1056% 99.3058%	Reference 7.4. NOTE: The time periods of 24 hours to 74 hours and 74 hours to 30 days are taken from Revision 1 of Reference 7.4. Revision 2 of Reference 7.4 changes the time periods to 24 hours to 72 hours and 72 hours to 30 days. Use of the time periods of 24 hours to 74 hours and 74 hours to 30 days results in larger radioactivity releases to the environment which is conservative.
Control Room Filter Atmospheric Dispersion Factors, sec/m^3 0 to 2 hours: 2 to 8 hours: 8 to 24 hours: 1 to 4 days: 4 to 30 days:	 2.51E-03 1.73E-03 6.86E-04 4.70E-04 3.52E-04	Table 6 of Reference 7.5

Table 5. Input Parameters for the MSIV/SCB Leakage Pathway

Parameter	Value	Reference / Comment
TSC Filter Atmospheric Dispersion Factors, sec/m^3		Table 7 of Reference 7.5
0 to 2 hours:	3.70E-03	
2 to 8 hours:	2.69E-03	
8 to 24 hours:	1.07E-03	
1 to 4 days:	7.19E-04	
4 to 30 days:	5.75E-04	
External Cloud Atmospheric Dispersion Factors, sec/m^3		Taken as the maximum atmospheric dispersion factor for releases from the Turbine Building
0 to 2 hours:	3.70E-03	Table 7 of Reference 7.5
2 to 8 hours:	2.69E-03	
8 to 24 hours:	1.07E-03	
1 to 4 days:	7.19E-04	
4 to 30 days:	5.75E-04	
Maximum CR Outside Air Intake Flow Rate, scfm	Same as for Primary Leakage Pathway	Refer to Table 3
Maximum TSC Outside Air Intake Flow Rate (Emergency Ventilation Mode), scfm	Same as for Primary Leakage Pathway	Refer to Table 3

Table 6. Reactor Building Dimensions

Parameter	Value	Reference / Comment
Elevation 935'-0"		
Origin of Geometry	Column N (X-Axis) Column 6 (Y-Axis) Elevation 0'-0"	This is the reactor centerline and is arbitrarily chosen as the origin.
Extent of Reactor Building in East-West Direction	1'6" West of Column 3.1 to 1'-6" East of Column 8.9	7.18
Extent of Reactor Building in North-South Direction	1'-3" South of Column S to Column K (1'-6" North of Column L)	7.18
Distance Between Columns in East-West Direction		7.18
3.1 to 4.1:	22'-9"	
4.1 to 5.1:	22'-3"	
5.1 to 6:	22'-3"	
6 to 6.9:	22'-3"	
6.9 to 7.9:	22'-3"	
7.9 to 8.9:	22'-9"	
Distance Between Columns in North-South Direction		7.18
S to R:	23'-0"	
R to P:	22'-3"	
P to N:	22'-3"	
N to M:	35'-3"	
M to L:	32'-0"	
L to K:	1'-6"	
Distance from Origin to East Wall	67'-3"	7.18
Thickness of East Wall	1'-6"	7.18
Distance from Origin to North Wall	67'-9"	7.18
Minimum Thickness of North Wall	1'-0"	7.18
Distance from Origin to South Wall	67'-3"	7.18

Table 6. Reactor Building Dimensions

Parameter	Value	Reference / Comment
Modeled Thickness of South Wall	1'-6"	Reference 7.18. The modeled thickness of the south wall is 1.5 feet. There appears to be several locations in the south wall without concrete. Due to the orientation of the Reactor Building and Control Building, these areas without concrete will have no impact on the doses in the Control Building.
Distance from Origin to West Wall	Calculated in Section 5.2	This distance is calculated to conserve the secondary containment free air volume below the refueling floor.
Minimum Thickness of West Wall	1'-6"	7.18
Elevation 962'-6"		
Distance from Origin to East Wall (South of Column M)	67'-3"	7.19
Thickness of East Wall (South of Column M)	1'-6"	7.19. The east wall changes thicknesses from 1.5 feet to 1 foot at 1'-3" North of Column M.
Distance from Origin to East Wall (North of Column M)	67'-9"	7.19
Thickness of East Wall (North of Column M)	1'-0"	Reference 7.19 and Section B.58 of Reference 7.6. The east wall changes thicknesses from 1.5 feet to 1 foot at 1'-3" North of Column M.
Distance from Origin to North Wall	66'-9"	7.19
Minimum Thickness of North Wall	2'-0"	7.19
Distance from Origin to South Wall	67'-3"	7.19
Minimum Thickness of South Wall	1'-6"	7.19
Distance from Origin to West Wall	Calculated in Section 5.2	This distance is calculated to conserve the secondary containment free air volume below the refueling floor.
Minimum Thickness of West Wall	1'-0"	7.19

Table 6. Reactor Building Dimensions

Parameter	Value	Reference / Comment
Elevation 985'-6"		
Distance from Origin to East Wall (South of Column P)	67'-9"	7.20
Thickness of East Wall (South of Column P)	1'-0"	7.20. The east wall changes thicknesses from 1 foot to 1.5 feet at 3'-9" South of Column P.
Distance from Origin to East Wall (Between Column P and Column M)	67'-3"	7.20
Thickness of East Wall (Between Column P and Column M)	1'-6"	7.20. The east wall is 1.5 feet thick from 3'-9" South of Column P to 26'-0" North of Column N.
Distance from Origin to East Wall (North of Column M)	67'-9"	7.20
Thickness of East Wall (North of Column M)	1'-0"	7.20. The east wall changes thicknesses from 1.5 feet to 1 foot at 26'-0" North of Column N.
Distance from Origin to North Wall	66'-9"	7.20
Thickness of North Wall	2'-0"	7.20
Distance from Origin to South Wall	67'-9"	7.20
Minimum Thickness of South Wall	1'-0"	7.20
Distance from Origin to West Wall	Calculated in Section 5.2	This distance is calculated to conserve the secondary containment free air volume below the refueling floor.
Minimum Thickness of West Wall	1'-0"	7.20
Elevation 1001'-2"		
Extent of Reactor Building in North-South Direction	1'-3" South of Column S to 1'-3" North of Column M	7.21 and 7.22
Distance from Origin to East Wall (South of Column P)	67'-9"	7.21
Thickness of East Wall (South of Column P)	1'-0"	7.21. The east wall changes thicknesses from 1 foot to 1.5 feet at 3'-9" South of Column P.
Distance from Origin to East Wall (Between Column P and Column M)	67'-3"	7.21

Table 6. Reactor Building Dimensions

Parameter	Value	Reference / Comment
Thickness of East Wall (Between Column P and 26' North of Column N)	1'-6"	7.21. The east wall is 1.5 feet thick from 3'-9" South of Column P to 26'-0" North of Column N.
Distance from Origin to East Wall (South of Column M)	67'-9"	7.21
Thickness of East Wall (South of Column M)	1'-0"	7.21. The east wall changes thicknesses from 1.5 feet to 1 foot at 26'-0" North of Column N.
Distance from Origin to North Wall	35'-6"	7.21
Thickness of North Wall	1'-0"	7.21
Distance from Origin to South Wall	67'-9"	7.21
Minimum Thickness of South Wall	1'-0"	7.21
Distance from Origin to West Wall	Calculated in Section 5.2	This distance is calculated to conserve the secondary containment free air volume below the refueling floor.
Minimum Thickness of West Wall	1'-0"	7.21
Refueling Floor, Elevation 1027'-8"		
Extent of Reactor Building Refueling Floor in North-South Direction	15.5" South of Column S to 15.5" North of Column M	7.23
Distance from Origin to East Wall	68'-9"	7.23
Distance from Origin to North Wall	36'-6.5"	7.23
Distance from Origin to South Wall	68'-9.5"	7.23
Distance from Origin to West Wall	Calculated in Section 5.2	This distance is calculated to conserve the Refueling Floor free air volume.
Roof Elevation	1073'-8"	7.24

Table 7. Control Building Dimensions

Parameter	Value	Reference / Comment
Elevation 928'-0"		
Extent of Control Building in East-West Direction	8" West of Column 8.97 to Column 13.2	7.25, 7.30, and 7.37. For modeling purposes, the west side of the Control Building is adjacent to the east side of the Reactor Building.
Extent of Control Building in North-South Direction	Column Ka to Column Ra	7.25, 7.30, and 7.37. For modeling purposes, the north side of the Control Building is adjacent to the north side of the Reactor Building.
Distance Between Columns in East-West Direction		7.25, 7.30, and 7.37.
8.97 to 10.1:	24'-11"	
10.1 to 11.1:	23'-6"	
11.1 to 11.3:	1'-11.5"	
11.3 to 11.5:	4'-9"	
11.5 to 11.6:	8'-5"	
11.6 to 11.9:	12'-11"	
11.9 to 13.2:	33'-5"	
Distance Between Columns in North-South Direction (Control Room Portion of Control Building)		7.25
Ka to Le:	18'-6"	
Le to Ma:	16'-0"	
Ma to Me:	16'-0"	
Me to Mj:	16'-0"	
Mj to Nf:	16'-0"	
Nf to Pd:	16'-0"	
Pd to Ra	16'-4.5"	

Table 7. Control Building Dimensions

Parameter	Value	Reference / Comment
Distance Between Columns in North-South Direction (TSC Portion of Control Building)		7.30 and 7.37
Ka to Kb:	1’-0”	
Kb to Lc:	13’-9.75”	
Lc to Lf:	13’-9.75”	
Lf to Mc:	13’-9.75”	
Mc to Mg:	13’-9.75”	
Mg to Mj:	10’-3”	
Mj to Nf:	16’-0”	
Nf to Pd:	16’-0”	
Pd to Ra	16’-4.5”	
Concrete Wall at Col. 8.97, Extending from Col. Ka to Col. Mj		7.18 and 7.25
Thickness:	1’-0”	
Distance from Origin to Inner Wall Surface:	69’-9”	
Concrete Wall at Col. 11.1, Extending from Col. Ka to Col. Mj		7.18 and 7.25
Thickness:	1’-7.5”	
Distance from Origin to Inner Wall Surface:	117’-5”	
Concrete Wall at Col. Ka, Extending from Col. 8.97 to Col. 11.1		7.18 and 7.25
Minimum Thickness:	1’-0”	
Distance from Origin to Inner Wall Surface:	67’-9”	
Concrete Wall at Col. Mj, Extending from Col. 8.97 to Col. 11.1		7.18 and 7.25
Thickness:	1’-0”	
Distance from Origin to Inner Wall Surface:	2’-3”	

Table 7. Control Building Dimensions

Parameter	Value	Reference / Comment
Minimum Concrete Ceiling Thickness	3”	7.27, 7.30, and 7.36
Elevation 939’-0”		
Cable Spreading Room West Concrete Wall Thickness: Distance from Origin to Inner Wall Surface:	 1’-0” 69’-9”	7.18 and 7.25
Cable Spreading Room East Concrete Wall Thickness: Distance from Origin to Inner Wall Surface:	 1’-7.5” 117’-5”	7.18 and 7.25
Cable Spreading Room North Concrete Wall Minimum Thickness: Distance from Origin to Inner Wall Surface:	 1’-0” 67’-9”	7.18 and 7.25
Cable Spreading Room South Concrete Wall Thickness: Distance from Origin to Inner Wall Surface:	 1’-0” 19’-3”	7.18 and 7.25
Concrete Ceiling Thickness Above Cable Spreading Room	1’-0”	7.26 and 7.27
Minimum Concrete Ceiling Thickness for Other Areas	3”	7.27, 7.30, and 7.37
Elevation 951’-0”		
Control Room West Concrete Wall Thickness: Distance from Origin to Inner Wall Surface:	 1’-3” 70’-0”	7.18 and 7.25

Table 7. Control Building Dimensions

Parameter	Value	Reference / Comment
Control Room East Concrete Wall Thickness: Distance from Origin to Inner Wall Surface:	 1'-7.5" 117'-5"	7.18 and 7.25
Control Room North Concrete Wall Minimum Thickness: Distance from Origin to Inner Wall Surface:	 2'-0" 66'-9"	7.18 and 7.25
Control Room South Concrete Wall Thickness: Distance from Origin to Inner Wall Surface:	 1'-0" 19'-3"	7.18 and 7.25
TSC West Wall (Extends from Col. Ka to Col. Mg) Material: Thickness: Distance from Origin to Inner Wall Surface:	 Precast Concrete Panel 5" 146'-10.5"	7.18, 7.25, 7.30, 7.32, 7.34, and 7.35
Control Room Floor Thickness	1'-0"	7.26
Concrete Ceiling Thickness Above Control Room	2'-0"	7.26 and 7.27
Minimum Concrete Ceiling Thickness for Other Areas	3"	7.30, 7.31, and 7.37
Elevation 965'-0"		
Wall at Column 11.9 Material: Thickness: Distance from Origin to Inner Wall Surface:	 Precast Concrete Panel 5" 146'-10.5"	7.18, 7.25, 7.30, 7.32, 7.33, 7.34, and 7.35. This is the same precast concrete wall as the west TSC wall on Elevation 951'-0".
Control Building Roof Thickness of Metal Decking:	20 gauge (0.0375")	7.26 and 7.31

Table 8. ECCS Piping Dimensions

Parameter	Value	Reference / Comment
TW33-12"-GE, Segment A (East-West Segment)		
Centerline Distance from Origin (X-Axis)	18'-1 11/16"	7.38
Centerline Elevation	953'-2"	7.38
Length of Pipe Segment	30'-3.5"	7.38
Radius of Pipe Segment	6"	Taken as half the diameter.
Pipe Clad Thickness	0.375"	Section B.59 of Reference 7.6
Distance from East end of pipe segment to East Wall of Reactor Building	2'10"	7.38
TW33-12"-GE, Segment B (North-South Segment) [1]		
Centerline Distance from Origin (Y-Axis)	64'5"	7.38
Centerline Elevation	953'-2"	7.38
Length of Pipe Segment	20'-7 11/16"	7.38

[1] The North End of Segment B joins the East End of Segment A

Table 9. SGTS Filter Dimensions

Parameter	Value	Reference / Comment
Location	NW Corner of Reactor Building on El. 985'-6"	Section B.79 of Reference 7.6
Charcoal Absorber Centerline Along the E-W Direction	Column 4.1	Section B.79 of Reference 7.6
Charcoal Absorber Centerline Along the N-S Direction	10 feet South of Column L	Section B.79 of Reference 7.6
Elevation Bottom of Bottom Train: Bottom of Top Train:	 985'-6" 992'-3"	Section B.79 of Reference 7.6. The two trains are stacked vertically.
SGTS Filter Dimensions Length: Width: Height:	 49" 24" 50"	Section B.79 of Reference 7.6. Modeled as a rectangular solid.
SGTS Filter Room East Concrete Wall Location in E-W Direction: Location in N-S Direction: Thickness:	 Inner Surface is 2'-6" East of Column 4.1 Extends from Column L to Column M 1'-6"	Reference 7.20
SGTS Filter Room Concrete Floor Slab Extent in the E-W Direction: Extent in the N-S Direction: Thickness:	 Column 3.1 to 4'-0" East of Column 4.1 Column L to Column M 1'-6"	Reference 7.20

Table 10. CR Filter Dimensions

Parameter	Value	Reference / Comment
Location	Units V-FE-11 and V-FE-12 are located on the second floor of the EFT Building on El. 943'-8".	Section B.77 of Reference 7.6
Elevation of the Bottom of Both Units	945'-2"	Section B.77 of Reference 7.6
Location in E-W Direction Distance from Column 6 (Y Axis) to Column 11 Distance from Column 11 to Column 11.05	West Edge is located 12'-0" East of Column 11.05 117'-6" 20"	Section B.77 of Reference 7.6 Reference 7.28 Section A.1.6 of Reference 7.6
Location in N-S Direction Distance from Column N (X Axis) to Column K Distance from Column K to Column J Distance from Column J to Column J_d Distance from Column J_d to Column J_e	Centerline of South Unit (Closest to the CR) is 8.25 feet North of Column J_e 70'-1" 28'-1.5" 8'-10.5" 20'-5"	Section B.77 of Reference 7.6 Reference 7.18 Reference 7.28 Section A.1.6 of Reference 7.6 Reference 7.29
CR Charcoal Absorber Dimensions Length: Width: Height:	 24" 24" 24"	Section B.77 of Reference 7.6
EFT Building South Wall Extent in the E-W Direction: Thickness:	 Control Room East Wall to TSC East Wall 1'-10"	Attachment E of Reference 7.6

Table 11. TSC Filter Dimensions

Parameter	Value	Reference / Comment
Location	Above the Control Building	Section B.81 of Reference 7.6
Centerline Along the E-W Direction	3 feet East of Column 11.3	Section B.81 of Reference 7.6
Centerline Along the N-S Direction	Column L_c	Section B.81 of Reference 7.6
Elevation of TSC Filter Skid	981'-9"	Section B.81 of Reference 7.6
TSC Charcoal Absorber Dimensions Length: Width: Height:	 28" 28" 24"	Section B.81 of Reference 7.6. These are the dimensions for each filter.

3.0 Assumptions and Limitations

3.1 In deriving the time-dependent source term, the assumptions associated with the AST and listed in Reference 7.2 are used in this analysis with the following exception. Per Table 4 of Reference 7.2, the onset time before the gap release phase is 2 minutes. This implies that there is no activity released from the fuel for the first 2 minutes following the LOCA. For consistency with Reference 7.4, the 2 minute decay period when no activity is released from the fuel is conservatively ignored. This results in activity released from the fuel at time zero post LOCA and also decreases the positive pressure period (PPP) from 5 minutes to 3 minutes. It is understood that during the PPP there is a release of activity from the Reactor Building to the environment. However, for direct shine from the sources within the Reactor Building, this release is conservatively ignored and no activity is released from the Reactor Building to the environment for the first 3 minutes post LOCA. For direct shine from sources outside the Reactor Building (CR and TSC filters and External Cloud), the activity is released directly to the environment as a ground level release without passing through the SGTS filter for the first 3 minutes post LOCA.

3.2 The gravel thickness on top of the Control Building roof is assumed to be 0.5 inches thick from Columns 8.97 to 11.1, 2 inches thick from Columns 11.1 to 11.9, and 0.5 inches thick from Columns 11.9 to 13.2. Refer to Attachment B for the basis of the gravel thicknesses on the Control Building roof. Also, the gravel on top of the Control Building roof is modeled as concrete with a density of 1.346 g/cm^3 (Section 2.3).

3.3 The steel used for the metal decking on the Control Building roof and for the ECCS pipe cladding is modeled as iron with the densities listed in Section 2.3.

3.4 In determining the Control Room dose from the SGTS filter, it is assumed that the filter efficiency is 100% for all isotopes except the noble gases. This maximizes the activity on the SGTS filter and results in conservative doses from the SGTS filter. In determining the Control Room doses from the CR and TSC filters, it is assumed that the Control Room and TSC filter efficiencies are 100% for all isotopes except the noble gases, with the SGTS filter efficiency as listed in Table 3. The noble gas removal efficiency for the SGTS, CR, and TSC filters is 0.0%.

3.5 In determining the Control Room doses from the CR filter, the TSC filter, and the external cloud from the primary containment and ESF system leakage pathways, it is conservatively assumed that the activity is released directly to the environment, i.e., there is no holdup or dilution of airborne activity within the secondary containment. Credit is taken for SGTS filtration post PPP.

3.6 In determining the Control Room doses from the CR filter, the TSC filter, and the external cloud from the MSIV/SCB leakage pathway, it is conservatively assumed that there is no holdup or activity deposition in the main steam line piping and no holdup within the condenser.

4.0 Methodology and Acceptance Criteria

The purpose of this calculation is to determine the 30 day post LOCA direct dose to the Control Room operator from external sources. The post LOCA source terms used in this analysis are based on the Alternative Source Term (AST) methodology provided in Regulatory Guide 1.183 (Reference 7.2). The Control Room operator doses in this analysis are calculated based on a core thermal power of 1918 Megawatt-Thermal (MW_{th}). The external sources, along with the activity leakage pathways, considered in this calculation include:

- Reactor Building Airborne Activity – 1) Primary Containment Leakage Pathway, and 2) ESF System Leakage Pathway;
- ECCS Piping Containing Suppression Pool Water – Activity from the core is released directly to the suppression pool water;
- SGTS Filter – 1) Primary Containment Leakage Pathway, and 2) ESF System Leakage Pathway;
- Control Room Filter – 1) Primary Containment Leakage Pathway, 2) ESF System Leak Pathway, and 3) MSIV/SCB Leakage Pathway;
- TSC Filter – 1) Primary Containment Leakage Pathway, 2) ESF System Leak Pathway, and 3) MSIV/SCB Leakage Pathway; and
- External Cloud Immediately Surrounding the Control Room – 1) Primary Containment Leakage Pathway, 2) ESF System Leak Pathway, and 3) MSIV/SCB Leakage Pathway.

The airborne activity within the Reactor Building is attributed to two leakage pathways: 1) Primary Containment Leakage, and 2) ESF System Leakage. For the primary containment leakage pathway, the core inventory is released from the fuel to the drywell, with the release fractions as specified in Table 2. The only drywell airborne activity removal mechanisms credited in this analysis are natural deposition of the particulates and radio-decay. The equations used to model the natural deposition of particulates in the drywell are discussed in Section 5.1.1. From the drywell, the airborne activity is released to the Reactor Building atmosphere with the leakage rates listed in Table 3. The airborne activity is then released from the Reactor Building to the environment via the SGTS. The positive pressure period (PPP) is 5 minutes. It is understood that during the PPP there is a release of activity from the Reactor Building to the environment. However, for direct shine from the sources within the Reactor Building, this release is conservatively ignored. After the PPP, airborne activity is released to the environment at the SGTS minimum exhaust rate of 3150 cfm. Per Assumption 3.1, the 2 minute period when no activity is released from the fuel is conservatively ignored. This results in activity released from the fuel at time zero post LOCA and also decreases the PPP from 5 minutes to 3 minutes.

For the ESF system leakage pathway associated with the Reactor Building airborne activity, the core inventory, with the exception of the noble gases, is released from the fuel and is instantaneously and homogeneously mixed in the suppression pool and RCS water volume at the time of release from the fuel with the release fractions as specified in Table 2. The ESF systems that recirculate suppression pool water outside of the primary containment are assumed to leak during their operation. The activity within the suppression pool is then leaked to the Reactor Building atmosphere through ESF system components such as valve packing glands, pump shaft seals, flanged connections, and other similar components. The ESF leakage rate into the Reactor Building is 1.31 gallons per minute. Per Appendix A, Section 5.2 of Reference 7.2, the leakage should be taken as two times the sum of the simultaneous leakage from all components in the ESF recirculation systems above which the technical specifications, licensee commitments to item III.D.1.1 of NUREG-0737, would require declaring such systems inoperable. Therefore, the ESF leakage rate into the Reactor Building used in this analysis is 2.62 gallons per minute. With the exception of iodine, all activity released through the ESF pathway remains in the liquid phase. The amount of iodine that becomes airborne within the Reactor Building is 10% (flashing fraction of 0.1 from Table 4). The airborne activity is then released from the Reactor Building to the environment via the SGTS, using the same methodology as described for the primary leakage pathway.

The direct dose to the Control Room from two 12 inch ECCS pipe segments, TW33-12"-GE Segment A and Segment B, containing suppression pool water, is also determined in this analysis. For the suppression pool water source term, the core inventory, with the exception of the noble gases, is released from the fuel and is instantaneously and homogeneously mixed in the suppression pool and RCS water volume with the release fractions as specified in Table 2. The only removal mechanism for the activity within the suppression pool water is radio-decay.

The buildup of activity on the SGTS filter is attributed to two leakage pathways: 1) Primary Containment Leakage, and 2) ESF System Leakage. The primary containment and ESF system leakage pathways are similar to those discussed above for the Reactor Building airborne activity with the following exceptions. First, there is no credit taken for activity holdup within the Secondary Containment, which implies that activity is released directly from Primary Containment or the Suppression Pool directly to the SGTS filter at the respective leakage rates. Second, there is no activity release to the environment from the SGTS filter, i.e., the leakage rate from the SGTS filter to the environment is set to zero to maximize the activity buildup on the SGTS filter. Third, for the duration of the 30 day accident period, the SGTS filter removal efficiency is set to 100% for all isotopes (with the exception of the noble gases). The SGTS removal efficiency for the noble gases is set to 0.0% for the duration of the 30 day accident period.

The buildup of activity on the CR and TSC filters are attributed to three leakage pathways: 1) Primary Containment Leakage, 2) ESF System Leakage, and 3) MSIV/SCB Leakage. For the primary containment leakage pathway, the core inventory is released from the fuel to the drywell,

with the release fractions as specified in Table 2. The only drywell airborne activity removal mechanisms credited in this analysis are natural deposition of the particulates and radio-decay. The equations used to model the natural deposition of particulates in the drywell are discussed in Section 5.1.1. From the drywell, the airborne activity is released to the Reactor Building atmosphere with the leakage rates listed in Table 3. The airborne activity is then released from the Reactor Building to the environment via the SGTS. The activity passing through the SGTS filter is reduced by the product of the SGTS filter removal efficiencies after PPP (Table 3), the atmospheric dispersion factors for the CR filter or the TSC filter (Table 3), and the CR or TSC outside air intake rate (Table 3). This model assumes no holdup of airborne activity within the secondary containment, which implies that the activity is release directly from Primary Containment to the atmosphere at the Primary Containment leakage rate. To maximize the activity buildup on the filters, the CR and TSC filter removal efficiencies are assumed to be 100% for all isotopes with the exception of the noble gases. The CR and TSC removal efficiencies for the noble gases is set to 0.0% for the duration of the 30 day accident period.

For the ESF system leakage pathway associated with the buildup of activity on the CR and TSC filters, the core inventory (with the exception of the noble gases) is released from the fuel and is instantaneously and homogeneously mixed in the suppression pool and RCS water volume at the time of release from the fuel with the release fractions as specified in Table 2. The ESF leakage rate into the Reactor Building is 2.62 gallons per minute. With the exception of iodine, all activity released through the ESF pathway remains in the liquid phase. The amount of iodine that becomes airborne within the Reactor Building is 10% (flashing fraction of 0.1 from Table 4). The airborne activity is then released from the Reactor Building to the environment via the SGTS. The activity passing through the SGTS filter is reduced by the product of the SGTS filter removal efficiencies after PPP (Table 4), the atmospheric dispersion factors for the CR filter or the TSC filter (Table 4), and the CR or TSC outside air intake rate (Table 4). This model assumes no holdup of airborne activity within the secondary containment, which implies that the activity is release directly from the Suppression Pool to the environment at the ESF leakage rate. To maximize the activity buildup on the filters, the CR and TSC filter removal efficiencies are assumed to be 100% for all isotopes with the exception of the noble gases. The CR and TSC removal efficiencies for the noble gases is set to 0.0% for the duration of the 30 day accident period.

For the MSIV/SCB leakage pathway associated with the buildup of activity on the CR and TSC filters, the core inventory is released from the fuel to the drywell with the release fractions as specified in Table 2. The only drywell airborne activity removal mechanisms credited in this analysis are natural deposition of the particulates and radio-decay. The equations used to model the natural deposition of particulates in the drywell are discussed in Section 5.1.1. From the drywell, the airborne activity is released to the condenser with the leakage rates listed in Table 5. The airborne activity is then released from the condenser directly to the environment. The activity passing through the condenser is reduced by the product of the condenser removal efficiencies (Table 5), the atmospheric dispersion factors for the CR filter or the TSC filter (Table 5), and the

CR or TSC outside air intake rate (Table 5). This model assumes no holdup or deposition of activity within main steam line piping and no holdup within the condenser. To maximize the activity buildup on the filters, the CR and TSC filter removal efficiencies are assumed to be 100% for all isotopes with the exception of the noble gases. The CR and TSC removal efficiencies for the noble gases is set to 0.0% for the duration of the 30 day accident period.

The direct dose to the Control Room from airborne activity within the external cloud immediately surrounding the Control room is attributed to three leakage pathways: 1) Primary Containment Leakage, 2) ESF System Leakage, and 3) MSIV/SCB Leakage. For the primary containment leakage pathway, the core inventory is released from the fuel to the drywell with the release fractions as specified in Table 2. The only drywell airborne activity removal mechanisms credited in this analysis are natural deposition of the particulates and radio-decay. The equations used to model the natural deposition of particulates in the drywell are discussed in Section 5.1.1. From the drywell, the airborne activity is released to the Reactor Building atmosphere with the leakage rates listed in Table 3. The airborne activity is then released from the Reactor Building to the environment via the SGTS. The activity passing through the SGTS filter is reduced by the product of the SGTS filter removal efficiencies after PPP (Table 3), the external cloud atmospheric dispersion factors (Table 3), and the volume of the external cloud (See Section 5.2.7). This model assumes no holdup of airborne activity within the secondary containment.

For the ESF system leakage pathway associated with the external cloud, the core inventory (with the exception of the noble gases) is released from the fuel and is instantaneously and homogeneously mixed in the suppression pool and RCS water volume at the time of release from the fuel with the release fractions as specified in Table 2. The ESF leakage rate into the Reactor Building is 2.62 gallons per minute. With the exception of iodine, all activity released through the ESF pathway remains in the liquid phase. The amount of iodine that becomes airborne within the Reactor Building is 10% (flashing fraction of 0.1 from Table 4). The airborne activity is then released from the Reactor Building to the environment via the SGTS. The activity passing through the SGTS filter is reduced by the product of the SGTS filter removal efficiencies after PPP (Table 4), the external cloud atmospheric dispersion factors (Table 4), and the volume of the external cloud (See Section 5.2.7). This model assumes no holdup of airborne activity within the secondary containment.

For the MSIV/SCB leakage pathway associated with the external cloud, the core inventory is released from the fuel to the drywell with the release fractions as specified in Table 2. The only drywell airborne activity removal mechanisms credited in this analysis are natural deposition of the particulates and radio-decay. The equations used to model the natural deposition of particulates in the drywell are discussed in Section 5.1.1. From the drywell, the airborne activity is released to the condenser with the leakage rates listed in Table 5. The airborne activity is then released from the condenser directly to the environment. The activity passing through the condenser is reduced by the product of the condenser removal efficiencies (Table 5), the external cloud atmospheric

dispersion factors (Table 5), and the volume of the external cloud (See Section 5.2.7). This model assumes no holdup or deposition of activity within main steam line piping and no holdup within the condenser.

The direct doses to the Control Room from the aforementioned external sources are calculated using the computer code RUNT-PC (Reference 7.1). RUNT-PC has been verified and validated under S&L's quality assurance program and therefore verification and validation is not required as part of this calculation. RUNT-PC calculates the gamma dose rates using gaussian quadrature integration of point and line kernel dose rate equations. Energy dependent linear attenuation coefficients and buildup factors, for each integration, are derived from the input parameters and internal databases. For all dose rate calculations in this analysis, the buildup factors are based on concrete. The gamma flux to dose rate conversion factors used in this analysis are based on tissue. The contribution from bremsstrahlung gamma radiation is included in the total dose to the Control Room.

The direct doses are calculated at 12 locations within the Control Room. These 12 locations are divided into a 3 by 4 grid, with 3 dose points in the East-West direction by 4 dose points in the North-South direction. The 3 dose points in the East-West direction are taken at 1 foot from the West wall, at Column 10.1, and at 1 foot from the East Wall. For each location in the East-West direction, the dose points in the North-South direction are at 1 foot from the North wall, at Column Le, at Column Ma, and at 1 foot from the South wall. All 12 dose points are taken at 6 feet above the floor elevation (El. 951'-0" + 6' = El. 957'-0").

The purpose of this calculation is to determine the direct dose to the Control Room from radiation sources external to the Control Room. As such, there is no specific acceptance criteria for this calculation, provided that the total dose (sum of the doses from external and internal sources) to the Control Room is under the 5 rem limit as specified in References 7.9 and 7.10.

5.0 Calculations

5.1 Activity Transport Models

The core inventory listed in Table 1 is used as input to RUNT-PC for the time zero post LOCA source term. This time zero post LOCA source term is used for the activity transport from the fuel to each external source attributed to the primary containment leakage pathway, the ESF leakage pathway, the suppression pool water activity, and the MSIV/SCB leakage pathway. The parameters required to determine the time-dependent source term for each of the aforementioned pathways are discussed below.

5.1.1 Reactor Building Airborne Activity

The direct dose to the Control Room from the Reactor Building airborne activity is attributed to the primary containment and ESF system leakage pathways. Refer to Figure 1 for the discussion on the primary containment leakage pathway and Figure 2 for the discussion on the ESF system leakage pathway.

For the primary containment leakage pathway, the time-dependent airborne activity is divided into three groups based on different release fractions and natural deposition characteristics. The first group includes the noble gases and the elemental and organic halogens (5% of the total halogen inventory). The second group includes the particulate halogens (95% of the total halogen inventory) and alkali metals. The third group includes the remaining particulate groups; tellurium metals, barium and strontium group, noble metals, cerium group, and lanthanides.

The core inventory release fractions associated with the AST for the gap release and early in-vessel damage phases are listed in Table 2 for each group of nuclides. The onset (time following the initiation of the accident) for the gap release phase is two minutes with a duration of 30 minutes. Per Assumption 3.1, the 2 minute onset period when no activity is released from the fuel is conservatively ignored. This results in activity released from the fuel during the gap release phase starting at time zero post LOCA and ending at 30 minutes post LOCA. The early in-vessel phase immediately follows the gap release phase and has a duration of 1.5 hours. The activity released from the core during each release phase is modeled as a linear release over the duration of the phase. The time dependent leakage rates from the fuel (L_{12} in Figure 1) are calculated as follows. The first order linear differential equation used to model the release of activity from the fuel is given in Equation 1.

Equation 1

$$\frac{dA}{dt} = \square(L_{12})\,A$$

$$A(t) = A_o\ EXP(\square L_{12}\ t)$$

Where: $A(t)$ is the activity at time t, Ci;
A_o is the initial activity, Ci;
L_{12} is the leakage rate from the fuel, fractions per second; and
t is the time, seconds.

In order to obtain more precise dose rate results at the onset of the accident when the dose rates are rapidly changing, the time interval for the gap release phase (time less than 30 minutes post LOCA) and the early in-vessel phase (time between 30 minutes and 2 hours post LOCA) is subdivided into smaller time intervals. The leakage rate for each time subinterval is calculated by solving Equation 1 for L_{12} as listed in Equation 2.

Equation 2

$$L_{12} = \square\frac{\ln\left(\frac{A(t)}{A_o}\right)}{t}$$

Where: L_{12} is the leakage rate from the fuel for the time subinterval, fractions per second;
$A(t)$ is the fraction of activity remaining in the fuel at the end of the time subinterval;
A_o is the fraction of activity remaining in the fuel at the beginning of the time subinterval;
t is the time in the subinterval, second.

The activity is linearly released from the fuel over the time subinterval. The fraction of activity remaining in the fuel at the end of each time subinterval (A(t)) in Equation 2 is calculated using Equation 3.

Equation 3

$$A(t) = A_o \,\square\, (\frac{t}{t_{phase}})\, RF$$

Where: A(t) is the fraction of activity remaining in the fuel at the end of the time subinterval;
A_o is the fraction of activity remaining in the fuel at the beginning of the time subinterval;
t is the time in the subinterval, second;
t_{phase} is the total time for the gap release phase (30 minutes) or the early in-vessel release phase (90 minutes);
RF is the nuclide group release fraction as listed in Table 2.

Per Table 2, the core inventory release fraction for the noble gases during the gap release phase is 0.05 (i.e., after the gap release phase, 95% of the noble gas activity remains in the fuel). The noble gas leakage rates from the fuel (L_{12} in Figure 1) during the gap release phase for each time subinterval are listed in Table 12. Per Table 2, the core inventory release fraction for the noble gases during the early in-vessel release phase is 0.95 (i.e., after the early in-vessel phase, there is no noble gas activity remaining in the fuel). The noble gas leakage rates from the fuel during the early in-vessel release phase are listed in Table 13. After 2 hours post LOCA, L_{12} in Figure 1 is set to 0.0 for the remainder of the 30 day accident period.

As mentioned above, the time-dependent airborne activity for the primary leakage pathway is divided into three groups based on different release fractions and natural deposition characteristics. The first group contains the noble gases and the elemental and organic halogens (5% of the total halogen inventory). The time zero post LOCA source term as listed in Table 1 is in units of Curies (Ci) per Megawatt-thermal (MW_{th}). The direct dose to the Control Room as determined in this calculation is based on a core power level of 1918 MW_{th}. Therefore, the initial scaling factor applied to the first group is 1918.0 for the noble gases and 95.9 (1918 * 5%) for the halogens. Per Table 2, 0.05 of the halogen source is released from the fuel during the gap release phase (same as the noble gases) and 0.25 of the halogen source is release from the fuel during the early in-vessel phase (as compared to 0.95 for the noble gases). Because the elemental and organic halogens are grouped with the noble gases, the noble gases have a different release fraction during the early in-vessel phase, and only one leakage rate from the Source Region to Barrier 1 can be specified in RUNT-PC for each time interval, a scaling factor is applied to the halogen activity at 30 minutes post LOCA (beginning of the early in-vessel phase) to conserve the total activity released from the fuel. This scaling factor is determined as follows. The leakage rates as calculated in Table 12 and Table 13 are based on 5% of the activity release in the first 30 minutes and 95% of the activity released during the next 90 minutes. Per Table 2, 25% of the halogen source is released from the fuel. Therefore, the scaling factor applied to the halogen source activity at 30 minutes post LOCA

is taken as the ratio of the halogen release fraction (0.25) to noble gas release fraction (0.95) upon which the leakage rates during the early in-vessel phase are calculated. This results in a scaling factor of 0.26316 (0.25/0.95). This approach, as opposed to determining a separate leakage rate for each nuclide group, was taken to cut down on the required number of computer runs.

The second group of nuclides associated with the primary leakage pathway includes the particulate halogens (95% of the total halogen inventory) and the alkali metals. The initial scaling factor applied to the second group is 1822.1 (1918 * 95%) for the halogens and 1918.0 for the alkali metals. Rather than calculating new leakage rates from the fuel (L_{12} in Figure 1) using Equation 2 and Equation 3 to account for the different release fractions associated with the halogens and alkali metals, the same leakage rates as listed in Table 12 and Table 13 are used with scaling factors applied to the source activity at 30 minutes. The same approach as discussed in the previous paragraph is used to determine the scaling factors for the halogens and alkali metals at the beginning of the early in-vessel phase. The scaling factor applied to the halogen source activity at 30 minutes post LOCA is 0.26316 (0.25/0.95). Per Table 2, the alkali metal release fraction during the early in-vessel phase is 0.20. Therefore, the scaling factor applied to the alkali metal source activity at 30 minutes post LOCA is 0.21053 (0.20/0.95). This approach, as opposed to determining a separate leakage rate for each nuclide group, was taken to cut down on the required number of computer runs.

The third group of nuclides associated with the primary leakage pathway includes the tellurium metals, the barium and strontium group, the noble metals, the cerium group, and the lanthanides. Per Table 2, there is no release from the fuel for any of the nuclides associated with this group during the gap release phase. Therefore, the leakage rate from fuel (L_{12} in Figure 1) is set to 0.0 from time zero to 30 minutes post LOCA. Per Table 2, the release fraction during the early in-vessel phase for the tellurium metals is 0.05, for the barium and strontium group is 0.02, for the noble metals is 0.0025, for the cerium group is 0.0005, and for the lanthanides is 0.0002. The initial scaling factor for the tellurium metals is 95.9 (0.05 * 1918), for the barium and strontium group is 38.36 (0.02 * 1918), for the noble metals is 4.795 (0.0025 * 1918), for the cerium group is 0.959 (0.0005 * 1918), and for the lanthanides is 0.3836 (0.0002 * 1918). The leakage rate from the fuel during the early in-vessel phase is calculated using Equation 2 and Equation 3 with a release fraction of 1.0 because the release fractions in Table 2 are accounted for in the initial scaling factor calculation above. This approach, as opposed to determining a separate leakage rate for each nuclide group, was taken to cut down on the required number of computer runs. The leakage rates from the fuel (L_{12} in Figure 1) during the early in-vessel phase for the third group of nuclides are listed in Table 14.

For the Reactor Building airborne activity due to primary containment leakage pathway, credit is taken for removal of particulates by natural deposition. The time dependent natural deposition removal rates (S_1 in Figure 1) for particulates are taken from Table 2.2.2.1-3 (10^{th} percentile equations) of Reference 7.12 and are listed below in Equation 4. Use of the 10^{th} percentile

equations minimizes the deposition removal rate and thus maximizes the doses. Particulates are defined as 95% of the halogen inventory, and 100% of the alkali metals, the tellurium metals, the barium and strontium group, the noble metals, the cerium group, and the lanthanide group (i.e., the second and third groups). No removal by natural deposition is credited for the first group containing the noble gases and elemental and organic halogens. The natural deposition equations are a function of the core thermal power level. The core thermal power level used in this analysis is 1918 MW-thermal.

Equation 4 $$S_1(10) = \frac{1.285 * Exp[-\frac{2119}{1918\,MW_{th}}]\,hr^{-1}}{60\,\min/hr * 60\,\sec/\min} = 1.18248E-04\,\sec^{-1}$$ (0 to 0.5 hrs)

$$S_1(10) = \frac{0.520 * Exp[-\frac{2173}{1918\,MW_{th}}]\,hr^{-1}}{60\,\min/hr * 60\,\sec/\min} = 4.65229E-05\,\sec^{-1}$$ (0.5 to 2.0 hrs)

$$S_1(10) = \frac{1.551 * Exp[-\frac{1507}{1918\,MW_{th}}]\,hr^{-1}}{60\,\min/hr * 60\,\sec/\min} = 1.96371E-04\,\sec^{-1}$$ (2.0 to 5.0 hrs)

$$S_1(10) = \frac{0.836 * Exp[-\frac{1051}{1918\,MW_{th}}]\,hr^{-1}}{60\,\min/hr * 60\,\sec/\min} = 1.34253E-04\,\sec^{-1}$$ (5.0 to 8.33 hrs)

$$S_1(10) = \frac{0.780 * Exp[-\frac{1316}{1918\,MW_{th}}]\,hr^{-1}}{60\,\min/hr * 60\,\sec/\min} = 1.09096E-04\,\sec^{-1}$$ (8.33 to 12.0 hrs)

$$S_1(10) = \frac{0.778 * Exp[-\frac{1548}{1918\,MW_{th}}]\,hr^{-1}}{60\,\min/hr * 60\,\sec/\min} = 9.64189E-05\,\sec^{-1}$$ (12.0 to 19.4 hrs)

$$S_1(10) = \frac{0.780 * Exp[-\frac{1686}{1918\,MW_{th}}]\,hr^{-1}}{60\,\min/hr * 60\,\sec/\min} = 8.99559E-05\,\sec^{-1}$$ (19.4 hrs to 30 days)

Per Table 3, the primary containment leakage rate is 1.1078 percent per day for time less than 24 hours post LOCA, 0.7151 percent per day for time between 24 and 74 hours post LOCA, and 0.5539 percent per day for time between 74 hours and 30 days post LOCA. RUNT-PC requires the units for leakage rates in fractions per second. The primary containment leakage rates (L_{24} in Figure 1) are converted from percent per day to fractions per second in Equation 5.

Equation 5 $$L_{24} = \frac{1.1078(\%/day)}{100*24(hrs/day)*60(\min/hr)*60(\sec/\min)} = 1.28218E-07\sec^{-1} \quad (0 \text{ to } 24 \text{ hrs})$$

$$L_{24} = \frac{0.7151(\%/day)}{100*24(hrs/day)*60(\min/hr)*60(\sec/\min)} = 8.27662E-08\sec^{-1} \quad (24 \text{ to } 74 \text{ hrs})$$

$$L_{24} = \frac{0.5539(\%/day)}{100*24(hrs/day)*60(\min/hr)*60(\sec/\min)} = 6.41088E-08\sec^{-1} \quad (74 \text{ hrs to } 30 \text{ d})$$

The activity is transported from the primary containment with leakage rate L_{24} calculated in Equation 5 into the Reactor Building. The airborne activity is then released from the Reactor Building to the environment via the SGTS. During the PPP, no airborne activity within the Reactor Building is released to the environment. After the PPP, airborne activity is release to the environment at the SGTS minimum exhaust rate of 3150 cfm (Table 3). Per Assumption 3.1, the 2 minute period when no activity is released from the fuel is conservatively ignored. This results in activity released from the fuel at time zero post LOCA and also decreases the PPP from 5 minutes to 3 minutes. The leakage rate from the Reactor Building, L_{48} in Figure 1, is calculated in Equation 6. Per Table 3, the volume of secondary containment is 1.68E+06 ft^3.

Equation 6 $$L_{48} = 0.0\sec^{-1} \quad (0 \text{ to } 3 \text{ min})$$

$$L_{48} = \frac{3150\, ft^3/\min}{1.68E+06\, ft^3 * 60(\sec/\min)} = 3.12500E-05\sec^{-1} \quad (3 \text{ min to } 30 \text{ days})$$

For the ESF system leakage pathway, only 10% of the halogens in the suppression pool water are released to the Reactor Building atmosphere with the remaining nuclide groups remaining in the suppression pool water. The time-dependent activity for the ESF system leakage pathway is divided into two groups based on different release fractions. The first group contains the halogens and the second group contains the tellurium metals group, which produces halogen daughter products.

For the first group (halogens), the leakage rates (L_{12} in Figure 2) from the fuel to the suppression pool are the same as those discussed above for the halogen group primary containment leakage pathway and are listed in Table 12 for the gap release phase and Table 13 for the early in-vessel phase. The initial halogen scaling factor applied at time zero post LOCA is 1918.0 and the halogen scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 0.26316 (0.25/0.95).

For the second group (tellurium metals), the leakage rates (L_{12} in Figure 2) from the fuel to the suppression pool are the same as those discussed above for the tellurium group primary containment leakage pathway and are listed in Table 14 for the early in-vessel phase. The leakage rate from the fuel to the suppression pool is set to 0.0 during the gap release phase (time less than 30 minutes post LOCA). The scaling factor applied to the tellurium metals group is 95.9 (1918 * 0.05).

Per Table 4, the ESF leakage rate is 1.31 gallons per minute and the ESF dilution volume is 79745.4 ft^3. Per Appendix A, Section 5.2 of Reference 7.2, the 1.31 gpm leakage rate is multiplied by a factor of 2. The ESF leakage rate from the equipment containing suppression pool water to the Reactor Building, L_{23} in Figure 2, is calculated in Equation 7.

Equation 7 $$L_{23} = \frac{1.31\, gal/\min * 2}{7.48051948\, gal/ft^3 * 79745.4\, ft^3 * 60 \sec/\min} = 7.32003E-08 \sec^{-1} \quad \text{(0 to 30 days)}$$

Per Appendix A, Section 5.3 of Reference 7.2, all radioactive material in the suppression pool water remains in the suppression pool water with the exception of iodine. The activity is transported from the suppression pool water through a filter compartment and into the Reactor Building atmosphere. The filter compartment is used to account for the iodine flashing fraction. The iodine flashing fraction is defined as the fraction of iodine activity in the suppression pool water that becomes airborne within the Reactor Building atmosphere. Per Table 4, the iodine flashing fraction is 0.1. The activity for all other isotopes passing through the filter compartment is multiplied by 0.0 to simulate the effect of keeping the activity in the suppression pool water. The leakage rate from the filter compartment to the Reactor Building, L_{34} in Figure 2, is equal to the leakage rate into the filter, L_{23}. The leakage rate from the Reactor Building to the environment is the same as the leakage rate calculated for the primary containment leakage pathway and is listed in Equation 6.

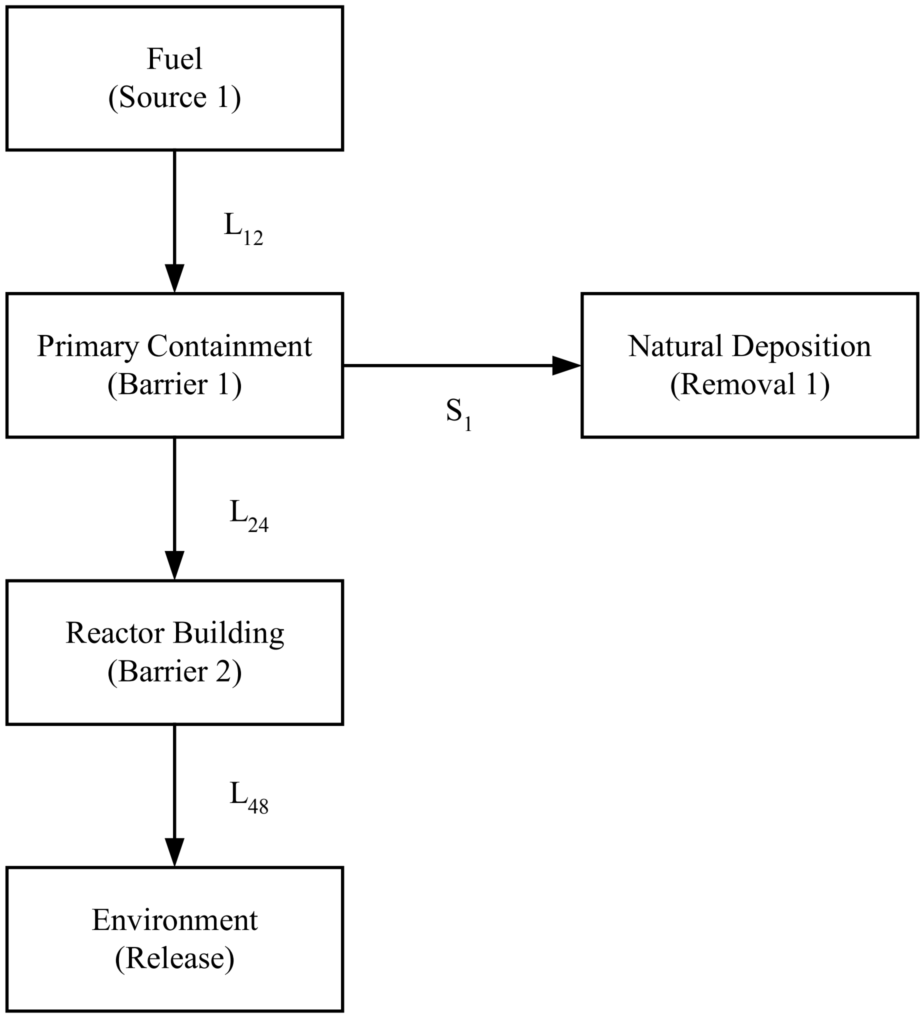


Figure 1. Reactor Building Airborne Activity Due to the Primary Leakage Pathway

Table 12. Noble Gas Leakage Rates from the Fuel During the Gap Release Phase

Beginning Time, min	Ending Time, min	Interval Time, min	Beginning Activity Fraction in the Fuel	Ending Activity Fraction in the Fuel	Leakage Rate, fractions / sec
0	3	3	1.0	0.995	2.78475E-05
3	5	2	0.995	0.991666667	2.79642E-05
5	10	5	0.991666667	0.983333333	2.81296E-05
10	15	5	0.983333333	0.975	2.83690E-05
15	20	5	0.975	0.966666667	2.86125E-05
20	25	5	0.966666667	0.958333333	2.88602E-05
25	30	5	0.958333333	0.95	2.91123E-05

Table 13. Noble Gas Leakage Rate from the Fuel During the Early In-Vessel Release Phase

Beginning Time, min	Ending Time, min	Interval Time, min	Beginning Activity Fraction in the Fuel	Ending Activity Fraction in the Fuel	Leakage Rate, fractions / sec
30	40	10	0.95	0.844444444	1.96305E-04
40	50	10	0.844444444	0.738888889	2.22552E-04
50	60	10	0.738888889	0.633333333	2.56918E-04
60	70	10	0.633333333	0.527777778	3.03869E-04
70	80	10	0.527777778	0.422222222	3.71906E-04
80	90	10	0.422222222	0.316666667	4.79470E-04
90	100	10	0.316666667	0.211111111	6.75775E-04
100	110	10	0.211111111	0.105555556	1.15525E-03
110	120	10	0.105555556	0.0	5.50689E-02

Table 14. Tellurium Metals, Barium and Strontium Group, Noble Metals, Cerium Group, and Lanthanide Group Leakage Rates from the Fuel During the Early In-Vessel Release Phase

Beginning Time, min	Ending Time, min	Interval Time, min	Beginning Activity Fraction in the Fuel	Ending Activity Fraction in the Fuel	Leakage Rate, fractions / sec
30	40	10	1.000	0.888888889	1.96305E-04
40	50	10	0.888888889	0.777777778	2.22552E-04
50	60	10	0.777777778	0.666666667	2.56918E-04
60	70	10	0.666666667	0.555555556	3.03869E-04
70	80	10	0.555555556	0.444444444	3.71906E-04
80	90	10	0.444444444	0.333333333	4.79470E-04
90	100	10	0.333333333	0.222222222	6.75775E-04
100	110	10	0.222222222	0.111111111	1.15525E-03
110	120	10	0.111111111	0.000000000	5.50689E-02

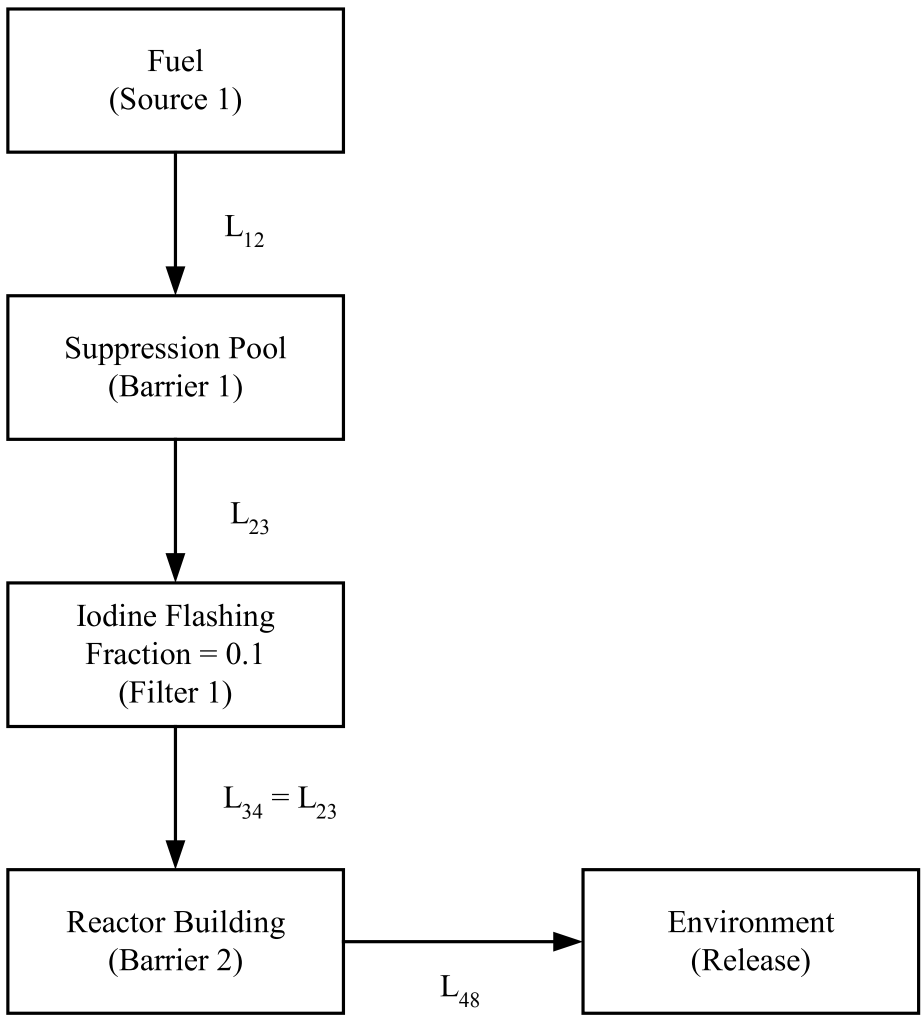


Figure 2. Reactor Building Airborne Activity Due to the ESF Leakage Pathway

5.1.2 ECCS Piping Containing Suppression Pool Water

The time-dependent activity in the suppression pool water contained within the two 12" ECCS pipe segments is divided into two groups based on different release fractions. The first group contains the halogens and alkali metals. The second group contains the tellurium metals, the barium and strontium group, the noble metals, the cerium group, and the lanthanides. The only removal mechanism for the activity in the suppression pool water is radio-decay.

For the first group (halogens and alkali metals), the leakage rates (L_{12} in Figure 3) from the fuel to the suppression pool are the same as those discussed in Section 5.1.1 and are listed in Table 12 for the gap release phase and Table 13 for the early in-vessel phase. At 2 hours post LOCA, the leakage rate (L_{12} in Figure 3) from the fuel to the suppression pool water is set to 0.0 for the duration of the 30 day accident period. The initial halogen scaling factor applied at time zero post LOCA is 1918.0 and the halogen scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 0.26316 (0.25/0.95). The initial alkali metal scaling factor applied at time zero post LOCA is 1918.0 and the alkali metal scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 0.21053 (0.20/0.95).

For the second group (tellurium metals, barium and strontium group, noble metals, cerium group, and lanthanides), the leakage rates (L_{12} in Figure 3) from the fuel to the suppression pool are the same as those discussed in Section 5.1.1. The leakage rate from the fuel to the suppression pool is set to 0.0 for the gap release phase (time less than 30 minutes post LOCA). The leakage rates from the fuel to the suppression pool during the early in-vessel phase (30 minutes to 2 hours post LOCA) are listed in Table 14. The leakage rate (L_{12} in Figure 3) from the fuel to the suppression pool is set to 0.0 for the gap release phase (time less than 30 minutes post LOCA). The leakage rates listed in Table 14 are based on 100% of the source being release to the suppression pool. Therefore, scaling factors are calculated for each group of nuclides by multiplying the core thermal power of 1918 MW_{th} by the group release fractions in Table 2. The initial scaling factor for the tellurium metals is 95.9 (0.05 * 1918), for the barium and strontium group is 38.36 (0.02 * 1918), for the noble metals is 4.795 (0.0025 * 1918), for the cerium group is 0.959 (0.0005 * 1918), and for the lanthanides is 0.3836 (0.0002 * 1918).

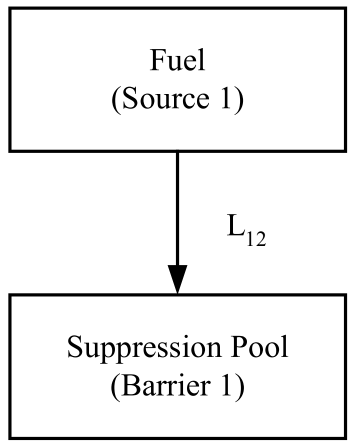


Figure 3. Suppression Pool Water Activity Transport Model

5.1.3 SGTS Filter

The direct dose to the Control Room from the buildup of activity on the SGTS filter is attributed to the primary containment and ESF system leakage pathways. Refer to Figure 4 for the discussion on the primary containment leakage pathway and Figure 5 for the discussion on the ESF system leakage pathway.

For the primary containment leakage pathway, the time-dependent airborne activity is divided into three groups based on different release fractions and natural deposition characteristics. The first group includes the elemental and organic halogens (5% of the total halogen inventory). The second group includes the particulate halogens (95% of the total halogen inventory) and alkali metals. The third group includes remaining particulate groups; tellurium metals, barium and strontium group, noble metals, cerium group, and lanthanides.

The leakage rates from the fuel to the primary containment (L_{12} in Figure 4) and the scaling factors for all three groups are the same as those discussed in Section 5.1.1 for the primary containment leakage pathway. The leakage rates from the fuel to the primary containment for the first (elemental and organic halogens) and second (particulate halogens and alkali metals) groups during the gap release phase are listed in Table 12 and during the early in-vessel phase are listed in Table 13. For the third group, the leakage rate from the fuel to the primary containment during the gap release phase (time less than 30 minutes) is set to 0.0 and during the early in-vessel phase the leakage rates are listed in Table 14. After the early in-vessel phase, the leakage rate from the fuel to the primary containment for all three groups is set to 0.0 for the duration of the 30 day accident period.

The time dependent natural deposition removal rates (S_1 in Figure 4) for particulates are listed in Equation 4. These removal rates are only applied to the second and third groups. No removal by natural deposition is credited for the first group containing the elemental and organic halogens.

From the primary containment, activity is transported directly to the SGTS filter with the primary containment leakage rates (L_{23} in Figure 4) calculated in Equation 5. The SGTS filter removal efficiency is set to 100% for all nuclides (except for the noble gases) for the duration of the 30 day accident period to maximize the buildup of activity on the filter. The filter removal efficiency for the noble gases is set to 0.0 for the duration of the 30 day accident period.

For the ESF system leakage pathway, only 10% of the halogens in the suppression pool water are released to the Reactor Building atmosphere with the remaining nuclide groups remaining in the suppression pool water. The time-dependent activity for the ESF system leakage pathway is divided into two groups based on different release fractions. The first group contains the halogens and the second group contains the tellurium metals group, which produces halogen daughter products.

For the first group (halogens), the leakage rates (L_{12} in Figure 5) from the fuel to the suppression pool are the same as those discussed above for the halogen group primary containment leakage pathway and are listed in Table 12 for the gap release phase and Table 13 for the early in-vessel phase. The initial halogen scaling factor applied at time zero post LOCA is 1918.0 and the halogen scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 0.26316 (0.25/0.95).

For the second group (tellurium metals), the leakage rates (L_{12} in Figure 5) from the fuel to the suppression pool are the same as those discussed above for the tellurium group primary containment leakage pathway and are listed in Table 14 for the early in-vessel phase. The leakage rate from the fuel to the suppression pool is set to 0.0 during the gap release phase (time less than 30 minutes post LOCA). The scaling factor applied to the tellurium metals group is 95.9 (1918 * 0.05).

The activity is transported from the suppression pool water through a filter compartment and into the Reactor Building atmosphere (L_{23} and L_{34} in Figure 5) with the leakage rate calculated in Equation 7. The filter compartment is used to account for the iodine flashing fraction of 0.1. The activity for all other isotopes passing through the filter compartment is multiplied by 0.0 to simulate the effect of keeping the activity in the suppression pool water. The leakage rate from the filter compartment to the Reactor Building, L_{34} in Figure 5, is equal to the leakage rate into the filter, L_{23}. The leakage rate from the Reactor Building to the SGTS filter (L_{45} in Figure 5) is set to an arbitrarily large value of 1000.0 fractions per second to account for no holdup or dilution within the Reactor Building.

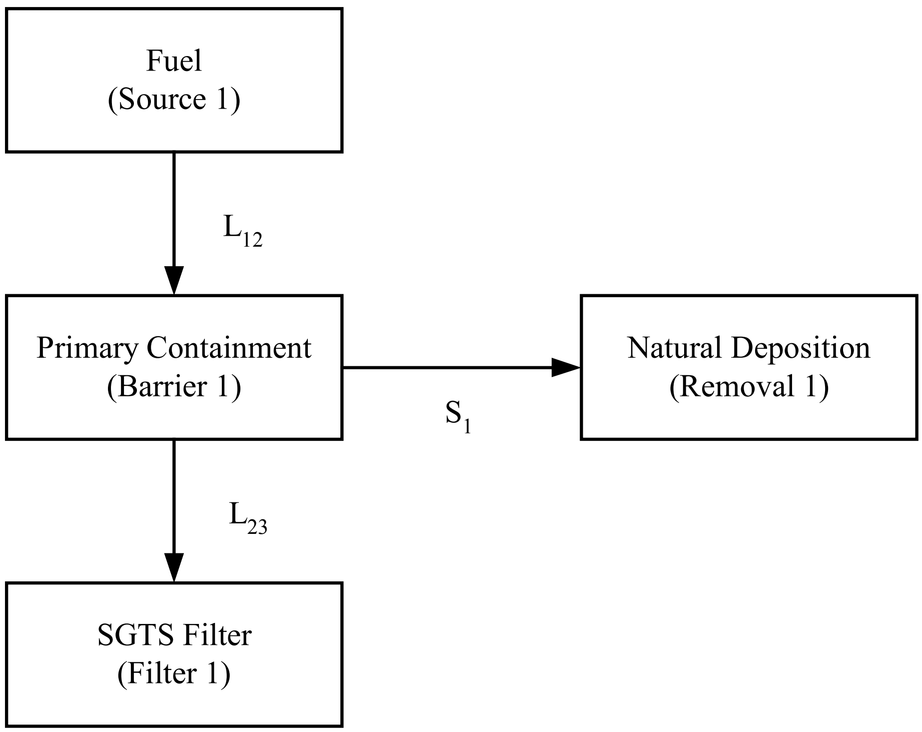


Figure 4. SGTS Filter Activity Due to the Primary Containment Leakage Pathway

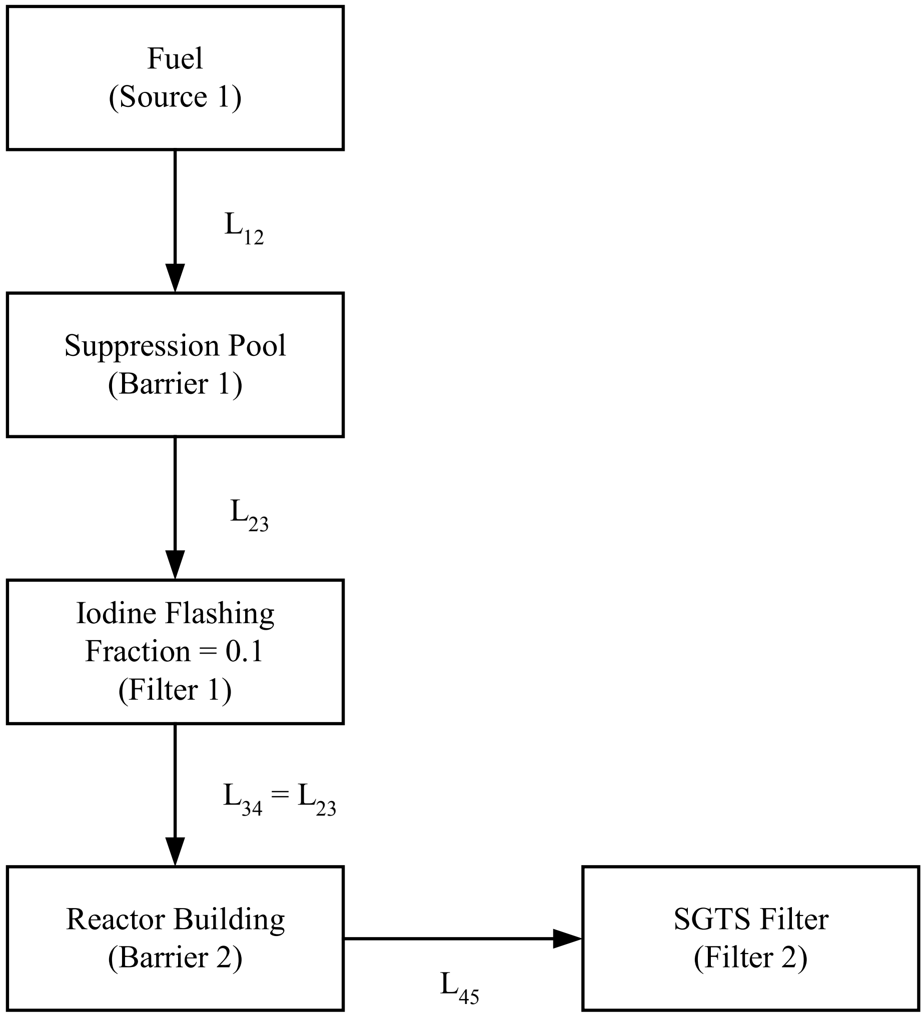


Figure 5. SGTS Filter Activity Due to the ESF System Leakage Pathway

5.1.4 CR and TSC Filters

The direct dose to the Control Room from the buildup of activity on the Control Room and TSC filters is attributed to the primary containment, ESF system, and MSIV/SCB leakage pathways. Refer to Figure 6 for the discussion on the primary containment leakage pathway, Figure 7 for the discussion on the ESF system leakage pathway, and Figure 8 for the discussion on the MSIV/SCB leakage pathway.

For the primary containment leakage pathway, the time-dependent airborne activity is divided into three groups based on different release fractions and natural deposition characteristics. The first group includes the elemental and organic halogens (5% of the total halogen inventory). The second group includes the particulate halogens (95% of the total halogen inventory) and alkali metals. The third group includes remaining particulate groups; tellurium metals, barium and strontium, noble metals, cerium group, and lanthanides.

The leakage rates from the fuel to the primary containment (L_{12} in Figure 6) and the scaling factors for all three groups are the same as those discussed in Section 5.1.1 for the primary containment leakage pathway. The leakage rates from the fuel to the primary containment for the first (elemental and organic halogens) and second (particulate halogens and alkali metals) groups during the gap release phase are listed in Table 12 and during the early in-vessel phase are listed in Table 13. For the third group, the leakage rate from the fuel to the primary containment during the gap release phase (time less than 30 minutes) is set to 0.0 and during the early in-vessel phase the leakage rates are listed in Table 14. After the early in-vessel phase, the leakage rate from the fuel to the primary containment for all three groups is set to 0.0 for the duration of the 30 day accident period.

The time dependent natural deposition removal rates (S_1 in Figure 6) for particulates are listed in Equation 4. These removal rates are only applied to the second and third groups. No removal by natural deposition is credited for the first group containing the elemental and organic halogens.

From the primary containment, activity is transported through a filter compartment and then to the atmosphere with the primary containment leakage rates (L_{23} and L_{34} in Figure 6) calculated in Equation 5. The activity passing through the filter compartment is adjusted to account for the SGTS filter removal efficiency, the atmospheric dispersion factors for the CR or TSC filters, and the CR or TSC filter outside air intake rate. These time-dependent adjustment factors for the CR and TSC filters are calculated as follows. Per Table 3, the SGTS filter removal efficiencies are 85% for the elemental and organic halogens, and 98% for the particulate halogens and remaining particulate groups. The atmospheric dispersion factors for the CR and TSC filters as well as the CR and TSC filter outside air intake flow rate are also listed in Table 3. The time dependent scaling factors applied to the activity passing through the filter compartment for the CR filter attributed to the primary containment leakage pathway are calculated using Equation 8 and are listed in Table

15. The time dependent scaling factors applied to the activity passing through the filter compartment for the TSC filter attributed to the primary containment leakage pathway are calculated using Equation 9 and listed in Table 16.

Equation 8

$$CR_i\ (t) = (1 - SGTS\ Eff_i) * \frac{X}{Q'}_{CR}(t) * \dot{F}_{CR}$$

Where: CR_i (t) is the CR filter scaling factor for nuclide group, i, at time, t, unitless; SGTS Eff_i is the SGTS filter removal efficiency for nuclide group, i, as listed in Table 3, unitless;

$\frac{X}{Q'}_{CR}(t)$ is the CR filter atmospheric dispersion factor at time, t, for the primary containment leakage pathway as listed in Table 3, sec/m^3;

$\dot{F}_{CR}$ is the CR outside air intake flow rate. The value listed in Table 3 is 1100 scfm. This value is divided by 35.314667 and by 60 to convert the units to m^3/sec. This results in a flow rate of 5.1914E-01 m^3/sec.

Equation 9

$$TSC_i\ (t) = (1 - SGTS\ Eff_i) * \frac{X}{Q'}_{TSC}(t) * \dot{F}_{TSC}$$

Where: TSC_i (t) is the TSC filter scaling factor for nuclide group, i, at time, t, unitless; SGTS Eff_i is the SGTS filter removal efficiency for nuclide group, i, as listed in Table 3 unitless;

$\frac{X}{Q'}_{TSC}(t)$ is the TSC filter atmospheric dispersion factor at time, t, for the primary containment leakage pathway as listed in Table 3, sec/m^3;

$\dot{F}_{TSC}$ is the TSC outside air intake flow rate. The value listed in Table 3 is 1100 scfm. This value is divided by 35.314667 and by 60 to convert the units to m^3/sec. This results in a flow rate of 5.1914E-01 m^3/sec.

The leakage rate from the atmosphere to the CR or TSC filter (L_{45} in Figure 6) is set to an arbitrarily large value of 1000.0 fractions/sec to account for no holdup or dilution within the atmosphere. The CR and TSC filter removal efficiency is set to 100% for all nuclides (except for the noble gases) for the duration of the 30 day accident period to maximize the buildup of activity on the filters. The filter removal efficiency for the noble gases is set to 0.0 for the duration of the 30 day accident period.

The time-dependent activity for the ESF system leakage pathway is divided into two groups based on different release fractions. The first group contains the halogens and the second group contains the tellurium metals group, which produces halogen daughter products.

For the first group (halogens), the leakage rates (L_{12} in Figure 7) from the fuel to the suppression pool are the same as those discussed above for the halogen group primary containment leakage pathway and are listed in Table 12 for the gap release phase and Table 13 for the early in-vessel phase. The initial halogen scaling factor applied at time zero post LOCA is 1918.0 and the halogen scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 0.26316 (0.25/0.95).

For the second group (tellurium metals), the leakage rates (L_{12} in Figure 7) from the fuel to the suppression pool are the same as those discussed above for the tellurium group primary containment leakage pathway and are listed in Table 14 for the early in-vessel phase. The leakage rate from the fuel to the suppression pool is set to 0.0 during the gap release phase (time less than 30 minutes post LOCA). The scaling factor applied to the tellurium metals group is 95.9 (1918 * 0.05).

The activity is transported from the suppression pool water through a filter compartment into the atmosphere (L_{23} and L_{34} in Figure 7) with the leakage rate calculated in Equation 7. The activity passing through the filter compartment is adjusted to account for the halogen flashing fraction of 0.1, the SGTS filter removal efficiency, the atmospheric dispersion factors for the CR and TSC filters, and the CR and TSC filter outside air intake rate. The scaling factor for the halogens are calculated using Equation 8 and Equation 9, with an additional factor of 0.1 to account for the halogen flashing fraction. Per Appendix A, Section 5.6 of Reference 7.2, the radioiodine that is available for release to the environment from the ESF system leakage pathway is assumed to be 97% elemental and 3% organic. Therefore, the 0.1 multiplier is applied to the elemental and organic halogen scaling factors and not the particulate halogen scaling factors. The scaling factors for all other nuclides passing through the filter compartment are set to 0.0 to simulate the effect of keeping the activity in the suppression pool. The time dependent scaling factors applied to the activity passing through the filter compartment for the CR filter attributed to the ESF system leakage pathway are listed in Table 17. The time dependent scaling factors applied to the activity passing through the filter compartment for the TSC filter attributed to the ESF system leakage pathway are listed in Table 18.

The leakage rate from the filter compartment to the atmosphere, L_{34} in Figure 7, is equal to the leakage rate into the filter, L_{23}. The leakage rate from the atmosphere to the CR or TSC filter (L_{45} in Figure 7) is set to an arbitrarily large value of 1000.0 fractions per second to account for no holdup or dilution within the atmosphere. The CR and TSC filter removal efficiency is set to 100% for all nuclides (except for the noble gases) for the duration of the 30 day accident period to

maximize the buildup of activity on the filters. The filter removal efficiency for the noble gases is set to 0.0 for the duration of the 30 day accident period.

The time-dependent activity for the MSIV/SCB leakage pathway is divided into four groups based on different release fractions, natural deposition characteristics, and condenser removal efficiencies. The first group includes the elemental halogens (4.85% of the total halogen inventory). The second group includes the organic halogens (0.15% of the total halogen inventory). The third group includes the particulate halogens (95% of the total halogen inventory) and the alkali metals. The fourth group includes remaining particulate groups; tellurium metals, barium and strontium, noble metals, cerium group, and lanthanides.

For the first, second, and third groups, the leakage rates (L_{12} in Figure 8) from the fuel to the primary containment are the same as those discussed above for the primary containment leakage pathway and are listed in Table 12 for the gap release phase and Table 13 for the early in-vessel phase. The leakage rate from the fuel to the primary containment after the early in-vessel phase is set to 0.0 for the remainder of the 30 day accident period. The initial halogen scaling factor applied to the first group at time zero post LOCA is 93.023 (1918 *0.0485), for the second group is 2.877 (1918 * 0.0015), and for the third group is 1822.1 (1918 * 0.95). The halogen scaling factor applied for the first, second, and third group at the start of the early in-vessel phase (30 minutes post LOCA) is 0.26316 (0.25/0.95). The initial alkali metal scaling factor applied at time zero post LOCA is 1918.0 and the scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 0.21053 (0.20/0.95).

For the fourth group (tellurium metals, barium and strontium, noble metals, cerium group, and lanthanides), the leakage rates (L_{12} in Figure 8) from the fuel to the primary containment are the same as those discussed above for the primary containment leakage pathway and are listed in Table 14 for the early in-vessel phase. The leakage rate from the fuel to the suppression pool is set to 0.0 during the gap release phase (time less than 30 minutes post LOCA) and after the early in-vessel phase for the duration of the 30 day accident period. The initial scaling factor for the tellurium metals is 95.9 (0.05 * 1918), for the barium and strontium group is 38.36 (0.02 * 1918), for the noble metals is 4.795 (0.0025 * 1918), for the cerium group is 0.959 (0.0005 * 1918), and for the lanthanides is 0.3836 (0.0002 * 1918).

The time dependent natural deposition removal rates (S_1 in Figure 8) for particulates are listed in Equation 4. These removal rates are only applied to the third and fourth groups. No removal by natural deposition is credited for the first and second groups containing the elemental and organic halogens.

The leakage rate from the primary containment to the condenser (L_{23} in Figure 8) is taken as the sum of the MSIV leakage rate and the SCB leakage rate. Per Table 5, the SCB leakage rate is 35.2 scfh, which is equivalent to 0.0922% per day, and the MSIV leakage rate is 200 scfh. The leakage rates used as input into RUNT-PC are required to have units of fractions per second. The total leakage rate of 235.2 scfh is converted to fractions per second by taking the ratio of 235.2 scfh to 35.2 scfh and multiplying by 0.0922% per day. This results in a leakage rate of 0.6161% per day or 7.13079E-08 fractions per second. This is the leakage rate from primary containment to the condenser for time less than 24 hours post LOCA. Per Table 5, the initial leakage rate is reduced by 0.6455 from 24 hours to 74 hours post LOCA and by 0.5 from 74 hours to 30 days post LOCA. Therefore, the leakage rate from primary containment to the condenser is 4.60292E-08 fractions per second (7.13079E-08 * 0.6455) from 24 hours to 74 hours post LOCA and 3.56539E-08 fractions per second (7.13079E-08 * 0.5) from 74 hours to 30 days post LOCA.

From the primary containment, activity is transported through a filter compartment and then to the atmosphere with the primary containment leakage rates (L_{23} and L_{34} in Figure 8) calculated in the previous paragraph. The activity passing through the filter compartment is adjusted to account for the condenser removal efficiency, the atmospheric dispersion factors for the CR or TSC filters, and the CR or TSC filter outside air intake rate. These time-dependent adjustment factors for the CR and TSC filters are calculated in Equation 10 and Equation 11, respectively. The condenser removal efficiency, atmospheric dispersion factors for the CR and TSC filters, and the CR and TSC filter outside air intake flow rate are listed in Table 5. The time dependent scaling factors applied to the activity passing through the filter compartment for the CR filter attributed to the MSIV/SCB leakage pathway are listed in Table 19. The time dependent scaling factors applied to the activity passing through the filter compartment for the TSC filter attributed to the MSIV/SCB leakage pathway are listed in Table 20.

Equation 10
$$CR_i\,(t) = (1 - Condenser\ Eff_i\,(t)) * \frac{X}{Q'}_{CR}(t) * \dot{F}_{CR}$$

Where: CR_i (t) is the CR filter scaling factor for nuclide group, i, at time, t, unitless;
Condenser Eff_i (t) is the condenser removal efficiency for nuclide group, i, at time, t, as listed in Table 5, unitless;
$\frac{X}{Q'}_{CR}(t)$ is the CR filter atmospheric dispersion factor at time, t, for the MSIV/SCB leakage pathway as listed in Table 5, sec/m^3;
$\dot{F}_{CR}$ is the CR outside air intake flow rate. The value listed in Table 5 is 1100 scfm. This value is divided by 35.314667 and by 60 to convert the units to m^3/sec. This results in a flow rate of 5.1914E-01 m^3/sec.

Equation 11

$$TSC_i(t) = (1 - Condenser\ Eff_i(t)) * \frac{X}{Q'}_{TSC}(t) * \dot{F}_{TSC}$$

Where: $TSC_i(t)$ is the TSC filter scaling factor for nuclide group, i, at time, t, unitless;
Condenser $Eff_i(t)$ is the condenser filter removal efficiency for nuclide group, i, at time, t, as listed in Table 5, unitless;
$\frac{X}{Q'}_{TSC}(t)$ is the TSC filter atmospheric dispersion factor at time, t, for the primary containment leakage pathway as listed in Table 5, sec/m^3;
$\dot{F}_{TSC}$ is the TSC outside air intake flow rate. The value listed in Table 5 is 1100 scfm. This value is divided by 35.314667 and by 60 to convert the units to m^3/sec. This results in a flow rate of 5.1914E-01 m^3/sec.

The leakage rate from the atmosphere to the CR or TSC filter (L_{45} in Figure 8) is set to an arbitrarily large value of 1000.0 fractions/sec to account for no holdup or dilution within the atmosphere. The CR and TSC filter removal efficiency is set to 100% for all nuclides (except for the noble gases) for the duration of the 30 day accident period to maximize the buildup of activity on the filters. The filter removal efficiency for the noble gases is set to 0.0 for the duration of the 30 day accident period.

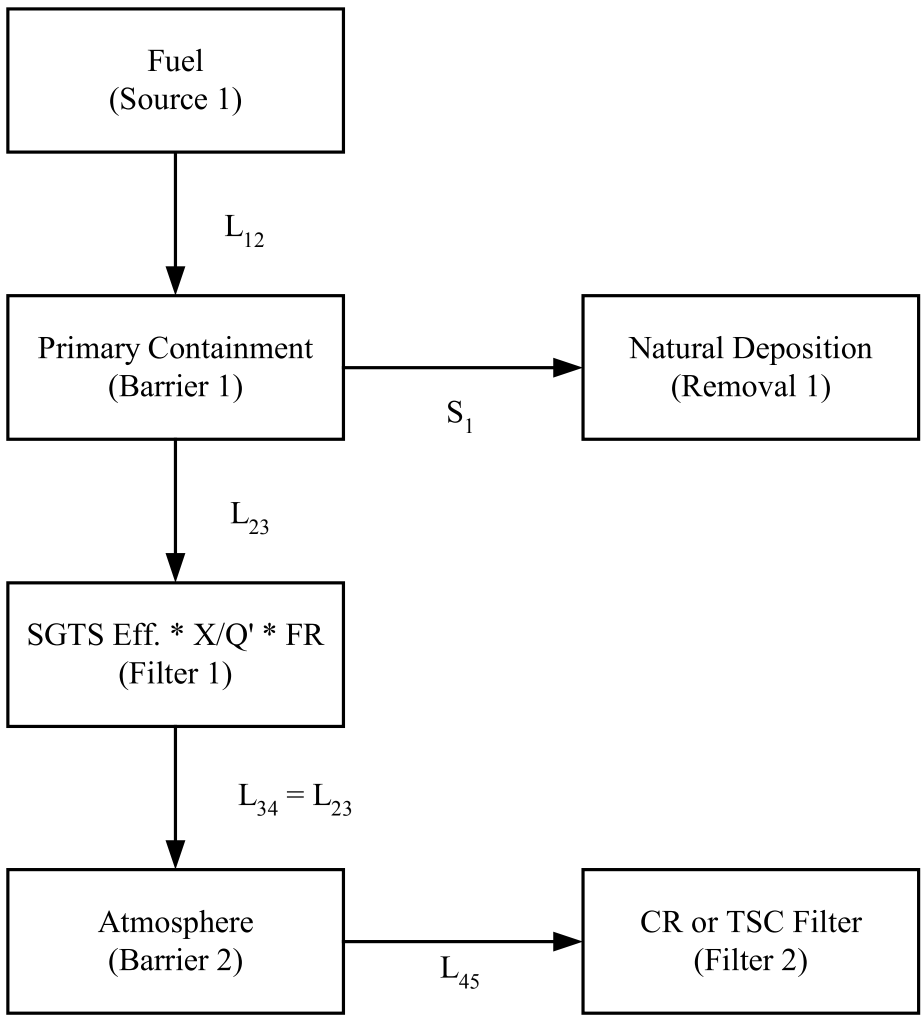


Figure 6. CR and TSC Filter Activity Due to the Primary Containment Leakage Pathway

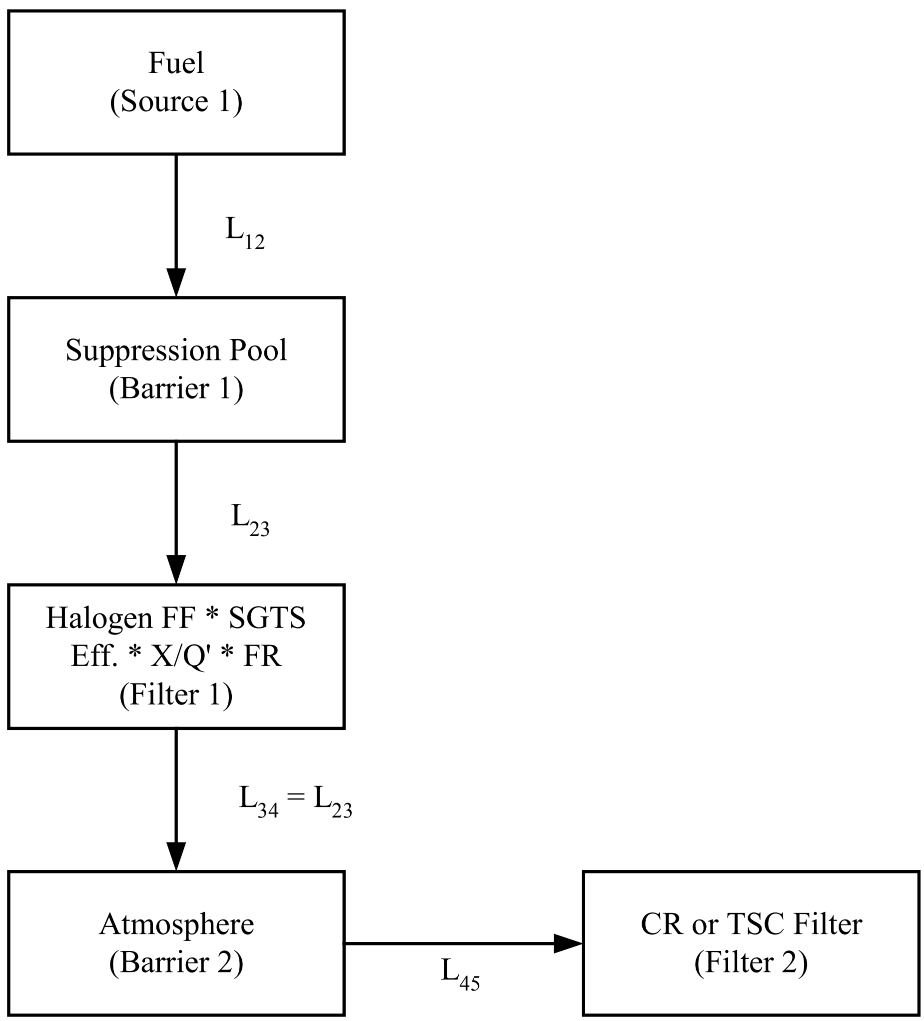


Figure 7. CR and TSC Filter Activity Due to the ESF System Leakage Pathway

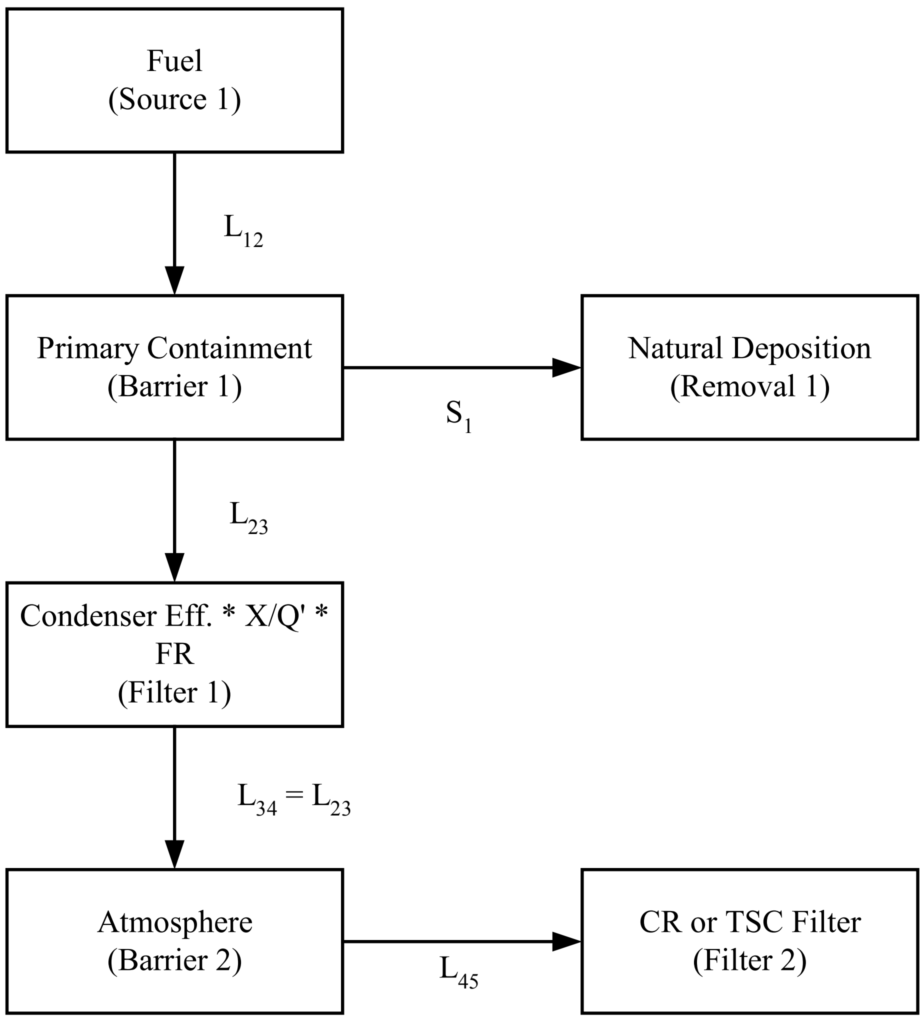


Figure 8. CR and TSC Filter Activity Due to the MSIV/SCB Leakage Pathway

Table 15. Time Dependent Scaling Factors (Unitless) for the CR Filter Activity for the Primary Containment Leakage Pathway

Time Period	Noble Gases	Elemental/Organic Halogens	Particulates
0 to 3 min	5.1914E-03	5.1914E-03	5.1914E-03
3 min to 2 hrs	1.9364E-06	2.9046E-07	3.8728E-08
2 hrs to 8 hrs	2.9176E-07	4.3764E-08	5.8352E-09
8 hrs to 24 hrs	1.1421E-07	1.7132E-08	2.2842E-09
1 day to 4 days	1.4951E-08	2.2427E-09	2.9903E-10
4 days to 30 days	8.0986E-10	1.2148E-10	1.6197E-11

Table 16. Time Dependent Scaling Factors (Unitless) for the TSC Filter Activity for the Primary Containment Leakage Pathway

Time Period	Noble Gases	Elemental/Organic Halogens	Particulates
0 to 3 min	9.9156E-03	9.9156E-03	9.9156E-03
3 min to 2 hrs	2.2323E-06	3.3485E-07	4.4646E-08
2 hrs to 8 hrs	3.2914E-07	4.9370E-08	6.5827E-09
8 hrs to 24 hrs	1.2823E-07	1.9234E-08	2.5646E-09
1 day to 4 days	1.6509E-08	2.4763E-09	3.3017E-10
4 days to 30 days	8.7216E-10	1.3082E-10	1.7443E-11

Table 17. Time Dependent Scaling Factors (Unitless) for the CR Filter Activity for the ESF System Leakage Pathway

Time Period	Noble Gases	Elemental/Organic Halogens	Particulates
0 to 3 min	0.0	5.1914E-04	0.0
3 min to 2 hrs	0.0	2.9046E-08	0.0
2 hrs to 8 hrs	0.0	4.3764E-09	0.0
8 hrs to 24 hrs	0.0	1.7132E-09	0.0
1 day to 4 days	0.0	2.2427E-10	0.0
4 days to 30 days	0.0	1.2148E-11	0.0

Table 18. Time Dependent Scaling Factors (Unitless) for the TSC Filter Activity for the ESF System Leakage Pathway

Time Period	Noble Gases	Elemental/Organic Halogens	Particulates
0 to 3 min	0.0	9.9156E-04	0.0
3 min to 2 hrs	0.0	3.3485E-08	0.0
2 hrs to 8 hrs	0.0	4.9370E-09	0.0
8 hrs to 24 hrs	0.0	1.9234E-09	0.0
1 day to 4 days	0.0	2.4763E-10	0.0
4 days to 30 days	0.0	1.3082E-11	0.0

Table 19. Time Dependent Scaling Factors (Unitless) for the CR Filter Activity for the MSIV/SCB Leakage Pathway

Time Period	Noble Gases/Organic Halogens	Elemental and Particulate Halogens / Particulates
0 to 2 hrs	1.3030E-03	1.7968E-05
2 hrs to 8 hrs	8.9812E-04	1.2384E-05
8 hrs to 24 hrs	3.5613E-04	4.9107E-06
24 hrs to 74 hrs	2.4400E-04	2.1823E-06
74 hrs to 4 days	2.4400E-04	1.6938E-06
4 days to 30 days	1.8274E-04	1.2686E-06

Table 20. Time Dependent Scaling Factors (Unitless) for the TSC Filter Activity for the MSIV/SCB Leakage Pathway

Time Period	Noble Gases/Organic Halogens	Elemental and Particulate Halogens / Particulates
0 to 2 hrs	1.9208E-03	2.6486E-05
2 hrs to 8 hrs	1.3965E-03	1.9256E-05
8 hrs to 24 hrs	5.5548E-04	7.6595E-06
24 hrs to 74 hrs	3.7326E-04	3.3385E-06
74 hrs to 4 days	3.7326E-04	2.5912E-06
4 days to 30 days	2.9851E-04	2.0722E-06

5.1.5 External Cloud

The direct dose to the Control Room from the activity in the external cloud immediately surrounding the Control Room is attributed to the primary containment, ESF system, and MSIV/SCB leakage pathways. Refer to Figure 9 for the discussion on the primary containment leakage pathway, Figure 10 for the discussion on the ESF system leakage pathway, and Figure 11 for the discussion on the MSIV/SCB leakage pathway.

For the primary containment leakage pathway, the time-dependent airborne activity is divided into three groups based on different release fractions and natural deposition characteristics. The first group includes the noble gases and the elemental and organic halogens (5% of the total halogen inventory). The second group includes the particulate halogens (95% of the total halogen inventory) and alkali metals. The third group includes remaining particulate groups; tellurium metals, barium and strontium, noble metals, cerium group, and lanthanides.

The leakage rates from the fuel to the primary containment (L_{12} in Figure 9) and the scaling factors for all three groups are the same as those discussed in Section 5.1.1 for the primary containment leakage pathway. The leakage rates from the fuel to the primary containment for the first (noble gases and elemental and organic halogens) and second (particulate halogens and alkali metals) groups during the gap release phase are listed in Table 12 and during the early in-vessel phase are listed in Table 13. For the third group, the leakage rate from the fuel to the primary containment during the gap release phase (time less than 30 minutes) is set to 0.0 and during the early in-vessel phase are listed in Table 14. After the early in-vessel phase, the leakage rate from the fuel to the primary containment for all three groups is set to 0.0 for the duration of the 30 day accident period.

The time dependent natural deposition removal rates (S_1 in Figure 9) for particulates are listed in Equation 4. These removal rates are only applied to the second and third groups. No removal by natural deposition is credited for the first group containing the noble gases and elemental and organic halogens.

From the primary containment, activity is transported through a filter compartment and then to the atmosphere with the primary containment leakage rates (L_{23} and L_{38} in Figure 9) calculated in Equation 5. The activity passing through the filter compartment is adjusted to account for the SGTS filter removal efficiency and the atmospheric dispersion factors. The activity for the external cloud is taken from the Release Compartment in Figure 9. Per Page 4-11 of Reference 7.1, the compartment inventories for the Release Compartment are in units of curies (Ci) per second. The time-dependent adjustment factors are calculated by multiplying the complement of the SGTS filter removal efficiency (Table 3) by the time dependent atmospheric dispersion factors (sec/m^3) also listed in Table 3. This results in the units on the scaling factors of sec/m^3 and the units for the Release Compartment are Ci/m^3. The activity in the Release Compartment is multiplied by the volume of each section of the external cloud in the shielding and dose rate portion of RUNT-PC to

obtain total curies of activity. Refer to Section 5.2.7 for the calculation of the volume of each section of the external cloud. The time dependent scaling factors applied to the filter compartment for the primary containment leakage pathway are listed in Table 21.

The time-dependent activity for the ESF system leakage pathway is divided into two groups based on different release fractions. The first group contains the halogens and the second group contains the tellurium metals group, which produces halogen daughter products.

For the first group (halogens), the leakage rates (L_{12} in Figure 10) from the fuel to the suppression pool are the same as those discussed above for the halogen group primary containment leakage pathway and are listed in Table 12 for the gap release phase and Table 13 for the early in-vessel phase. The initial halogen scaling factor applied at time zero post LOCA is 1918.0 and the halogen scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 0.26316 (0.25/0.95).

For the second group (tellurium metals), the leakage rates (L_{12} in Figure 10) from the fuel to the suppression pool are the same as those discussed above for the tellurium group primary containment leakage pathway and are listed in Table 14 for the early in-vessel phase. The leakage rate from the fuel to the suppression pool is set to 0.0 during the gap release phase (time less than 30 minutes post LOCA). The scaling factor applied to the tellurium metals group is 95.9 (1918 * 0.05).

The activity is transported from the suppression pool water through a filter compartment into the atmosphere (L_{23} and L_{38} in Figure 10) with the leakage rate calculated in Equation 7. The activity passing through the filter compartment is adjusted to account for the halogen flashing fraction of 0.1, the SGTS filter removal efficiency and the atmospheric dispersion factors. The scaling factor for the halogens are the same as those discussed above for the primary containment leakage pathway, with an additional factor of 0.1 to account for the halogen flashing fraction. Per Appendix A, Section 5.6 of Reference 7.2, the radioiodine that is available for release to the environment from the ESF system leakage pathway is assumed to be 97% elemental and 3% organic. Therefore, the 0.1 multiplier is applied to the elemental and organic halogen scaling factors and not the particulate halogen scaling factors. The scaling factors for all other nuclides passing through the filter compartment are set to 0.0 to simulate the effect of keeping the activity in the suppression pool. The time dependent scaling factors applied to the activity passing through the filter compartment are listed in Table 22. As for the primary containment leakage pathway above, the scaling factors are in units of sec/m^3 and the units in the Release Compartment are Ci/m^3. The activity in the Release Compartment is multiplied by the volume of each section of the external cloud in the shielding and dose rate portion of RUNT-PC to obtain total curies of activity. Refer to Section 5.2.7 for the calculation of the volume of each section of the external cloud.

The time-dependent activity for the MSIV/SCB leakage pathway is divided into four groups based on different release fractions and natural deposition characteristics. The first group includes the elemental halogens (4.85% of the total halogen inventory). The second group includes the noble gases and organic halogens (0.15% of the total halogen inventory). The third group includes the particulate halogens (95% of the total halogen inventory) and the alkali metals. The fourth group includes remaining particulate groups; tellurium metals, barium and strontium, noble metals, cerium group, and lanthanides.

For the first, second, and third groups, the leakage rates (L_{12} in Figure 11) from the fuel to the primary containment are the same as those discussed above for the primary containment leakage pathway and are listed in Table 12 for the gap release phase and Table 13 for the early in-vessel phase. The leakage rate from the fuel to the primary containment after the early in-vessel phase is set to 0.0 for the remainder of the 30 day accident period. The initial noble gas scaling factor applied at time zero post LOCA is 1918.0 and the scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 1.0 (0.95/0.95). The initial halogen scaling factor applied to the first group at time zero post LOCA is 93.023 (1918 *0.0485), for the second group is 2.877 (1918 * 0.0015), and for the third group is 1822.1 (1918 * 0.95). The halogen scaling factor applied for the first, second, and third group at the start of the early in-vessel phase (30 minutes post LOCA) is 0.26316 (0.25/0.95). The initial alkali metal scaling factor applied at time zero post LOCA is 1918.0 and the scaling factor applied at the start of the early in-vessel phase (30 minutes post LOCA) is 0.21053 (0.20/0.95).

For the fourth group (tellurium metals, barium and strontium, noble metals, cerium group, and lanthanides), the leakage rates (L_{12} in Figure 11) from the fuel to the primary containment are the same as those discussed above for the primary containment leakage pathway and are listed in Table 14 for the early in-vessel phase. The leakage rate from the fuel to the suppression pool is set to 0.0 during the gap release phase (time less than 30 minutes post LOCA) and after the early in-vessel phase for the duration of the 30 day accident period. The initial scaling factor for the tellurium metals is 95.9 (0.05 * 1918), for the barium and strontium group is 38.36 (0.02 * 1918), for the noble metals is 4.795 (0.0025 * 1918), for the cerium group is 0.959 (0.0005 * 1918), and for the lanthanides is 0.3836 (0.0002 * 1918).

The time dependent natural deposition removal rates (S_1 in Figure 11) for particulates are listed in Equation 4. These removal rates are only applied to the third and fourth groups. No removal by natural deposition is credited for the first and second groups containing the noble gases and elemental and organic halogens.

The leakage rates from the primary containment to the condenser (L_{23} in Figure 11) are the same as those calculated in Section 5.1.4 for the MSIV/SCB leakage pathway. From 0 to 24 hours post LOCA, the leakage rate is 7.13079E-08 fractions per second. From 24 to 74 hours post LOCA, the leakage rate is 4.60292E-08 fractions per second. From 74 hours to 30 days post LOCA, the leakage rate is 3.56539E-08 fractions per second.

From the primary containment, activity is transported through a filter compartment and then to the atmosphere with the primary containment leakage rates (L_{23} and L_{38} in Figure 11) as discussed in the previous paragraph. The activity passing through the filter compartment is adjusted to account for the condenser removal efficiency and the atmospheric dispersion factors. The condenser removal efficiency and atmospheric dispersion factors are listed in Table 5. The time-dependent adjustment factors are calculated by multiplying the complement of the condenser removal efficiency (Table 5) by the time dependent atmospheric dispersion factors (sec/m^3) also listed in Table 5. The time dependent scaling factors applied to the activity passing through the filter compartment are listed in Table 23. As for the primary containment and ESF system leakage pathways above, the scaling factors are in units of sec/m^3 and the units in the Release Compartment are Ci/m^3. The activity in the Release Compartment is multiplied by the volume of each section of the external cloud in the shielding and dose rate portion of RUNT-PC to obtain total curies of activity. Refer to Section 5.2.7 for the calculation of the volume of each section of the external cloud.

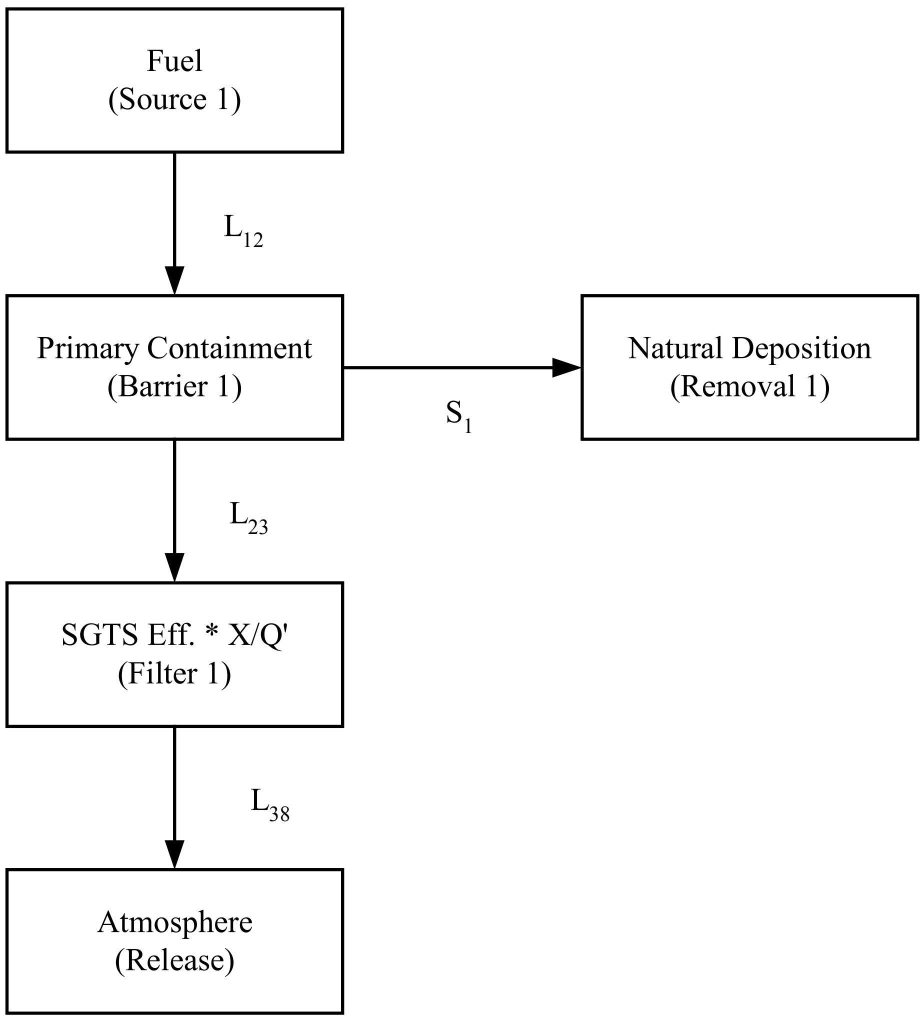


Figure 9. External Cloud Activity Due to the Primary Containment Leakage Pathway

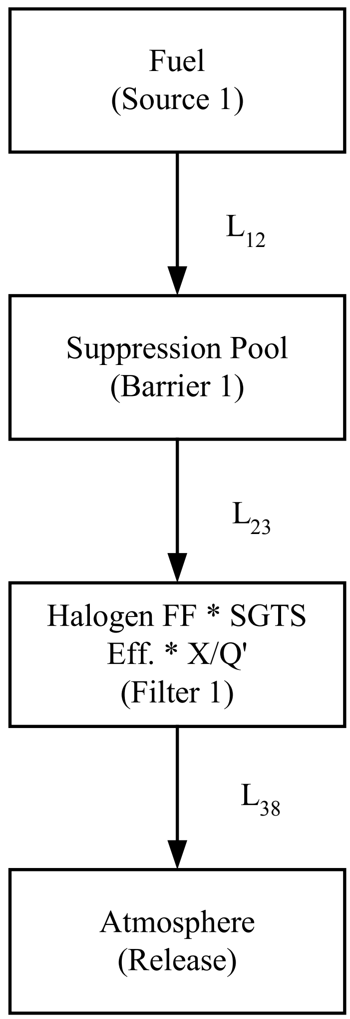


Figure 10. External Cloud Activity Due to the ESF System Leakage Pathway

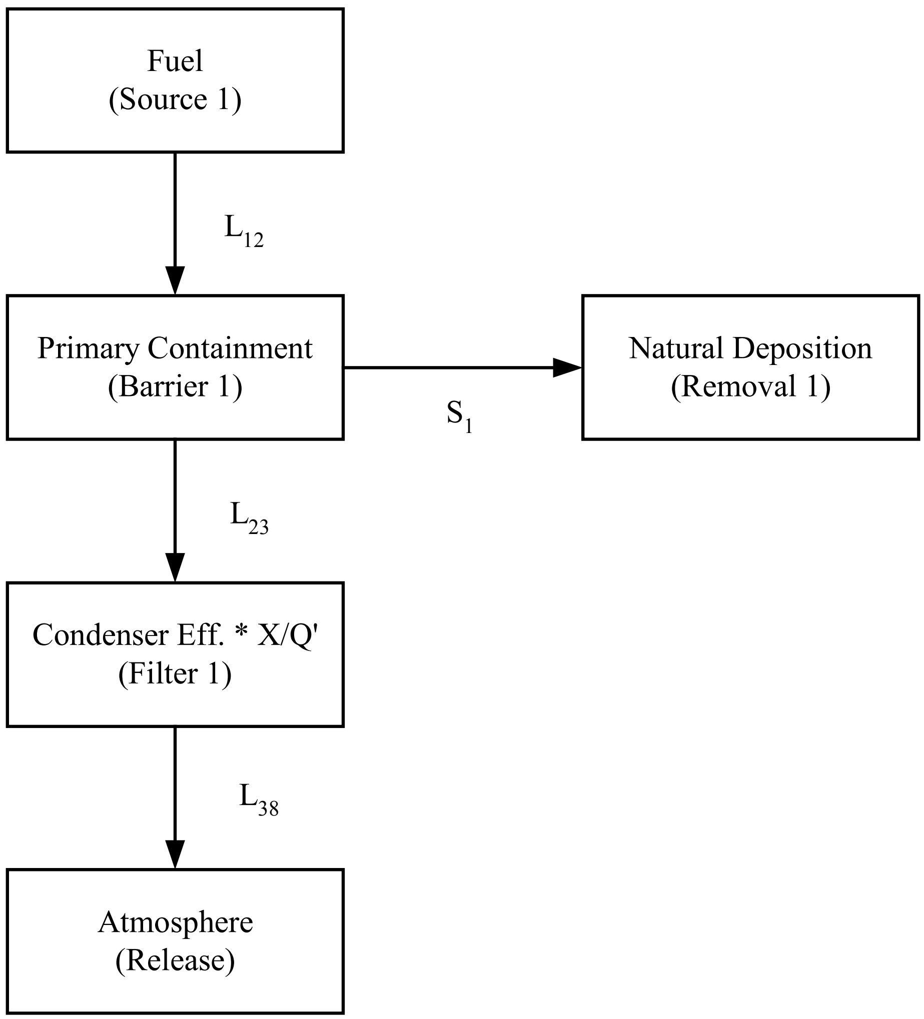


Figure 11. External Cloud Activity Due to the MSIV/SCB Leakage Pathway

Table 21. Time Dependent Scaling Factors (sec/m^3) for the External Cloud Activity Attributed to the Primary Containment Leakage Pathway

Time Period	Noble Gases	Elemental/Organic Halogens	Particulates
0 to 3 min	1.9100E-02	1.9100E-02	1.9100E-02
3 min to 2 hrs	4.3000E-06	6.4500E-07	8.6000E-08
2 hrs to 8 hrs	6.3400E-07	9.5100E-08	1.2680E-08
8 hrs to 24 hrs	2.4700E-07	3.7050E-08	4.9400E-09
1 day to 4 days	3.1800E-08	4.7700E-09	6.3600E-10
4 days to 30 days	1.6800E-09	2.5200E-10	3.3600E-11

Table 22. Time Dependent Scaling Factors (sec/m^3) for the External Cloud Activity Attributed to the ESF System Leakage Pathway

Time Period	Noble Gases	Elemental/Organic Halogens	Particulates
0 to 3 min	0.0	1.9100E-03	0.0
3 min to 2 hrs	0.0	6.4500E-08	0.0
2 hrs to 8 hrs	0.0	9.5100E-09	0.0
8 hrs to 24 hrs	0.0	3.7050E-09	0.0
1 day to 4 days	0.0	4.7700E-10	0.0
4 days to 30 days	0.0	2.5200E-11	0.0

Table 23. Time Dependent Scaling Factors (sec/m^3) for the External Cloud Activity Attributed to the MSIV/SCB Leakage Pathway

Time Period	Noble Gases/Organic Halogens	Elemental and Particulate Halogens/Particulates
0 to 2 hrs	3.7000E-03	5.1019E-05
2 hrs to 8 hrs	2.6900E-03	3.7092E-05
8 hrs to 24 hrs	1.0700E-03	1.4754E-05
24 hrs to 74 hrs	7.1900E-04	6.4307E-06
74 hrs to 4 days	7.1900E-04	4.9913E-06
4 days to 30 days	5.7500E-04	3.9917E-06

5.2 Shielding Geometry Models

The shielding geometry models for the Reactor Building and Control Building, as well as the remainder of the external radiation sources contributing to the Control Room external dose are discussed in the following sections.

5.2.1 Reactor Building

The geometry models for the Reactor Building from Elevation 935'-0" to Elevation 1027'-8" (Refueling Floor) are illustrated in Figure 12 through Figure 16. In Figure 12 through Figure 16, the numbers in triangles represent the boundary numbers and the numbers in circles represent the zone numbers. The dimensions used in Figure 12 through Figure 16 are obtained using the data in Table 6. The material composition for each zone (numbers in circles) in Figure 12 through Figure 16 is listed in Table 24. Due to the orientation of the Reactor Building and the Control Building, the distance from Surface 3 to Surface 4 in the East-West direction is calculated in Equation 12 to conserve the free air volume below Elevation 1027'-8". Per Table 3, the secondary containment free air volume is 1.68E+06 ft^3 and the refueling floor free air volume is 655780.7 ft^3. The refueling floor is at Elevation 1027'-8" and extends to Elevation 1073'-8". Therefore, the secondary containment free air volume below Elevation 1027'-8" is 1.024E+06 ft^3 (1.68E+06 – 655780.7)

Equation 12 [(962'-6" – 935'-0") * (135') * (X)] +

[((985'-6" – 962'-6") * (103'-9") * (X)) + ((985'-6" – 962'-6") * (30'-3") * (X + 6"))] +

[((1001'-2" – 985'-6") * (41'-9") * (X + 6")) + ((1001'-2" – 985'-6") * (52') * (X)) +

((1001'-2" – 985'-6") * (40'-9") * (X + 6"))] +

[((1027'-8" – 1001'-2") * (41'-9") * (X + 6")) + ((1027'-8" – 1001'-2") * (52') * (X)) +

((1027'-8" – 1001'-2") * (9'-6") * (X + 6"))] = 1.024E+06 ft^3

The distance from Surface 3 to Surface 4 in the East-West direction is calculated by solving Equation 12 for X. Solving Equation 12 for X yields a distance from Surface 3 to Surface 4 of 87.85 feet. Therefore, the distance from the origin to the West Wall is 20.6 feet (87.85 –67'-3").

For the refueling floor in the Reactor Building, the distance from Surface 7 to Surface 23 (refer to Figure 16) in the East-West direction is calculated in Equation 13 to conserve the refueling floor free air volume. Solving Equation 13 for X yields a distance from Surface 7 to Surface 23 of 135.34 feet. Therefore, the distance from the origin to the West Wall on the refueling floor is 66.59 feet (135.34 – 68'-9").

Equation 13 $(1073'\text{-}8'' - 1027'\text{-}8'') * (105'\text{-}4'') * (X) = 655780.7\ ft^3$

Due to the configuration of the Reactor Building, the airborne activity within the Reactor Building is divided into three source regions based on elevation: 1) Elevations 935'-0" to Elevation 1001'-2", 2) Elevation 1001'-2" to Elevation 1027'-8", and 3) the refueling floor, Elevation 1027'-8" to Elevation 1073'-8". Scaling factors are applied to the doses from each source region to account for the volume of each source region. The scaling factors for each of the three source regions are calculated by taking the ratio of the volume of each of the source regions to the total volume of secondary containment (1.68E+06 ft^3). The first source region is composed of Zones 1, 6, 7, 13, 14, and 15 (refer to Figure 12 through Figure 14). The total volume of Zones 1, 6, 7, 13, 14, and 15 is 7.827E+05 ft^3. Therefore, the scaling factor for Source Region 1 in the Reactor Building is 0.466 (7.827E+05 / 1.68E+06). The second source region is composed of Zones 22, 23, and 24 (refer to Figure 15). The total volume of Zones 22, 23, and 24 is 2.411E+05 ft^3. Therefore, the scaling factor for Source Region 2 in the Reactor Building is 0.144 (2.411E+05 / 1.68E+06). The third source region is composed of Zone 31 (refer to Figure 16). The total volume of Zone 31 is 6.558E+05 ft^3. Therefore, the scaling factor for Source Region 3 (the refueling floor) is 0.390 (6.558E+05 / 1.68E+06).

5.2.2 Control Building

The geometry models for the Control Building from Elevation 928'-0" to Elevation 965'-0" are illustrated in Figure 17 through Figure 20. The dimensions used in Figure 17 through Figure 20 are obtained using the data in Table 7. In Figure 17 through Figure 20, the numbers in triangles represent the boundary numbers and the numbers in circles represent the zone numbers. The material composition for each zone (numbers in circles) in Figure 17 through Figure 20 is listed in Table 24.

5.2.3 ECCS Piping

The geometry model for ECCS pipe TW33-12"-GE Segment A and Segment B are illustrated in Figure 21 and Figure 22, respectively. The dimensions used in Figure 21 and Figure 22 are obtained using the data in Table 8. In Figure 21 and Figure 22, the numbers in triangles represent the boundary numbers and the numbers in circles represent the zone numbers. The material composition for each zone (numbers in circles) in Figure 21 and Figure 22 is listed in Table 24.

Scaling factors are applied to the doses from each pipe segment to account for the volume of suppression pool water within each segment. The scaling factors for each segment are calculated by taking the ratio of the volume of water in each segment to the total dilution volume for the suppression pool (79745.4 ft^3). Per Figure 21, Segment A has a length of 30'-3.5" and a radius of 6 inches. The volume of Segment A is 23.791 ft^3 (pi*(0.5)^2*(30'-3.5")). Therefore, the scaling factor for Segment A is 2.9834E-04 (23.791 / 79745.4). Per Figure 22, Segment B has a length of 20'-7 11/16" and a radius of 6 inches. The volume of Segment B is 16.2111 ft^3 (pi*(0.5)^2*(20'-7 11/16")). Therefore, the scaling factor for Segment B is 2.0329E-04 (16.2111 / 79745.4).

5.2.4 SGTS Filter

The SGTS filter is located in the northwest corner of the Reactor Building on Elevation 985'-6". The shielding geometry model for the SGTS filter is illustrated in Figure 23. The dimensions used in Figure 23 are obtained using the data in Table 9. Per Table 9, the SGTS filter slab extends from Column L to Column M in the North-South direction. In order to simply the slab geometry, the slab in the shielding model only extends to 1'-3" North of Column M, which corresponds to Surface 14 in Figure 13. This is a conservative simplification and will not impact the Control Room doses due to the SGTS filter because it slightly decreases the SGTS filter room slab area. Only one filter train is modeled in this analysis. The dose to the Control Room from the SGTS filter is attributed to the filter train closest to the Control Room with all of the activity accumulated on the single SGTS charcoal filter. In Figure 23, the numbers in triangles represent the boundary numbers and the numbers in circles represent the zone numbers. The material composition for each zone (numbers in circles) in Figure 23 is listed in Table 25.

5.2.5 CR Filter

The CR filter is located in the EFT Building on Elevation 943'-8". The EFT Building is located northeast of the Control Room. The shielding geometry model for the CR filter is illustrated in Figure 24. The dimensions used in Figure 24 are obtained using the data in Table 10. The model depicted in Figure 24 conservatively assumes that the south wall of the EFT Building is flush with the north wall of the Control Building. In reality, there is a 2 inch gap between the buildings. Only one filter train is modeled in this analysis. The dose to the Control Room from the CR filter is attributed to the filter train closest to the Control Room with all of the activity accumulated on the single CR charcoal filter. In Figure 24, the numbers in triangles represent the boundary numbers and the numbers in circles represent the zone numbers. The material composition for each zone (numbers in circles) in Figure 24 is listed in Table 26.

5.2.6 TSC Filter

The TSC filter is located above the Control Building at Elevation 981'-9". The shielding geometry model for the TSC filter is illustrated in Figure 25 (plan view) and Figure 26 (elevation view). The dimensions used in Figure 25 and Figure 26 are obtained using the data in Table 7 and Table 11. Only one filter train is modeled in this analysis. Because the TSC charcoal filters are located at approximately the same distance to the Control Room, the single TSC filter is modeled at the midpoint between the two TSC charcoal filters. In Figure 25 and Figure 26, the numbers in triangles represent the boundary numbers and the numbers in circles represent the zone numbers. The material composition for each zone (numbers in circles) in Figure 25 and Figure 26 is listed in Table 27.

5.2.7 External Cloud

The Control Room dose due to activity present in the external cloud immediately surrounding the Control Room is calculated by summing the doses attributed to the external cloud present at the following locations:

- Below the Control Room on Elevation 939'-0",
- Above the Control Room at Elevation 965'-0",
- North wall of the Control Room,
- East wall of the Control Room, and
- South wall of the Control Room

It should be noted that the Control Room dose due to the external cloud present at the west wall of the Control Room has already been accounted for in the Reactor Building airborne activity models.

The Control Room dose due to the external cloud is calculated using the RUNT-PC one dimensional model for a rectangular solid source with slab shields as illustrated in Figure 27. The parameters illustrated in Figure 27 for each of the external cloud models are discussed below.

The depth of the external cloud (T_1 in Figure 27) for the area below the Control Room on Elevation 939'-0" is taken as the elevation of the Control Room (El. 951') minus the Control Room floor slab thickness (1 foot) minus the Elevation of the floor below the Control Room (El. 939'). This results in the parameter T_1 of 11 feet (3.3528 meters). The length of the external cloud in the north-south direction (Y in Figure 27) is taken as the inner surface of the north wall to the inner surface of the south wall. This results in the parameter Y of 47.5 feet (14.478 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. The length of the external cloud in the east-west direction (SLTH in Figure 27) is taken as the inner surface of the east wall to the inner surface of the west wall. This results in the parameter SLTH of 47'-5" (14.4526 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. Therefore, the volume of the external cloud

for the area below the Control Room is calculated to be 7.0156E+02 m^3 (3.3528 * 14.478 * 14.4526). This volume is used as a scaling factor to determine the total activity within the external cloud for the area below the Control Room. The Control Room concrete floor slab (T_2 in Figure 27) is 1 foot thick (30.48 cm) and is obtained from Table 7. The dose receptor coordinates are given in terms of X, YP, and SP. The dose receptor is located 1 cm from the Control Room concrete floor slab directly in the center of the external cloud geometry. Therefore, the parameter X is 366.76 cm ($T_1 + T_2 + 1$ cm), the parameter YP is 723.9 cm (Y/2), and the parameter SP is 722.63 cm (SLTH/2). The parameters used to determine the Control Room dose from the external cloud for the area below the Control Room are summarized in Table 28.

The depth of the external cloud (T_1 in Figure 27) for the area above the Control Room on Elevation 965'-0" is taken as the height from floor to ceiling of Elevation 965'-0" (Surface 51 minus Surface 43 in Figure 20). This results in the parameter T_1 of 16.2052 feet (4.9393475 meters). The length of the external cloud in the north-south direction (Y in Figure 27) is taken as the inner surface of the Control Room north wall to the inner surface of the south wall. This results in the parameter Y of 47.5 feet (14.478 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. The length of the external cloud in the east-west direction (SLTH in Figure 27) is taken as the inner surface of the Control Room east wall to the inner surface of the west wall. This results in the parameter SLTH of 47'-5" (14.4526 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. Therefore, the volume of the external cloud for the area above the Control Room is calculated to be 1.0335E+03 m^3 (4.9393475 * 14.478 * 14.4526). This volume is used as a scaling factor to determine the total activity within the external cloud for the area above the Control Room. The concrete slab above the Control Room (T_2 in Figure 27) is 2 feet thick (60.96 cm) and is obtained from Table 7. The dose receptor coordinates are given in terms of X, YP, and SP. The dose receptor is located 1 cm below the Control Room concrete ceiling slab directly in the center of the external cloud geometry. Therefore, the parameter X is 555.89475 cm ($T_1 + T_2 + 1$ cm), the parameter YP is 723.9 cm (Y/2), and the parameter SP is 722.63 cm (SLTH/2). The parameters used to determine the Control Room dose from the external cloud for the area above the Control Room are summarized in Table 28.

Due to the lack of appreciable shielding in the Turbine Building on Elevation 951', the depth of the external cloud (T_1 in Figure 27) for the area north of the Control Room is assumed to be 100 meters. The height of the external cloud (Y in Figure 27) is taken as the height from the floor to the ceiling in the Control Room. This results in the parameter Y of 12 feet (3.6576 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. The length of the external cloud in the east-west direction (SLTH in Figure 27) is taken as the inner surface of the east wall to the inner surface of the west wall. This results in the parameter SLTH of 47'-5" (14.4526 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. Therefore, the volume of the external cloud for the area north of the Control Room is calculated to be 5.2862E+03 m^3 (100 * 3.6576 * 14.4526). This volume is used as a scaling factor to determine the total activity within the external cloud for the area north of the Control Room. The concrete Control Room

north wall (T_2 in Figure 27) is 2 feet thick (60.96 cm) and is obtained from Table 7. The dose receptor coordinates are given in terms of X, YP, and SP. The dose receptor is located 1 cm inside the Control Room north wall directly in the center of the external cloud geometry. Therefore, the parameter X is 10061.96 cm ($T_1 + T_2 + 1$ cm), the parameter YP is 182.88 cm (Y/2), and the parameter SP is 722.63 cm (SLTH/2). The parameters used to determine the Control Room dose from the external cloud for the area north of the Control Room are summarized in Table 28.

The depth of the external cloud (T_1 in Figure 27) for the area east of the Control Room is taken as the distance between the east wall of the Control Room and the west wall of the TSC (Surface 31 to Surface 46 in Figure 19). This results in the parameter T_1 of 27'-5" feet (8.3566 meters). The height of the external cloud (Y in Figure 27) is taken as the height from the floor to the ceiling in the Control Room. This results in the parameter Y of 12 feet (3.6576 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. The length of the external cloud in the north-south direction (SLTH in Figure 27) is taken as the inner surface of the Control Room north wall to the inner surface of the Control Room south wall. This results in the parameter SLTH of 47.5 feet (14.478 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. Therefore, the volume of the external cloud for the area east of the Control Room is calculated to be 4.4252E+02 m^3 (8.3566 * 3.6576 * 14.478). This volume is used as a scaling factor to determine the total activity within the external cloud for the area east of the Control Room. The concrete Control Room east wall (T_2 in Figure 27) is 1'-7.5" thick (49.53 cm) and is obtained from Table 7. The dose receptor coordinates are given in terms of X, YP, and SP. The dose receptor is located 1 cm inside the Control Room east wall directly in the center of the external cloud geometry. Therefore, the parameter X is 886.19 cm ($T_1 + T_2 + 1$ cm), the parameter YP is 182.88 cm (Y/2), and the parameter SP is 723.9 cm (SLTH/2). The parameters used to determine the Control Room dose from the external cloud for the area east of the Control Room are summarized in Table 28.

Due to the lack of appreciable shielding in the southern portion of the Control Building on Elevation 951', the depth of the external cloud (T_1 in Figure 27) for the area south of the Control Room is assumed to be 100 meters. The height of the external cloud (Y in Figure 27) is taken as the height from the floor to the ceiling in the Control Room. This results in the parameter Y of 12 feet (3.6576 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. The length of the external cloud in the east-west direction (SLTH in Figure 27) is taken as the inner surface of the east wall to the inner surface of the west wall. This results in the parameter SLTH of 47'-5" (14.4526 meters) and is obtained using the data and dimensions from Table 7 and Figure 19. Therefore, the volume of the external cloud for the area south of the Control Room is calculated to be 5.2862E+03 m^3 (100 * 3.6576 * 14.4526). This volume is used as a scaling factor to determine the total activity within the external cloud for the area south of the Control Room. The concrete Control Room south wall (T_2 in Figure 27) is 1 foot thick (30.48 cm) and is obtained from Table 7. The dose receptor coordinates are given in terms of X, YP, and SP. The dose receptor is located 1 cm inside the Control Room south wall directly in the center of the external cloud geometry.

Therefore, the parameter X is 10031.48 cm ($T_1 + T_2 + 1$ cm), the parameter YP is 182.88 cm (Y/2), and the parameter SP is 722.63 cm (SLTH/2). The parameters used to determine the Control Room dose from the external cloud for the area south of the Control Room are summarized in Table 28.

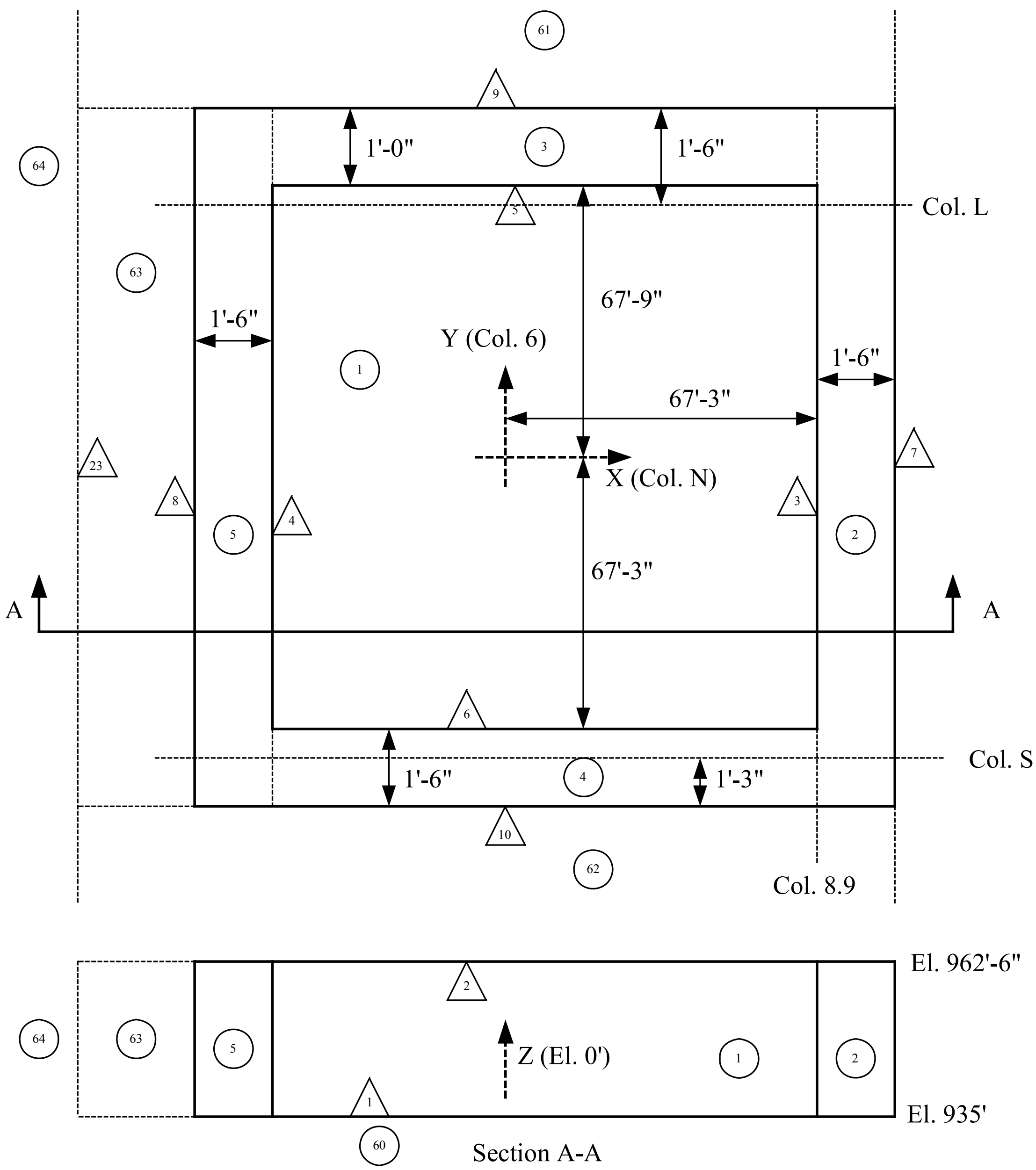


Figure 12. Geometry Model for the Reactor Building, Elevation 935'-0" (Not to Scale)

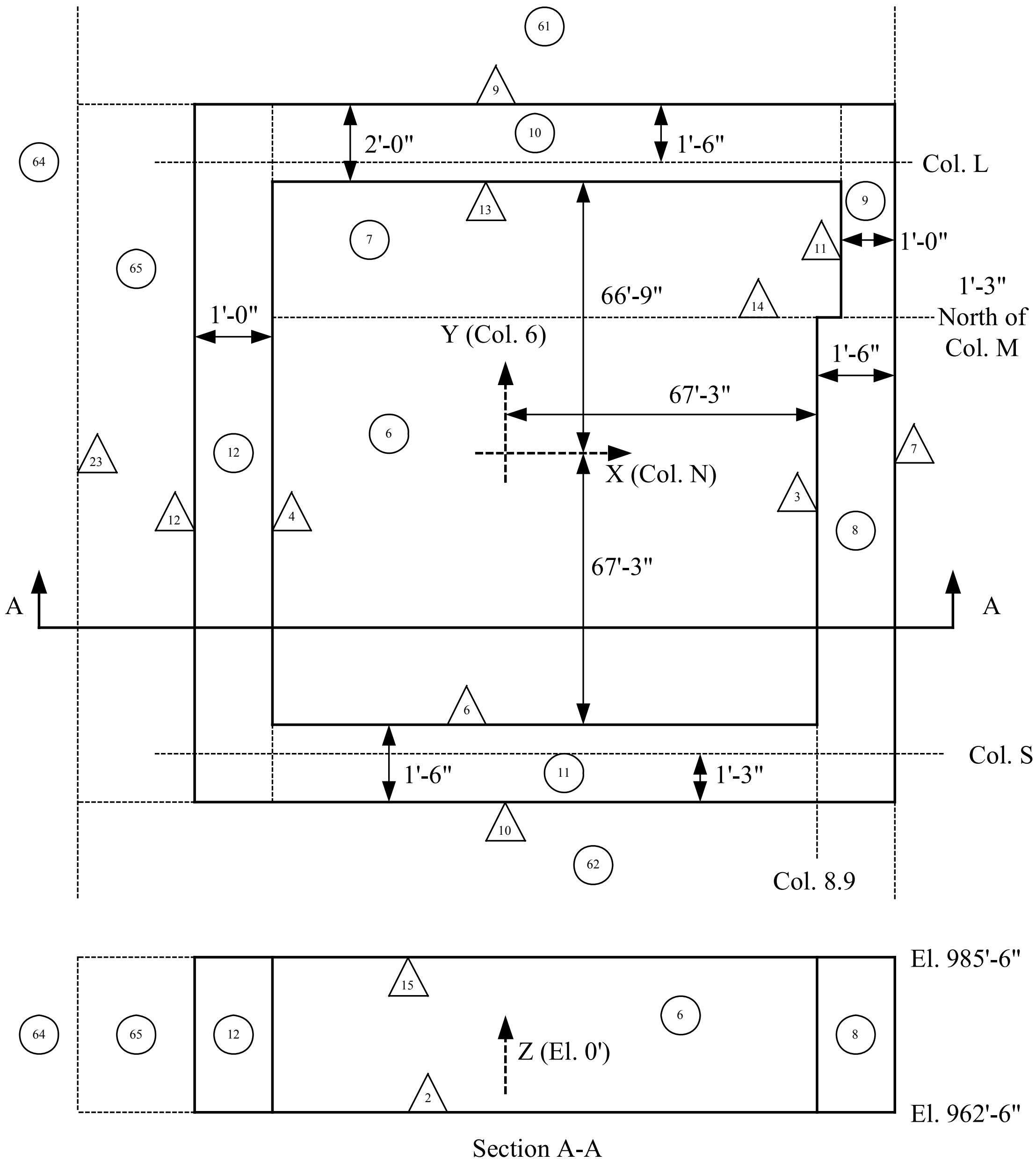


Figure 13. Geometry Model for the Reactor Building, Elevation 962’-6” (Not to Scale)

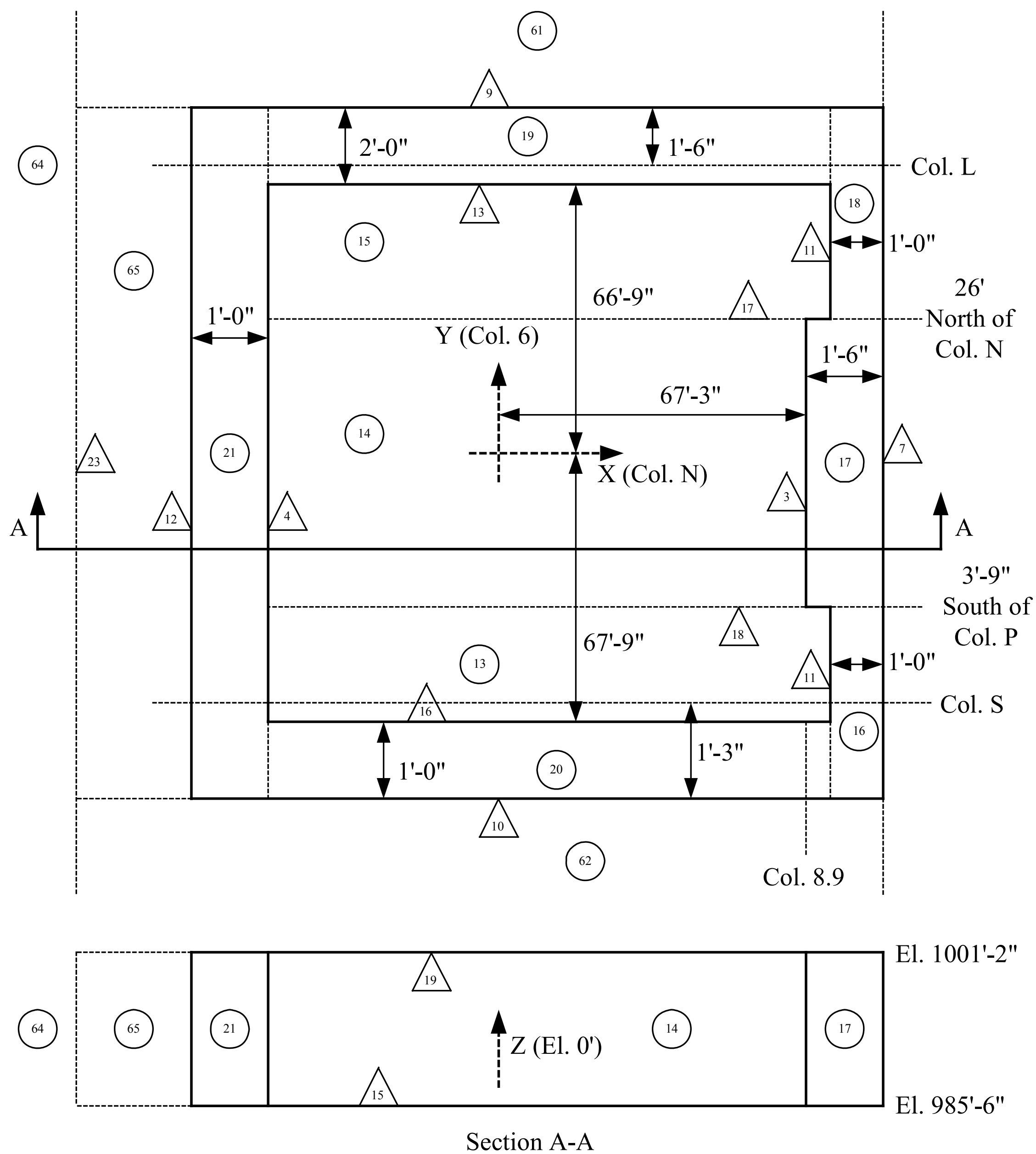


Figure 14. Geometry Model for the Reactor Building, Elevation 985’-6” (Not to Scale)

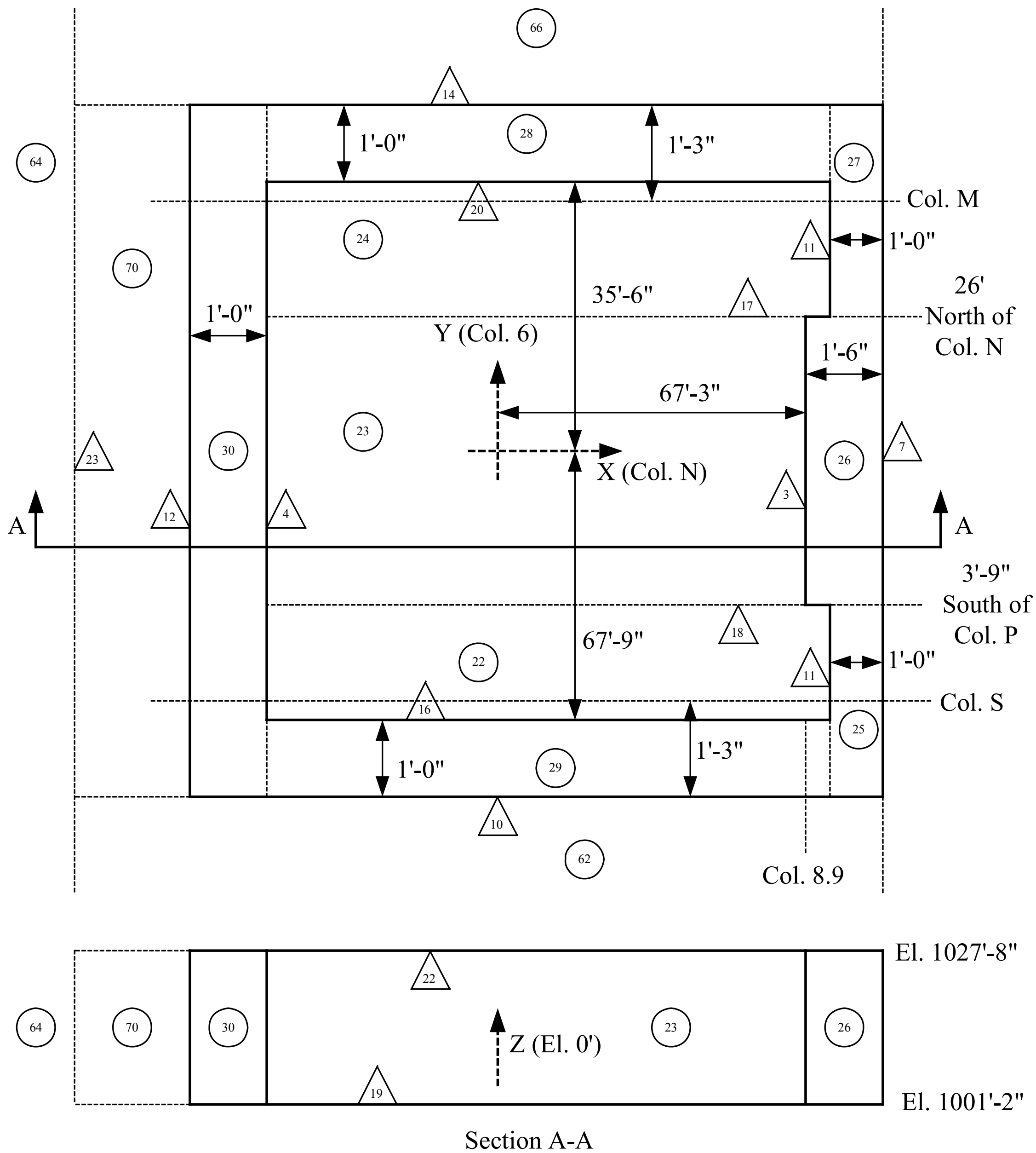


Figure 15. Geometry Model for the Reactor Building, Elevation 1001'-2" (Not to Scale)

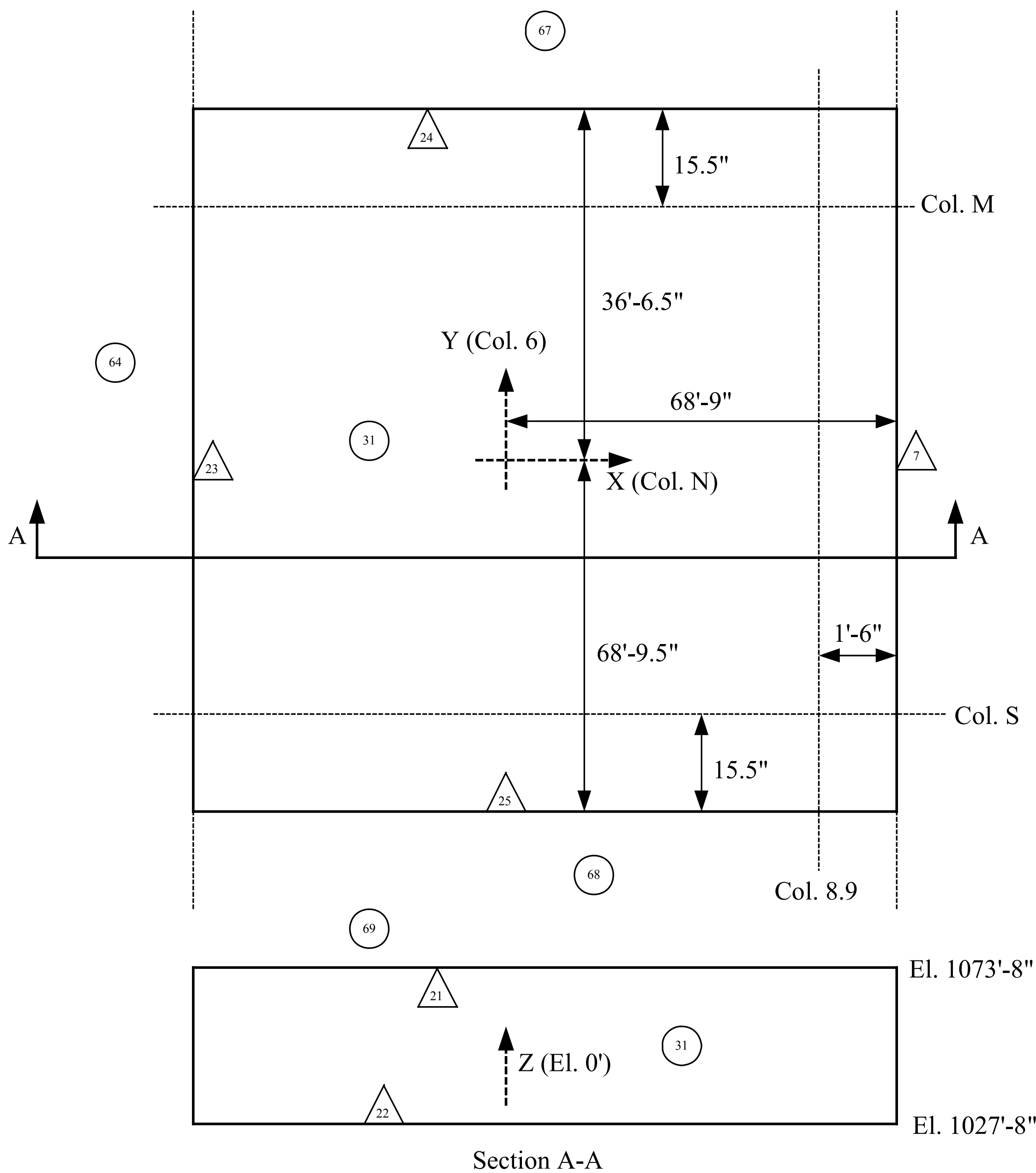


Figure 16. Geometry Model for the Reactor Building Refueling Floor, Elevation 1027'-8" (Not to Scale)

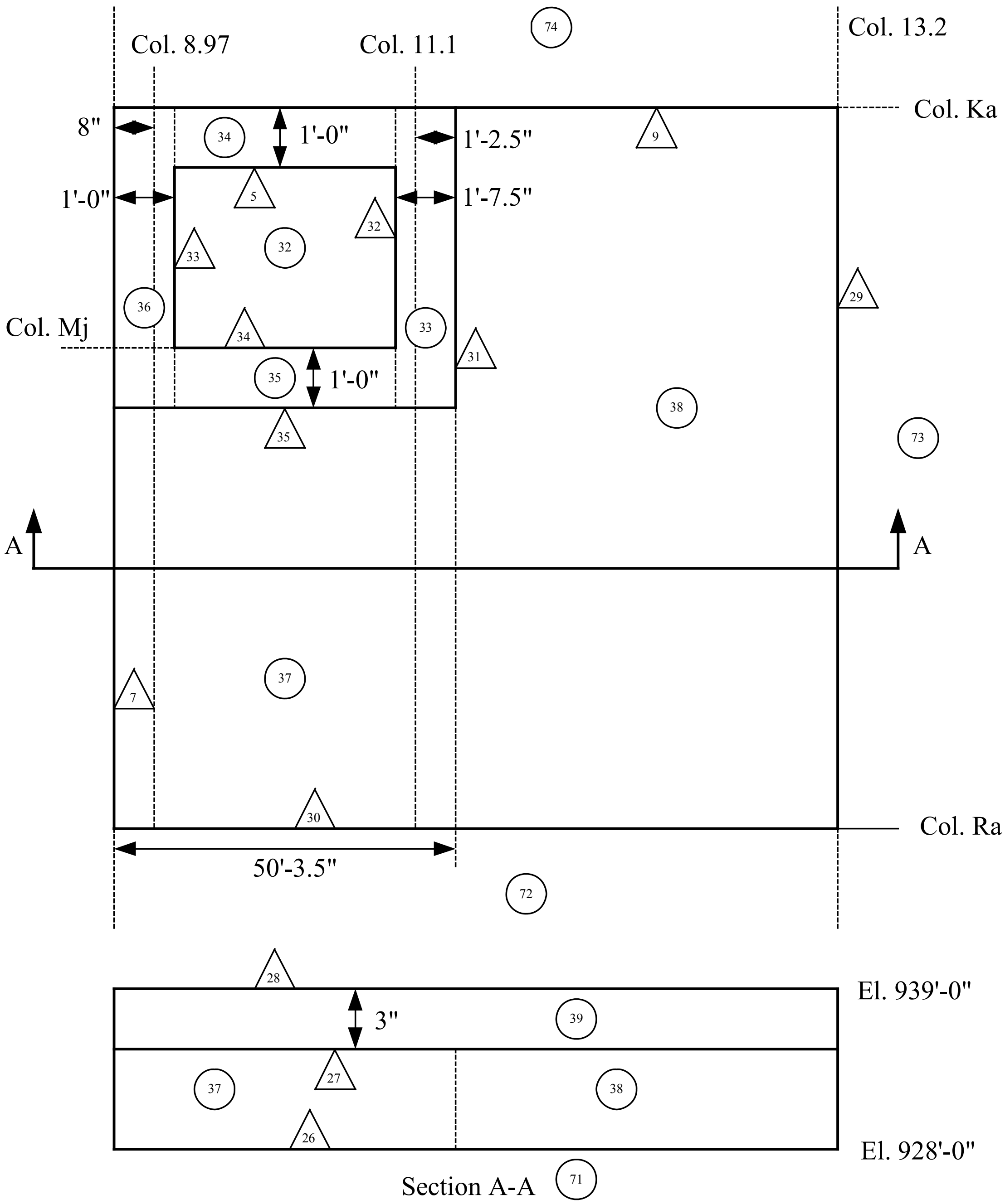


Figure 17. Geometry Model for the Control Building, Elevation 928'-0" (Not to Scale)

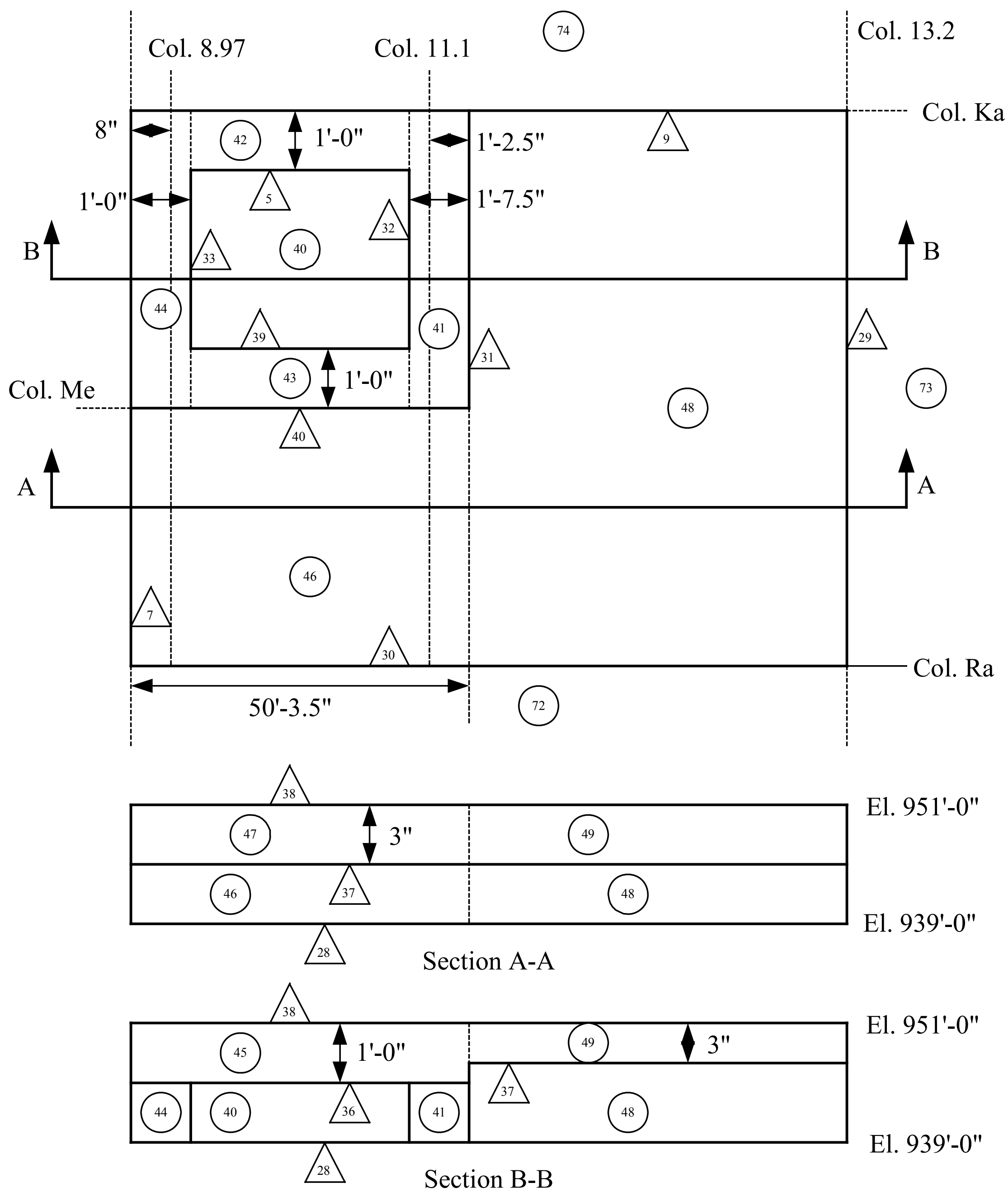


Figure 18. Geometry Model for the Control Building, Elevation 939'-0" (Not to Scale)

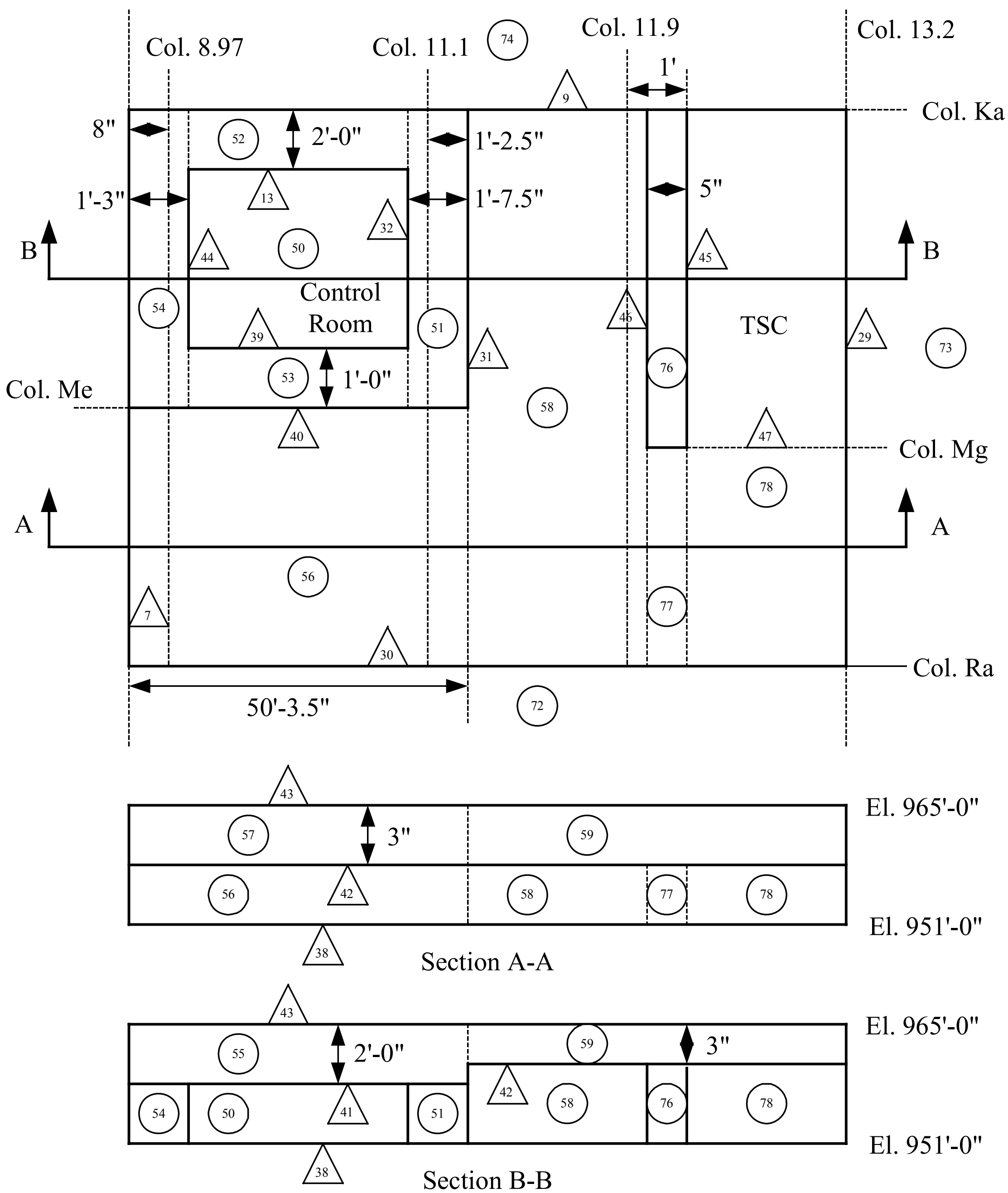


Figure 19. Geometry Model for the Control Building, Elevation 951'-0" (Not to Scale)

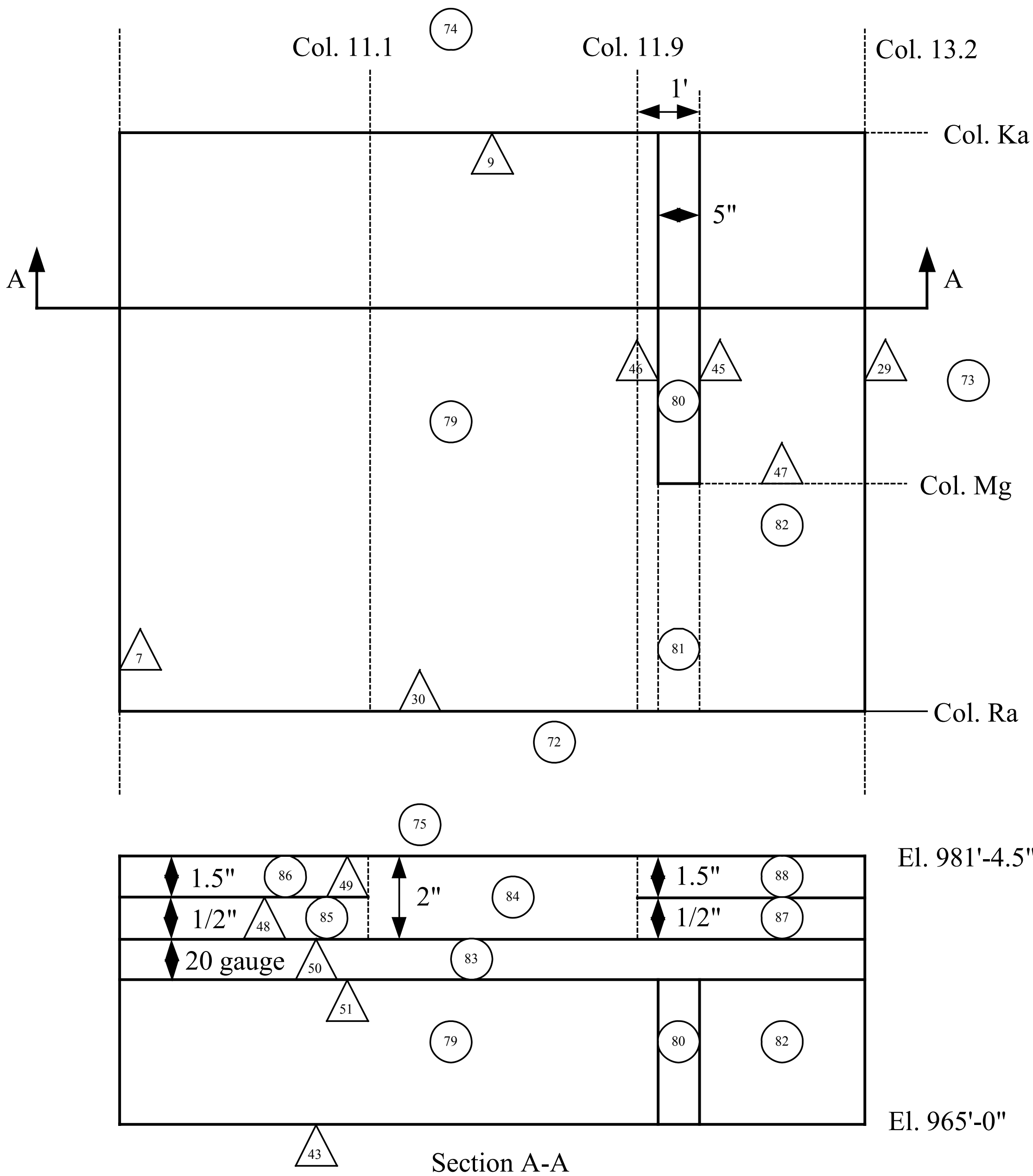


Figure 20. Geometry Model for the Control Building, Elevation 965’-0” (Not to Scale)

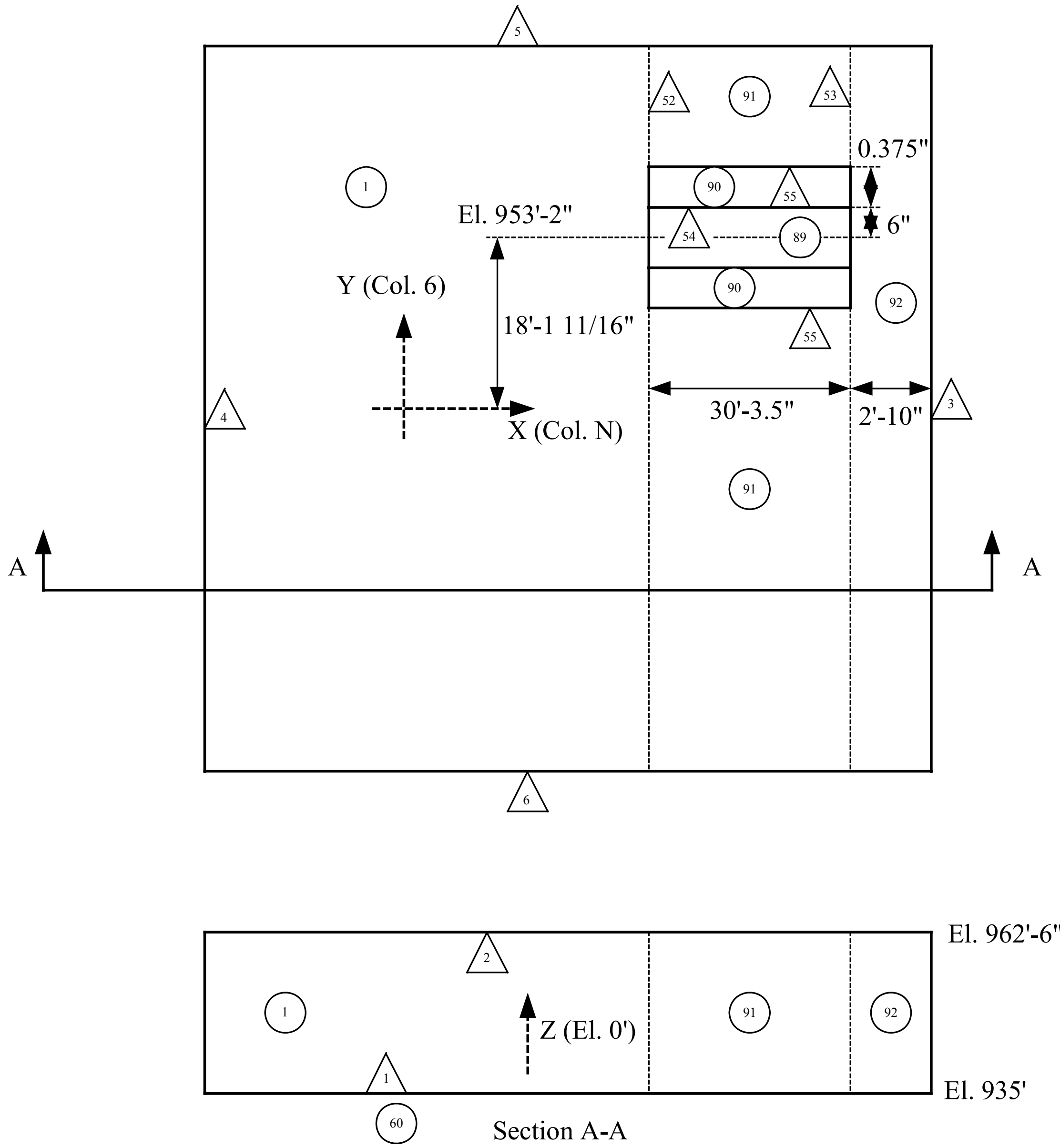


Figure 21. Geometry Model for the ECCS Pipe TW33-12"-GE, Segment A (Not to Scale)

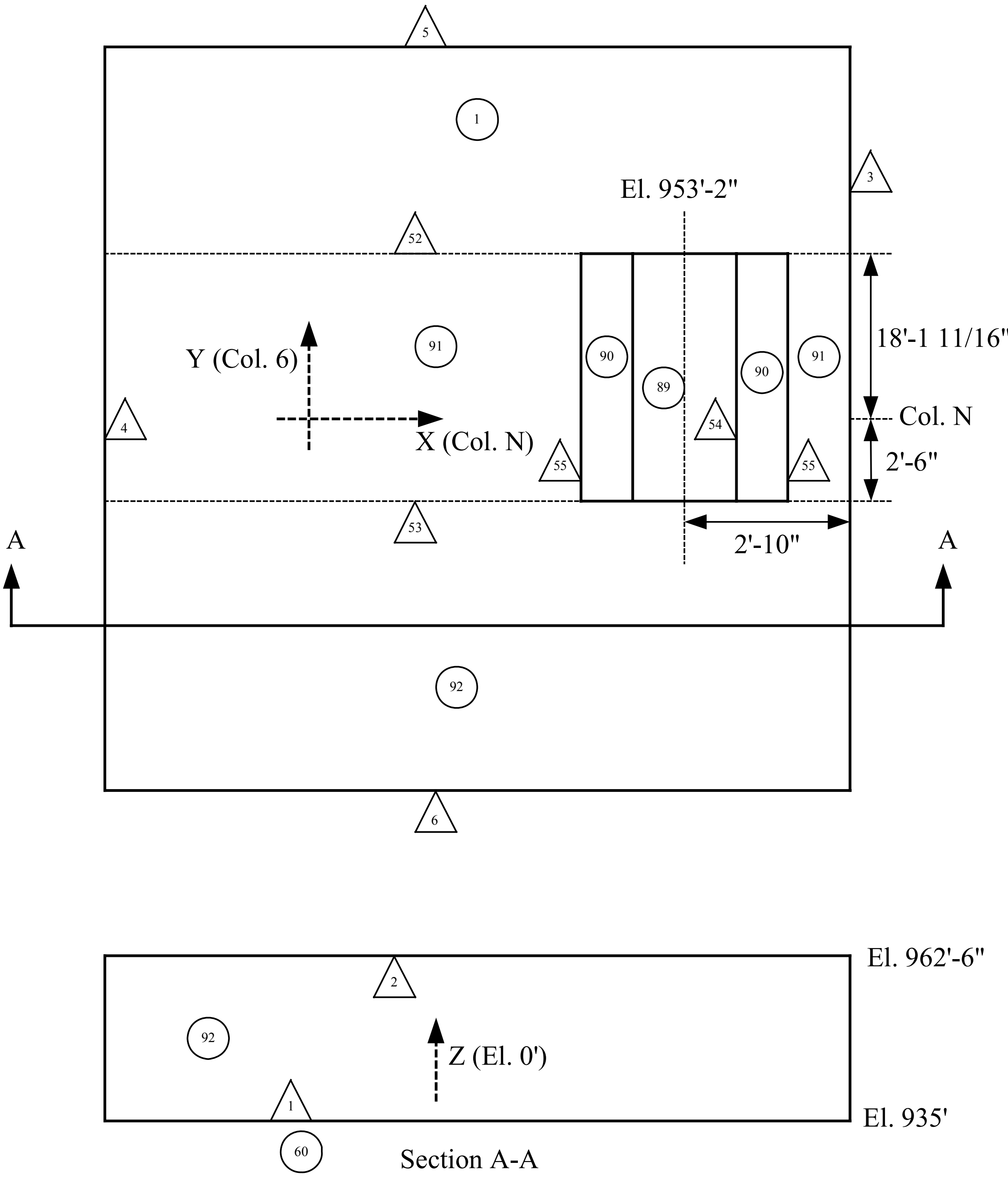


Figure 22. Geometry Model for the ECCS Pipe TW33-12”-GE, Segment B (Not to Scale)

Table 24. Zone Compositions for the Reactor Building, Control Building, and ECCS Piping Models Illustrated in Figure 12 through Figure 22

Zone Number	Material Composition
1	Air
2	Concrete
3	Concrete
4	Concrete
5	Concrete
6	Air
7	Air
8	Concrete
9	Concrete
10	Concrete
11	Concrete
12	Concrete
13	Air
14	Air
15	Air
16	Concrete
17	Concrete
18	Concrete
19	Concrete
20	Concrete
21	Concrete
22	Air
23	Air
24	Air
25	Concrete
26	Concrete
27	Concrete
28	Concrete
29	Concrete
30	Concrete
31	Air
32	Air
33	Concrete

Table 24. Zone Compositions for the Reactor Building, Control Building, and ECCS Piping Models Illustrated in Figure 12 through Figure 22

Zone Number	Material Composition
34	Concrete
35	Concrete
36	Concrete
37	Air
38	Air
39	Concrete
40	Air
41	Concrete
42	Concrete
43	Concrete
44	Concrete
45	Concrete
46	Air
47	Concrete
48	Air
49	Concrete
50	Air
51	Concrete
52	Concrete
53	Concrete
54	Concrete
55	Concrete
56	Air
57	Concrete
58	Air
59	Concrete
60	Air
61	Air
62	Air
63	Air
64	Air
65	Air
66	Air
67	Air

Table 24. Zone Compositions for the Reactor Building, Control Building, and ECCS Piping Models Illustrated in Figure 12 through Figure 22

Zone Number	Material Composition
68	Air
69	Air
70	Air
71	Air
72	Air
73	Air
74	Air
75	Air
76	Precast Concrete Panel
77	Air
78	Air
79	Air
80	Precast Concrete Panel
81	Air
82	Air
83	Corrugated Steel Sheet
84	Gravel
85	Gravel
86	Air
87	Gravel
88	Air
89	Water
90	Steel
91	Air
92	Air

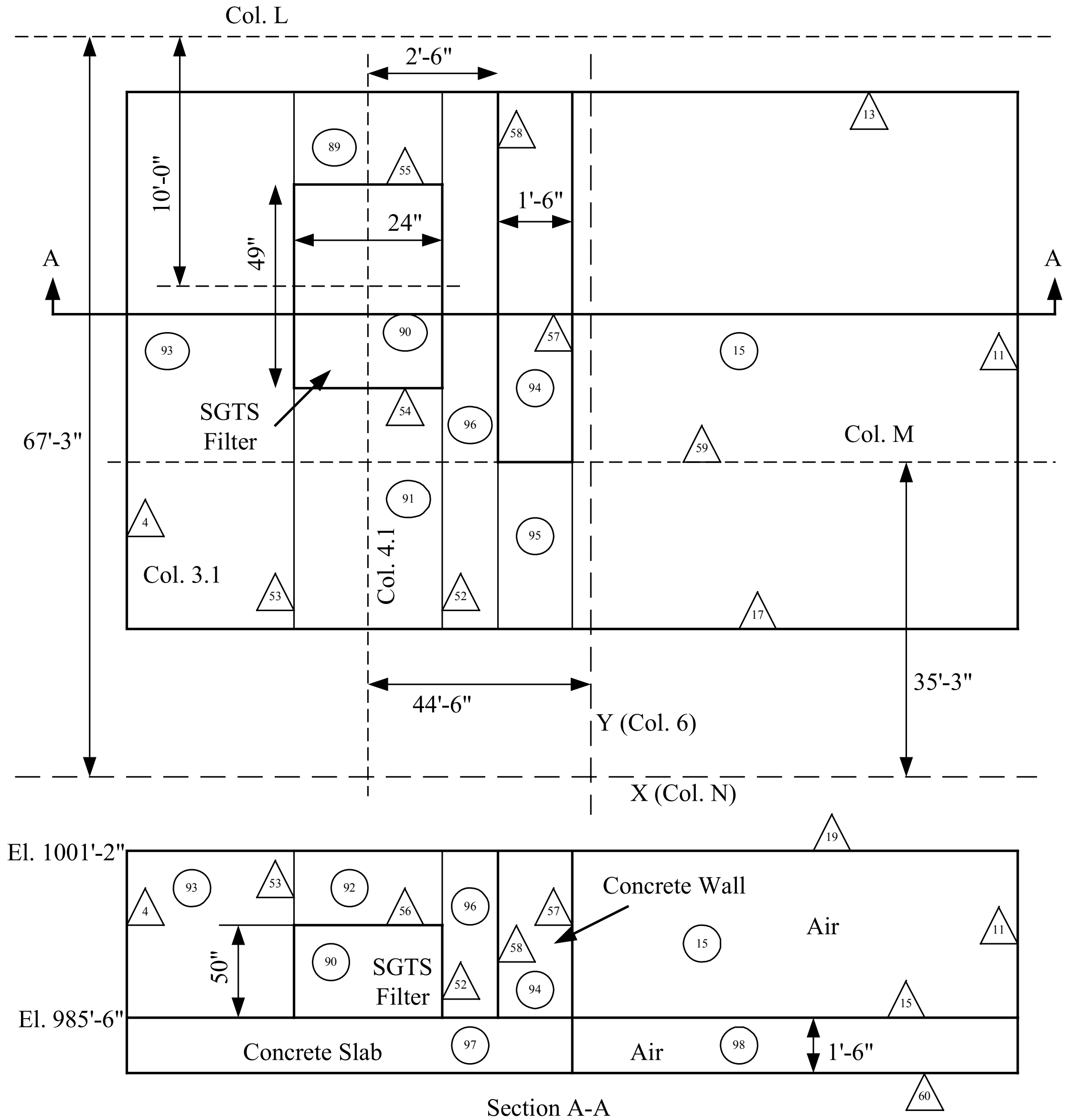


Figure 23. Geometry Model for the SGTS Filter located in the Northwest Corner of the Reactor Building on El. 985'-6" (Not to Scale)

Table 25. Zone Compositions for the SGTS Filter Model Illustrated in Figure 23

Zone Number	Material Composition
15	Air
89	Air
90 (SGTS Filter)	Carbon, Density of 0.48 g/cm^3
91	Air
92	Air
93	Air
94 (SGTS Filter Room East Wall)	Concrete
95	Air
96	Air
97 (SGTS Filter Room Slab)	Concrete
98	Air

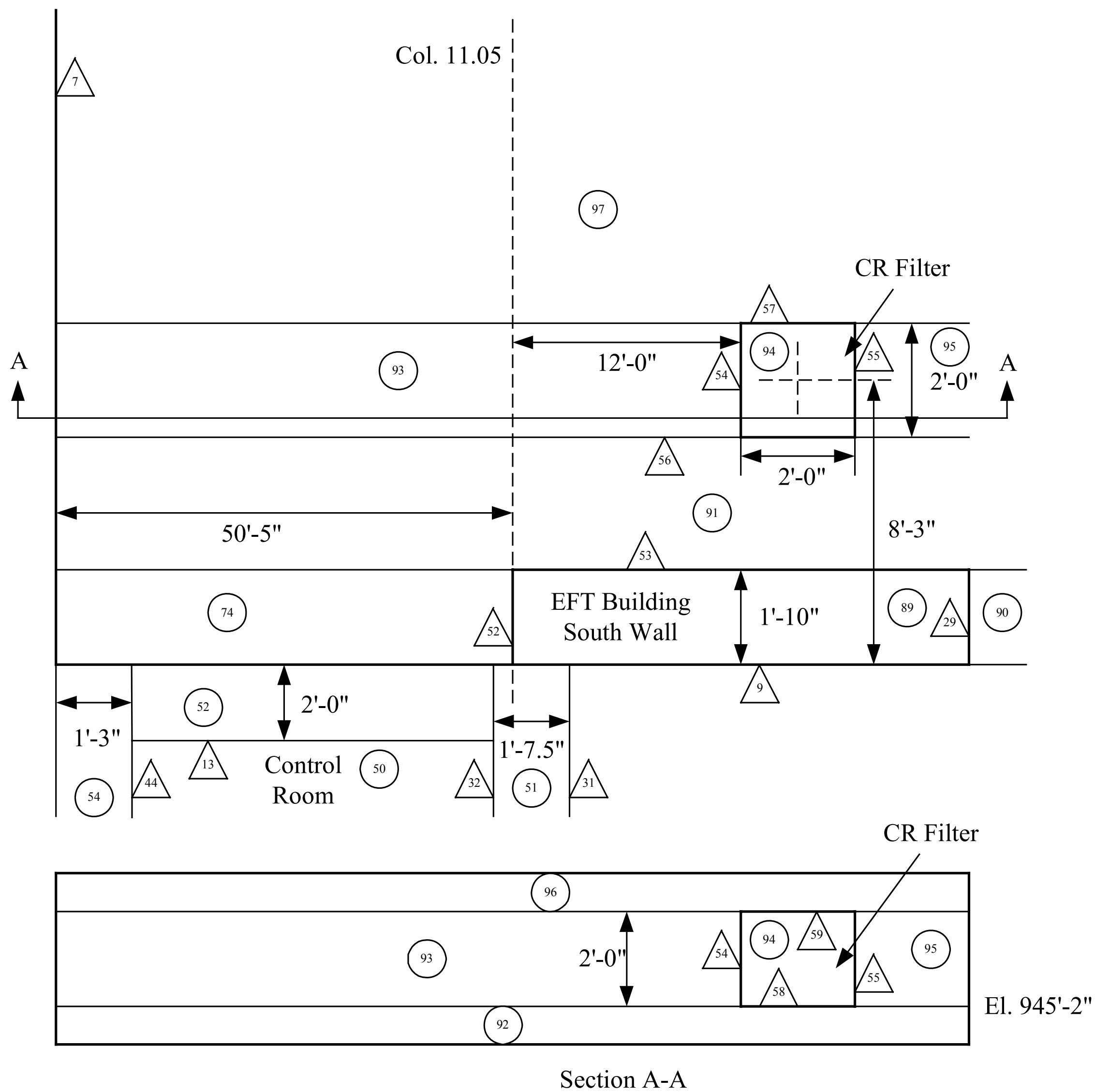


Figure 24. Geometry Model for the CR Filter located in the EFT Building on El. 943'-8" (Not to Scale)

Table 26. Zone Compositions for the CR Filter Model Illustrated in Figure 24

Zone Number	Material Composition
50 (Control Room)	Air
51 (CR East Wall)	Concrete
52 (CR North Wall)	Concrete
54 (CR West Wall)	Concrete
74	Air
89 (EFT Building South Wall)	Concrete
90	Air
91	Air
92	Air
93	Air
94 (CR Filter)	Carbon, Density of 0.48 g/cm^3
95	Air
96	Air
97	Air

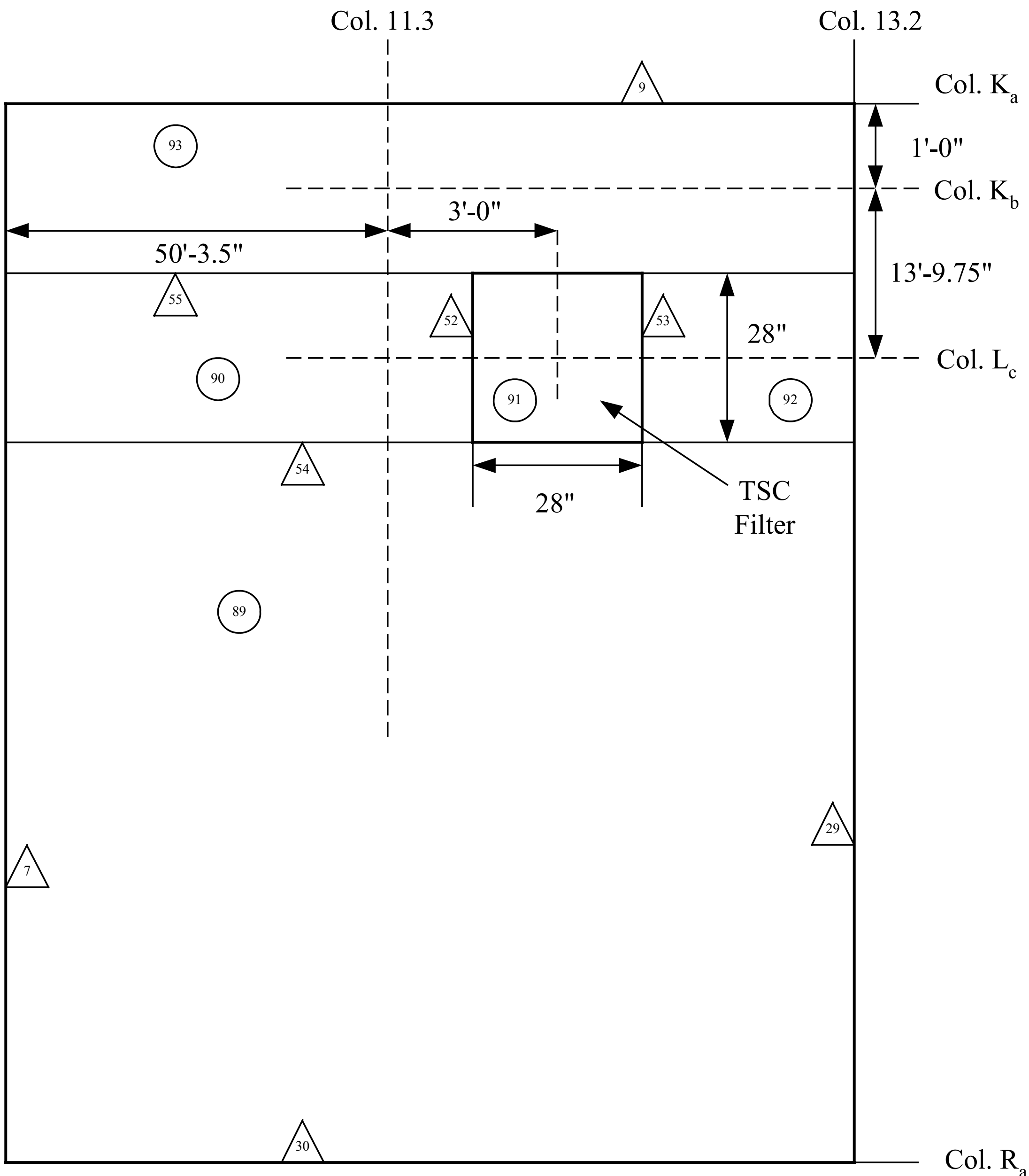


Figure 25. Plan View, Geometry Model for the TSC Filter Located Above the Control Building on El. 981'-9" (Not to Scale)

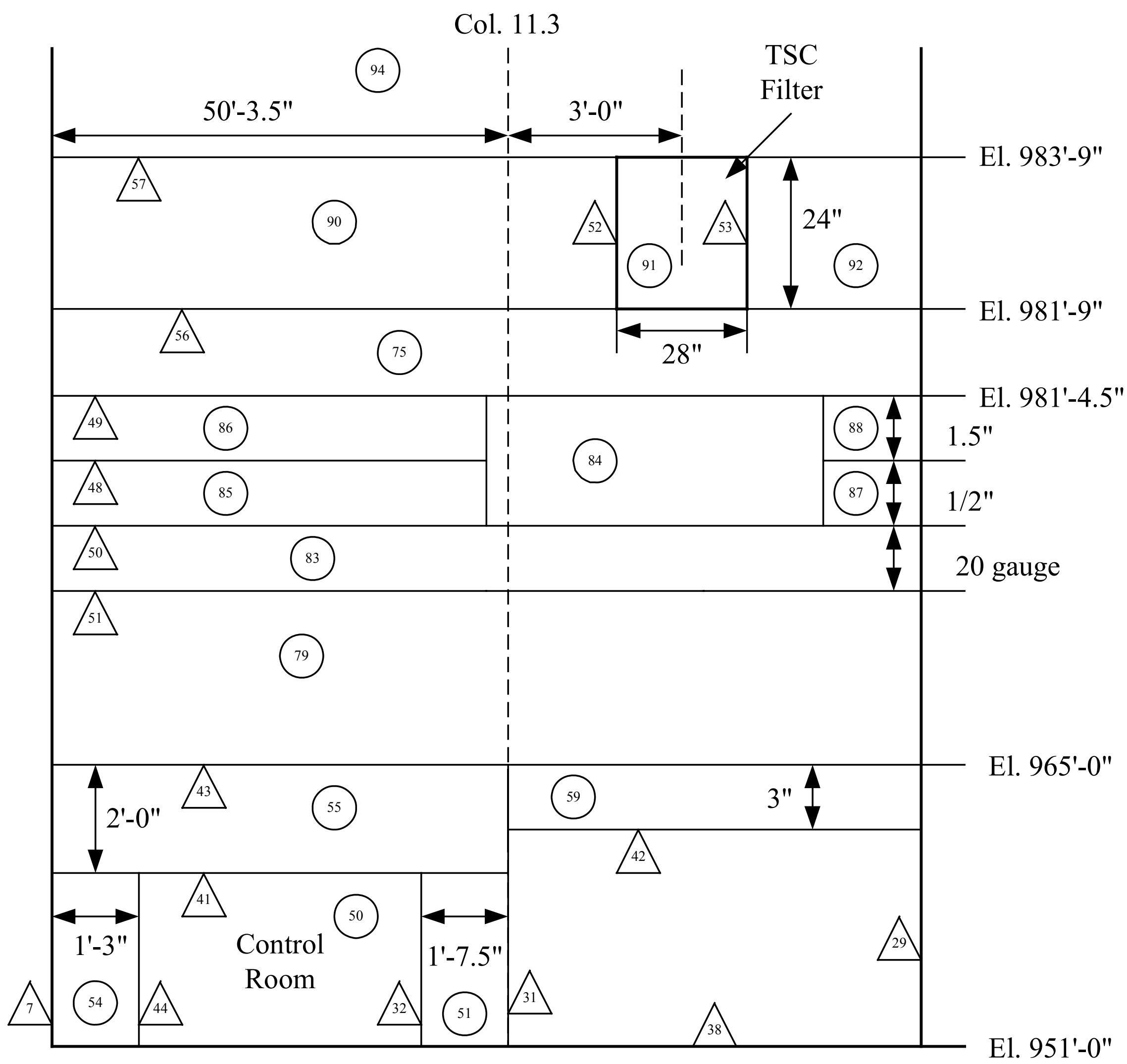


Figure 26. Elevation View, Geometry Model for the TSC Filter Located Above the Control Building on El. 981'-9" (Not to Scale)

Table 27. Zone Compositions for the TSC Filter Model Illustrated in Figure 25 and Figure 26

Zone Number	Material Composition
50 (Control Room)	Air
51 (CR East Wall)	Concrete
54 (CR West Wall)	Concrete
55 (CR Ceiling)	Concrete
59	Concrete
75	Air
79	Air
83	Corrugated Steel Sheet
84	Gravel
85	Gravel
86	Air
87	Gravel
88	Air
89	Air
90	Air
91 (TSC Filter)	Carbon, Density of 0.48 g/cm^3
92	Air
93	Air
94	Air

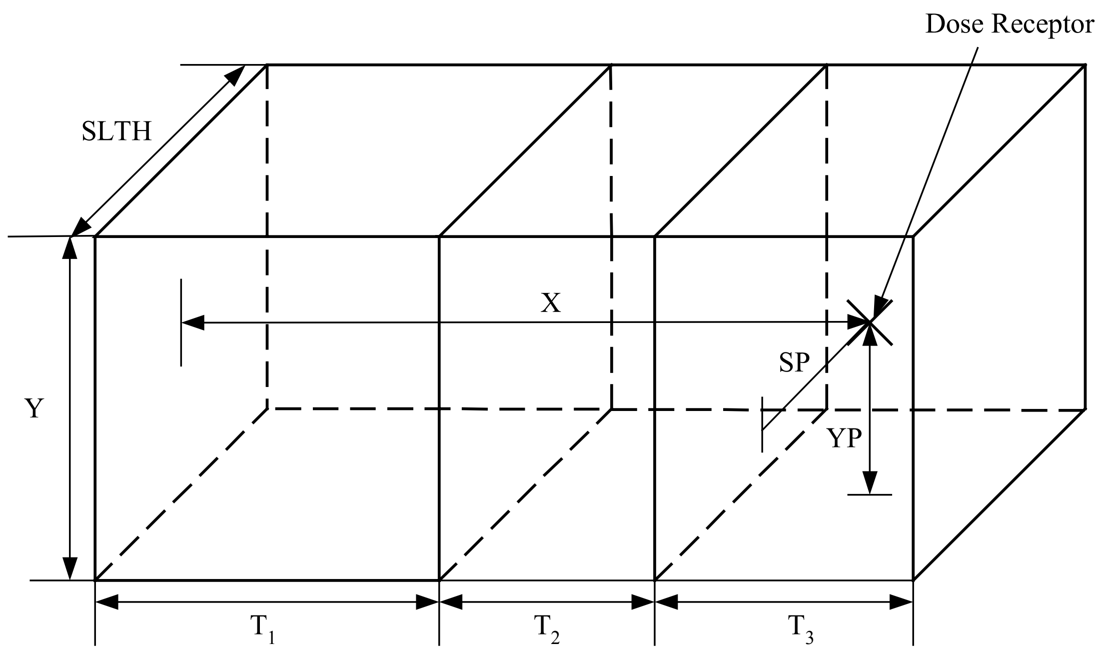


Figure 27. Geometry Model for the Control Room Dose Due to External Cloud Activity

Table 28. External Cloud Geometry Parameters

Parameter	EC Below the Control Room	EC Above the Control Room	EC North of Control Room	EC East of Control Room	EC South of Control Room
T_1, cm	335.28	493.93475	10000.0	835.66	10000.0
T_2, cm	30.48	60.96	60.96	49.53	30.48
Y, cm	1447.8	1447.8	365.76	365.76	365.76
SLTH, cm	1445.26	1445.26	1445.26	1447.8	1445.26
Volume, m^3	7.0156E+02	1.0335E+03	5.2862E+03	4.4252E+02	5.2862E+03
X, cm	366.76	555.89475	10061.96	886.19	10031.48
YP, cm	723.9	723.9	182.88	182.88	182.88
SP, cm	722.63	722.63	722.63	723.9	722.63

5.3 Control Room Doses

The doses to the Control Room attributed to each radiation source external to the Control Room are discussed in the following sections.

5.3.1 Reactor Building Airborne Activity

The Control Room dose due to Reactor Building airborne activity is attributed to the primary containment and ESF system leakage pathways. The occupancy factors listed in Section 2.4 are manually accounted for using Equation 14.

Equation 14 $$TD_{30\ Days} = D_{1\ Day} + [(D_{4\ Days} - D_{1\ Day}) * 0.6] + [(D_{30\ Days} - D_{4\ Days}) * 0.4]$$

Where: $TD_{30\ Days}$ is the 30 day post LOCA dose with occupancy factors, rem;
$D_{1\ Day}$ is the 1 day post LOCA dose without occupancy factors, rem;
$D_{4\ Days}$ is the 4 day post LOCA dose without occupancy factors, rem;
$D_{30\ Days}$ is the 30 day post LOCA dose without occupancy factors, rem;
0.6 is the occupancy factor from 1 to 4 days post LOCA;
0.4 is the occupancy factor from 4 to 30 days post LOCA.

The Control Room doses due to Source Region 1 (Elevation 935’-0” to Elevation 1001’-2”) in the Reactor Building from the primary containment leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 29 through Table 31, respectively. The 30 day post LOCA Control Room doses with occupancy factors due to Source Region 1 within the Reactor Building from the primary containment leakage pathway are listed in Table 32. The Control Room doses due to Source Region 2 (Elevation 1001’-2” to Elevation 1027’-8”) in the Reactor Building from the primary containment leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 33 through Table 35, respectively. The 30 day post LOCA Control Room doses with occupancy factors due to Source Region 2 within the Reactor Building from the primary containment leakage pathway are listed in Table 36. The Control Room doses due to Source Region 3 (Refueling Floor) in the Reactor Building from the primary containment leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 37 through Table 39, respectively. The 30 day post LOCA Control Room doses with occupancy factors due to Source Region 3 within the Reactor Building from the primary containment leakage pathway are listed in Table 40. The 30 day post LOCA Control Room doses with occupancy factors due to all three source regions within the Reactor Building from the primary containment leakage pathway are summarized in Table 41. Per Table 41, the maximum 30 day Control Room dose due to airborne activity in the Reactor Building from the primary containment leakage pathway is 1.812E-01 rem and occurs in the southwest corner of the Control Room.

The Control Room doses due to Source Region 1 (Elevation 935'-0" to Elevation 1001'-2") in the Reactor Building from the ESF system leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 42 through Table 44, respectively. The 30 day post LOCA Control Room doses with occupancy factors due to Source Region 1 within the Reactor Building from the ESF system leakage pathway are listed in Table 45. The Control Room doses due to Source Region 2 (Elevation 1001'-2" to Elevation 1027'-8") in the Reactor Building from the ESF system leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 46 through Table 48, respectively. The 30 day post LOCA Control Room doses with occupancy factors due to Source Region 2 within the Reactor Building from the ESF system leakage pathway are listed in Table 49. The Control Room doses due to Source Region 3 (Refueling Floor) in the Reactor Building from the ESF system leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 50 through Table 52, respectively. The 30 day post LOCA Control Room doses with occupancy factors due to Source Region 3 within the Reactor Building from the ESF system leakage pathway are listed in Table 53. The 30 day post LOCA Control Room doses with occupancy factors due to all three source regions within the Reactor Building from the ESF system leakage pathway are summarized in Table 54. Per Table 54, the maximum 30 day Control Room dose due to airborne activity in the Reactor Building from the ESF system leakage pathway is 7.025E-03 rem and occurs in the southwest corner of the Control Room.

5.3.2 ECCS Piping

The direct doses to the Control Room from two 12 inch ECCS pipe segments, TW33-12"-GE Segment A and Segment B, containing suppression pool water, are also determined in this analysis. Segment A is the east-west section of TW33-12"-GE and Segment B is the north-south section of the same pipe. The occupancy factors listed in Section 2.4 are manually accounted for using Equation 14. The Control Room doses attributed to pipe Segment A at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 55 through Table 57, respectively. The 30 day post LOCA Control Room doses with occupancy factors attributed to pipe Segment A are listed in Table 58. Per Table 58, the maximum 30 day Control Room dose due to pipe Segment A is 2.730E-01 rem and occurs in the southwest corner of the Control Room. The Control Room doses attributed to pipe Segment B at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 59 through Table 61, respectively. The 30 day post LOCA Control Room doses with occupancy factors attributed to pipe Segment B are listed in Table 62. Per Table 62, the maximum 30 day Control Room dose due to pipe Segment B is 1.184E-01 rem and occurs in the southwest corner of the Control Room.

5.3.3 SGTS Filter

The Control Room doses due to the SGTS filter are attributed to the primary containment and ESF system leakage pathways. The occupancy factors listed in Section 2.4 are manually accounted for using Equation 14. The Control Room doses due to the SGTS filter attributed to the primary containment leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 63 through Table 65, respectively. The 30 day post LOCA Control Room doses from the SGTS filter attributed to the primary containment leakage pathway with occupancy factors are listed in Table 66. The Control Room doses due to the SGTS filter attributed to the ESF system leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 67 through Table 69, respectively. The 30 day post LOCA Control Room doses from the SGTS filter attributed to the ESF system leakage pathway with occupancy factors are listed in Table 70. The total Control Room doses due to the SGTS filter (sum of the doses attributed to the primary containment and ESF system leakage pathways) are listed in Table 71. Per Table 71, the maximum 30 day Control Room dose due to the SGTS filter is 4.263E-03 rem and occurs in the central portion of the Control Room.

5.3.4 CR Filter

The Control Room doses due to the CR filter are attributed to the primary containment, ESF system, and MSIV/SCB leakage pathways. The occupancy factors listed in Section 2.4 are manually accounted for using Equation 14. The Control Room doses due to the CR filter attributed to the primary containment leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 72 through Table 74, respectively. The 30 day post LOCA Control Room doses from the CR filter attributed to the primary containment leakage pathway with occupancy factors are listed in Table 75. The Control Room doses due to the CR filter attributed to the ESF system leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 76 through Table 78, respectively. The 30 day post LOCA Control Room doses from the CR filter attributed to the ESF system leakage pathway with occupancy factors are listed in Table 79. The Control Room doses due to the CR filter attributed to the MSIV/SCB leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 80 through Table 82, respectively. The 30 day post LOCA Control Room doses from the CR filter attributed to the MSIV/SCB leakage pathway with occupancy factors are listed in Table 83. The total Control Room doses due to the CR filter (sum of the doses attributed to the primary containment, ESF system, and MSIV/SCB leakage pathways) are listed in Table 84. Per Table 84, the maximum 30 day Control Room dose due to the CR filter is 5.996E-09 rem and occurs in the northeast corner of the Control Room.

5.3.5 TSC Filter

The Control Room doses due to the TSC filter are attributed to the primary containment, ESF system, and MSIV/SCB leakage pathways. The occupancy factors listed in Section 2.4 are manually accounted for using Equation 14. The Control Room doses due to the TSC filter attributed to the primary containment leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 85 through Table 87, respectively. The 30 day post LOCA Control Room doses from the TSC filter attributed to the primary containment leakage pathway with occupancy factors are listed in Table 88. The Control Room doses due to the TSC filter attributed to the ESF system leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 89 through Table 91, respectively. The 30 day post LOCA Control Room doses from the TSC filter attributed to the ESF system leakage pathway with occupancy factors are listed in Table 92. The Control Room doses due to the TSC filter attributed to the MSIV/SCB leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 93 through Table 95, respectively. The 30 day post LOCA Control Room doses from the TSC filter attributed to the MSIV/SCB leakage pathway with occupancy factors are listed in Table 96. The total Control Room doses due to the TSC filter (sum of the doses attributed to the primary containment, ESF system, and MSIV/SCB leakage pathways) are listed in Table 97. Per Table 97, the maximum 30 day Control Room dose due to the TSC filter is 2.850E-05 rem and occurs in the east portion of the Control Room.

5.3.6 External Cloud

The Control Room doses due to the external cloud activity are attributed to the primary containment, ESF system, and MSIV/SCB leakage pathways. The occupancy factors listed in Section 2.4 are manually accounted for using Equation 14. The Control Room doses due to the external cloud activity from the primary containment leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 98 through Table 100, respectively. The 30 day post LOCA Control Room doses due to the external cloud activity from the primary containment leakage pathway with occupancy factors are listed in Table 101. The Control Room doses due to the external cloud activity from the ESF system leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 102 through Table 104, respectively. The 30 day post LOCA Control Room doses due to the external cloud activity from the ESF system leakage pathway with occupancy factors are listed in Table 105. The Control Room doses due to the external cloud activity from the MSIV/SCB leakage pathway at 1 day, 4 days, and 30 days post LOCA without occupancy factors are listed in Table 106 through Table 108, respectively. The 30 day post LOCA Control Room doses due the external cloud activity from the MSIV/SCB leakage pathway with occupancy factors are listed in Table 109. The total Control Room doses due to the external cloud activity (sum of the doses attributed to the primary containment, ESF system, and MSIV/SCB leakage pathways) are listed in Table 110. Per Table 110, the 30 day Control Room dose due to the external cloud is 7.757E-02 rem.

Table 29. Control Room Dose (rem) at 1 Day Post LOCA Due to Source Region 1 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	8.061E-02	1.082E-02	1.392E-03	9.282E-02
CR - Column 10.1, 1' from North Wall, 6' above Floor	5.274E-02	7.935E-03	1.038E-03	6.171E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.731E-02	4.082E-03	5.344E-04	3.193E-02
CR - 1' from West Wall, Column Le, 6' above Floor	1.280E-01	1.732E-02	2.230E-03	1.476E-01
CR - Column 10.1, Column Le, 6' above Floor	7.656E-02	1.168E-02	1.531E-03	8.977E-02
CR - 1' from East Wall, Column Le, 6' above Floor	3.592E-02	5.434E-03	7.120E-04	4.207E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	1.415E-01	1.903E-02	2.448E-03	1.630E-01
CR - Column 10.1, Column Ma, 6' above Floor	8.096E-02	1.172E-02	1.523E-03	9.420E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	3.494E-02	5.196E-03	6.783E-04	4.081E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.493E-01	1.982E-02	2.548E-03	1.717E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	4.733E-02	6.480E-03	8.367E-04	5.465E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.309E-02	3.263E-03	4.228E-04	2.678E-02

Table 30. Control Room Dose (rem) at 4 Days Post LOCA Due to Source Region 1 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	8.188E-02	1.098E-02	1.576E-03	9.444E-02
CR - Column 10.1, 1' from North Wall, 6' above Floor	5.363E-02	8.059E-03	1.172E-03	6.286E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.777E-02	4.147E-03	6.034E-04	3.252E-02
CR - 1' from West Wall, Column Le, 6' above Floor	1.300E-01	1.758E-02	2.524E-03	1.501E-01
CR - Column 10.1, Column Le, 6' above Floor	7.786E-02	1.187E-02	1.729E-03	9.146E-02
CR - 1' from East Wall, Column Le, 6' above Floor	3.653E-02	5.520E-03	8.038E-04	4.285E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	1.437E-01	1.931E-02	2.772E-03	1.658E-01
CR - Column 10.1, Column Ma, 6' above Floor	8.229E-02	1.190E-02	1.722E-03	9.591E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	3.552E-02	5.277E-03	7.661E-04	4.156E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.516E-01	2.011E-02	2.885E-03	1.746E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	4.808E-02	6.577E-03	9.468E-04	5.560E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.346E-02	3.312E-03	4.781E-04	2.725E-02

Table 31. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 1 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	8.193E-02	1.098E-02	1.576E-03	9.449E-02
CR - Column 10.1, 1' from North Wall, 6' above Floor	5.368E-02	8.059E-03	1.172E-03	6.291E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.780E-02	4.147E-03	6.034E-04	3.255E-02
CR - 1' from West Wall, Column Le, 6' above Floor	1.301E-01	1.758E-02	2.524E-03	1.502E-01
CR - Column 10.1, Column Le, 6' above Floor	7.794E-02	1.187E-02	1.730E-03	9.154E-02
CR - 1' from East Wall, Column Le, 6' above Floor	3.656E-02	5.520E-03	8.038E-04	4.288E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	1.438E-01	1.931E-02	2.772E-03	1.659E-01
CR - Column 10.1, Column Ma, 6' above Floor	8.236E-02	1.190E-02	1.722E-03	9.598E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	3.555E-02	5.277E-03	7.662E-04	4.159E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.517E-01	2.011E-02	2.886E-03	1.747E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	4.811E-02	6.577E-03	9.468E-04	5.563E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.348E-02	3.312E-03	4.781E-04	2.727E-02

Table 32. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 1 in the Reactor Building Attributed to Primary Containment Leakage (Occupancy Factors Included)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	8.139E-02	1.092E-02	1.502E-03	9.381E-02
CR - Column 10.1, 1' from North Wall, 6' above Floor	5.329E-02	8.009E-03	1.118E-03	6.242E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.760E-02	4.121E-03	5.758E-04	3.229E-02
CR - 1' from West Wall, Column Le, 6' above Floor	1.292E-01	1.748E-02	2.406E-03	1.491E-01
CR - Column 10.1, Column Le, 6' above Floor	7.737E-02	1.179E-02	1.650E-03	9.082E-02
CR - 1' from East Wall, Column Le, 6' above Floor	3.630E-02	5.486E-03	7.671E-04	4.255E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	1.429E-01	1.920E-02	2.642E-03	1.647E-01
CR - Column 10.1, Column Ma, 6' above Floor	8.179E-02	1.183E-02	1.642E-03	9.526E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	3.530E-02	5.245E-03	7.310E-04	4.128E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.507E-01	1.999E-02	2.751E-03	1.735E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	4.779E-02	6.538E-03	9.028E-04	5.523E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.332E-02	3.292E-03	4.560E-04	2.707E-02

Table 33. Control Room Dose (rem) at 1 Day Post LOCA Due to Source Region 2 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.774E-04	3.220E-05	4.032E-06	4.136E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.616E-05	1.253E-06	1.620E-07	2.758E-05
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.421E-05	6.983E-07	9.003E-08	1.500E-05
CR - 1' from West Wall, Column Le, 6' above Floor	9.219E-04	8.535E-05	1.070E-05	1.018E-03
CR - Column 10.1, Column Le, 6' above Floor	8.165E-05	4.782E-06	6.063E-07	8.704E-05
CR - 1' from East Wall, Column Le, 6' above Floor	3.801E-05	2.156E-06	2.742E-07	4.044E-05
CR - 1' from West Wall, Column Ma, 6' above Floor	1.757E-03	1.716E-04	2.153E-05	1.950E-03
CR - Column 10.1, Column Ma, 6' above Floor	1.142E-04	7.149E-06	9.028E-07	1.223E-04
CR - 1' from East Wall, Column Ma, 6' above Floor	6.326E-05	3.750E-06	4.754E-07	6.749E-05
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.481E-03	2.437E-04	3.059E-05	2.755E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.897E-04	1.087E-05	1.380E-06	2.020E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	3.157E-04	2.301E-05	2.884E-06	3.416E-04

Table 34. Control Room Dose (rem) at 4 Days Post LOCA Due to Source Region 2 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.823E-04	3.259E-05	4.610E-06	4.195E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.646E-05	1.266E-06	1.872E-07	2.791E-05
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.437E-05	7.057E-07	1.040E-07	1.518E-05
CR - 1' from West Wall, Column Le, 6' above Floor	9.343E-04	8.643E-05	1.221E-05	1.033E-03
CR - Column 10.1, Column Le, 6' above Floor	8.262E-05	4.835E-06	6.980E-07	8.815E-05
CR - 1' from East Wall, Column Le, 6' above Floor	3.846E-05	2.180E-06	3.159E-07	4.096E-05
CR - 1' from West Wall, Column Ma, 6' above Floor	1.781E-03	1.738E-04	2.455E-05	1.979E-03
CR - Column 10.1, Column Ma, 6' above Floor	1.156E-04	7.229E-06	1.038E-06	1.239E-04
CR - 1' from East Wall, Column Ma, 6' above Floor	6.400E-05	3.791E-06	5.472E-07	6.834E-05
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.515E-03	2.468E-04	3.488E-05	2.797E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.919E-04	1.099E-05	1.590E-06	2.045E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	3.196E-04	2.327E-05	3.308E-06	3.462E-04

Table 35. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 2 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.824E-04	3.259E-05	4.610E-06	4.196E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.646E-05	1.266E-06	1.872E-07	2.791E-05
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.437E-05	7.057E-07	1.040E-07	1.518E-05
CR - 1' from West Wall, Column Le, 6' above Floor	9.345E-04	8.643E-05	1.221E-05	1.033E-03
CR - Column 10.1, Column Le, 6' above Floor	8.262E-05	4.835E-06	6.980E-07	8.815E-05
CR - 1' from East Wall, Column Le, 6' above Floor	3.846E-05	2.180E-06	3.160E-07	4.096E-05
CR - 1' from West Wall, Column Ma, 6' above Floor	1.781E-03	1.738E-04	2.455E-05	1.979E-03
CR - Column 10.1, Column Ma, 6' above Floor	1.156E-04	7.229E-06	1.038E-06	1.239E-04
CR - 1' from East Wall, Column Ma, 6' above Floor	6.401E-05	3.791E-06	5.473E-07	6.835E-05
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.516E-03	2.468E-04	3.488E-05	2.798E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.919E-04	1.099E-05	1.590E-06	2.045E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	3.196E-04	2.327E-05	3.309E-06	3.462E-04

Table 36. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 2 in the Reactor Building Attributed to Primary Containment Leakage (Occupancy Factors Included)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.804E-04	3.243E-05	4.379E-06	4.172E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.634E-05	1.261E-06	1.771E-07	2.778E-05
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.431E-05	7.027E-07	9.841E-08	1.511E-05
CR - 1' from West Wall, Column Le, 6' above Floor	9.294E-04	8.600E-05	1.161E-05	1.027E-03
CR - Column 10.1, Column Le, 6' above Floor	8.223E-05	4.814E-06	6.613E-07	8.771E-05
CR - 1' from East Wall, Column Le, 6' above Floor	3.828E-05	2.170E-06	2.993E-07	4.075E-05
CR - 1' from West Wall, Column Ma, 6' above Floor	1.771E-03	1.729E-04	2.334E-05	1.968E-03
CR - Column 10.1, Column Ma, 6' above Floor	1.150E-04	7.197E-06	9.839E-07	1.232E-04
CR - 1' from East Wall, Column Ma, 6' above Floor	6.371E-05	3.775E-06	5.185E-07	6.800E-05
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.502E-03	2.456E-04	3.316E-05	2.781E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.910E-04	1.094E-05	1.506E-06	2.035E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	3.180E-04	2.317E-05	3.139E-06	3.443E-04

Table 37. Control Room Dose (rem) at 1 Day Post LOCA Due to Source Region 3 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.194E-03	4.132E-04	5.678E-05	2.664E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.334E-02	2.528E-03	3.435E-04	1.621E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.066E-02	1.730E-03	2.287E-04	1.262E-02
CR - 1' from West Wall, Column Le, 6' above Floor	2.805E-03	5.332E-04	7.405E-05	3.412E-03
CR - Column 10.1, Column Le, 6' above Floor	1.678E-02	3.361E-03	4.618E-04	2.060E-02
CR - 1' from East Wall, Column Le, 6' above Floor	1.430E-02	2.466E-03	3.294E-04	1.710E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	3.392E-03	6.264E-04	8.700E-05	4.105E-03
CR - Column 10.1, Column Ma, 6' above Floor	1.987E-02	4.128E-03	5.718E-04	2.457E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	1.813E-02	3.274E-03	4.408E-04	2.184E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	3.983E-03	7.630E-04	1.071E-04	4.853E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.285E-02	5.111E-03	7.193E-04	2.868E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.202E-02	4.401E-03	6.048E-04	2.703E-02

Table 38. Control Room Dose (rem) at 4 Days Post LOCA Due to Source Region 3 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.238E-03	4.207E-04	6.370E-05	2.722E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.360E-02	2.573E-03	3.857E-04	1.656E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.085E-02	1.758E-03	2.578E-04	1.287E-02
CR - 1' from West Wall, Column Le, 6' above Floor	2.862E-03	5.431E-04	8.303E-05	3.488E-03
CR - Column 10.1, Column Le, 6' above Floor	1.713E-02	3.422E-03	5.180E-04	2.107E-02
CR - 1' from East Wall, Column Le, 6' above Floor	1.456E-02	2.507E-03	3.708E-04	1.744E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	3.460E-03	6.380E-04	9.759E-05	4.196E-03
CR - Column 10.1, Column Ma, 6' above Floor	2.029E-02	4.205E-03	6.409E-04	2.514E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	1.847E-02	3.331E-03	4.957E-04	2.230E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.066E-03	7.775E-04	1.200E-04	4.964E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.337E-02	5.210E-03	8.048E-04	2.938E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.247E-02	4.480E-03	6.785E-04	2.763E-02

Table 39. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 3 in the Reactor Building Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.243E-03	4.207E-04	6.371E-05	2.727E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.363E-02	2.573E-03	3.858E-04	1.659E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.087E-02	1.758E-03	2.578E-04	1.289E-02
CR - 1' from West Wall, Column Le, 6' above Floor	2.869E-03	5.431E-04	8.303E-05	3.495E-03
CR - Column 10.1, Column Le, 6' above Floor	1.717E-02	3.422E-03	5.180E-04	2.111E-02
CR - 1' from East Wall, Column Le, 6' above Floor	1.458E-02	2.507E-03	3.708E-04	1.746E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	3.469E-03	6.380E-04	9.759E-05	4.205E-03
CR - Column 10.1, Column Ma, 6' above Floor	2.035E-02	4.205E-03	6.409E-04	2.520E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	1.851E-02	3.331E-03	4.957E-04	2.234E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.079E-03	7.775E-04	1.200E-04	4.977E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.345E-02	5.210E-03	8.049E-04	2.946E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.253E-02	4.481E-03	6.785E-04	2.769E-02

Table 40. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 3 in the Reactor Building Attributed to Primary Containment Leakage (Occupancy Factors Included)

Dose Receptor Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.222E-03	4.177E-04	6.094E-05	2.701E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.351E-02	2.555E-03	3.689E-04	1.643E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.078E-02	1.747E-03	2.462E-04	1.277E-02
CR - 1' from West Wall, Column Le, 6' above Floor	2.842E-03	5.391E-04	7.944E-05	3.461E-03
CR - Column 10.1, Column Le, 6' above Floor	1.701E-02	3.398E-03	4.955E-04	2.090E-02
CR - 1' from East Wall, Column Le, 6' above Floor	1.446E-02	2.491E-03	3.542E-04	1.731E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	3.436E-03	6.334E-04	9.335E-05	4.163E-03
CR - Column 10.1, Column Ma, 6' above Floor	2.015E-02	4.174E-03	6.133E-04	2.493E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	1.835E-02	3.308E-03	4.737E-04	2.213E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.038E-03	7.717E-04	1.148E-04	4.925E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.319E-02	5.170E-03	7.706E-04	2.914E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.231E-02	4.449E-03	6.490E-04	2.741E-02

Table 41. Control Room Dose (rem) at 30 Days Post LOCA Due Airborne Activity in the Reactor Building Attributed to Primary Containment Leakage (Occupancy Factors Included)

Dose Receptor Location	Source Region 1	Source Region 2	Source Region 3	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	9.381E-02	4.172E-04	2.701E-03	9.693E-02
CR - Column 10.1, 1' from North Wall, 6' above Floor	6.242E-02	2.778E-05	1.643E-02	7.888E-02
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.229E-02	1.511E-05	1.277E-02	4.508E-02
CR - 1' from West Wall, Column Le, 6' above Floor	1.491E-01	1.027E-03	3.461E-03	1.536E-01
CR - Column 10.1, Column Le, 6' above Floor	9.082E-02	8.771E-05	2.090E-02	1.118E-01
CR - 1' from East Wall, Column Le, 6' above Floor	4.255E-02	4.075E-05	1.731E-02	5.990E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	1.647E-01	1.968E-03	4.163E-03	1.708E-01
CR - Column 10.1, Column Ma, 6' above Floor	9.526E-02	1.232E-04	2.493E-02	1.203E-01
CR - 1' from East Wall, Column Ma, 6' above Floor	4.128E-02	6.800E-05	2.213E-02	6.348E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.735E-01	2.781E-03	4.925E-03	1.812E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	5.523E-02	2.035E-04	2.914E-02	8.457E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.707E-02	3.443E-04	2.741E-02	5.482E-02

Table 42. Control Room Dose (rem) at 1 Day Post LOCA Due to Source Region 1 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.687E-03	1.232E-04	2.810E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.960E-03	9.360E-05	2.054E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.007E-03	4.839E-05	1.055E-03
CR - 1' from West Wall, Column Le, 6' above Floor	4.301E-03	1.976E-04	4.499E-03
CR - Column 10.1, Column Le, 6' above Floor	2.884E-03	1.385E-04	3.023E-03
CR - 1' from East Wall, Column Le, 6' above Floor	1.340E-03	6.453E-05	1.405E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	4.726E-03	2.167E-04	4.943E-03
CR - Column 10.1, Column Ma, 6' above Floor	2.902E-03	1.364E-04	3.038E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	1.283E-03	6.122E-05	1.344E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.926E-03	2.253E-04	5.151E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.607E-03	7.444E-05	1.681E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	8.080E-04	3.779E-05	8.458E-04

Table 43. Control Room Dose (rem) at 4 Days Post LOCA Due to Source Region 1 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.430E-03	4.561E-04	3.886E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.532E-03	3.465E-04	2.879E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.302E-03	1.791E-04	1.481E-03
CR - 1' from West Wall, Column Le, 6' above Floor	5.493E-03	7.314E-04	6.224E-03
CR - Column 10.1, Column Le, 6' above Floor	3.731E-03	5.125E-04	4.244E-03
CR - 1' from East Wall, Column Le, 6' above Floor	1.733E-03	2.389E-04	1.972E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	6.033E-03	8.022E-04	6.835E-03
CR - Column 10.1, Column Ma, 6' above Floor	3.731E-03	5.049E-04	4.236E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	1.655E-03	2.266E-04	1.882E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	6.283E-03	8.339E-04	7.117E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.056E-03	2.755E-04	2.332E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.037E-03	1.399E-04	1.177E-03

Table 44. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 1 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.540E-03	8.135E-04	4.354E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.645E-03	6.180E-04	3.263E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.359E-03	3.195E-04	1.679E-03
CR - 1' from West Wall, Column Le, 6' above Floor	5.670E-03	1.305E-03	6.975E-03
CR - Column 10.1, Column Le, 6' above Floor	3.904E-03	9.143E-04	4.818E-03
CR - 1' from East Wall, Column Le, 6' above Floor	1.811E-03	4.261E-04	2.237E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	6.225E-03	1.431E-03	7.656E-03
CR - Column 10.1, Column Ma, 6' above Floor	3.877E-03	9.006E-04	4.778E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	1.725E-03	4.042E-04	2.129E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	6.479E-03	1.487E-03	7.966E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.126E-03	4.914E-04	2.617E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.075E-03	2.495E-04	1.325E-03

Table 45. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 1 in the Reactor Building Attributed to ESF System Leakage (Occupancy Factors Included)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.177E-03	4.659E-04	3.643E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.348E-03	3.539E-04	2.702E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.207E-03	1.830E-04	1.390E-03
CR - 1' from West Wall, Column Le, 6' above Floor	5.087E-03	7.473E-04	5.834E-03
CR - Column 10.1, Column Le, 6' above Floor	3.461E-03	5.236E-04	3.985E-03
CR - 1' from East Wall, Column Le, 6' above Floor	1.607E-03	2.440E-04	1.851E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	5.587E-03	8.195E-04	6.407E-03
CR - Column 10.1, Column Ma, 6' above Floor	3.458E-03	5.158E-04	3.974E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	1.534E-03	2.315E-04	1.766E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.819E-03	8.517E-04	6.670E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.904E-03	2.814E-04	2.186E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	9.606E-04	1.429E-04	1.103E-03

Table 46. Control Room Dose (rem) at 1 Day Post LOCA Due to Source Region 2 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	8.134E-06	3.380E-07	8.472E-06
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.194E-07	1.312E-08	3.325E-07
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.779E-07	7.302E-09	1.852E-07
CR - 1' from West Wall, Column Le, 6' above Floor	2.151E-05	9.034E-07	2.241E-05
CR - Column 10.1, Column Le, 6' above Floor	1.217E-06	4.971E-08	1.267E-06
CR - 1' from East Wall, Column Le, 6' above Floor	5.487E-07	2.240E-08	5.711E-07
CR - 1' from West Wall, Column Ma, 6' above Floor	4.318E-05	1.827E-06	4.501E-05
CR - Column 10.1, Column Ma, 6' above Floor	1.817E-06	7.415E-08	1.891E-06
CR - 1' from East Wall, Column Ma, 6' above Floor	9.537E-07	3.893E-08	9.926E-07
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	6.131E-05	2.597E-06	6.391E-05
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.766E-06	1.129E-07	2.879E-06
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.833E-06	2.390E-07	6.072E-06

Table 47. Control Room Dose (rem) at 4 Days Post LOCA Due to Source Region 2 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.008E-05	1.251E-06	1.133E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.871E-07	4.857E-08	4.357E-07
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.159E-07	2.702E-08	2.429E-07
CR - 1' from West Wall, Column Le, 6' above Floor	2.678E-05	3.343E-06	3.012E-05
CR - Column 10.1, Column Le, 6' above Floor	1.484E-06	1.840E-07	1.668E-06
CR - 1' from East Wall, Column Le, 6' above Floor	6.688E-07	8.289E-08	7.517E-07
CR - 1' from West Wall, Column Ma, 6' above Floor	5.390E-05	6.761E-06	6.066E-05
CR - Column 10.1, Column Ma, 6' above Floor	2.222E-06	2.744E-07	2.496E-06
CR - 1' from East Wall, Column Ma, 6' above Floor	1.164E-06	1.441E-07	1.308E-06
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	7.657E-05	9.612E-06	8.618E-05
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.371E-06	4.178E-07	3.789E-06
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	7.177E-06	8.843E-07	8.061E-06

Table 48. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 2 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.019E-05	2.231E-06	1.242E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.881E-07	8.659E-08	4.747E-07
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.165E-07	4.818E-08	2.647E-07
CR - 1' from West Wall, Column Le, 6' above Floor	2.713E-05	5.962E-06	3.309E-05
CR - Column 10.1, Column Le, 6' above Floor	1.490E-06	3.280E-07	1.818E-06
CR - 1' from East Wall, Column Le, 6' above Floor	6.714E-07	1.478E-07	8.192E-07
CR - 1' from West Wall, Column Ma, 6' above Floor	5.468E-05	1.205E-05	6.673E-05
CR - Column 10.1, Column Ma, 6' above Floor	2.233E-06	4.893E-07	2.722E-06
CR - 1' from East Wall, Column Ma, 6' above Floor	1.169E-06	2.569E-07	1.426E-06
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	7.770E-05	1.714E-05	9.484E-05
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.384E-06	7.448E-07	4.129E-06
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	7.228E-06	1.577E-06	8.805E-06

Table 49. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 2 in the Reactor Building Attributed to ESF System Leakage (Occupancy Factors Included)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	9.346E-06	1.278E-06	1.062E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.604E-07	4.960E-08	4.100E-07
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.009E-07	2.760E-08	2.285E-07
CR - 1' from West Wall, Column Le, 6' above Floor	2.481E-05	3.415E-06	2.823E-05
CR - Column 10.1, Column Le, 6' above Floor	1.380E-06	1.879E-07	1.567E-06
CR - 1' from East Wall, Column Le, 6' above Floor	6.218E-07	8.466E-08	7.065E-07
CR - 1' from West Wall, Column Ma, 6' above Floor	4.992E-05	6.903E-06	5.683E-05
CR - Column 10.1, Column Ma, 6' above Floor	2.064E-06	2.803E-07	2.345E-06
CR - 1' from East Wall, Column Ma, 6' above Floor	1.082E-06	1.472E-07	1.229E-06
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	7.092E-05	9.817E-06	8.074E-05
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.134E-06	4.266E-07	3.561E-06
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	6.660E-06	9.033E-07	7.563E-06

Table 50. Control Room Dose (rem) at 1 Day Post LOCA Due to Source Region 3 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.003E-04	5.432E-06	1.057E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	6.153E-04	3.246E-05	6.478E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	4.251E-04	2.097E-05	4.461E-04
CR - 1' from West Wall, Column Le, 6' above Floor	1.290E-04	7.149E-06	1.361E-04
CR - Column 10.1, Column Le, 6' above Floor	8.151E-04	4.415E-05	8.593E-04
CR - 1' from East Wall, Column Le, 6' above Floor	6.038E-04	3.056E-05	6.344E-04
CR - 1' from West Wall, Column Ma, 6' above Floor	1.517E-04	8.385E-06	1.601E-04
CR - Column 10.1, Column Ma, 6' above Floor	9.985E-04	5.514E-05	1.054E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	7.996E-04	4.123E-05	8.408E-04
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.842E-04	1.043E-05	1.946E-04
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.230E-03	7.052E-05	1.301E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.067E-03	5.785E-05	1.125E-03

Table 51. Control Room Dose (rem) at 4 Days Post LOCA Due to Source Region 3 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.341E-04	2.011E-05	1.542E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	8.160E-04	1.202E-04	9.362E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	5.531E-04	7.763E-05	6.307E-04
CR - 1' from West Wall, Column Le, 6' above Floor	1.737E-04	2.647E-05	2.002E-04
CR - Column 10.1, Column Le, 6' above Floor	1.090E-03	1.635E-04	1.254E-03
CR - 1' from East Wall, Column Le, 6' above Floor	7.911E-04	1.131E-04	9.042E-04
CR - 1' from West Wall, Column Ma, 6' above Floor	2.040E-04	3.104E-05	2.350E-04
CR - Column 10.1, Column Ma, 6' above Floor	1.343E-03	2.041E-04	1.547E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	1.053E-03	1.526E-04	1.206E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.505E-04	3.860E-05	2.891E-04
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.677E-03	2.611E-04	1.938E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.428E-03	2.142E-04	1.642E-03

Table 52. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 3 in the Reactor Building Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.455E-04	3.589E-05	1.814E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	8.755E-04	2.144E-04	1.090E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	5.813E-04	1.385E-04	7.198E-04
CR - 1' from West Wall, Column Le, 6' above Floor	1.899E-04	4.724E-05	2.371E-04
CR - Column 10.1, Column Le, 6' above Floor	1.181E-03	2.917E-04	1.473E-03
CR - 1' from East Wall, Column Le, 6' above Floor	8.378E-04	2.018E-04	1.040E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	2.229E-04	5.540E-05	2.783E-04
CR - Column 10.1, Column Ma, 6' above Floor	1.466E-03	3.643E-04	1.830E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	1.122E-03	2.723E-04	1.394E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.778E-04	6.891E-05	3.467E-04
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.858E-03	4.661E-04	2.324E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.548E-03	3.822E-04	1.930E-03

Table 53. Control Room Dose (rem) at 30 Days Post LOCA Due to Source Region 3 in the Reactor Building Attributed to ESF System Leakage (Occupancy Factors Included)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.251E-04	2.055E-05	1.457E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	7.595E-04	1.228E-04	8.823E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	5.132E-04	7.931E-05	5.925E-04
CR - 1' from West Wall, Column Le, 6' above Floor	1.623E-04	2.705E-05	1.893E-04
CR - Column 10.1, Column Le, 6' above Floor	1.016E-03	1.670E-04	1.183E-03
CR - 1' from East Wall, Column Le, 6' above Floor	7.349E-04	1.156E-04	8.504E-04
CR - 1' from West Wall, Column Ma, 6' above Floor	1.906E-04	3.172E-05	2.224E-04
CR - Column 10.1, Column Ma, 6' above Floor	1.254E-03	2.086E-04	1.463E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	9.792E-04	1.559E-04	1.135E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.349E-04	3.946E-05	2.744E-04
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.571E-03	2.669E-04	1.837E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.332E-03	2.189E-04	1.550E-03

Table 54. Control Room Dose (rem) at 30 Days Post LOCA Due Airborne Activity in the Reactor Building Attributed to ESF System Leakage (Occupancy Factors Included)

Dose Receptor Location	Source Region 1	Source Region 2	Source Region 3	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.643E-03	1.062E-05	1.457E-04	3.799E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.702E-03	4.100E-07	8.823E-04	3.585E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.390E-03	2.285E-07	5.925E-04	1.982E-03
CR - 1' from West Wall, Column Le, 6' above Floor	5.834E-03	2.823E-05	1.893E-04	6.052E-03
CR - Column 10.1, Column Le, 6' above Floor	3.985E-03	1.567E-06	1.183E-03	5.170E-03
CR - 1' from East Wall, Column Le, 6' above Floor	1.851E-03	7.065E-07	8.504E-04	2.702E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	6.407E-03	5.683E-05	2.224E-04	6.686E-03
CR - Column 10.1, Column Ma, 6' above Floor	3.974E-03	2.345E-06	1.463E-03	5.439E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	1.766E-03	1.229E-06	1.135E-03	2.902E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	6.670E-03	8.074E-05	2.744E-04	7.025E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.186E-03	3.561E-06	1.837E-03	4.027E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.103E-03	7.563E-06	1.550E-03	2.662E-03

Table 55. Control Room Dose (rem) at 1 Day Post LOCA Due to ECCS Pipe Segment A (No Occupancy Factors)

Dose Receptor Location	Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.384E-05	4.064E-06	2.790E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	6.981E-04	1.134E-04	8.115E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.843E-03	2.960E-04	2.139E-03
CR - 1' from West Wall, Column Le, 6' above Floor	6.519E-04	1.064E-04	7.583E-04
CR - Column 10.1, Column Le, 6' above Floor	3.887E-03	6.245E-04	4.512E-03
CR - 1' from East Wall, Column Le, 6' above Floor	4.191E-03	6.711E-04	4.862E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	1.182E-02	1.898E-03	1.372E-02
CR - Column 10.1, Column Ma, 6' above Floor	1.158E-02	1.854E-03	1.343E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	4.409E-03	7.072E-04	5.116E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	7.628E-02	1.221E-02	8.849E-02
CR - Column 10.1, 1' from South Wall, 6' above Floor	4.520E-05	7.396E-06	5.260E-05
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	3.756E-08	6.525E-09	4.409E-08

Table 56. Control Room Dose (rem) at 4 Days Post LOCA Due to ECCS Pipe Segment A (No Occupancy Factors)

Dose Receptor Location	Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.679E-05	2.463E-05	5.142E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	8.095E-04	6.571E-04	1.467E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.175E-03	1.678E-03	3.853E-03
CR - 1' from West Wall, Column Le, 6' above Floor	7.521E-04	6.207E-04	1.373E-03
CR - Column 10.1, Column Le, 6' above Floor	4.593E-03	3.537E-03	8.130E-03
CR - 1' from East Wall, Column Le, 6' above Floor	5.019E-03	3.741E-03	8.760E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	1.402E-02	1.070E-02	2.472E-02
CR - Column 10.1, Column Ma, 6' above Floor	1.393E-02	1.029E-02	2.422E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	5.350E-03	3.883E-03	9.233E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	9.171E-02	6.772E-02	1.594E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	5.184E-05	4.343E-05	9.527E-05
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	4.190E-08	4.007E-08	8.197E-08

Table 57. Control Room Dose (rem) at 30 Days Post LOCA Due to ECCS Pipe Segment A (No Occupancy Factors)

Dose Receptor Location	Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.081E-05	1.449E-04	1.757E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.054E-03	3.770E-03	4.824E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.025E-03	9.500E-03	1.253E-02
CR - 1' from West Wall, Column Le, 6' above Floor	9.599E-04	3.575E-03	4.535E-03
CR - Column 10.1, Column Le, 6' above Floor	6.415E-03	2.001E-02	2.643E-02
CR - 1' from East Wall, Column Le, 6' above Floor	7.356E-03	2.094E-02	2.830E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	1.989E-02	6.036E-02	8.025E-02
CR - Column 10.1, Column Ma, 6' above Floor	2.071E-02	5.741E-02	7.812E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	8.221E-03	2.151E-02	2.973E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.364E-01	3.779E-01	5.143E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	6.461E-05	2.510E-04	3.156E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	4.666E-08	2.374E-07	2.841E-07

Table 58. Control Room Dose (rem) at 30 Days Post LOCA Due to ECCS Pipe Segment A (Occupancy Factors Included)

Dose Receptor Location	Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.722E-05	6.451E-05	9.173E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	8.627E-04	1.685E-03	2.548E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.382E-03	4.254E-03	6.636E-03
CR - 1' from West Wall, Column Le, 6' above Floor	7.951E-04	1.597E-03	2.392E-03
CR - Column 10.1, Column Le, 6' above Floor	5.039E-03	8.961E-03	1.400E-02
CR - 1' from East Wall, Column Le, 6' above Floor	5.623E-03	9.393E-03	1.502E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	1.549E-02	2.704E-02	4.253E-02
CR - Column 10.1, Column Ma, 6' above Floor	1.570E-02	2.576E-02	4.147E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	6.122E-03	9.663E-03	1.579E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.034E-01	1.696E-01	2.730E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	5.429E-05	1.120E-04	1.663E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	4.207E-08	1.056E-07	1.477E-07

Table 59. Control Room Dose (rem) at 1 Day Post LOCA Due to ECCS Pipe Segment B (No Occupancy Factors)

Dose Receptor Location	Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	0.000E+00	2.711E-23	2.711E-23
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.300E-05	3.928E-06	2.693E-05
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	7.961E-04	1.285E-04	9.246E-04
CR - 1' from West Wall, Column Le, 6' above Floor	2.361E-16	1.259E-16	3.620E-16
CR - Column 10.1, Column Le, 6' above Floor	6.121E-04	9.999E-05	7.121E-04
CR - 1' from East Wall, Column Le, 6' above Floor	2.233E-03	3.583E-04	2.591E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	1.937E-08	4.101E-09	2.347E-08
CR - Column 10.1, Column Ma, 6' above Floor	6.788E-03	1.089E-03	7.877E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	2.025E-03	3.263E-04	2.351E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	3.288E-02	5.285E-03	3.817E-02
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.072E-03	3.350E-04	2.407E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	7.364E-05	1.224E-05	8.588E-05

Table 60. Control Room Dose (rem) at 4 Days Post LOCA Due to ECCS Pipe Segment B (No Occupancy Factors)

Dose Receptor Location	Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	0.000E+00	2.712E-23	2.712E-23
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.584E-05	2.383E-05	4.967E-05
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	9.288E-04	7.386E-04	1.667E-03
CR - 1' from West Wall, Column Le, 6' above Floor	2.578E-16	6.660E-16	9.238E-16
CR - Column 10.1, Column Le, 6' above Floor	7.049E-04	5.849E-04	1.290E-03
CR - 1' from East Wall, Column Le, 6' above Floor	2.642E-03	2.025E-03	4.667E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	2.120E-08	2.714E-08	4.834E-08
CR - Column 10.1, Column Ma, 6' above Floor	8.071E-03	6.123E-03	1.419E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	2.440E-03	1.809E-03	4.249E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	3.893E-02	2.986E-02	6.879E-02
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.417E-03	1.927E-03	4.344E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	8.373E-05	7.283E-05	1.566E-04

Table 61. Control Room Dose (rem) at 30 Days Post LOCA Due to ECCS Pipe Segment B (No Occupancy Factors)

Dose Receptor Location	Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	0.000E+00	2.718E-23	2.718E-23
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.965E-05	1.402E-04	1.699E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.238E-03	4.217E-03	5.455E-03
CR - 1' from West Wall, Column Le, 6' above Floor	2.578E-16	4.340E-15	4.598E-15
CR - Column 10.1, Column Le, 6' above Floor	8.928E-04	3.374E-03	4.267E-03
CR - 1' from East Wall, Column Le, 6' above Floor	3.713E-03	1.144E-02	1.515E-02
CR - 1' from West Wall, Column Ma, 6' above Floor	2.168E-08	1.694E-07	1.911E-07
CR - Column 10.1, Column Ma, 6' above Floor	1.154E-02	3.447E-02	4.601E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	3.667E-03	1.008E-02	1.375E-02
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.487E-02	1.686E-01	2.235E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.217E-03	1.101E-02	1.423E-02
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.009E-04	4.241E-04	5.250E-04

Table 62. Control Room Dose (rem) at 30 Days Post LOCA Due to ECCS Pipe Segment B (Occupancy Factors Included)

Dose Receptor Location	Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	0.000E+00	2.714E-23	2.714E-23
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.623E-05	6.242E-05	8.865E-05
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	9.994E-04	1.886E-03	2.885E-03
CR - 1' from West Wall, Column Le, 6' above Floor	2.491E-16	1.920E-15	2.169E-15
CR - Column 10.1, Column Le, 6' above Floor	7.429E-04	1.507E-03	2.250E-03
CR - 1' from East Wall, Column Le, 6' above Floor	2.907E-03	5.124E-03	8.031E-03
CR - 1' from West Wall, Column Ma, 6' above Floor	2.066E-08	7.483E-08	9.549E-08
CR - Column 10.1, Column Ma, 6' above Floor	8.945E-03	1.545E-02	2.439E-02
CR - 1' from East Wall, Column Ma, 6' above Floor	2.765E-03	4.524E-03	7.289E-03
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.289E-02	7.553E-02	1.184E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.599E-03	4.923E-03	7.522E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	8.656E-05	1.891E-04	2.757E-04

Table 63. Control Room Dose (rem) at 1 Day Post LOCA Due to the SGTS Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	4.586E-05	2.203E-04	4.297E-05	3.091E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.778E-04	8.597E-04	1.632E-04	1.201E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	6.237E-16	2.941E-15	1.397E-15	4.962E-15
CR - 1' from West Wall, Column Le, 6' above Floor	4.639E-05	2.229E-04	4.347E-05	3.128E-04
CR - Column 10.1, Column Le, 6' above Floor	1.791E-04	8.659E-04	1.644E-04	1.209E-03
CR - 1' from East Wall, Column Le, 6' above Floor	6.336E-16	2.987E-15	1.418E-15	5.039E-15
CR - 1' from West Wall, Column Ma, 6' above Floor	3.621E-05	1.738E-04	3.404E-05	2.441E-04
CR - Column 10.1, Column Ma, 6' above Floor	1.529E-04	7.389E-04	1.405E-04	1.032E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	4.545E-16	2.143E-15	1.039E-15	3.637E-15
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.341E-05	1.122E-04	2.216E-05	1.578E-04
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.357E-05	1.131E-04	2.220E-05	1.589E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.771E-17	2.719E-16	1.578E-16	4.874E-16

Table 64. Control Room Dose (rem) at 4 Days Post LOCA Due to the SGTS Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	6.669E-05	2.589E-04	2.688E-04	5.944E-04
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.641E-04	1.039E-03	9.928E-04	2.296E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	8.630E-16	3.273E-15	9.393E-15	1.353E-14
CR - 1' from West Wall, Column Le, 6' above Floor	6.747E-05	2.620E-04	2.718E-04	6.013E-04
CR - Column 10.1, Column Le, 6' above Floor	2.661E-04	1.046E-03	9.998E-04	2.312E-03
CR - 1' from East Wall, Column Le, 6' above Floor	8.767E-16	3.325E-15	9.537E-15	1.374E-14
CR - 1' from West Wall, Column Ma, 6' above Floor	5.253E-05	2.037E-04	2.135E-04	4.697E-04
CR - Column 10.1, Column Ma, 6' above Floor	2.267E-04	8.906E-04	8.569E-04	1.974E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	6.290E-16	2.385E-15	6.925E-15	9.939E-15
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	3.382E-05	1.309E-04	1.397E-04	3.044E-04
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.417E-05	1.324E-04	1.394E-04	3.060E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	7.987E-17	3.026E-16	9.757E-16	1.358E-15

Table 65. Control Room Dose (rem) at 30 Days Post LOCA Due to the SGTS Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	6.831E-05	3.295E-04	1.576E-03	1.974E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.772E-04	1.465E-03	5.727E-03	7.469E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	8.633E-16	3.273E-15	6.352E-14	6.766E-14
CR - 1' from West Wall, Column Le, 6' above Floor	6.912E-05	3.336E-04	1.594E-03	1.997E-03
CR - Column 10.1, Column Le, 6' above Floor	2.792E-04	1.476E-03	5.767E-03	7.522E-03
CR - 1' from East Wall, Column Le, 6' above Floor	8.770E-16	3.325E-15	6.449E-14	6.869E-14
CR - 1' from West Wall, Column Ma, 6' above Floor	5.371E-05	2.564E-04	1.254E-03	1.564E-03
CR - Column 10.1, Column Ma, 6' above Floor	2.373E-04	1.245E-03	4.950E-03	6.432E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	6.292E-16	2.385E-15	4.681E-14	4.982E-14
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	3.448E-05	1.618E-04	8.228E-04	1.019E-03
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.491E-05	1.659E-04	8.194E-04	1.020E-03
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	7.990E-17	3.026E-16	6.562E-15	6.945E-15

Table 66. Control Room Dose (rem) at 30 Days Post LOCA Due to the SGTS Filter Attributed to Primary Containment Leakage (Occupancy Factors Included)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	5.901E-05	2.717E-04	7.013E-04	1.032E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.348E-04	1.138E-03	2.555E-03	3.927E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	7.674E-16	3.140E-15	2.785E-14	3.175E-14
CR - 1' from West Wall, Column Le, 6' above Floor	5.970E-05	2.750E-04	7.093E-04	1.044E-03
CR - Column 10.1, Column Le, 6' above Floor	2.365E-04	1.146E-03	2.573E-03	3.955E-03
CR - 1' from East Wall, Column Le, 6' above Floor	7.796E-16	3.190E-15	2.827E-14	3.224E-14
CR - 1' from West Wall, Column Ma, 6' above Floor	4.647E-05	2.128E-04	5.579E-04	8.172E-04
CR - Column 10.1, Column Ma, 6' above Floor	2.014E-04	9.717E-04	2.208E-03	3.381E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	5.593E-16	2.288E-15	2.052E-14	2.337E-14
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.992E-05	1.358E-04	3.659E-04	5.316E-04
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.023E-05	1.381E-04	3.645E-04	5.328E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	7.102E-17	2.903E-16	2.883E-15	3.244E-15

Table 67. Control Room Dose (rem) at 1 Day Post LOCA Due to the SGTS Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	5.242E-05	1.632E-06	5.405E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.033E-04	6.349E-06	2.096E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	7.130E-16	1.776E-17	7.308E-16
CR - 1' from West Wall, Column Le, 6' above Floor	5.303E-05	1.651E-06	5.468E-05
CR - Column 10.1, Column Le, 6' above Floor	2.047E-04	6.395E-06	2.111E-04
CR - 1' from East Wall, Column Le, 6' above Floor	7.243E-16	1.805E-17	7.424E-16
CR - 1' from West Wall, Column Ma, 6' above Floor	4.139E-05	1.290E-06	4.268E-05
CR - Column 10.1, Column Ma, 6' above Floor	1.748E-04	5.455E-06	1.803E-04
CR - 1' from East Wall, Column Ma, 6' above Floor	5.196E-16	1.285E-17	5.325E-16
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.676E-05	8.358E-07	2.760E-05
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.695E-05	8.404E-07	2.779E-05
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	6.597E-17	1.563E-18	6.753E-17

Table 68. Control Room Dose (rem) at 4 Days Post LOCA Due to the SGTS Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	7.949E-05	6.294E-06	8.578E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.161E-04	2.449E-05	3.406E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.019E-15	6.849E-17	1.087E-15
CR - 1' from West Wall, Column Le, 6' above Floor	8.043E-05	6.367E-06	8.680E-05
CR - Column 10.1, Column Le, 6' above Floor	3.184E-04	2.466E-05	3.431E-04
CR - 1' from East Wall, Column Le, 6' above Floor	1.035E-15	6.960E-17	1.105E-15
CR - 1' from West Wall, Column Ma, 6' above Floor	6.259E-05	4.976E-06	6.757E-05
CR - Column 10.1, Column Ma, 6' above Floor	2.713E-04	2.104E-05	2.923E-04
CR - 1' from East Wall, Column Ma, 6' above Floor	7.424E-16	4.956E-17	7.920E-16
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.027E-05	3.223E-06	4.349E-05
CR - Column 10.1, 1' from South Wall, 6' above Floor	4.070E-05	3.241E-06	4.394E-05
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	9.428E-17	6.027E-18	1.003E-16

Table 69. Control Room Dose (rem) at 30 Days Post LOCA Due to the SGTS Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	8.256E-05	1.130E-05	9.386E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.413E-04	4.401E-05	3.853E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.019E-15	1.229E-16	1.142E-15
CR - 1' from West Wall, Column Le, 6' above Floor	8.355E-05	1.143E-05	9.498E-05
CR - Column 10.1, Column Le, 6' above Floor	3.439E-04	4.433E-05	3.882E-04
CR - 1' from East Wall, Column Le, 6' above Floor	1.035E-15	1.249E-16	1.160E-15
CR - 1' from West Wall, Column Ma, 6' above Floor	6.480E-05	8.935E-06	7.374E-05
CR - Column 10.1, Column Ma, 6' above Floor	2.917E-04	3.781E-05	3.295E-04
CR - 1' from East Wall, Column Ma, 6' above Floor	7.428E-16	8.895E-17	8.318E-16
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.150E-05	5.787E-06	4.729E-05
CR - Column 10.1, 1' from South Wall, 6' above Floor	4.209E-05	5.819E-06	4.791E-05
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	9.433E-17	1.082E-17	1.052E-16

Table 70. Control Room Dose (rem) at 30 Days Post LOCA Due to the SGTS Filter Attributed to ESF System Leakage (Occupancy Factors Included)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	6.989E-05	6.432E-06	7.632E-05
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.811E-04	2.504E-05	3.061E-04
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	8.966E-16	6.996E-17	9.666E-16
CR - 1' from West Wall, Column Le, 6' above Floor	7.072E-05	6.506E-06	7.722E-05
CR - Column 10.1, Column Le, 6' above Floor	2.831E-04	2.522E-05	3.083E-04
CR - 1' from East Wall, Column Le, 6' above Floor	9.107E-16	7.110E-17	9.818E-16
CR - 1' from West Wall, Column Ma, 6' above Floor	5.499E-05	5.085E-06	6.008E-05
CR - Column 10.1, Column Ma, 6' above Floor	2.409E-04	2.151E-05	2.624E-04
CR - 1' from East Wall, Column Ma, 6' above Floor	6.534E-16	5.063E-17	7.041E-16
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	3.536E-05	3.294E-06	3.865E-05
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.576E-05	3.312E-06	3.907E-05
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	8.298E-17	6.159E-18	8.913E-17

Table 71. Control Room Dose (rem) at 30 Days Post LOCA Due to the SGTS (Occupancy Factors Included)

Dose Receptor Location	Primary Leakage	ESF Leakage	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.032E-03	7.632E-05	1.108E-03
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.927E-03	3.061E-04	4.233E-03
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.175E-14	9.666E-16	3.272E-14
CR - 1' from West Wall, Column Le, 6' above Floor	1.044E-03	7.722E-05	1.121E-03
CR - Column 10.1, Column Le, 6' above Floor	3.955E-03	3.083E-04	4.263E-03
CR - 1' from East Wall, Column Le, 6' above Floor	3.224E-14	9.818E-16	3.322E-14
CR - 1' from West Wall, Column Ma, 6' above Floor	8.172E-04	6.008E-05	8.773E-04
CR - Column 10.1, Column Ma, 6' above Floor	3.381E-03	2.624E-04	3.643E-03
CR - 1' from East Wall, Column Ma, 6' above Floor	2.337E-14	7.041E-16	2.408E-14
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.316E-04	3.865E-05	5.703E-04
CR - Column 10.1, 1' from South Wall, 6' above Floor	5.328E-04	3.907E-05	5.719E-04
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	3.244E-15	8.913E-17	3.334E-15

Table 72. Control Room Dose (rem) at 1 Day Post LOCA Due to the CR Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	9.368E-18	1.508E-17	6.370E-20	2.451E-17
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.324E-13	1.425E-12	3.985E-15	1.561E-12
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.332E-11	1.783E-10	4.504E-13	1.921E-10
CR - 1' from West Wall, Column Le, 6' above Floor	9.646E-13	1.394E-11	3.322E-14	1.494E-11
CR - Column 10.1, Column Le, 6' above Floor	1.191E-12	1.650E-11	4.061E-14	1.773E-11
CR - 1' from East Wall, Column Le, 6' above Floor	1.446E-12	1.781E-11	4.715E-14	1.930E-11
CR - 1' from West Wall, Column Ma, 6' above Floor	8.086E-19	6.339E-19	3.069E-21	1.446E-18
CR - Column 10.1, Column Ma, 6' above Floor	1.870E-12	2.689E-11	6.436E-14	2.882E-11
CR - 1' from East Wall, Column Ma, 6' above Floor	1.462E-14	1.192E-13	3.638E-16	1.342E-13
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.969E-19	8.985E-20	4.905E-22	2.872E-19
CR - Column 10.1, 1' from South Wall, 6' above Floor	6.594E-13	9.326E-12	2.262E-14	1.001E-11
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.457E-16	9.252E-16	3.334E-18	1.174E-15

Table 73. Control Room Dose (rem) at 4 Days Post LOCA Due to the CR Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	9.453E-18	1.626E-17	4.464E-19	2.616E-17
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.404E-13	1.545E-12	2.651E-14	1.712E-12
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.435E-11	1.951E-10	2.876E-12	2.123E-10
CR - 1' from West Wall, Column Le, 6' above Floor	1.048E-12	1.547E-11	2.061E-13	1.672E-11
CR - Column 10.1, Column Le, 6' above Floor	1.288E-12	1.816E-11	2.561E-13	1.970E-11
CR - 1' from East Wall, Column Le, 6' above Floor	1.547E-12	1.938E-11	3.071E-13	2.123E-11
CR - 1' from West Wall, Column Ma, 6' above Floor	8.122E-19	6.837E-19	2.076E-20	1.517E-18
CR - Column 10.1, Column Ma, 6' above Floor	2.030E-12	2.980E-11	4.001E-13	3.223E-11
CR - 1' from East Wall, Column Ma, 6' above Floor	1.528E-14	1.288E-13	2.491E-15	1.466E-13
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.974E-19	9.694E-20	3.172E-21	2.975E-19
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.145E-13	1.030E-11	1.416E-13	1.116E-11
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.508E-16	9.977E-16	2.354E-17	1.272E-15

Table 74. Control Room Dose (rem) at 30 Days Post LOCA Due to the CR Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	9.453E-18	1.629E-17	2.965E-18	2.871E-17
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.404E-13	1.602E-12	1.638E-13	1.906E-12
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.436E-11	2.116E-10	1.730E-11	2.433E-10
CR - 1' from West Wall, Column Le, 6' above Floor	1.049E-12	1.785E-11	1.219E-12	2.012E-11
CR - Column 10.1, Column Le, 6' above Floor	1.289E-12	2.019E-11	1.529E-12	2.301E-11
CR - 1' from East Wall, Column Le, 6' above Floor	1.548E-12	2.047E-11	1.870E-12	2.389E-11
CR - 1' from West Wall, Column Ma, 6' above Floor	8.122E-19	6.843E-19	1.387E-19	1.635E-18
CR - Column 10.1, Column Ma, 6' above Floor	2.032E-12	3.421E-11	2.369E-12	3.861E-11
CR - 1' from East Wall, Column Ma, 6' above Floor	1.528E-14	1.311E-13	1.573E-14	1.621E-13
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.974E-19	9.697E-20	2.121E-20	3.156E-19
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.151E-13	1.162E-11	8.418E-13	1.318E-11
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.508E-16	1.003E-15	1.535E-16	1.407E-15

Table 75. Control Room Dose (rem) at 30 Days Post LOCA Due to the CR Filter Attributed to Primary Containment Leakage (Occupancy Factors Included)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	9.419E-18	1.580E-17	1.301E-18	2.652E-17
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.372E-13	1.520E-12	7.242E-14	1.729E-12
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.394E-11	1.950E-10	7.675E-12	2.166E-10
CR - 1' from West Wall, Column Le, 6' above Floor	1.015E-12	1.581E-11	5.421E-13	1.737E-11
CR - Column 10.1, Column Le, 6' above Floor	1.250E-12	1.831E-11	6.791E-13	2.024E-11
CR - 1' from East Wall, Column Le, 6' above Floor	1.507E-12	1.919E-11	8.283E-13	2.152E-11
CR - 1' from West Wall, Column Ma, 6' above Floor	8.108E-19	6.640E-19	6.086E-20	1.536E-18
CR - Column 10.1, Column Ma, 6' above Floor	1.967E-12	3.040E-11	1.053E-12	3.342E-11
CR - 1' from East Wall, Column Ma, 6' above Floor	1.502E-14	1.259E-13	6.936E-15	1.478E-13
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.972E-19	9.412E-20	9.315E-21	3.006E-19
CR - Column 10.1, 1' from South Wall, 6' above Floor	6.927E-13	1.044E-11	3.741E-13	1.151E-11
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.488E-16	9.708E-16	6.744E-17	1.287E-15

Table 76. Control Room Dose (rem) at 1 Day Post LOCA Due to the CR Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.063E-18	2.076E-21	1.065E-18
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.001E-13	2.168E-16	1.003E-13
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.247E-11	2.655E-14	1.250E-11
CR - 1' from West Wall, Column Le, 6' above Floor	9.708E-13	2.025E-15	9.728E-13
CR - Column 10.1, Column Le, 6' above Floor	1.153E-12	2.430E-15	1.155E-12
CR - 1' from East Wall, Column Le, 6' above Floor	1.249E-12	2.689E-15	1.252E-12
CR - 1' from West Wall, Column Ma, 6' above Floor	4.468E-20	8.267E-23	4.476E-20
CR - Column 10.1, Column Ma, 6' above Floor	1.874E-12	3.914E-15	1.878E-12
CR - 1' from East Wall, Column Ma, 6' above Floor	8.383E-15	1.812E-17	8.401E-15
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	6.335E-21	1.111E-23	6.346E-21
CR - Column 10.1, 1' from South Wall, 6' above Floor	6.508E-13	1.366E-15	6.522E-13
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	6.513E-17	1.349E-19	6.526E-17

Table 77. Control Room Dose (rem) at 4 Days Post LOCA Due to the CR Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.159E-18	2.723E-21	1.162E-18
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.092E-13	2.844E-16	1.095E-13
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.365E-11	3.483E-14	1.368E-11
CR - 1' from West Wall, Column Le, 6' above Floor	1.066E-12	2.657E-15	1.069E-12
CR - Column 10.1, Column Le, 6' above Floor	1.263E-12	3.189E-15	1.266E-12
CR - 1' from East Wall, Column Le, 6' above Floor	1.365E-12	3.528E-15	1.369E-12
CR - 1' from West Wall, Column Ma, 6' above Floor	4.876E-20	1.085E-22	4.887E-20
CR - Column 10.1, Column Ma, 6' above Floor	2.058E-12	5.136E-15	2.063E-12
CR - 1' from East Wall, Column Ma, 6' above Floor	9.143E-15	2.377E-17	9.167E-15
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	6.917E-21	1.457E-23	6.932E-21
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.138E-13	1.792E-15	7.156E-13
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	7.103E-17	1.770E-19	7.121E-17

Table 78. Control Room Dose (rem) at 30 Days Post LOCA Due to the CR Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.159E-18	2.765E-21	1.162E-18
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.092E-13	2.888E-16	1.095E-13
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.366E-11	3.537E-14	1.370E-11
CR - 1' from West Wall, Column Le, 6' above Floor	1.068E-12	2.698E-15	1.071E-12
CR - Column 10.1, Column Le, 6' above Floor	1.264E-12	3.238E-15	1.267E-12
CR - 1' from East Wall, Column Le, 6' above Floor	1.365E-12	3.583E-15	1.369E-12
CR - 1' from West Wall, Column Ma, 6' above Floor	4.876E-20	1.101E-22	4.887E-20
CR - Column 10.1, Column Ma, 6' above Floor	2.060E-12	5.215E-15	2.065E-12
CR - 1' from East Wall, Column Ma, 6' above Floor	9.144E-15	2.414E-17	9.168E-15
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	6.917E-21	1.480E-23	6.932E-21
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.146E-13	1.820E-15	7.164E-13
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	7.103E-17	1.798E-19	7.121E-17

Table 79. Control Room Dose (rem) at 30 Days Post LOCA Due to the CR Filter Attributed to ESF System Leakage (Occupancy Factors Included)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.121E-18	2.481E-21	1.123E-18
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.056E-13	2.591E-16	1.058E-13
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.318E-11	3.173E-14	1.321E-11
CR - 1' from West Wall, Column Le, 6' above Floor	1.029E-12	2.421E-15	1.031E-12
CR - Column 10.1, Column Le, 6' above Floor	1.219E-12	2.905E-15	1.222E-12
CR - 1' from East Wall, Column Le, 6' above Floor	1.319E-12	3.214E-15	1.322E-12
CR - 1' from West Wall, Column Ma, 6' above Floor	4.713E-20	9.881E-23	4.723E-20
CR - Column 10.1, Column Ma, 6' above Floor	1.985E-12	4.679E-15	1.990E-12
CR - 1' from East Wall, Column Ma, 6' above Floor	8.839E-15	2.166E-17	8.861E-15
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	6.684E-21	1.328E-23	6.697E-21
CR - Column 10.1, 1' from South Wall, 6' above Floor	6.889E-13	1.633E-15	6.906E-13
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	6.867E-17	1.613E-19	6.883E-17

Table 80. Control Room Dose (rem) at 1 Day Post LOCA Due to the CR Filter Attributed to MSIV/SCB Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental Halogens	Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.239E-15	2.735E-17	8.373E-17	2.791E-17	2.378E-15
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.295E-11	2.544E-12	7.832E-12	1.779E-12	2.511E-11
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	7.745E-10	3.167E-10	9.776E-10	2.012E-10	2.270E-09
CR - 1' from West Wall, Column Le, 6' above Floor	4.120E-11	2.466E-11	7.639E-11	1.484E-11	1.571E-10
CR - Column 10.1, Column Le, 6' above Floor	6.105E-11	2.927E-11	9.047E-11	1.814E-11	1.989E-10
CR - 1' from East Wall, Column Le, 6' above Floor	1.072E-10	3.172E-11	9.776E-11	2.107E-11	2.578E-10
CR - 1' from West Wall, Column Ma, 6' above Floor	2.036E-16	1.153E-18	3.527E-18	1.329E-18	2.096E-16
CR - Column 10.1, Column Ma, 6' above Floor	8.154E-11	4.760E-11	1.474E-10	2.874E-11	3.053E-10
CR - 1' from East Wall, Column Ma, 6' above Floor	2.016E-12	2.137E-13	6.568E-13	1.622E-13	3.049E-12
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.057E-17	1.640E-19	5.010E-19	2.099E-19	5.144E-17
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.099E-11	1.653E-11	5.113E-11	1.010E-11	1.088E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.054E-14	1.669E-15	5.119E-15	1.476E-15	5.880E-14

Table 81. Control Room Dose (rem) at 4 Days Post LOCA Due to the CR Filter Attributed to MSIV/SCB Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental Halogens	Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.244E-15	3.384E-17	9.280E-17	2.032E-16	2.574E-15
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.322E-11	3.162E-12	8.741E-12	1.210E-11	3.722E-11
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	8.090E-10	3.965E-10	1.104E-09	1.312E-09	3.622E-09
CR - 1' from West Wall, Column Le, 6' above Floor	4.400E-11	3.117E-11	8.770E-11	9.401E-11	2.569E-10
CR - Column 10.1, Column Le, 6' above Floor	6.430E-11	3.679E-11	1.028E-10	1.168E-10	3.207E-10
CR - 1' from East Wall, Column Le, 6' above Floor	1.107E-10	3.954E-11	1.096E-10	1.401E-10	3.999E-10
CR - 1' from West Wall, Column Ma, 6' above Floor	2.039E-16	1.428E-18	3.910E-18	9.431E-18	2.187E-16
CR - Column 10.1, Column Ma, 6' above Floor	8.692E-11	6.012E-11	1.690E-10	1.825E-10	4.985E-10
CR - 1' from East Wall, Column Ma, 6' above Floor	2.040E-12	2.649E-13	7.300E-13	1.136E-12	4.171E-12
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.062E-17	2.031E-19	5.555E-19	1.438E-18	5.282E-17
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.284E-11	2.082E-11	5.834E-11	6.461E-11	1.766E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.074E-14	2.066E-15	5.675E-15	1.073E-14	6.921E-14

Table 82. Control Room Dose (rem) at 30 Days Post LOCA Due to the CR Filter Attributed to MSIV/SCB Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental Halogens	Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.244E-15	3.385E-17	9.298E-17	1.357E-15	3.728E-15
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.322E-11	3.166E-12	9.110E-12	7.498E-11	1.005E-10
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	8.094E-10	3.977E-10	1.211E-09	7.917E-09	1.034E-08
CR - 1' from West Wall, Column Le, 6' above Floor	4.406E-11	3.136E-11	1.032E-10	5.578E-10	7.364E-10
CR - Column 10.1, Column Le, 6' above Floor	6.435E-11	3.693E-11	1.160E-10	6.999E-10	9.172E-10
CR - 1' from East Wall, Column Le, 6' above Floor	1.107E-10	3.962E-11	1.167E-10	8.561E-10	1.123E-09
CR - 1' from West Wall, Column Ma, 6' above Floor	2.039E-16	1.428E-18	3.913E-18	6.344E-17	2.727E-16
CR - Column 10.1, Column Ma, 6' above Floor	8.703E-11	6.045E-11	1.976E-10	1.084E-09	1.429E-09
CR - 1' from East Wall, Column Ma, 6' above Floor	2.040E-12	2.650E-13	7.449E-13	7.200E-12	1.025E-11
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.062E-17	2.032E-19	5.557E-19	9.700E-18	6.108E-17
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.288E-11	2.092E-11	6.693E-11	3.853E-10	5.060E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.074E-14	2.066E-15	5.709E-15	7.028E-14	1.288E-13

Table 83. Control Room Dose (rem) at 30 Days Post LOCA Due to the CR Filter Attributed to MSIV/SCB Leakage (Occupancy Factors Included)

Dose Receptor Location	Elemental Halogens	Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.242E-15	3.125E-17	8.924E-17	5.946E-16	2.957E-15
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.311E-11	2.916E-12	8.525E-12	3.312E-11	5.768E-11
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	7.954E-10	3.651E-10	1.096E-09	3.510E-09	5.766E-09
CR - 1' from West Wall, Column Le, 6' above Floor	4.290E-11	2.864E-11	8.938E-11	2.479E-10	4.088E-10
CR - Column 10.1, Column Le, 6' above Floor	6.302E-11	3.384E-11	1.031E-10	3.106E-10	5.106E-10
CR - 1' from East Wall, Column Le, 6' above Floor	1.093E-10	3.644E-11	1.077E-10	3.789E-10	6.323E-10
CR - 1' from West Wall, Column Ma, 6' above Floor	2.038E-16	1.318E-18	3.758E-18	2.779E-17	2.366E-16
CR - Column 10.1, Column Ma, 6' above Floor	8.481E-11	5.524E-11	1.718E-10	4.816E-10	7.935E-10
CR - 1' from East Wall, Column Ma, 6' above Floor	2.030E-12	2.445E-13	7.067E-13	3.172E-12	6.154E-12
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.060E-17	1.875E-19	5.338E-19	4.252E-18	5.557E-17
CR - Column 10.1, 1' from South Wall, 6' above Floor	3.212E-11	1.914E-11	5.889E-11	1.711E-10	2.812E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.066E-14	1.907E-15	5.466E-15	3.085E-14	8.888E-14

Table 84. Control Room Dose (rem) at 30 Days Post LOCA Due to the CR Filter (Occupancy Factors Included)

Dose Receptor Location	Primary Leakage	ESF Leakage	MSIV/SCB Leakage	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	2.652E-17	1.123E-18	2.957E-15	2.985E-15
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.729E-12	1.058E-13	5.768E-11	5.951E-11
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.166E-10	1.321E-11	5.766E-09	5.996E-09
CR - 1' from West Wall, Column Le, 6' above Floor	1.737E-11	1.031E-12	4.088E-10	4.272E-10
CR - Column 10.1, Column Le, 6' above Floor	2.024E-11	1.222E-12	5.106E-10	5.320E-10
CR - 1' from East Wall, Column Le, 6' above Floor	2.152E-11	1.322E-12	6.323E-10	6.552E-10
CR - 1' from West Wall, Column Ma, 6' above Floor	1.536E-18	4.723E-20	2.366E-16	2.382E-16
CR - Column 10.1, Column Ma, 6' above Floor	3.342E-11	1.990E-12	7.935E-10	8.289E-10
CR - 1' from East Wall, Column Ma, 6' above Floor	1.478E-13	8.861E-15	6.154E-12	6.310E-12
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	3.006E-19	6.697E-21	5.557E-17	5.588E-17
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.151E-11	6.906E-13	2.812E-10	2.934E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	1.287E-15	6.883E-17	8.888E-14	9.024E-14

Table 85. Control Room Dose (rem) at 1 Day Post LOCA Due to the TSC Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	9.828E-11	1.574E-09	2.204E-12	1.674E-09
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.635E-08	2.818E-07	3.758E-10	2.985E-07
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	2.855E-08	5.040E-07	6.800E-10	5.332E-07
CR - 1' from West Wall, Column Le, 6' above Floor	1.295E-10	2.084E-09	2.906E-12	2.216E-09
CR - Column 10.1, Column Le, 6' above Floor	2.618E-08	4.542E-07	6.062E-10	4.810E-07
CR - 1' from East Wall, Column Le, 6' above Floor	6.980E-08	1.248E-06	1.698E-09	1.319E-06
CR - 1' from West Wall, Column Ma, 6' above Floor	5.681E-11	9.008E-10	1.274E-12	9.589E-10
CR - Column 10.1, Column Ma, 6' above Floor	6.705E-09	1.141E-07	1.525E-10	1.210E-07
CR - 1' from East Wall, Column Ma, 6' above Floor	6.539E-09	1.132E-07	1.517E-10	1.199E-07
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.218E-11	1.867E-10	2.725E-13	1.992E-10
CR - Column 10.1, 1' from South Wall, 6' above Floor	6.611E-10	1.090E-08	1.485E-11	1.158E-08
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.209E-10	3.664E-09	4.979E-12	3.890E-09

Table 86. Control Room Dose (rem) at 4 Days Post LOCA Due to the TSC Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.069E-10	1.765E-09	1.343E-11	1.885E-09
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.812E-08	3.407E-07	2.095E-09	3.609E-07
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.197E-08	6.373E-07	3.616E-09	6.729E-07
CR - 1' from West Wall, Column Le, 6' above Floor	1.410E-10	2.344E-09	1.764E-11	2.503E-09
CR - Column 10.1, Column Le, 6' above Floor	2.909E-08	5.553E-07	3.338E-09	5.877E-07
CR - 1' from East Wall, Column Le, 6' above Floor	7.864E-08	1.618E-06	8.798E-09	1.705E-06
CR - 1' from West Wall, Column Ma, 6' above Floor	6.170E-11	1.006E-09	7.815E-12	1.076E-09
CR - Column 10.1, Column Ma, 6' above Floor	7.400E-09	1.354E-07	8.682E-10	1.437E-07
CR - 1' from East Wall, Column Ma, 6' above Floor	7.262E-09	1.384E-07	8.369E-10	1.465E-07
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.317E-11	2.063E-10	1.702E-12	2.212E-10
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.233E-10	1.246E-08	8.823E-11	1.327E-08
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.422E-10	4.234E-09	2.927E-11	4.505E-09

Table 87. Control Room Dose (rem) at 30 Days Post LOCA Due to the TSC Filter Attributed to Primary Containment Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.071E-10	2.132E-09	7.862E-11	2.318E-09
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.829E-08	5.462E-07	1.160E-08	5.761E-07
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.257E-08	1.179E-06	1.928E-08	1.231E-06
CR - 1' from West Wall, Column Le, 6' above Floor	1.413E-10	2.862E-09	1.031E-10	3.106E-09
CR - Column 10.1, Column Le, 6' above Floor	2.940E-08	9.242E-07	1.832E-08	9.719E-07
CR - 1' from East Wall, Column Le, 6' above Floor	8.068E-08	3.204E-06	4.588E-08	3.331E-06
CR - 1' from West Wall, Column Ma, 6' above Floor	6.178E-11	1.191E-09	4.592E-11	1.299E-09
CR - Column 10.1, Column Ma, 6' above Floor	7.448E-09	2.033E-07	4.878E-09	2.156E-07
CR - 1' from East Wall, Column Ma, 6' above Floor	7.346E-09	2.307E-07	4.595E-09	2.426E-07
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.318E-11	2.334E-10	1.010E-11	2.567E-10
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.253E-10	1.629E-08	5.092E-10	1.752E-08
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.431E-10	5.770E-09	1.678E-10	6.181E-09

Table 88. Control Room Dose (rem) at 30 Days Post LOCA Due to the TSC Filter Attributed to Primary Containment Leakage (Occupancy Factors Included)

Dose Receptor Location	Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.035E-10	1.835E-09	3.502E-11	1.974E-09
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.748E-08	3.993E-07	5.209E-09	4.220E-07
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.084E-08	8.007E-07	8.707E-09	8.402E-07
CR - 1' from West Wall, Column Le, 6' above Floor	1.365E-10	2.447E-09	4.593E-11	2.630E-09
CR - Column 10.1, Column Le, 6' above Floor	2.805E-08	6.624E-07	8.238E-09	6.987E-07
CR - 1' from East Wall, Column Le, 6' above Floor	7.592E-08	2.104E-06	2.079E-08	2.201E-06
CR - 1' from West Wall, Column Ma, 6' above Floor	5.978E-11	1.038E-09	2.044E-11	1.118E-09
CR - Column 10.1, Column Ma, 6' above Floor	7.141E-09	1.540E-07	2.186E-09	1.634E-07
CR - 1' from East Wall, Column Ma, 6' above Floor	7.006E-09	1.652E-07	2.066E-09	1.743E-07
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.278E-11	2.093E-10	4.489E-12	2.266E-10
CR - Column 10.1, 1' from South Wall, 6' above Floor	6.992E-10	1.337E-08	2.273E-10	1.429E-08
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.340E-10	4.620E-09	7.497E-11	4.929E-09

Table 89. Control Room Dose (rem) at 1 Day Post LOCA Due to the TSC Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.032E-10	1.345E-13	1.033E-10
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.798E-08	2.472E-11	1.800E-08
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.160E-08	4.701E-11	3.165E-08
CR - 1' from West Wall, Column Le, 6' above Floor	1.365E-10	1.778E-13	1.367E-10
CR - Column 10.1, Column Le, 6' above Floor	2.886E-08	4.035E-11	2.890E-08
CR - 1' from East Wall, Column Le, 6' above Floor	7.751E-08	1.206E-10	7.763E-08
CR - 1' from West Wall, Column Ma, 6' above Floor	5.915E-11	7.730E-14	5.923E-11
CR - Column 10.1, Column Ma, 6' above Floor	7.334E-09	9.835E-12	7.344E-09
CR - 1' from East Wall, Column Ma, 6' above Floor	7.191E-09	1.011E-11	7.201E-09
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.230E-11	1.625E-14	1.232E-11
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.097E-10	9.242E-13	7.106E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.378E-10	3.127E-13	2.381E-10

Table 90. Control Room Dose (rem) at 4 Days Post LOCA Due to the TSC Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.131E-10	1.757E-13	1.133E-10
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.000E-08	3.230E-11	2.003E-08
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.551E-08	6.145E-11	3.557E-08
CR - 1' from West Wall, Column Le, 6' above Floor	1.497E-10	2.323E-13	1.499E-10
CR - Column 10.1, Column Le, 6' above Floor	3.218E-08	5.274E-11	3.223E-08
CR - 1' from East Wall, Column Le, 6' above Floor	8.763E-08	1.576E-10	8.779E-08
CR - 1' from West Wall, Column Ma, 6' above Floor	6.474E-11	1.010E-13	6.484E-11
CR - Column 10.1, Column Ma, 6' above Floor	8.129E-09	1.285E-11	8.142E-09
CR - 1' from East Wall, Column Ma, 6' above Floor	8.020E-09	1.321E-11	8.033E-09
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.343E-11	2.123E-14	1.345E-11
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.808E-10	1.208E-12	7.820E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.621E-10	4.086E-13	2.625E-10

Table 91. Control Room Dose (rem) at 30 Days Post LOCA Due to the TSC Filter Attributed to ESF System Leakage (No Occupancy Factors)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.133E-10	1.784E-13	1.135E-10
CR - Column 10.1, 1' from North Wall, 6' above Floor	2.019E-08	3.281E-11	2.022E-08
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.621E-08	6.249E-11	3.627E-08
CR - 1' from West Wall, Column Le, 6' above Floor	1.500E-10	2.358E-13	1.502E-10
CR - Column 10.1, Column Le, 6' above Floor	3.255E-08	5.358E-11	3.260E-08
CR - 1' from East Wall, Column Le, 6' above Floor	8.999E-08	1.604E-10	9.015E-08
CR - 1' from West Wall, Column Ma, 6' above Floor	6.484E-11	1.025E-13	6.494E-11
CR - Column 10.1, Column Ma, 6' above Floor	8.184E-09	1.305E-11	8.197E-09
CR - 1' from East Wall, Column Ma, 6' above Floor	8.117E-09	1.342E-11	8.130E-09
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.345E-11	2.155E-14	1.347E-11
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.832E-10	1.226E-12	7.844E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.632E-10	4.148E-13	2.636E-10

Table 92. Control Room Dose (rem) at 30 Days Post LOCA Due to the TSC Filter Attributed to ESF System Leakage (Occupancy Factors Included)

Dose Receptor Location	Halogens	Tellurium Metals	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.092E-10	1.603E-13	1.094E-10
CR - Column 10.1, 1' from North Wall, 6' above Floor	1.927E-08	2.947E-11	1.930E-08
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	3.423E-08	5.609E-11	3.428E-08
CR - 1' from West Wall, Column Le, 6' above Floor	1.445E-10	2.119E-13	1.448E-10
CR - Column 10.1, Column Le, 6' above Floor	3.100E-08	4.812E-11	3.105E-08
CR - 1' from East Wall, Column Le, 6' above Floor	8.453E-08	1.439E-10	8.467E-08
CR - 1' from West Wall, Column Ma, 6' above Floor	6.254E-11	9.212E-14	6.264E-11
CR - Column 10.1, Column Ma, 6' above Floor	7.833E-09	1.172E-11	7.845E-09
CR - 1' from East Wall, Column Ma, 6' above Floor	7.727E-09	1.205E-11	7.739E-09
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.299E-11	1.937E-14	1.301E-11
CR - Column 10.1, 1' from South Wall, 6' above Floor	7.533E-10	1.102E-12	7.544E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	2.528E-10	3.727E-13	2.532E-10

Table 93. Control Room Dose (rem) at 1 Day Post LOCA Due to the TSC Filter Attributed to MSIV/SCB Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental Halogens	Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.032E-09	2.249E-09	6.858E-09	1.301E-09	1.344E-08
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.305E-07	3.920E-07	1.227E-06	2.212E-07	2.171E-06
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	5.319E-07	6.874E-07	2.190E-06	4.000E-07	3.809E-06
CR - 1' from West Wall, Column Le, 6' above Floor	3.882E-09	2.976E-09	9.083E-09	1.715E-09	1.766E-08
CR - Column 10.1, Column Le, 6' above Floor	5.136E-07	6.289E-07	1.977E-06	3.568E-07	3.476E-06
CR - 1' from East Wall, Column Le, 6' above Floor	1.244E-06	1.684E-06	5.419E-06	9.985E-07	9.346E-06
CR - 1' from West Wall, Column Ma, 6' above Floor	1.860E-09	1.288E-09	3.925E-09	7.522E-10	7.825E-09
CR - Column 10.1, Column Ma, 6' above Floor	1.439E-07	1.600E-07	4.971E-07	8.981E-08	8.908E-07
CR - 1' from East Wall, Column Ma, 6' above Floor	1.317E-07	1.567E-07	4.925E-07	8.932E-08	8.702E-07
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.797E-10	2.679E-10	8.137E-10	1.609E-10	1.722E-09
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.706E-08	1.548E-08	4.749E-08	8.759E-09	8.879E-08
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.566E-09	5.185E-09	1.597E-08	2.936E-09	2.966E-08

Table 94. Control Room Dose (rem) at 4 Days Post LOCA Due to the TSC Filter Attributed to MSIV/SCB Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental Halogens	Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.296E-09	2.866E-09	7.978E-09	8.110E-09	2.225E-08
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.854E-07	5.216E-07	1.558E-06	1.264E-06	3.729E-06
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	6.387E-07	9.410E-07	2.931E-06	2.180E-06	6.691E-06
CR - 1' from West Wall, Column Le, 6' above Floor	4.234E-09	3.798E-09	1.060E-08	1.065E-08	2.928E-08
CR - Column 10.1, Column Le, 6' above Floor	6.038E-07	8.423E-07	2.544E-06	2.014E-06	6.004E-06
CR - 1' from East Wall, Column Le, 6' above Floor	1.522E-06	2.345E-06	7.461E-06	5.305E-06	1.663E-05
CR - 1' from West Wall, Column Ma, 6' above Floor	2.010E-09	1.637E-09	4.541E-09	4.719E-09	1.291E-08
CR - Column 10.1, Column Ma, 6' above Floor	1.654E-07	2.106E-07	6.176E-07	5.238E-07	1.517E-06
CR - 1' from East Wall, Column Ma, 6' above Floor	1.542E-07	2.099E-07	6.337E-07	5.049E-07	1.503E-06
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.098E-10	3.380E-10	9.295E-10	1.028E-09	2.805E-09
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.897E-08	1.995E-08	5.651E-08	5.326E-08	1.487E-07
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	6.221E-09	6.723E-09	1.923E-08	1.767E-08	4.984E-08

Table 95. Control Room Dose (rem) at 30 Days Post LOCA Due to the TSC Filter Attributed to MSIV/SCB Leakage (No Occupancy Factors)

Dose Receptor Location	Elemental Halogens	Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.305E-09	2.891E-09	9.880E-09	4.765E-08	6.373E-08
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.947E-07	5.516E-07	2.624E-06	7.030E-06	1.060E-05
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	6.746E-07	1.057E-06	5.744E-06	1.168E-05	1.916E-05
CR - 1' from West Wall, Column Le, 6' above Floor	4.246E-09	3.836E-09	1.328E-08	6.246E-08	8.382E-08
CR - Column 10.1, Column Le, 6' above Floor	6.221E-07	9.010E-07	4.457E-06	1.110E-05	1.708E-05
CR - 1' from East Wall, Column Le, 6' above Floor	1.644E-06	2.743E-06	1.570E-05	2.779E-05	4.788E-05
CR - 1' from West Wall, Column Ma, 6' above Floor	2.014E-09	1.650E-09	5.503E-09	2.783E-08	3.700E-08
CR - Column 10.1, Column Ma, 6' above Floor	1.681E-07	2.191E-07	9.698E-07	2.956E-06	4.313E-06
CR - 1' from East Wall, Column Ma, 6' above Floor	1.591E-07	2.255E-07	1.113E-06	2.784E-06	4.282E-06
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	5.104E-10	3.396E-10	1.070E-09	6.124E-09	8.044E-09
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.908E-08	2.029E-08	7.634E-08	3.086E-07	4.243E-07
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	6.272E-09	6.881E-09	2.720E-08	1.017E-07	1.421E-07

Table 96. Control Room Dose (rem) at 30 Days Post LOCA Due to the TSC Filter Attributed to MSIV/SCB Leakage (Occupancy Factors Included)

Dose Receptor Location	Elemental Halogens	Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.194E-09	2.629E-09	8.291E-09	2.120E-08	3.532E-08
CR - Column 10.1, 1' from North Wall, 6' above Floor	3.672E-07	4.818E-07	1.852E-06	3.153E-06	5.854E-06
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	6.103E-07	8.860E-07	3.760E-06	5.268E-06	1.052E-05
CR - 1' from West Wall, Column Le, 6' above Floor	4.098E-09	3.484E-09	1.107E-08	2.780E-08	4.645E-08
CR - Column 10.1, Column Le, 6' above Floor	5.750E-07	7.804E-07	3.082E-06	4.986E-06	9.423E-06
CR - 1' from East Wall, Column Le, 6' above Floor	1.460E-06	2.240E-06	9.940E-06	1.258E-05	2.622E-05
CR - 1' from West Wall, Column Ma, 6' above Floor	1.952E-09	1.503E-09	4.679E-09	1.238E-08	2.051E-08
CR - Column 10.1, Column Ma, 6' above Floor	1.579E-07	1.938E-07	7.103E-07	1.323E-06	2.385E-06
CR - 1' from East Wall, Column Ma, 6' above Floor	1.472E-07	1.949E-07	7.689E-07	1.250E-06	2.361E-06
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.980E-10	3.106E-10	9.394E-10	2.720E-09	4.468E-09
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.825E-08	1.830E-08	6.083E-08	1.376E-07	2.350E-07
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.979E-09	6.171E-09	2.111E-08	4.539E-08	7.865E-08

Table 97. Control Room Dose (rem) at 30 Days Post LOCA Due to the TSC Filter (Occupancy Factors Included)

Dose Receptor Location	Primary Leakage	ESF Leakage	MSIV/SCB Leakage	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.974E-09	1.094E-10	3.532E-08	3.740E-08
CR - Column 10.1, 1' from North Wall, 6' above Floor	4.220E-07	1.930E-08	5.854E-06	6.296E-06
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	8.402E-07	3.428E-08	1.052E-05	1.140E-05
CR - 1' from West Wall, Column Le, 6' above Floor	2.630E-09	1.448E-10	4.645E-08	4.922E-08
CR - Column 10.1, Column Le, 6' above Floor	6.987E-07	3.105E-08	9.423E-06	1.015E-05
CR - 1' from East Wall, Column Le, 6' above Floor	2.201E-06	8.467E-08	2.622E-05	2.850E-05
CR - 1' from West Wall, Column Ma, 6' above Floor	1.118E-09	6.264E-11	2.051E-08	2.169E-08
CR - Column 10.1, Column Ma, 6' above Floor	1.634E-07	7.845E-09	2.385E-06	2.556E-06
CR - 1' from East Wall, Column Ma, 6' above Floor	1.743E-07	7.739E-09	2.361E-06	2.543E-06
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	2.266E-10	1.301E-11	4.468E-09	4.707E-09
CR - Column 10.1, 1' from South Wall, 6' above Floor	1.429E-08	7.544E-10	2.350E-07	2.500E-07
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	4.929E-09	2.532E-10	7.865E-08	8.384E-08

Table 98. Control Room Dose (rem) at 1 Day Post LOCA Due to the External Cloud Activity from Primary Containment Leakage (No Occupancy Factors)

Airborne Source Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
Floor	3.581E-05	5.214E-05	1.773E-08	8.797E-05
Ceiling	2.500E-06	1.544E-06	4.707E-10	4.044E-06
North Wall	4.613E-06	3.152E-06	9.730E-10	7.766E-06
East Wall	8.085E-06	7.275E-06	2.328E-09	1.536E-05
South Wall	7.389E-05	1.202E-04	4.135E-08	1.941E-04

Table 99. Control Room Dose (rem) at 4 Days Post LOCA Due to the External Cloud Activity from Primary Containment Leakage (No Occupancy Factors)

Airborne Source Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
Floor	3.582E-05	5.214E-05	1.773E-08	8.798E-05
Ceiling	2.500E-06	1.544E-06	4.707E-10	4.044E-06
North Wall	4.613E-06	3.152E-06	9.730E-10	7.766E-06
East Wall	8.085E-06	7.275E-06	2.328E-09	1.536E-05
South Wall	7.390E-05	1.202E-04	4.135E-08	1.941E-04

Table 100. Control Room Dose (rem) at 30 Days Post LOCA Due to the External Cloud Activity from Primary Containment Leakage (No Occupancy Factors)

Airborne Source Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
Floor	3.582E-05	5.214E-05	1.773E-08	8.798E-05
Ceiling	2.500E-06	1.544E-06	4.707E-10	4.044E-06
North Wall	4.613E-06	3.152E-06	9.730E-10	7.766E-06
East Wall	8.085E-06	7.275E-06	2.328E-09	1.536E-05
South Wall	7.390E-05	1.202E-04	4.135E-08	1.941E-04

Table 101. Control Room Dose (rem) at 30 Days Post LOCA Due to the External Cloud Activity from Primary Containment Leakage (Occupancy Factors Included)

Airborne Source Location	Noble Gases and Elemental / Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
Floor	3.582E-05	5.214E-05	1.773E-08	8.797E-05
Ceiling	2.500E-06	1.544E-06	4.707E-10	4.044E-06
North Wall	4.613E-06	3.152E-06	9.730E-10	7.766E-06
East Wall	8.085E-06	7.275E-06	2.328E-09	1.536E-05
South Wall	7.390E-05	1.202E-04	4.135E-08	1.941E-04

Table 102. Control Room Dose (rem) at 1 Day Post LOCA Due to the External Cloud Activity from ESF System Leakage (No Occupancy Factors)

Airborne Source Location	Halogens	Tellurium Metals	Total
Floor	3.241E-06	1.397E-08	3.255E-06
Ceiling	9.819E-08	3.117E-10	9.850E-08
North Wall	2.000E-07	6.531E-10	2.007E-07
East Wall	4.582E-07	1.658E-09	4.599E-07
South Wall	7.451E-06	3.316E-08	7.484E-06

Table 103. Control Room Dose (rem) at 4 Days Post LOCA Due to the External Cloud Activity from ESF System Leakage (No Occupancy Factors)

Airborne Source Location	Halogens	Tellurium Metals	Total
Floor	3.242E-06	1.413E-08	3.256E-06
Ceiling	9.821E-08	3.153E-10	9.853E-08
North Wall	2.000E-07	6.607E-10	2.007E-07
East Wall	4.583E-07	1.677E-09	4.600E-07
South Wall	7.456E-06	3.354E-08	7.490E-06

Table 104. Control Room Dose (rem) at 30 Days Post LOCA Due to the External Cloud Activity from ESF System Leakage (No Occupancy Factors)

Airborne Source Location	Halogens	Tellurium Metals	Total
Floor	3.242E-06	1.413E-08	3.256E-06
Ceiling	9.821E-08	3.153E-10	9.853E-08
North Wall	2.000E-07	6.607E-10	2.007E-07
East Wall	4.583E-07	1.677E-09	4.600E-07
South Wall	7.456E-06	3.354E-08	7.490E-06

Table 105. Control Room Dose (rem) at 30 Days Post LOCA Due to the External Cloud Activity from ESF System Leakage (Occupancy Factors Included)

Airborne Source Location	Halogens	Tellurium Metals	Total
Floor	3.242E-06	1.407E-08	3.256E-06
Ceiling	9.820E-08	3.139E-10	9.852E-08
North Wall	2.000E-07	6.577E-10	2.007E-07
East Wall	4.583E-07	1.669E-09	4.599E-07
South Wall	7.454E-06	3.339E-08	7.487E-06

Table 106. Control Room Dose (rem) at 1 Day Post LOCA Due to the External Cloud Activity from MSIV/SCB Leakage (No Occupancy Factors)

Airborne Source Location	Elemental Halogens	Noble Gases and Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
Floor	4.470E-05	2.179E-02	2.712E-04	1.156E-05	2.212E-02
Ceiling	8.273E-07	1.574E-03	5.696E-06	3.057E-07	1.581E-03
North Wall	1.715E-06	2.898E-03	1.179E-05	6.309E-07	2.912E-03
East Wall	4.390E-06	5.032E-03	2.953E-05	1.509E-06	5.067E-03
South Wall	1.109E-04	4.467E-02	6.586E-04	2.701E-05	4.547E-02

Table 107. Control Room Dose (rem) at 4 Days Post LOCA Due to the External Cloud Activity from MSIV/SCB Leakage (No Occupancy Factors)

Airborne Source Location	Elemental Halogens	Noble Gases and Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
Floor	4.746E-05	2.183E-02	2.712E-04	1.156E-05	2.216E-02
Ceiling	8.500E-07	1.576E-03	5.696E-06	3.057E-07	1.583E-03
North Wall	1.765E-06	2.900E-03	1.179E-05	6.309E-07	2.914E-03
East Wall	4.555E-06	5.036E-03	2.953E-05	1.509E-06	5.072E-03
South Wall	1.182E-04	4.478E-02	6.586E-04	2.701E-05	4.558E-02

Table 108. Control Room Dose (rem) at 30 Days Post LOCA Due to the External Cloud Activity from MSIV/SCB Leakage (No Occupancy Factors)

Airborne Source Location	Elemental Halogens	Noble Gases and Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
Floor	4.800E-05	2.184E-02	2.712E-04	1.156E-05	2.217E-02
Ceiling	8.530E-07	1.576E-03	5.696E-06	3.057E-07	1.583E-03
North Wall	1.772E-06	2.900E-03	1.179E-05	6.309E-07	2.914E-03
East Wall	4.584E-06	5.036E-03	2.953E-05	1.509E-06	5.072E-03
South Wall	1.196E-04	4.479E-02	6.586E-04	2.701E-05	4.560E-02

Table 109. Control Room Dose (rem) at 30 Days Post LOCA Due to the External Cloud Activity from MSIV/SCB Leakage (Occupancy Factors Included)

Airborne Source Location	Elemental Halogens	Noble Gases and Organic Halogens	Particulate Halogens and Alkali Metals	Tellurium Metals, Ba/Sr, Noble Metals, Cerium Group, and Lanthanides	Total
Floor	4.657E-05	2.182E-02	2.712E-04	1.156E-05	2.215E-02
Ceiling	8.421E-07	1.575E-03	5.696E-06	3.057E-07	1.582E-03
North Wall	1.748E-06	2.899E-03	1.179E-05	6.309E-07	2.913E-03
East Wall	4.501E-06	5.034E-03	2.953E-05	1.509E-06	5.070E-03
South Wall	1.158E-04	4.474E-02	6.586E-04	2.701E-05	4.554E-02

Table 110. Control Room Dose (rem) at 30 Days Post LOCA Due to the External Cloud Activity (Occupancy Factors Included)

Airborne Source Location	Primary Leakage	ESF Leakage	MSIV/SCB Leakage	Total
Floor	8.797E-05	3.256E-06	2.215E-02	2.224E-02
Ceiling	4.044E-06	9.852E-08	1.582E-03	1.586E-03
North Wall	7.766E-06	2.007E-07	2.913E-03	2.921E-03
East Wall	1.536E-05	4.599E-07	5.070E-03	5.086E-03
South Wall	1.941E-04	7.487E-06	4.554E-02	4.574E-02
			Total:	**7.757E-02**

6.0 Results and Conclusions

The purpose of this calculation is to determine the post LOCA direct doses to the Control Room from external radiation sources. These external radiation sources include:

- Airborne activity within the Reactor Building,
- ECCS piping containing suppression pool water activity,
- Standby Gas Treatment System (SGTS) charcoal filter,
- Control Room (CR) charcoal filter,
- Technical Support Center (TSC) charcoal filter, and
- Activity in the atmosphere immediately surrounding the Control Room (External Cloud).

The post LOCA source terms used in this analysis are based on the Alternative Source Term (AST) methodology provided in Regulatory Guide 1.183 (Reference 7.2). The Control Room doses in this analysis are calculated based on a core thermal power of 1918 Megawatt-Thermal (MW_{th}).

The 30 day post LOCA Control Room doses due to the aforementioned external radiation sources at 12 locations within the Control Room are listed Table 111. Per Table 111, the maximum 30 day Control Room dose is 6.578E-01 rem and occurs in the southwest corner of the Control Room. The average 30 day Control Room dose for all 12 dose locations is 2.338E-01 rem. The major contributor to the Control Room dose is the two ECCS pipe segments, which account for approximately 60% of the total Control Room dose at the maximum dose point location. The Control Room doses at the 12 dose locations as listed in Table 111 are illustrated in Attachment C.

The purpose of this calculation is to determine the direct dose to the Control Room from radiation sources external to the Control Room. The Control Room doses due to post LOCA airborne sources internal to the Control Room are not addressed in this calculation. As such, there is no specific acceptance criteria for this calculation, provided that the total dose (sum of the doses from external and internal sources) to the Control Room is under the 5 rem limit as specified in References 7.9 and 7.10.

Table 111. 30 Day Post LOCA Control Room Doses (rem) Due to External Sources

Dose Receptor Location	Reactor Building Airborne Activity	ECCS Piping	SGTS Filter	CR Filter
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	1.007E-01	9.173E-05	1.108E-03	2.985E-15
CR - Column 10.1, 1' from North Wall, 6' above Floor	8.247E-02	2.636E-03	4.233E-03	5.951E-11
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	4.707E-02	9.522E-03	3.272E-14	5.996E-09
CR - 1' from West Wall, Column Le, 6' above Floor	1.597E-01	2.392E-03	1.121E-03	4.272E-10
CR - Column 10.1, Column Le, 6' above Floor	1.170E-01	1.625E-02	4.263E-03	5.320E-10
CR - 1' from East Wall, Column Le, 6' above Floor	6.260E-02	2.305E-02	3.322E-14	6.552E-10
CR - 1' from West Wall, Column Ma, 6' above Floor	1.775E-01	4.253E-02	8.773E-04	2.382E-16
CR - Column 10.1, Column Ma, 6' above Floor	1.258E-01	6.586E-02	3.643E-03	8.289E-10
CR - 1' from East Wall, Column Ma, 6' above Floor	6.638E-02	2.307E-02	2.408E-14	6.310E-12
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	1.882E-01	3.914E-01	5.703E-04	5.588E-17
CR - Column 10.1, 1' from South Wall, 6' above Floor	8.860E-02	7.689E-03	5.719E-04	2.934E-10
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	5.749E-02	2.758E-04	3.334E-15	9.024E-14

Dose Receptor Location	TSC Filter	External Cloud	Total
CR - 1' from West Wall, 1' from North Wall, 6' above Floor	3.740E-08	7.757E-02	1.795E-01
CR - Column 10.1, 1' from North Wall, 6' above Floor	6.296E-06	7.757E-02	1.669E-01
CR - 1' from East Wall, 1' from North Wall, 6' above Floor	1.140E-05	7.757E-02	1.342E-01
CR - 1' from West Wall, Column Le, 6' above Floor	4.922E-08	7.757E-02	2.407E-01
CR - Column 10.1, Column Le, 6' above Floor	1.015E-05	7.757E-02	2.151E-01
CR - 1' from East Wall, Column Le, 6' above Floor	2.850E-05	7.757E-02	1.633E-01
CR - 1' from West Wall, Column Ma, 6' above Floor	2.169E-08	7.757E-02	2.985E-01
CR - Column 10.1, Column Ma, 6' above Floor	2.556E-06	7.757E-02	2.728E-01
CR - 1' from East Wall, Column Ma, 6' above Floor	2.543E-06	7.757E-02	1.670E-01
CR - 1' from West Wall, 1' from South Wall, 6' above Floor	4.707E-09	7.757E-02	6.578E-01
CR - Column 10.1, 1' from South Wall, 6' above Floor	2.500E-07	7.757E-02	1.744E-01
CR - 1' from East Wall, 1' from South Wall, 6' above Floor	8.384E-08	7.757E-02	1.353E-01

7.0 References

7.1 S&L Program No. 03.7.705-1.1, "RUNT-PC, A Computer Program for Modeling Radionuclide Buildup and Decay and General Purpose Isotope Shielding Analysis Using Guassian Quadrature Integration of Point and Line Kernel Dose Rate Equations for Predefined and Ad Hoc Source and Shield Geometries," March 23, 2001.

7.2 USNRC Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," July 2000.

7.3 S&L Calculation 2004-07600, "Alternative Source Term – Core Isotopic Inventory," Revision 0.

7.4 S&L Calculation 2004-02101, "MNGP AST – LOCA Radiological Consequence Analysis," Revision 1. (AAC Calculation MNGP-003)

7.5 S&L Calculation 2004-02100, MNGP AST – CR/TSC Post-Accident Atmospheric Dispersion Analysis," Revision 2. (AAC Calculation MNGP-002)

7.6 MNGP Calculation CA-03-190, "Design Inputs for Alternate Source Term (AST) Radiological Analysis," Revision 1.

7.7 MNGP Calculation CA-96-039, "EFT/TSC Filter Train Post Accident Isotope Loading Under Rerate Conditions," Revision 0.

7.8 MNGP Calculation CA-96-040, "Standby Gas Treatment System Post Accident Isotope Loading Under Rerate Conditions," Revision 0.

7.9 10 CFR 50.67, Accident Source Term.

7.10 NUREG 0737, Part II.B.2, Design Review of Plant Shielding and Environmental Qualification of Equipment for Spaces/Systems Which May Be Used in Postaccident Operations, November 1980.

7.11 USNRC Regulatory Guide 1.49, "Power Levels of Nuclear Power Plants," Revision 1, December 1973.

7.12 NUREG/CR-6604, "RADTRAD: A Simplified Model for RADionuclide Transport and Removal And Dose Estimation," December 1997.

7.13 ANSI/ANS-6.4-1997, "Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants."

7.14 Federal Emergency Management Agency TR-68, “Mass Thickness Manual for Walls, Floors, and Roofs,” September 1980.

7.15 Chilton, A. B., et. al, “Principles of Radiation Shielding,” 1984.

7.16 Eshbach, O. W., et. al, “Handbook of Engineering Fundamentals,” Third Edition.

7.17 GE Nuclear Energy, “Nuclides and Isotopes, Chart of the Nuclides,” 14th Edition.

7.18 Drawing NF-36024, “Monticello Nuclear Generating Plant, Reactor Building, Floor Framing Plan El. 935’-0”,” Revision E.

7.19 Drawing NF-36026, “Reactor Building, Floor Framing Plan El. 962’-6”, Sh. 1” Revision 9.

7.20 Drawing NF-36028, “Monticello Nuclear Generating Plant, Reactor Building, Floor Framing Plan – El. 985’-6” Sh. 1,” Revision C.

7.21 Drawing NF-36324, “Reactor Building, Floor Framing Plan – El. 1001’-2”, Sh. 1,” Revision 9.

7.22 Drawing NF-36062, “Equipment Location – Reactor, Turb. & RW. Bldgs, Section A-A,” Revision 2.

7.23 Drawing NF-36058, “Equipment Location – Reactor Bldg. Plan at El. 1027’-8”,” Revision 2.

7.24 Drawing NF-36311, “Roof Plan,” Revision 12.

7.25 Drawing NF-36310, “Monticello Nuclear Generating Plant, Office & Control Building Floor Plans,” Revision V.

7.26 Drawing NF-36313, “Monticello Nuclear Generating Plant, Office & Control Building Elevations & Sections,” Revision G.

7.27 Drawing NF-36549, “Office and Control Building Exterior Wall Elevations,” Revision K.

7.28 Drawing NF-36303, “Monticello Nuclear Generating Plant, Turbine Building Floor Plan at El. 931’-0”,” Revision J.

7.29 Drawing NF-93486, “Monticello Nuclear Generating Plant, Emergency Filtration Train Bldg, HVAC Equip & Duct Layout, Third Floor & Roof,” Revision C.

7.30 Drawing NH-87111, “Monticello Nuclear Generating Plant, First and Second Floor Plans and Steel Details,” Revision C.

7.31 Drawing NH-87112, “Monticello Nuclear Generating Plant, Third Floor Roof Plans and Steel Details,” Revision D.

7.32 Drawing NH-87101, “Office & Control Building Addition & Remodeling, Architectural Floor Plans – Basement & First Floor Plans – Room Finish Schedule,” Revision B.

7.33 Drawing NH-87102, “Office & Control Building Addition & Remodeling, Architectural Floor Plans – Second & Third Floor Plans – Room Finish Schedule,” Revision F.

7.34 Drawing NH-87104, “Office & Control Building Addition & Remodeling, Wall Section Details - Vertical,” Revision B.

7.35 Drawing NH-87105, “Office & Control Building Addition & Remodeling, Architectural – Horizontal Details,” Revision B.

7.36 Drawing NH-94207, “Administration Bldg – 2nd Addition, Foundation, 1st Floor Plan,” Revision B.

7.37 Drawing NH-94208, “Administration Bldg – 2nd Addition, Second & Third Floors & Roof Plans,” Revision A.

7.38 Drawing NF-36504, “Area-3 Piping Drawings Plan Below El. 962’-6”,” Revision L.

Attachments

A) RUNT-PC Files
B) Control Building Roof Gravel Thickness
C) Direct Dose Plots

- Final -

Attachment A. RUNT-PC Files

The RUNT-PC files generated for this calculation are contained on the CD-ROM labeled, "Calculation 2005-00480, Post LOCA Direct Dose to the Control Room from External Sources, Revision 0." The file names, file sizes, file time stamps, and a brief description of each file are listed in Table A1. The RUNT-PC computer code has been verified and validated under S&L's Quality Assurance Program, and therefore, verification and validation of RUNT-PC is not required as part of this calculation. RUNT-PC was executed from the following controlled file path: \\SNL1B\SYS3\OPS$\RUN70511\.

Table A1. RUNT-PC File Names, File Sizes, File Time Stamps, and Descriptions

File Name	Time Stamp	Size	Description
RB1-PL-1.txt	1/6/2005 18:04	40,762	Input File, Reactor Building Airborne Activity, Source Region 1, Primary Containment Leakage, Noble Gases and Elemental/Organic Halogens
RB1-PL-1.out	1/6/2005 22:42	3,649,339	Output File, Reactor Building Airborne Activity, Source Region 1, Primary Containment Leakage, Noble Gases and Elemental/Organic Halogens
RB1-PL-2.txt	1/7/2005 10:35	40,994	Input File, Reactor Building Airborne Activity, Source Region 1, Primary Containment Leakage, Particulate Halogens and Alkali Metals
RB1-PL-2.out	1/7/2005 14:13	3,642,619	Output File, Reactor Building Airborne Activity, Source Region 1, Primary Containment Leakage, Particulate Halogens and Alkali Metals
RB1-PL-3.txt	1/7/2005 11:06	40,972	Input File, Reactor Building Airborne Activity, Source Region 1, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
RB1-PL-3.out	1/7/2005 15:06	4,148,266	Output File, Reactor Building Airborne Activity, Source Region 1, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
RB2-PL-1.txt	1/7/2005 11:17	40,764	Input File, Reactor Building Airborne Activity, Source Region 2, Primary Containment Leakage, Noble Gases and Elemental/Organic Halogens
RB2-PL1.out	1/7/2005 12:50	3,653,063	Output File, Reactor Building Airborne Activity, Source Region 2, Primary Containment Leakage, Noble Gases and Elemental/Organic Halogens
RB2-PL-2.txt	1/7/2005 11:23	40,996	Input File, Reactor Building Airborne Activity, Source Region 2, Primary Containment Leakage, Particulate Halogens and Alkali Metals
RB2-PL-2.out	1/7/2005 15:52	3,646,343	Output File, Reactor Building Airborne Activity, Source Region 2, Primary Containment Leakage, Particulate Halogens and Alkali Metals
RB2-PL-3.txt	1/7/2005 11:23	40,974	Input File, Reactor Building Airborne Activity, Source Region 2, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
RB2-PL-3.out	1/7/2005 16:07	4,151,990	Output File, Reactor Building Airborne Activity, Source Region 2, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
RB3-PL-1.txt	1/7/2005 11:30	40,719	Input File, Reactor Building Airborne Activity, Source Region 3, Primary Containment Leakage, Noble Gases and Elemental/Organic Halogens
RB3-PL-1.out	1/7/2005 17:39	3,655,336	Output File, Reactor Building Airborne Activity, Source Region 3, Primary Containment Leakage, Noble Gases and Elemental/Organic Halogens

Table A1. RUNT-PC File Names, File Sizes, File Time Stamps, and Descriptions

File Name	Time Stamp	Size	Description
RB3-PL-2.txt	1/7/2005 11:30	40,951	Input File, Reactor Building Airborne Activity, Source Region 3, Primary Containment Leakage, Particulate Halogens and Alkali Metals
RB3-PL-2.out	1/7/2005 18:07	3,648,616	Output File, Reactor Building Airborne Activity, Source Region 3, Primary Containment Leakage, Particulate Halogens and Alkali Metals
RB3-PL-3.txt	1/7/2005 11:31	40,929	Input File, Reactor Building Airborne Activity, Source Region 3, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
RB3-PL-3.out	1/7/2005 18:31	4,154,263	Output File, Reactor Building Airborne Activity, Source Region 3, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
RB1-ESF-1.txt	1/7/2005 11:52	50,196	Input File, Reactor Building Airborne Activity, Source Region 1, ESF System Leakage, Halogens
RB1-ESF-1.out	1/7/2005 21:36	3,629,158	Output File, Reactor Building Airborne Activity, Source Region 1, ESF System Leakage, Halogens
RB1-ESF-2.txt	1/7/2005 17:07	50,132	Input File, Reactor Building Airborne Activity, Source Region 1, ESF System Leakage, Tellurium Metals
RB1-ESF-2.out	1/7/2005 21:27	3,649,954	Output File, Reactor Building Airborne Activity, Source Region 1, ESF System Leakage, Tellurium Metals
RB2-ESF-1.txt	1/7/2005 17:21	50,198	Input File, Reactor Building Airborne Activity, Source Region 2, ESF System Leakage, Halogens
RB2-ESF-1.out	1/7/2005 20:02	3,632,882	Output File, Reactor Building Airborne Activity, Source Region 2, ESF System Leakage, Halogens
RB2-ESF-2.txt	1/7/2005 17:22	50,134	Input File, Reactor Building Airborne Activity, Source Region 2, ESF System Leakage, Tellurium Metals
RB2-ESF-2.out	1/10/2005 10:15	3,653,678	Output File, Reactor Building Airborne Activity, Source Region 2, ESF System Leakage, Tellurium Metals
RB3-ESF-1.txt	1/7/2005 17:23	50,153	Input File, Reactor Building Airborne Activity, Source Region 3, ESF System Leakage, Halogens
RB3-ESF-1.out	1/10/2005 11:26	3,635,155	Output File, Reactor Building Airborne Activity, Source Region 3, ESF System Leakage, Halogens
RB3-ESF-2.txt	1/7/2005 17:24	50,089	Input File, Reactor Building Airborne Activity, Source Region 3, ESF System Leakage, Tellurium Metals
RB3-ESF-2.out	1/10/2005 11:26	3,655,951	Output File, Reactor Building Airborne Activity, Source Region 3, ESF System Leakage, Tellurium Metals
PSA-SP-1.txt	1/7/2005 17:32	39,679	Input File, ECCS Pipe Segment A, Halogens and Alkali Metals
PSA-SP-1.out	1/10/2005 11:09	3,648,573	Output File, ECCS Pipe Segment A, Halogens and Alkali Metals
PSA-SP-2.txt	1/7/2005 17:32	39,382	Input File, ECCS Pipe Segment A, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
PSA-SP-2.out	1/10/2005 11:14	4,153,267	Output File, ECCS Pipe Segment A, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
PSB-SP-1.txt	1/7/2005 17:32	39,678	Input File, ECCS Pipe Segment B, Halogens and Alkali Metals
PSB-SP-1.out	1/10/2005 11:17	3,648,345	Output File, ECCS Pipe Segment B, Halogens and Alkali Metals
PSB-SP-2.txt	1/7/2005 17:32	39,381	Input File, ECCS Pipe Segment B, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides

Table A1. RUNT-PC File Names, File Sizes, File Time Stamps, and Descriptions

File Name	Time Stamp	Size	Description
PSB-SP-2.out	1/10/2005 11:21	4,153,039	Output File, ECCS Pipe Segment B, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
SGTS-PL-1.txt	8/20/2005 11:26	51,318	Input File, SGTS Filter, Primary Containment Leakage, Elemental/Organic Halogens
SGTS-PL-1.out	8/20/2005 11:36	3,647,069	Output File, SGTS Filter, Primary Containment Leakage, Elemental/Organic Halogens
SGTS-PL-2.txt	8/20/2005 11:27	51,565	Input File, SGTS Filter, Primary Containment Leakage, Particulate Halogens and Alkali Metals
SGTS-PL-2.out	8/20/2005 11:37	3,696,452	Output File, SGTS Filter, Primary Containment Leakage, Particulate Halogens and Alkali Metals
SGTS-PL-3.txt	8/20/2005 11:29	51,500	Input File, SGTS Filter, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
SGTS-PL-3.out	8/20/2005 11:39	4,201,236	Output File, SGTS Filter, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
SGTS-ESF-1.txt	8/20/2005 11:23	58,914	Input File, SGTS Filter, ESF System Leakage, Halogens
SGTS-ESF-1.out	8/20/2005 11:33	3,680,998	Output File, SGTS Filter, ESF System Leakage, Halogens
SGTS-ESF-2.txt	8/20/2005 11:25	58,849	Input File, SGTS Filter, ESF System Leakage, Tellurium Metals
SGTS-ESF-2.out	8/20/2005 11:34	3,701,794	Output File, SGTS Filter, ESF System Leakage, Tellurium Metals
CR-PL-1.txt	8/20/2005 13:22	60,188	Input File, CR Filter, Primary Containment Leakage, Elemental/Organic Halogens
CR-PL-1.out	8/20/2005 13:49	3,748,016	Output File, CR Filter, Primary Containment Leakage, Elemental/Organic Halogens
CR-PL-2.txt	8/20/2005 13:28	60,444	Input File, CR Filter, Primary Containment Leakage, Particulate Halogens and Alkali Metals
CR-PL-2.out	8/20/2005 13:54	3,743,571	Output File, CR Filter, Primary Containment Leakage, Particulate Halogens and Alkali Metals
CR-PL-3.txt	8/20/2005 13:35	60,382	Input File, CR Filter, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
CR-PL-3.out	8/20/2005 13:56	4,250,512	Output File, CR Filter, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
CR-ESF-1.txt	8/20/2005 13:39	59,835	Input File, CR Filter, ESF System Leakage, Halogens
CR-ESF-1.out	8/20/2005 13:46	3,692,989	Output File, CR Filter, ESF System Leakage, Halogens
CR-ESF-2.txt	8/20/2005 13:43	59,770	Input File, CR Filter, ESF System Leakage, Tellurium Metals
CR-ESF-2.out	8/20/2005 13:47	3,714,021	Output File, CR Filter, ESF System Leakage, Tellurium Metals
CR-MSIVSCB-1.txt	1/13/2005 16:25	60,165	Input File, CR Filter, MSIV/SCB Leakage, Elemental Halogens
CR-MSIVSCB-1.out	1/13/2005 17:14	3,746,716	Output File, CR Filter, MSIV/SCB Leakage, Elemental Halogens
CR-MSIVSCB-2.txt	1/13/2005 16:33	60,163	Input File, CR Filter, MSIV/SCB Leakage, Organic Halogens
CR-MSIVSCB-2.out	1/13/2005 17:17	3,692,700	Output File, CR Filter, MSIV/SCB Leakage, Organic Halogens
CR-MSIVSCB-3.txt	1/13/2005 16:39	60,431	Input File, CR Filter, MSIV/SCB Leakage, Particulate Halogens and Alkali Metals

Table A1. RUNT-PC File Names, File Sizes, File Time Stamps, and Descriptions

File Name	Time Stamp	Size	Description
CR-MSIVSCB-3.out	1/13/2005 17:23	3,742,336	Output File, CR Filter, MSIV/SCB Leakage, Particulate Halogens and Alkali Metals
CR-MSIVSCB-4.txt	1/13/2005 16:47	60,364	Input File, CR Filter, MSIV/SCB Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
CR-MSIVSCB-4.out	1/13/2005 17:28	4,261,952	Output File, CR Filter, MSIV/SCB Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
TSC-PL-1.txt	8/20/2005 15:24	59,905	Input File, TSC Filter, Primary Containment Leakage, Elemental/Organic Halogens
TSC-PL-1.out	8/20/2005 15:45	3,741,212	Output File, TSC Filter, Primary Containment Leakage, Elemental/Organic Halogens
TSC-PL-2.txt	8/20/2005 15:30	60,162	Input File, TSC Filter, Primary Containment Leakage, Particulate Halogens and Alkali Metals
TSC-PL-2.out	8/20/2005 15:46	3,736,767	Output File, TSC Filter, Primary Containment Leakage, Particulate Halogens and Alkali Metals
TSC-PL-3.txt	8/20/2005 15:36	60,097	Input File, TSC Filter, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
TSC-PL-3.out	8/20/2005 15:47	4,244,423	Output File, TSC Filter, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
TSC-ESF-1.txt	8/20/2005 15:40	59,576	Input File, TSC Filter, ESF System Leakage, Halogens
TSC-ESF-1.out	8/20/2005 15:44	3,686,185	Output File, TSC Filter, ESF System Leakage, Halogens
TSC-ESF-2.txt	8/20/2005 15:43	59,512	Input File, TSC Filter, ESF System Leakage, Tellurium Metals
TSC-ESF-2.out	8/20/2005 15:44	3,707,217	Output File, TSC Filter, ESF System Leakage, Tellurium Metals
TSC-MSIVSCB-1.txt	1/19/2005 15:44	59,844	Input File, TSC Filter, MSIV/SCB Leakage, Elemental Halogens
TSC-MSIVSCB-1.out	1/19/2005 15:46	3,740,692	Output File, TSC Filter, MSIV/SCB Leakage, Elemental Halogens
TSC-MSIVSCB-2.txt	1/14/2005 10:35	59,842	Input File, TSC Filter, MSIV/SCB Leakage, Organic Halogens
TSC-MSIVSCB-2.out	1/14/2005 10:48	3,686,156	Output File, TSC Filter, MSIV/SCB Leakage, Organic Halogens
TSC-MSIVSCB-3.txt	1/14/2005 10:40	60,110	Input File, TSC Filter, MSIV/SCB Leakage, Particulate Halogens and Alkali Metals
TSC-MSIVSCB-3.out	1/14/2005 10:50	3,735,792	Output File, TSC Filter, MSIV/SCB Leakage, Particulate Halogens and Alkali Metals
TSC-MSIVSCB-4.txt	1/14/2005 10:43	60,045	Input File, TSC Filter, MSIV/SCB Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
TSC-MSIVSCB-4.out	1/14/2005 10:53	4,255,148	Output File, TSC Filter, MSIV/SCB Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
EC-PL-1.txt	8/22/2005 9:02	40,947	Input File, External Cloud, Primary Containment Leakage, Noble Gases and Elemental/Organic Halogens
EC-PL-1.out	8/22/2005 9:27	1,613,989	Output File, External Cloud, Primary Containment Leakage, Noble Gases and Elemental/Organic Halogens
EC-PL-2.txt	8/22/2005 9:12	41,189	Input File, External Cloud, Primary Containment Leakage, Particulate Halogens and Alkali Metals

Table A1. RUNT-PC File Names, File Sizes, File Time Stamps, and Descriptions

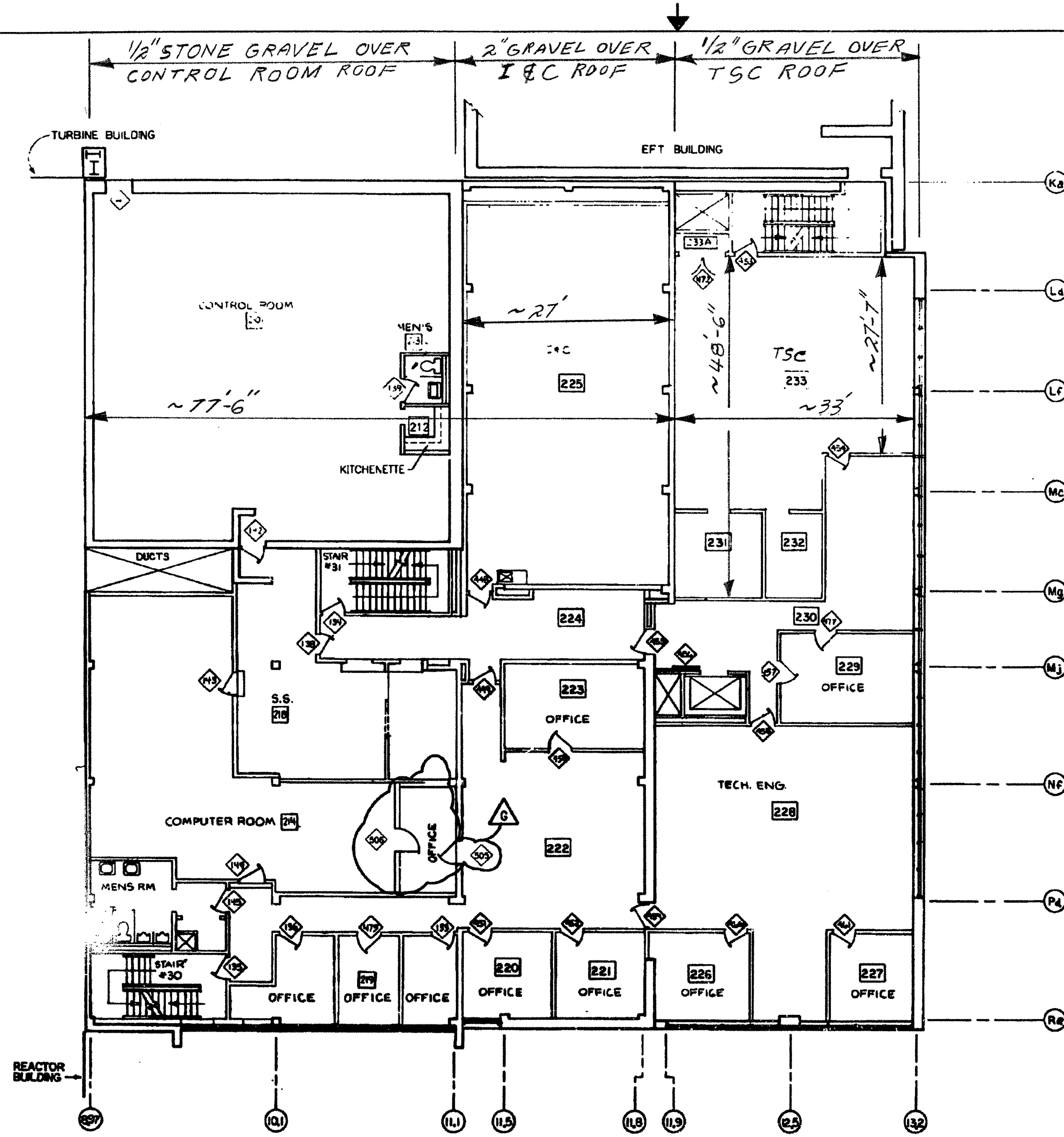
File Name	Time Stamp	Size	Description
EC-PL-2.out	8/22/2005 9:28	1,607,417	Output File, External Cloud, Primary Containment Leakage, Particulate Halogens and Alkali Metals
EC-PL-3.txt	8/22/2005 9:18	41,125	Input File, External Cloud, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
EC-PL-3.out	8/22/2005 9:29	2,011,746	Output File, External Cloud, Primary Containment Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
EC-ESF-1.txt	8/22/2005 9:22	40,642	Input File, External Cloud, ESF System Leakage, Halogens
EC-ESF-1.out	8/22/2005 9:29	1,568,143	Output File, External Cloud, ESF System Leakage, Halogens
EC-ESF-2.txt	8/22/2005 9:26	40,578	Input File, External Cloud, ESF System Leakage, Tellurium Metals
EC-ESF-2.out	8/22/2005 9:29	1,584,731	Output File, External Cloud, ESF System Leakage, Tellurium Metals
EC-MSIVSCB-1.txt	1/17/2005 10:37	40,916	Input File, External Cloud, MSIV/SCB Leakage, Elemental Halogens
EC-MSIVSCB-1.out	1/17/2005 10:40	1,568,143	Output File, External Cloud, MSIV/SCB Leakage, Elemental Halogens
EC-MSIVSCB-2.txt	1/17/2005 10:37	40,940	Input File, External Cloud, MSIV/SCB Leakage, Noble Gases and Organic Halogens
EC-MSIVSCB-2.out	1/17/2005 10:41	1,613,889	Output File, External Cloud, MSIV/SCB Leakage, Noble Gases and Organic Halogens
EC-MSIVSCB-3.txt	1/17/2005 10:37	41,191	Input File, External Cloud, MSIV/SCB Leakage, Particulate Halogens and Alkali Metals
EC-MSIVSCB-3.out	1/17/2005 10:42	1,606,842	Output File, External Cloud, MSIV/SCB Leakage, Particulate Halogens and Alkali Metals
EC-MSIVSCB-4.txt	1/17/2005 10:39	41,127	Input File, External Cloud, MSIV/SCB Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides
EC-MSIVSCB-4.out	1/17/2005 10:44	2,016,546	Output File, External Cloud, MSIV/SCB Leakage, Tellurium Metals, Ba/Sr Group, Noble Metals, Cerium Group, and Lanthanides

- Final -

Attachment B. Control Building Roof Gravel Thickness

The gravel thickness on the Control Building roof is 0.5 inches from Column 8.97 to Column 11.1, 2 inches from Column 11.1 to Column 11.9, and 0.5 inches from Column 11.9 to Column 13.2. This was verified by a walkdown performed by R. Braesch (NMC) and J. Rich (S&L). The results of this walkdown are illustrated on the next page.

NH-94203



SECOND FLOOR PLAN

SCALE 1/8"=1'-0"

EL 951'

4-23-04

Richard C Brussch

John Rich 4/23/04

REVISIONS

D — AS BUILT OPERATIONS OFFICE REMODELING PER DRR# MO-92-152. DWN:WS 9/30/92 CHK:GPD10/1/92 MOD:90M068 FILMED:10/6/92

E — AS BUILT REVISED TO REFLECT THE INSTALLATION OF COMMUNICATIONS FIBER OPTIC DATALINK MOD PER DRR/CRR MO-93-93. DWN:CEP 5-3-93 CHK:PEB 8-25-93 MOD: 92Q39C FILMED: 2-22-94

F — AS BUILT REVISED TO REFLECT CONTROL ROOM KITCHEN MODIFICATION PER DRR MO-97-0121. DWN:PLA 8-25-97 CHK: GEP 8-26-97 MOD: 96Q200 FILMED: 9-8-97

G — AS-BUILT: COMPUTER ROOM REMODELED PER CRR/DRR: MO-98-0024. DWN: JJG 3-24-98 CHK: 4-2-98 MOD: 970245 FILMED: 6-11-98

DRAWING REFERENCE

NF 36310 ..... FLOOR PLAN

NF-36319 ---- DOOR SCHEDULE

Calculation 2005-00480
Revision 0
Attachment B
Page B2 of B2 / Final

RD

SIGNIFICANT NUMBER	8700		ADMIN	1	1200	2		

NSP — MONTICELLO NUCLEAR GENERATING PLANT UNIT 1

MONTICELLO NUCLEAR GENERATING PLANT
ADMINISTRATION BUILDING
SECOND FLOOR PLAN-ELEV. 951'

NORTHERN STATES POWER COMPANY MINNEAPOLIS

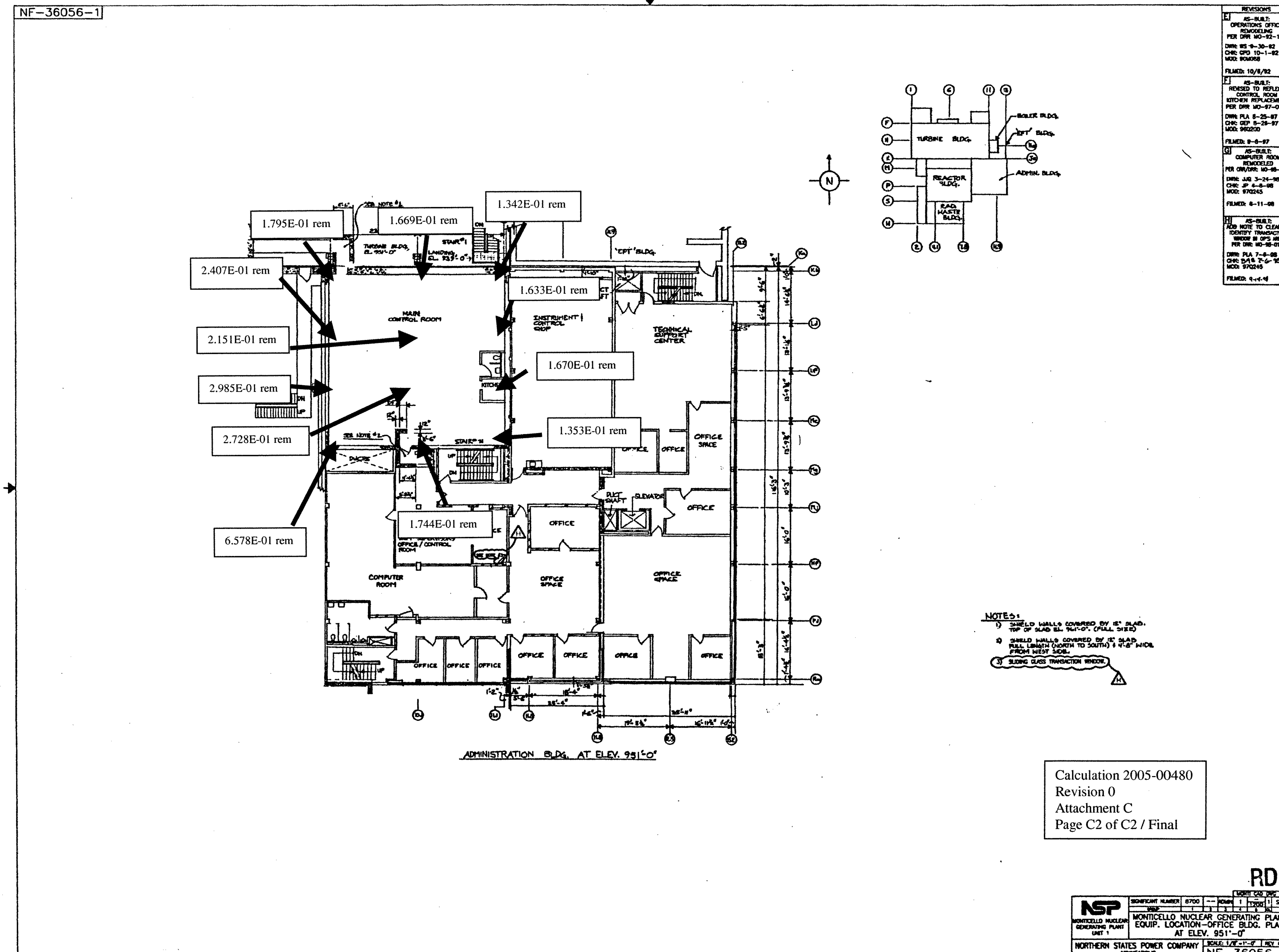
SCALE: NONE — REV G

NH-94203

FOR REFERENCE ONLY SEE CARD

Attachment C. Direct Dose Plots

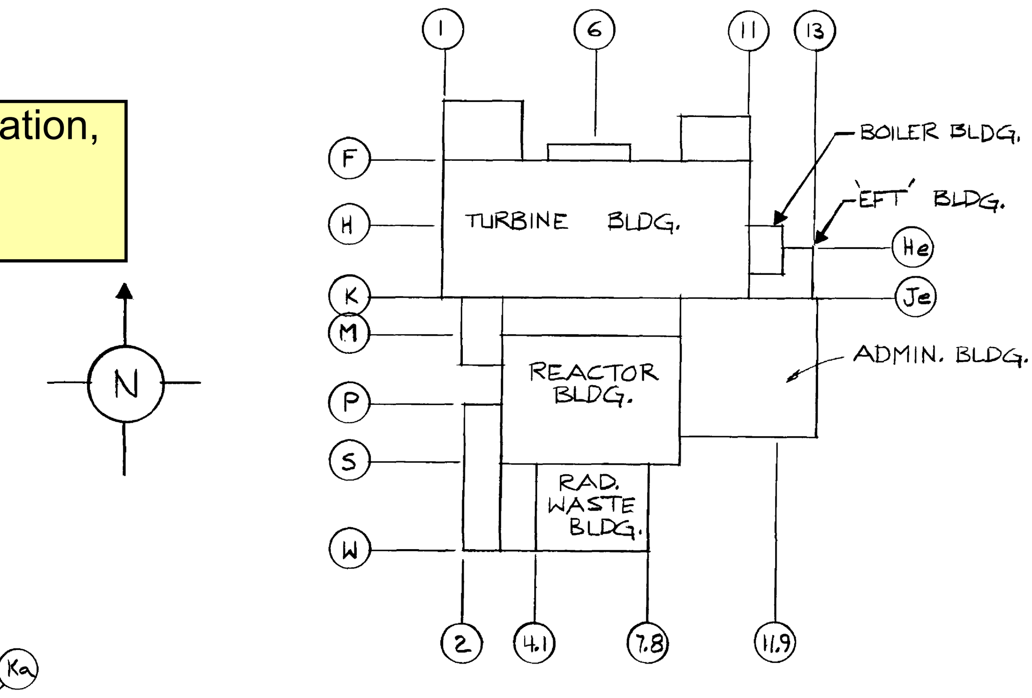
The 30 day post LOCA Control Room doses from external sources as listed in Table 111 for each of the 12 locations within the Control Room are illustrated on Page C2.

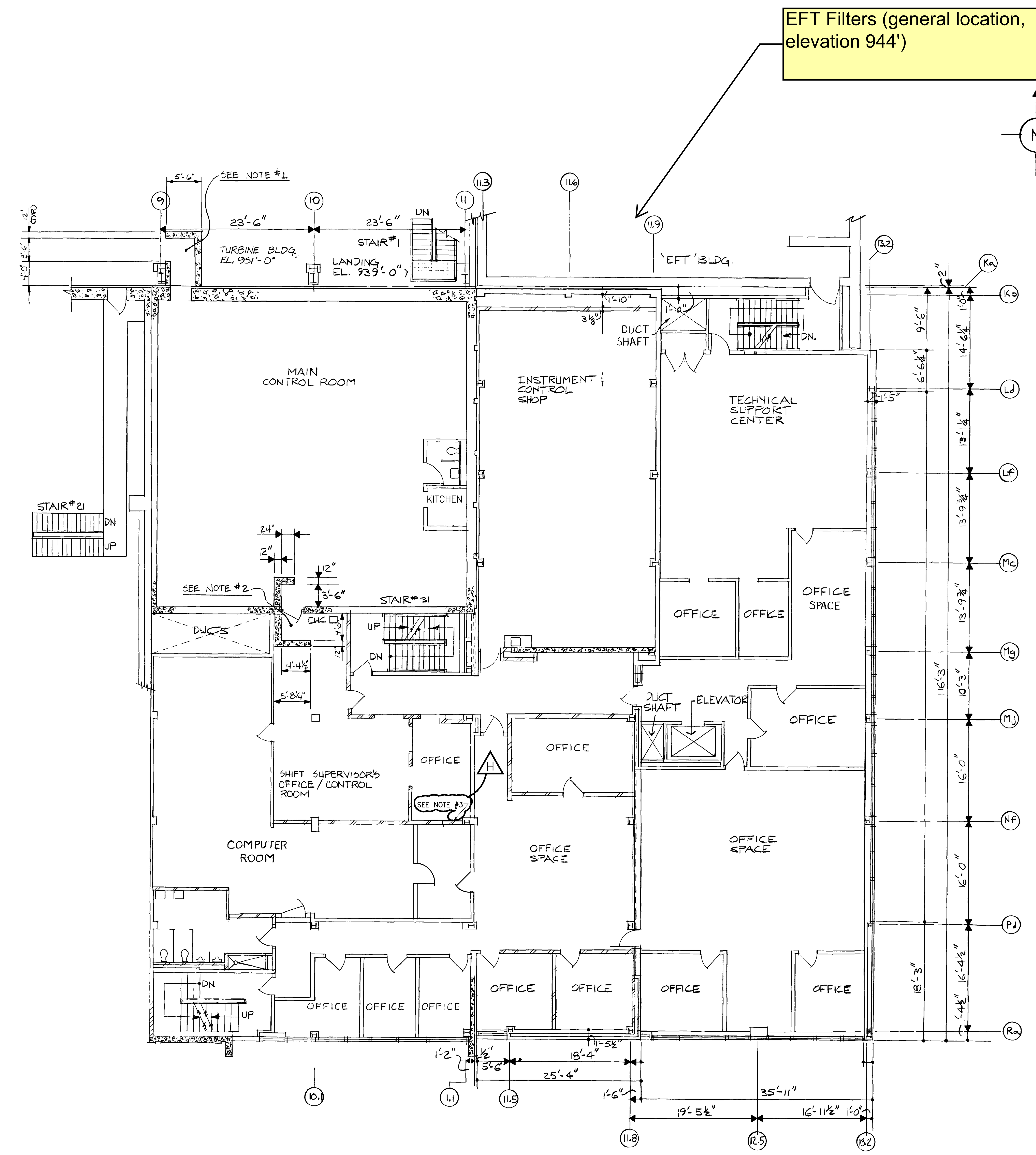


Calculation 2005-00480
Revision 0
Attachment C
Page C2 of C2 / Final

NF-36056-1

REVISIONS
E AS-BUILT: OPERATIONS OFFICE REMODELING PER DRR MO-92-152 DWN: WS 9-30-92 CHK: GPD 10-1-92 MOD: 90M068 FILMED: 10/6/92
F AS-BUILT: REVISED TO REFLECT CONTROL ROOM KITCHEN REPLACEMENT PER DRR MO-97-0121 DWN: PLA 8-25-97 CHK: GEP 8-26-97 MOD: 96Q200 FILMED: 9-8-97
G AS-BUILT: COMPUTER ROOM REMODELED PER CRR/DRR: MO-98-0024 DWN: JJG 3-24-98 CHK: JP 4-8-98 MOD: 97Q245 FILMED: 6-11-98
H AS-BUILT: ADD NOTE TO CLEARLY IDENTIFY TRANSACTION WINDOW IN OP'S AREA PER DRR: MO-98-0128 DWN: PLA 7-6-98 CHK: MOD: 97Q245 FILMED:





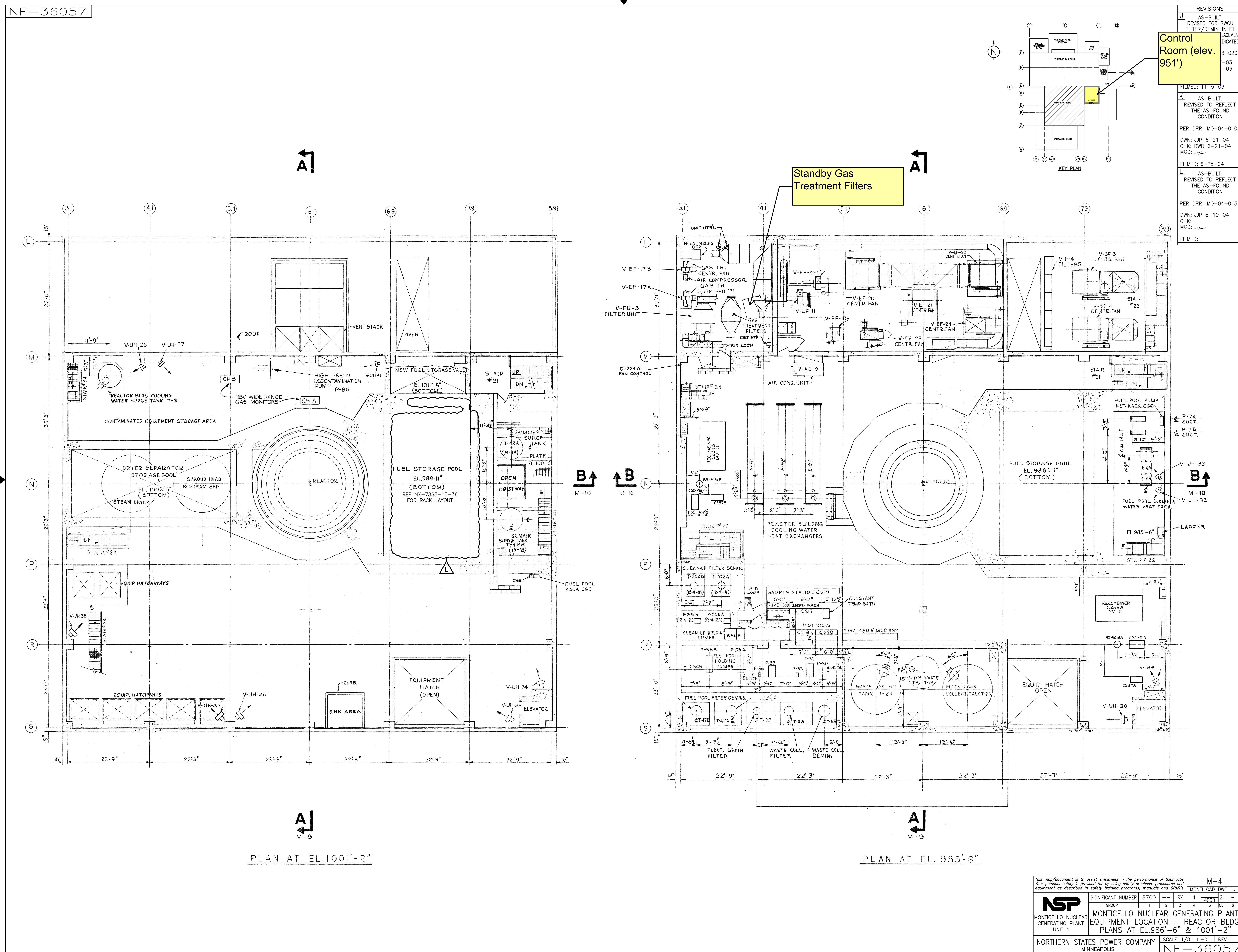
ADMINISTRATION BLDG. AT ELEV. 951'-0"

NOTES:

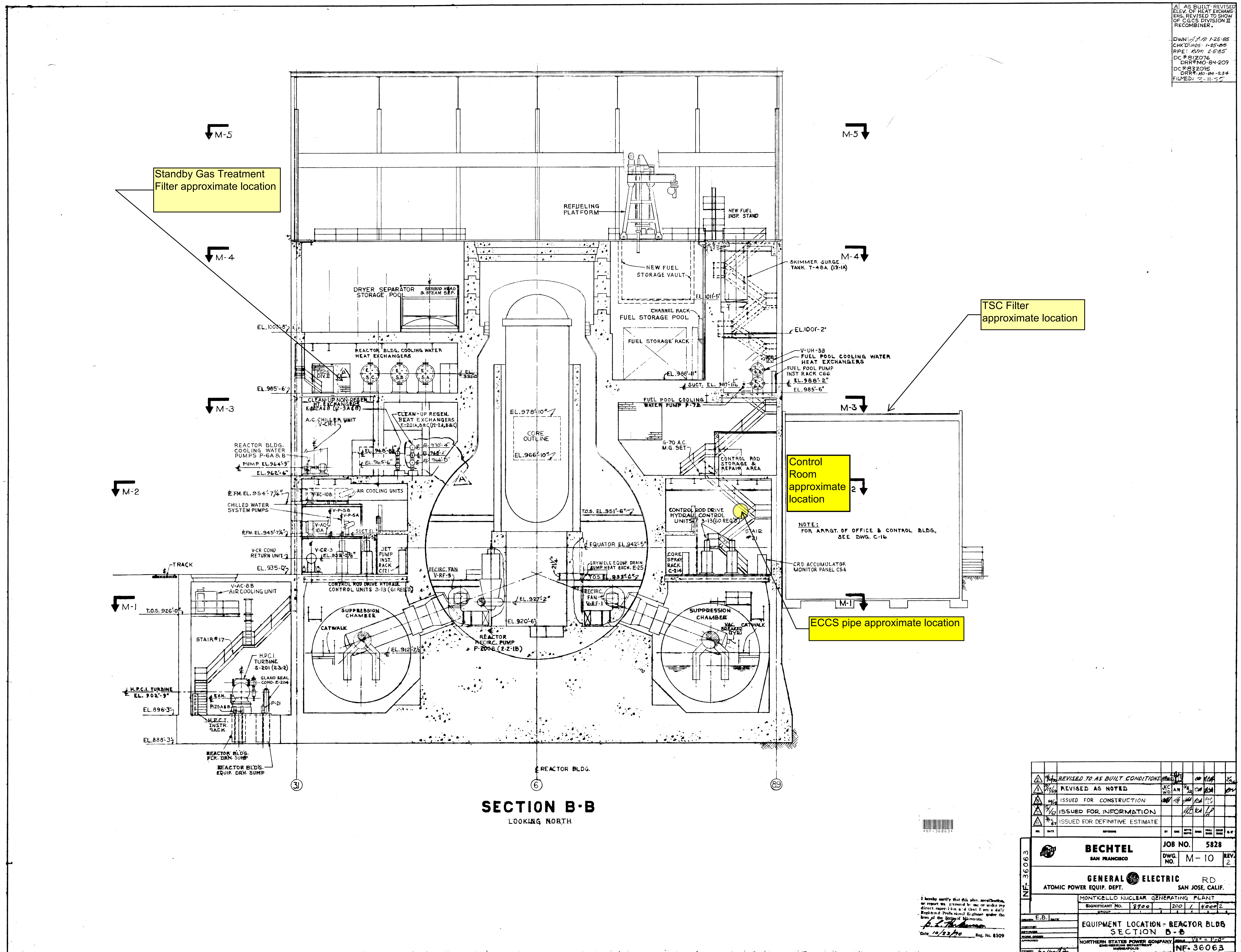
1) SHIELD WALLS COVERED BY 12" SLAB. TOP OF SLAB EL. 961'-0". (FULL SIZE)
2) SHIELD WALLS COVERED BY 12" SLAB FULL LENGTH (NORTH TO SOUTH) & 4'-8" WIDE FROM WEST SIDE.
3) SLIDING GLASS TRANSACTION WINDOW.

NSP	SIGNIFICANT NUMBER	8700	--	ADMIN	1	1200	1 STR
MONTICELLO NUCLEAR GENERATING PLANT UNIT 1	MONTICELLO NUCLEAR GENERATING PLANT EQUIP. LOCATION-OFFICE BLDG. PLAN AT ELEV. 951'-0"						
NORTHERN STATES POWER COMPANY MINNEAPOLIS	SCALE: 1/8"=1'-0"	REV H					
	NF-36056-1						

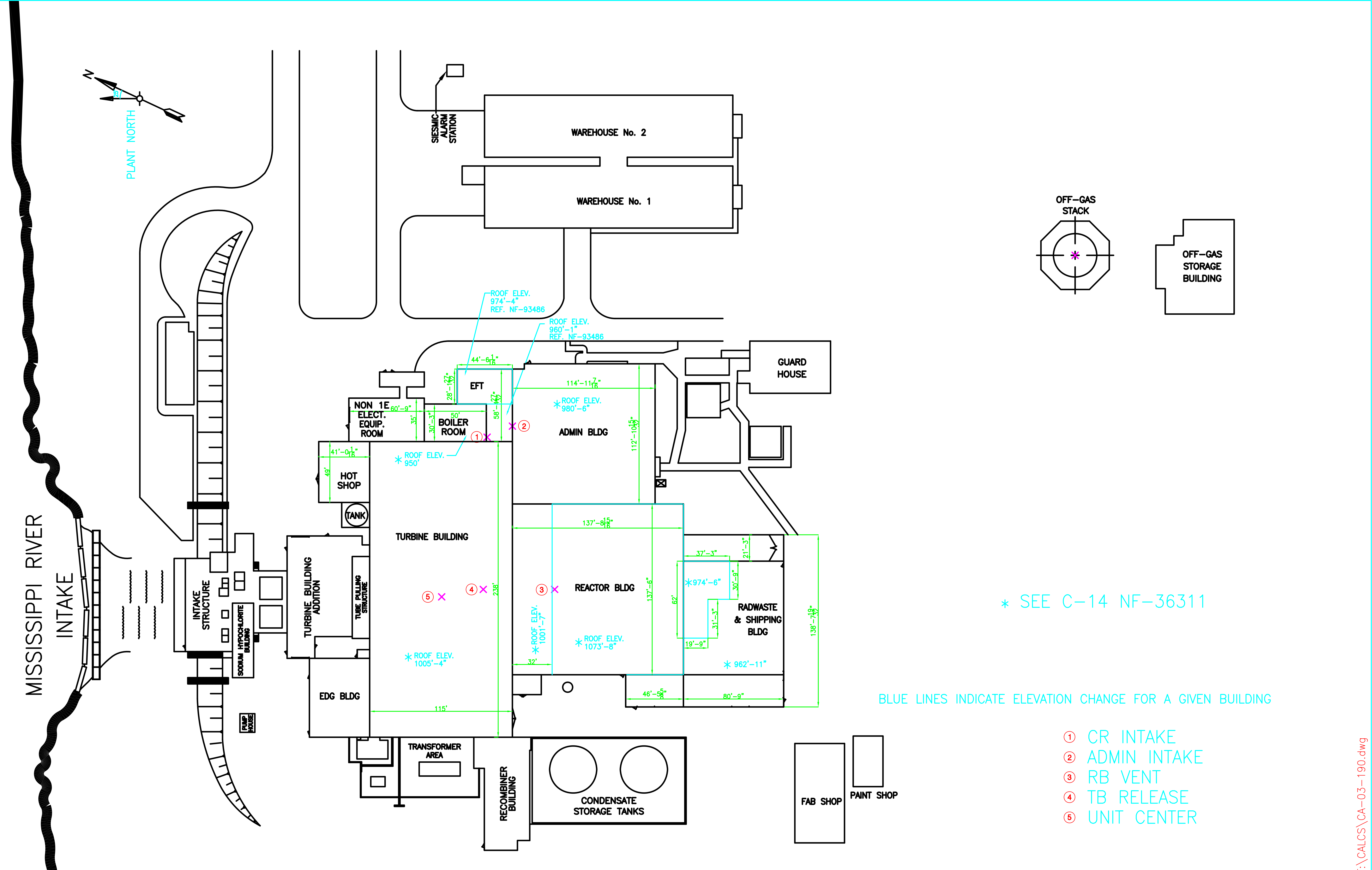
MONTI CAD DWG "F"



NF-36057
REVISIONS
J AS-BUILT: REVISED FOR RWCU FILTER/DEMIN INLET
FILMED: 11-5-03
K AS-BUILT: REVISED TO REFLECT THE AS-FOUND CONDITION
PER DRR: MO-04-0106
DWN: JJP 6-21-04
CHK: RWD 6-21-04
FILMED: 6-25-04
L AS-BUILT: REVISED TO REFLECT THE AS-FOUND CONDITION
PER DRR: MO-04-0136
DWN: JJP 8-10-04
Control Room (elev. 951')
KEY PLAN
Standby Gas Treatment Filters
CONTAMINATED EQUIPMENT STORAGE AREA
DRYER SEPARATOR STORAGE POOL
REACTOR
FUEL STORAGE POOL
EQUIP HATCHWAYS
EQUIPMENT HATCH (OPEN)
SINK AREA
ELEVATOR
REACTOR BUILDING COOLING WATER HEAT EXCHANGERS
FUEL STORAGE POOL EL.988'-11" (BOTTOM)
FUEL POOL FILTER DEMINS
WASTE COLLECT. TANK T-24
FLOOR DRAIN COLLECT. TANK T-26
EQUIP. HATCH OPEN
PLAN AT EL.1001'-2"
PLAN AT EL.985'-6"
This map/document is to assist employees in the performance of their jobs. Your personal safety is provided for by using safety practices, procedures and equipment as described in safety training programs, manuals and SPAR's.
M-4
NSP
MONTICELLO NUCLEAR GENERATING PLANT UNIT 1
MONTICELLO NUCLEAR GENERATING PLANT
EQUIPMENT LOCATION – REACTOR BLDG.
PLANS AT EL.986'-6" & 1001'-2"
NORTHERN STATES POWER COMPANY
MINNEAPOLIS
SCALE: 1/8"=1'-0"
REV. L
NF-36057



Standby Gas Treatment Filter approximate location
TSC Filter approximate location
Control Room approximate location
ECCS pipe approximate location
REFUELING PLATFORM
NEW FUEL INSP. STAND
NEW FUEL STORAGE VAULT
SKIMMER SURGE TANK T-48A (13-1A)
DRYER SEPARATOR STORAGE POOL
SHROUD HEAD & STEAM SEP.
CHANNEL RACK
FUEL STORAGE POOL
FUEL STORAGE RACK
EL.1001'-2"
REACTOR BLDG. COOLING WATER HEAT EXCHANGERS
FUEL POOL COOLING WATER HEAT EXCHANGERS
FUEL POOL PUMP INST RACK C66
FUEL POOL COOLING WATER PUMP P-7B
CLEAN-UP NON-REGEN. HT. EXCHANGERS
CLEAN-UP REGEN. HEAT EXCHANGERS
A.C. CHILLER UNIT V-CH-1
REACTOR BLDG. COOLING WATER PUMPS P-6A & B
CORE OUTLINE
EL.978'-10"
EL.966'-10"
G-70 A.C. M.G. SET
CONTROL ROD STORAGE & REPAIR AREA
AIR COOLING UNITS
CHILLED WATER SYSTEM PUMPS
CONTROL ROD DRIVE HYDRAULIC CONTROL UNITS 3-13 (60 REQ'D)
NOTE: FOR ARRGT. OF OFFICE & CONTROL BLDG. SEE DWG. C-16
EQUATOR EL.942'-5"
STAIR #21
CORE SPRAY RACK C-214
CRD ACCUMULATOR MONITOR PANEL C54
V-CR COND RETURN UNIT
JET PUMP INST. RACK C121
RECIRC. FAN V-RF-3
DRYWELL EQUIP. DRAIN SUMP HEAT EXCH. E-25
TRACK
V-AC-8B AIR COOLING UNIT
CONTROL ROD DRIVE HYDRAUL. CONTROL UNITS 3-13 (61 REQ'D)
SUPPRESSION CHAMBER
CATWALK
REACTOR RECIRC. PUMP P-200B (2-2-1B)
VAC. BREAKER (TYP.)
STAIR #17
H.P.C.I. TURBINE S-201 (23-2)
GLAND SEAL COND. E-204
H.P.C.I. INSTR. RACK
REACTOR BLDG. FLR. DRN. SUMP
REACTOR BLDG. EQUIP. DRN. SUMP
REACTOR BLDG.
SECTION B-B
LOOKING NORTH
A AS BUILT-REVISED ELEV. OF HEAT EXCHANGERS. REVISED TO SHOW OF CGCS DIVISION II RECOMBINER.
BECHTEL SAN FRANCISCO
JOB NO. 5828
DWG. NO. M-10 REV. 2
GENERAL ELECTRIC ATOMIC POWER EQUIP. DEPT. SAN JOSE, CALIF.
MONTICELLO NUCLEAR GENERATING PLANT
EQUIPMENT LOCATION - REACTOR BLDG SECTION B-B
NORTHERN STATES POWER COMPANY
NF-36063
REV. A



This map/document is to assist employees in the performance of their jobs. Your personal safety is provided for by using safety practices, procedures and equipment as described in safety training programs, manuals and SPAR's.

MONTICELLO NUCLEAR GENERATING PLANT
AST PROJECT CALC 03-190, DIR A.1.8, A.1.9
ATTACHMENT B, PAGE 1 OF 1

NX-7831-197-1

NOTES:

1. REFERANCE DRAWINGS AND DOCUMENTS:
   INSTALLATION SPECIFICATION 22A2186.
   INSTALLATION INSTRUCTION 22A2186AB.
   REACTOR INSTALLATION AND ASSEMBLY REQUIREMENTS DRAWING 158B7269.

2. TORQUE 2" DIA. STUDS TO 625 FT.LBS ± 25 FT..LBS AND 2 1/2" DIA STUDS TO 1225 FT.LBS ± 25 FT.LBS. USE LUBRCANT SIMILAR TO NEVER-SEEZ, ANTI-SEIZE AND SEALING COMPOUND TYPE NICKEL NS-165 EXCEPT COMPOSTION OF LUBRICANT NOT TO EXCEED 150 PPM LEAD 200 PPM CHLORINE 20 PPM FLUORINE, AND 350 PPM SUIPHUR. USE ON THREAD AND NUT FACES ONLY. DO NOT CONTAMINATE ANY OTHER SURFACES REMOVE ALL EXCESS LUBRICANT AFTER TORQUEING.

G.E. 104R919

This map/document is to assist employees in the performance of their jobs. Your personal safety is provided for by using safety practices, procedures and equipment as described in safety training programs, manuals and SPAR's.

MONTI CAD DWG 'B'

SIGNIFICANT NUMBER	8700	--	RX	1	MECH 9010	2	
GROUP	1	2	3	4	5	CL	6

NSP — MONTICELLO NUCLEAR GENERATING PLANT UNIT 1

MONTICELLO NUCLEAR GENERATING PLANT
REACTOR VESSEL & INTERNALS

NORTHERN STATES POWER COMPANY
MINNEAPOLIS

SCALE: NONE — REV D

NX-7831-197-1