RAI Volume 2, Chapter 2.1.1.6, Second Set, Number 9:

> Provide the estimated time needed for the ITS diesel generators to power the full load in case of loss of off-site power. The information is required for NRC staff to assess the ability of ITS diesel generators to support functions of ITS HVAC systems in CRCF and WHF.

1. RESPONSE

The estimated time by which the important to safety (ITS) diesel generators are needed to start and be fully loaded with the ITS loads in the event of loss of offsite power is up to 8 hours. This 8-hour time requirement is determined by demonstrating that doses, as a result of the bounding Category 2 event sequence in the Canister Receipt and Closure Facility (CRCF) or Wet Handling Facility (WHF), remain within the Category 2 event sequence offsite public dose performance objectives without reliance on ITS high-efficiency particulate air (HEPA) filtration. Thus, the ITS heating, ventilation, and air-conditioning (HVAC) system could remain inoperable with resulting loss of HEPA filtration for up to 8 hours during or following a radionuclide release as a result of a Category 2 event sequence. Attachment A provides an evaluation of the impact of loss of ITS HEPA filtration for an 8-hour period for the bounding WHF or CRCF event sequence with an end-state of filtered radionuclide release. The evaluation shows that ITS HEPA filtration can be suspended for up to 8 hours any time during the 30-day mission of the ITS HVAC system. The ITS diesel generators will obtain full load within a considerably shorter time frame.

The design capability of the ITS diesel generators is in accordance with IEEE Std 387-1995, *Standard Criteria for Diesel-Generator Units Applied as Standby Power Generating Stations*. The duration for starting, accelerating, sequencing, and loading of the ITS diesel generators will be determined during detailed design; however, this duration is expected to be less than 3 minutes, and will be in accordance with Section 4.1 of IEEE Std 387-1995. The ITS diesel generators are designed to start and accept load within the 8-hour time period established by the preclosure safety analysis. Upon receipt of a start-diesel signal, the automatic ITS diesel generator control system will provide startup and adjustment of frequency and voltage to a ready-to-load condition, in accordance with Section 4.5 of IEEE Std 387-1995.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2008. *Preclosure Consequence Analyses*. 000-00C-MGR0-00900-000-00E. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080310.0031.

BSC 2009a. *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis*. 060-PSA-CR00-00200-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0004.

BSC 2009b. *Wet Handling Facility Reliability and Event Sequence Categorization Analysis*. 050-PSA-WH00-00200-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20090112.0006.

IEEE Std 387-1995. 2001. *Standard Criteria for Diesel-Generator Units Applied as Standby Power Generating Stations*. New York, New York: Institute of Electrical and Electronics Engineers. TIC: 258750.

5. ATTACHMENT A

This attachment presents an evaluation of the impact of the unavailability of ITS HEPA filtration during any 8-hour period of the bounding WHF or CRCF event sequence with an end state of filtered radionuclide release. The time period starts with a demand for electrical power from the ITS diesel generators. The evaluation demonstrates that, even with ITS HEPA filtration unavailable during an 8-hour period, the offsite public doses would remain within the preclosure performance objectives over a 30-day period following a Category 2 event sequence that relies on ITS HEPA filtration.

A.1 BOUNDING EVENT SEQUENCE TO EVALUATE LOSS OF FILTRATION

CRCF Category 2 event sequences are summarized in Table 7-2 of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009a). The Category 2 event sequences, along with their corresponding consequence analysis bounding event number (shown in brackets), are listed with greater detail in Table 6.8-3 (BSC 2009a). Although filtered events of structural challenges to a high-level radioactive waste canister appear in Table 6.8-3 (BSC 2009a), *Preclosure Consequence Analyses* (BSC 2008, Section 6.8.9) only relies on ITS HEPA filtration for event sequences involving transportation, aging, and disposal canisters. Event sequence ESD09-TAD-SEQ3-RRF [2-09] from Table 6.8-3 (BSC 2009a), evaluated in bounding event 2-09 (BSC 2008), involves a transportation, aging, and disposal canister and relies on ITS HEPA filtration.

WHF Category 2 event sequences are summarized in Table 7-2 of *Wet Handling Facility Reliability and Event Sequence Categorization Analysis* (BSC 2009b). The Category 2 event sequences are listed with greater detail in Table 6.8-3 (BSC 2009a) and include ESD16-CSNF-SEQ1-RRF [2-05], ESD18-DPC-SEQ1-RRF [2-07], ESD17-DPC-SEQ1-RRF [2-07], ESD27-TAD-SEQ1-RRF [2-09], ESD31-CSNF-SEQ3-RRF [2-14], and ESD20-CSNF-SEQ3-RRF [2-05]. Only the bounding consequence events, 2-05, 2-07 and 2-09, rely on ITS HEPA filtration as evaluated in *Preclosure Consequence Analyses* (BSC 2008, Sections 6.8.5, 6.8.7, and 6.8.9). This attachment uses event 2-07 involving a dual-purpose canister (DPC) because it has the highest potential offsite public dose consequence (BSC 2008, Tables 67 and 68).

A.2 BASIS TO ESTIMATE DOSES FOR AN UNFILTERED TIME PERIOD

Bounding event dose consequences in *Preclosure Consequence Analyses* (BSC 2008) are determined for either 30-day filtered or 30-day unfiltered conditions. The doses include contributions from an initial burst radionuclide release, which is modeled with a one hour duration (BSC 2008, Section 3.2.2), and a fuel oxidation radionuclide release that occurs continuously and uniformly over the remainder of the 30-day period. The dose consequences have been integrated over the 30-day period so that results by individual time periods are not available. These integrated results, along with filtration factors developed in this attachment, assess the impact of an unfiltered release for a period of 8 hours any time during the 30-day period.

The impact of ITS HEPA filtration being unavailable during the initial 8 hours following the bounding event sequence is estimated in order to demonstrate that the doses would remain within the preclosure performance objective for any 8-hour period for any event sequence. The first 8 hours have the highest dose consequences because the time-dependent atmospheric dispersion factors and breathing rates are highest during that period (BSC 2008, Tables 5 and 16). The airborne releases are modeled to include the initial burst release and a continuous, uniform fuel oxidation release over a period of 30 days. Because the HVAC is assumed to be unavailable for the first 8 hours, the entire burst release and the first 8 hours of the oxidation release are assumed to be unfiltered. The approach used in the preclosure consequence analysis conservatively considers oxidation to begin at the initial loss of containment rather than at the time and temperature at which significant oxidation commences. The oxidation release has two components: gaseous radionuclides and particulate radionuclides.

A.3 METHOD TO ESTIMATE 30-DAY OXIDATION PARTICULATE DOSE UNFILTERED, D_{POx}^{30U}

The 30-day total oxidation dose with ITS HVAC filtration is the sum of doses from gaseous radionuclides (that are analyzed as unfiltered) and from particulate radionuclides filtered for 30 days. The filtered and unfiltered gaseous doses are identical. The filtered particulate dose is equal to the unfiltered particulate dose times the ITS HEPA leak path factor of 1.0×10^{-4} (i.e., equal to one minus the filter efficiency). As shown in Equation 1, the total 30-day oxidation dose without ITS HEPA filtration for the entire 30-day period is the sum of doses from gases plus particulates unfiltered for 30 days. Subtracting the 30-day filtered total oxidation dose from the 30-day unfiltered total oxidation dose, rearranging, and noting that the filtered and unfiltered gaseous doses are equal provides a method to estimate the 30-day unfiltered particulate dose, D_{POx}^{30U}, to a very good approximation.

$$D_{TOx}^{30F} = D_{GOx}^{30F} + D_{POx}^{30F} = D_{GOx}^{30F} + D_{POx}^{30U} \times 10^{-4}$$

and

$$D_{TOx}^{30U} = D_{GOx}^{30U} + D_{POx}^{30U} \qquad \text{(Eq. 1)}$$

subtracting and rearranging

$$D_{POx}^{30U} = \frac{\left(D_{TOx}^{30U} - D_{TOx}^{30F}\right)}{\left(1 - 10^{-4}\right)} \cong \left(D_{TOx}^{30U} - D_{TOx}^{30F}\right)$$

Where:

D_{TOx}^{30F} is the 30-day filtered oxidation total dose.

D_{GOx}^{30F} is the 30-day filtered oxidation dose from gases.

D_{POx}^{30F} is the 30-day filtered oxidation dose from particulates.

D_{TOx}^{30U} is the 30-day unfiltered oxidation total dose.

D_{GOx}^{30U} is the 30-day unfiltered oxidation dose from gases.

D_{POx}^{30U} is the 30-day unfiltered oxidation dose from particulates.

A.4 METHOD TO ESTIMATE 30-DAY TOTAL DOSE WITH FIRST 8 HOURS UNFILTERED, D_T^{8U}

The 30-day total dose with ITS HEPA filtration unavailable for the first 8 hours is the sum of the 30-day dose from an unfiltered burst release and the 30-day dose from an oxidation release with gases unfiltered and particulates filtered except for the first 8 hours. The 30-day total dose with ITS HEPA filtration unavailable for the first 8 hours, D_T^{8U}, is shown in Equation 2.

$$D_T^{8U} = D_B^{30U} + D_{GOx}^{30F} + D_{POx}^{8U-30F} \quad \text{(Eq. 2)}$$

Where:

D_T^{8U} is the 30-day total dose unfiltered for the first 8 hours.

D_B^{30U} is the 30-day unfiltered burst release total dose.

D_{GOx}^{30F} is the 30-day oxidation dose from gases (filtered equals unfiltered).

D_{POx}^{8U-30F} is the 30-day oxidation dose from particulates with the first 8 hours unfiltered and remaining time filtered.

D_{POx}^{8U-30F} is estimated as the full 30-day filtered particulate oxidation dose that includes a filtered release during the first 8 hours, plus the 8-hour unfiltered particulate oxidation dose. The first 8 hours include both a filtered and an unfiltered particulate dose, but this results in only a minor conservatism because the filtered dose portion is smaller by a factor of 1×10^4 compared to the unfiltered dose portion. The 8-hour unfiltered particulate oxidation dose is estimated by multiplying the full 30-day unfiltered particulate oxidation dose in Equation 1 with a filtration factor, FF^{8U}, to account for only 8 hours versus 30 days of unfiltered release. When this approach is implemented with Equation 2, the total 30-day dose with ITS HEPA filtration unavailable for the first 8 hours, D_T^{8U}, can be determined by Equation 3.

$$\begin{aligned} D_T^{8U} &= D_B^{30U} + D_{GOx}^{30F} + D_{POx}^{30F} + D_{POx}^{8U} \\ &= D_B^{30U} + \left(D_{GOx}^{30F} + D_{POx}^{30F}\right) + D_{POx}^{30U} \times FF^{8U} \\ &= D_B^{30U} + D_{TOx}^{30F} + \left(D_{TOx}^{30U} - D_{TOx}^{30F}\right) \times FF^{8U} \end{aligned} \quad \text{(Eq. 3)}$$

Where:

D_T^{8U} is the 30-day total dose unfiltered for the first 8 hours.

D_B^{30U} is the 30-day unfiltered burst release total dose.

D_{GOx}^{30F} is the 30-day oxidation dose from gases (filtered equals unfiltered).

D_{POx}^{30F} is the 30-day filtered oxidation dose from particulates.

D_{POx}^{8U} is the 8-hour unfiltered oxidation dose from particulates.

D_{POx}^{30U} is the 30-day unfiltered oxidation dose from particulates.

FF^{8U} is a filtration factor to account for only 8 hours of unfiltered particulate release.

D_{TOx}^{30F} is the 30-day filtered oxidation total dose.

D_{TOx}^{30U} is the 30-day unfiltered oxidation total dose.

A.5 FILTRATION FACTOR FOR AN 8 HOUR UNFILTERED RELEASE

Pathway factors are defined as the product of the time-dependent parameters that affect each dose pathway. Different dose pathways use different combinations of time-dependent atmospheric dispersion and breathing rate parameters. Ingestion and ground shine doses are proportional to the deposition rate only. Resuspended soil inhalation dose is proportional to the deposition rate and breathing rate. Air submersion dose is proportional to the depleted atmospheric dispersion factor, and air inhalation dose is proportional to the depleted atmospheric dispersion factor and breathing rate. Pathway factors for each of five atmospheric dispersion time periods, *j*, (0 to 2 hours, 2 to 8 hours, 8 to 24 hours, 24 to 96 hours, and 96 to 720 hours) are determined for dose receptor locations both in the general environment and not in the general environment by Equations 4 through 7:

$$XQ_{F,j}^{L} = \chi/Q_j^{L} \times HEPA_j^{F} \times \Delta T_j = \textit{air submersion pathway factor} \quad \text{(Eq. 4)}$$

$$Dep_{F,j}^{L} = Dep_j^{L} \times HEPA_j^{F} \times \Delta T_j = \textit{ground shine \& ingestion pathway factor} \quad \text{(Eq. 5)}$$

$$Inh_{F,j}^{L} = \chi/Q_j^{L} \times BR_j^{L} \times HEPA_j^{F} \times \Delta T_j = \textit{air inhalation pathway factor} \quad \text{(Eq. 6)}$$

$$Rsp_{F,j}^{L} = Dep_j^{L} \times BR_j^{L} \times HEPA_j^{F} \times \Delta T_j = \textit{resuspended soil inhalation pathway factor} \quad \text{(Eq. 7)}$$

Where:

L is the dose receptor location: *GE* for general environment or *NG* for not in general environment.

F is the HEPA filtration time period: *8U* for 8 hours unfiltered or *30U* for 30 days unfiltered.

χ/Q_j^L is the depleted atmospheric dispersion factor at location L and time period j.

Dep_j^L is the deposition rate at location L and time period j.

$HEPA_j^F$ is the HEPA filtration factor for period F and time period j.

ΔT_j is the duration of time period j.

BR_j^L is the breathing rate at location L and time period j.

Pathway ratios are determined by dividing the sum over the 5 time periods of the pathway factors for an 8-hour unfiltered release by the sum for a 30-day unfiltered release.

$$AS^L = \sum_{j=1}^{5} XQ_{8U,j}^L \Big/ \sum_{j=1}^{5} XQ_{30U,j}^L = air\ submersion\ pathway\ ratio \quad \text{(Eq. 8)}$$

$$GS^L = IG^L = \sum_{j=1}^{5} Dep_{8U,j}^L \Big/ \sum_{j=1}^{5} Dep_{30U,j}^L = ground\ shine \& ingestion\ pathway\ ratio \quad \text{(Eq. 9)}$$

$$AI^L = \sum_{j=1}^{5} Inh_{8U,j}^L \Big/ \sum_{j=1}^{5} Inh_{30U,j}^L = air\ inhalation\ pathway\ ratio \quad \text{(Eq. 10)}$$

$$RI^L = \sum_{j=1}^{5} Rsp_{8U,j}^L \Big/ \sum_{j=1}^{5} Rsp_{30U,j}^L = resuspended\ soil\ inhalation\ pathway\ ratio \quad \text{(Eq. 11)}$$

The pathway ratios are presented in Table 1 and Table 2 for each pathway for two-dose receptor locations: in the general environment and not in the general environment, respectively.

The filtration factors, FF_{GE}^{8U} for the general environment and FF_{NG}^{8U} for not in the general environment, are conservatively set equal to the maximum of the pathway ratios for each of the two receptor locations and are used to estimate the 8-hour unfiltered oxidation particulate dose for all pathways. The calculated values in Table 1 and Table 2 for FF_{GE}^{8U} and FF_{NG}^{8U} are 1.6×10^{-1} and 8.8×10^{-2}, respectively.

A.6 DOSES WITH AN 8-HOUR UNFILTERED RELEASE FOR BOUNDING EVENT 2-07

The bounding event in *Preclosure Consequence Analyses* (BSC 2008) that relies on ITS HEPA filtration is event 2-07 that involves a DPC containing either 36 pressurized water reactor or 74 boiling water reactor assemblies. A DPC containing 36 pressurized water reactor assemblies results in higher doses than one with 74 boiling water reactor assemblies. Therefore, the pressurized water reactor case is bounding and used to determine the doses for an event with an initial 8-hour unfiltered release period.

To determine doses, the method developed in Section A.4 (to estimate the 30-day total dose with first 8 hours unfiltered) is used with the filtration factors for an 8-hour unfiltered release (from Section A.5) and the 30-day filtered and 30-day unfiltered dose consequences in *Preclosure Consequence Analyses* (BSC 2008). Dose receptor locations include both a receptor in the general environment and a receptor not in the general environment. Both total effective dose equivalent and organ doses are determined to demonstrate that the dose consequences are within the preclosure performance objectives. Because the organ of maximum dose is different for the burst and for the oxidation release, both are calculated.

The public doses at the site boundary with ITS HVAC unavailable in the first 8 hours in the general environment and not in the general environment are shown in Table 3 and Table 4, respectively. For the dose receptor located in the general environment, the results are a total effective dose equivalent of 0.66 rem, a maximum total organ dose equivalent of 15 rem, a skin dose equivalent of 0.32 rem and a lens dose equivalent of 0.98 rem (i.e., total effective dose equivalent plus skin dose equivalent). For the dose receptor located not in the general environment, the results are a total effective dose equivalent of 1.6 rem, a maximum total organ dose equivalent of 39 rem, a skin dose equivalent of 0.68 rem and a lens dose equivalent of 2.3 rem. These are within the 10 CFR 63.111 Category 2 event sequence offsite public dose performance objectives of 5 rem total effective dose equivalent, 50 rem total organ dose equivalent to the maximum organ, 50 rem skin dose equivalent and 15 rem lens dose equivalent, showing that an 8-hour period to establish or re-establish ITS HEPA filtration maintains doses within regulatory limits.

Table 1. Filtration Factor for 8 hour Unfiltered Release—General Environment

Symbol	Parameters	0 to 2 hours	2 to 8 hours	8 to 24 hours	24 to 96 hours	96 to 720 hours	Units
			Atmospheric Dispersion Time Periods				
ΔT	Duration	2	6	16	72	624	hr
$HEPA^{30U}$	HEPA Factor—Unfiltered	1	1	1	1	1	
$HEPA^{8U}$	HEPA Factor—8 hour Unfiltered[a]	1	1	1×10^{-4}	1×10^{-4}	1×10^{-4}	
		Time-dependent Parameters for General Environment					
χ/Q^{GE}	Depleted χ/Q[b]	4.4×10^{-6}	2.5×10^{-6}	1.5×10^{-6}	6.6×10^{-7}	2.1×10^{-7}	s/m^3
Dep^{GE}	Deposition Rate[b]	1.2×10^{-8}	6.9×10^{-9}	4.2×10^{-9}	2.0×10^{-9}	7.1×10^{-10}	m^{-2}
BR^{GE}	Breathing rate(BR)[c]	3.5×10^{-4}	3.5×10^{-4}	1.8×10^{-4}	2.3×10^{-4}	2.3×10^{-4}	m^3/s
	Time Period Pathway Factors for 8 hour Unfiltered - General Environment – Equations 4 to 7						Sum
$XQ^{GE}{}_{8U}$	Depleted χ/Q	8.8×10^{-6}	1.5×10^{-5}	2.3×10^{-9}	4.7×10^{-9}	1.3×10^{-8}	2.4×10^{-5}
$Dep^{GE}{}_{8U}$	Deposition Rate	2.3×10^{-8}	4.1×10^{-8}	6.8×10^{-12}	1.5×10^{-11}	4.4×10^{-11}	6.5×10^{-8}
$Inh^{GE}{}_{8U}$	Depleted χ/Q × BR	3.1×10^{-9}	5.2×10^{-9}	4.2×10^{-13}	1.1×10^{-12}	3.0×10^{-12}	8.3×10^{-9}
$Rsp^{GE}{}_{8U}$	Deposition Rate × BR	8.2×10^{-12}	1.4×10^{-11}	1.2×10^{-15}	3.4×10^{-15}	1.0×10^{-14}	2.3×10^{-11}
	Time Period Pathway Factors for 30 Day Unfiltered - General Environment – Equations 4 to 7						Sum
$XQ^{GE}{}_{30U}$	Depleted χ/Q	8.8×10^{-6}	1.5×10^{-5}	2.3×10^{-5}	4.7×10^{-5}	1.3×10^{-4}	2.2×10^{-4}
$Dep^{GE}{}_{30U}$	Deposition Rate	2.3×10^{-8}	4.1×10^{-8}	6.8×10^{-8}	1.5×10^{-7}	4.4×10^{-7}	7.2×10^{-7}
$Inh^{GE}{}_{30U}$	Depleted χ/Q × BR	3.1×10^{-9}	5.2×10^{-9}	4.2×10^{-9}	1.1×10^{-8}	3.0×10^{-8}	5.3×10^{-8}
$Rsp^{GE}{}_{30U}$	Deposition Rate ×BR	8.2×10^{-12}	1.4×10^{-11}	1.2×10^{-11}	3.4×10^{-11}	1.0×10^{-10}	1.7×10^{-10}
	Pathway Ratios for 8 hour Unfiltered Particulate Release - General Environment – Equations 8 to 11						
AS^{GE}	Air Submersion	1.1×10^{-1}					
GS^{GE}	Ground Shine/Ingestion	8.9×10^{-2}					
AI^{GE}	Air Inhalation	1.6×10^{-1}					
RI^{GE}	Resuspension Inhalation	1.3×10^{-1}					
	Filtration Factor for 8 hour Unfiltered Particulate Release - General Environment						
$FF^{8U}{}_{GE}$	Maximum	1.6×10^{-1}					

Source: [a]HEPA filtration factor is from Section 6.1.4.1 of BSC 2008.
[b]Atmospheric dispersion factors and deposition rates are from Table 5 of BSC 2008.
[C]Breathing rates are from Table 16 and Section 6.1.6.1 of BSC 2008.

Table 2. Filtration Factor for 8 hr Unfiltered Release—Not in General Environment

			Atmospheric Dispersion Time Periods				
Symbol	**Parameters**	**0 to 2 hours**	**2 to 8 hours**	**8 to 24 hours**	**24 to 96 hours**	**96 to 720 hours**	**Units**
ΔT	Duration	2	6	16	72	624	hr
$HEPA^{30U}$	HEPA Factor - Unfiltered	1	1	1	1	1	
$HEPA^{8U}$	HEPA Factor - 8 hr Unfiltered[a]	1	1	1×10^{-4}	1×10^{-4}	1×10^{-4}	
		Time-dependent Parameters for Not in General Environment					
χ/Q^{NG}	Depleted χ/Q[b]	1.5×10^{-5}	8.5×10^{-6}	5.3×10^{-6}	2.6×10^{-6}	9.0×10^{-7}	s/m^3
Dep^{NG}	Deposition Rate[b]	4.5×10^{-8}	2.7×10^{-8}	1.7×10^{-8}	8.8×10^{-9}	3.3×10^{-9}	m^{-2}
BR^{NG}	Breathing rate, BR[c]	3.5×10^{-4}	3.5×10^{-4}	3.5×10^{-4}	3.5×10^{-4}	3.5×10^{-4}	m^3/s
	Time Period Pathway Factors for 8 hour Unfiltered - Not in General Environment – Equations 4 to 7						**Sum**
$XQ^{NG}{}_{8U}$	Depleted χ/Q	2.9×10^{-5}	5.1×10^{-5}	8.5×10^{-9}	1.8×10^{-8}	5.6×10^{-8}	8.0×10^{-5}
$Dep^{NG}{}_{8U}$	Deposition Rate	9.0×10^{-8}	1.6×10^{-7}	2.8×10^{-11}	6.4×10^{-11}	2.1×10^{-10}	2.5×10^{-7}
$Inh^{NG}{}_{8U}$	Depleted χ/Q × BR	1.0×10^{-8}	1.8×10^{-8}	3.0×10^{-12}	6.5×10^{-12}	2.0×10^{-11}	2.8×10^{-8}
$Rsp^{NG}{}_{8U}$	Deposition Rate × BR	3.1×10^{-11}	5.7×10^{-11}	9.7×10^{-15}	2.2×10^{-14}	7.3×10^{-14}	8.9×10^{-11}
	Time Period Pathway Factors for 30 Day Unfiltered - Not in General Environment – Equations 4 to 7						**Sum**
$XQ^{NG}{}_{30U}$	Depleted χ/Q	2.9×10^{-5}	5.1×10^{-5}	8.5×10^{-5}	1.8×10^{-4}	5.6×10^{-4}	9.1×10^{-4}
$Dep^{NG}{}_{30U}$	Deposition Rate	9.0×10^{-8}	1.6×10^{-7}	2.8×10^{-7}	6.4×10^{-7}	2.1×10^{-6}	3.2×10^{-6}
$Inh^{NG}{}_{30U}$	Depleted χ/Q × BR	1.0×10^{-8}	1.8×10^{-8}	3.0×10^{-8}	6.5×10^{-8}	2.0×10^{-7}	3.2×10^{-7}
$Rsp^{NG}{}_{30U}$	Deposition Rate × BR	3.1×10^{-11}	5.7×10^{-11}	9.7×10^{-11}	2.2×10^{-10}	7.3×10^{-10}	1.1×10^{-9}
	Pathway Ratios for 8 hour Unfiltered Particulate Release - Not in General Environment – Equations 8 to 11						
AS^{NG}	Air Submersion	8.8×10^{-2}					
GS^{NG}	Ground Shine	7.8×10^{-2}					
AI^{NG}	Air Inhalation	8.8×10^{-2}					
RI^{NG}	Resuspension Inhalation	7.8×10^{-2}					
	Filtration Factor for 8 hr Unfiltered Particulate Release – Not in General Environment						
$FF^{8U}{}_{NG}$	Maximum	8.8×10^{-2}					

Source: [a]HEPA filtration factor is from Section 6.1.4.1 of BSC 2008.
[b]Atmospheric dispersion factors and deposition rates are from Table 5 of BSC 2008.
[C]Breathing rates are from Table 16 and Section 6.1.6.1 of BSC 2008.

Table 3. DPC Event 2-07 Total Doses in General Environment with 8 hours Unfiltered

		Doses (Sv/SFA)			
Parameter	**Description**	**TEDE**	**TODE (Bone Surface)**	**Skin**	
D_B^{30U}	30-day Unfiltered Burst Release[a]	1.4×10^{-4}	2.8×10^{-3}	8.4×10^{-5}	
D_{TOx}^{30U}	30-day Unfiltered Oxidation Release[a]	3.1×10^{-4}	8.9×10^{-3}	2.7×10^{-5}	
D_{TOx}^{30F}	30-day Filtered Oxidation Release[b]	1.2×10^{-7}	9.8×10^{-7}	7.7×10^{-7}	
FF^{GE}	8-hr Filtration Factor	1.6×10^{-1}	1.6×10^{-1}	1.6×10^{-1}	Table 1
D_T^{8U}	Total 30-day with 8-hr Unfiltered Release	1.8×10^{-4}	4.2×10^{-3}	8.9×10^{-5}	Equation 3
DPC_T	DPC Total 30-day with 8-hr Unfiltered Release (36 SFA/DPC)	6.6×10^{2}	1.5×10^{4}	3.2×10^{2}	mrem/DPC

NOTE: $DPCT = D_T^{8U} \times 36$ (SFA/DPC) × 100 (rem/Sv) × 1000 (mrem/rem)
TEDE = total effective dose equivalent; TODE = total organ dose equivalent; SFA = spent fuel assembly; Sv = Sieverts.

Source: [a]PWR Air General Environment no HEPA.xls, results in BSC 2008.
[b]PWR Air General Environment.xls, results in BSC 2008.

Table 4. DPC Event 2-07 Total Doses Not in General Environment with 8 hours Unfiltered

		Doses (Sv/SFA)			
Parameter	**Description**	**TEDE**	**TODE (Bone Surface)**	**Skin**	
D_B^{30U}	30-day Unfiltered Burst Release[a]	3.9×10^{-4}	9.3×10^{-3}	1.8×10^{-4}	
D_{TOx}^{30U}	30-day Unfiltered Oxidation Release[a]	6.5×10^{-4}	1.9×10^{-2}	6.4×10^{-5}	
D_{TOx}^{30F}	30-day Filtered Oxidation Release[b]	1.8×10^{-7}	2.0×10^{-6}	8.0×10^{-7}	
FF^{NG}	8-hr Filtration Factor	8.8×10^{-2}	8.8×10^{-2}	8.8×10^{-2}	Table 2
D_T^{8U}	Total 30-day with 8-hr Unfiltered Release	4.5×10^{-4}	1.1×10^{-2}	1.9×10^{-4}	Equation 3
DPC_T	DPC Total 30-day with 8-hr Unfiltered Release (36 SFA/DPC)	1.6×10^{3}	3.9×10^{4}	6.8×10^{2}	mrem/DPC

NOTE: $DPCT = D_T^{8U} \times 36$ (SFA/DPC) × 100 (rem/Sv) × 1000 (mrem/rem)
TEDE = total effective dose equivalent; TODE = total organ dose equivalent; Sv = Sieverts; SFA = spent fuel assembly.

Source: [a]PWR Air Site Boundary no HEPA.xls, results in BSC 2008
[b]PWR Air Site Boundary.xls, results in BSC 2008