US Army Corps
of Engineers ®

BALTIMORE DISTRICT

RECORD OF DECISION AMENDMENT

FOR

BUILDING 23 AT THE W.R. GRACE FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM (FUSRAP) SITE

5500 Chemical Road

Curtis Bay, Maryland

February 2020

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5500 Chemical Road

Curtis Bay, Maryland

Approved by:

_____ _____

Signature Date

Karen J. Baker
Programs Director
North Atlantic Division

DECLARATION FOR THE RECORD OF DECISION AMENDMENT

SITE NAME AND LOCATION

The subject of this Record of Decision (ROD) Amendment is the southwest quadrant of Building 23 at the W.R. Grace Curtis Bay facility, located at 5500 Chemical Road in Baltimore, Maryland.

STATEMENT OF BASIS AND PURPOSE

This amendment to the ROD signed in May 2005 for the southwest quadrant of Building 23 at the W.R. Grace Curtis Bay Facility in Baltimore, Maryland presents changes to the selected remedy compliant with the 40 Code of Federal Regulations (CFR) §300.435(c)(2). The United States Army Corps of Engineers (USACE) is the lead Federal agency for selection of the necessary and appropriate response actions for radioactive contamination related to work performed at this site by the property owner (W.R. Grace) for the Atomic Energy Commission. USACE and W.R. Grace are working together under the terms of a 2008 Settlement Agreement to implement the remedial action for the southwest quadrant of Building 23. USACE and W.R. Grace have selected an amended remedy in accordance with the Comprehensive Environmental Response, Compensation and Liability Act, as amended by the Superfund Amendments and Reauthorization Act [42 U.S.C. 9601 *et seq*.], and the National Oil and Hazardous Substances Pollution Contingency Plan [40 CFR Part 300]. This document will become part of the Administrative Record file for the site, which is available at the following public information repositories:

USACE Baltimore District offices
2 Hopkins Plaza
Baltimore, Maryland 21201

Enoch Pratt Free Library, Brooklyn Branch
300 Patapsco Avenue
Baltimore, Maryland 21225

ASSESSMENT OF THE SITE

The response action selected in this ROD Amendment is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

DESCRIPTION OF THE AMENDMENT TO THE SELECTED REMEDY

Building 23 at the W.R. Grace Curtis Bay facility is typically described in plan view as consisting of four rectangular sections of approximately equal size ("quadrants"), and the remedial action for Building 23 targets the southwestern section of the building ("southwest quadrant"). The remedy selected in the ROD for the southwest quadrant of Building 23, which was finalized in May 2005, provides for either decontaminating or removing areas of radioactivity in the southwest quadrant of Building 23 to meet remedial goals (RGs) (USACE 2005). Where decontamination is impractical or undesirable, the remedy indicates that removal will be undertaken to ensure RGs

are met. In addition, in small areas where residual radioactivity may potentially exceed RGs, but the area is inaccessible for verification that RGs are met and/or removal is impractical or undesirable, the ROD allows performance of a dose assessment. The dose assessment would be conducted specific to the conditions presented by the known, or estimated, residual activity in that small area to determine whether the dose from the remaining radioactivity meets the benchmark dose established by the Applicable or Relevant and Appropriate Requirement (ARAR), which is Title 10 CFR Section 40, Appendix A, Criterion 6(6). The selected remedy also provides for the cleanup of soils beneath the southwest quadrant to meet industrial use standards, which is the foreseeable future use for the land occupied by Building 23. As part of the closure process for the remedial action, the ROD indicates that the level of residual contamination in soil beneath the southwest quadrant of Building 23 shall be evaluated to ensure the resultant dose levels meet the industrial use criteria established by the ARAR.

Remedial activities were conducted at the site between 2009 and 2013, in accordance with the selected remedy identified in the 2005 ROD. These activities included decontamination and removal (demolition) of contaminated areas of the building, including removal of building components with the highest reported radiological activity (4^{th} and 5^{th} floor concrete floors and 5^{th} floor roof). However, the complexity of the building interior creates access challenges that make decontamination to meet the ARAR difficult, and also makes it difficult to verify achievement of the RGs on all building surfaces. Results of radiological surveys, conducted after completion of the remedial actions, indicated that contamination in excess of the RGs still remained on surfaces in various portions of the building.

Based on the persistence of low levels of residual radiological activity exceeding RGs on building surfaces and the difficulty of decontamination due to the complexity of the building interior, USACE and W.R. Grace reevaluated whether the remedy selected in the April 2005 ROD could be successfully implemented as planned. The selected remedy was evaluated in comparison to the alternative of demolition of the southwest quadrant of Building 23. While a demolition alternative was evaluated in the 2005 ROD, that alternative included demolition followed by complete reconstruction of the southwest quadrant and reinstallation of processing equipment that was housed in the quadrant at the time. Currently, no production operations remain in the southwest quadrant, although certain support operations remain on the ground floor. As such, it was determined that the southwest quadrant can be demolished and not fully reconstructed, provided that any facility support infrastructure currently located within the southwest quadrant (e.g., utility lines, electrical substation) is appropriately relocated.

Based on the difficulty of achieving and verifying achievement of RGs via the selected remedy and W.R. Grace concurrence with demolition of the southwest quadrant of Building 23 (without reconstruction), a fundamental change in the remedy from decontamination and removal to demolition of the southwest quadrant was determined to be the most effective and implementable option for this site.

In support of the reevaluation of the remedy, additional radiological delineation of soil was conducted in 2017 to assess the level of residual contamination in soil beneath the southwest quadrant of Building 23. The additional soil data collected in 2017 indicated exceedances of the industrial use criteria at depths not previously identified and at locations in close proximity to

facility infrastructure. It was determined that excavation would not be feasible to remove all impacted soil following demolition of the southwest quadrant; as such, land use controls for soil are incorporated into the amended remedy.
This ROD amendment fundamentally changes the selected remedy with respect to scope as follows:

- The amended remedy, Demolition of the Southwest Quadrant of Building 23, replaces the remedy selected in the 2005 ROD (Decontamination with Removal to Industrial Use Levels).
- Land use controls for soil are included as part of the amended remedy to address radionuclide concentrations in soil exceeding RGs.
- The RGs for building surfaces are revised to reflect current site conditions and guidance.

The State of Maryland concurs with the changes to the selected remedy.

STATUTORY DETERMINATIONS

The amended remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the hazardous substances that are the subject of this response action, is cost effective, and uses permanent solutions to the maximum extent possible. The amended remedy does not satisfy the statutory preference for treatment as a principal element of the remedy because treatment of the residual radiological activity at this site is not feasible.

Following implementation of the amended remedy, hazardous substances, pollutants, or contaminants in site soils will remain above levels that allow for unlimited use and unrestricted exposure. Therefore, five-year reviews will be required for this remedial action to ensure that the remedy is, or will be, protective of human health and the environment. The Federal Government will conduct the five-year reviews.

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DECISION SUMMARY

1.0 INTRODUCTION

This Record of Decision (ROD) Amendment documents fundamental changes to the remedial action being conducted for the southwest quadrant of Building 23 at the W.R. Grace Formerly Utilized Sites Remedial Action Program (FUSRAP) site, located in Curtis Bay, Maryland. This ROD Amendment was prepared by the U.S. Army Corps of Engineers (USACE) in accordance with §117(c) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and 40 Code of Federal Regulations (CFR) §300.435(c)(2)(i) of the National Contingency Plan (NCP). The statute and regulation require that a lead agency document changes made during a Remedial Action (RA), after adoption of a final RA plan, when such action differs in any significant or fundamental respect from the final plan. The lead agency for this site is USACE, Baltimore District, and the support agency is the Maryland Department of the Environment (MDE). USACE and the property owner, W.R. Grace, are working together under the terms of a 2008 Settlement Agreement to implement the remedy for the southwest quadrant of Building 23.

The Final ROD for the southwest quadrant of Building 23 was signed 17 May 2005, and the selected remedy was Decontamination with Removal to Industrial Use Levels (USACE 2005). Remedial activities were conducted at the site between 2009 and 2013, in accordance with this selected remedy. However, contamination in excess of the remedial goals remained on building surfaces following these remedial actions. Based on the persistence of low levels of residual radiological activity on building surfaces and the difficulty of decontamination due to the complexity of the building interior, USACE and W.R. Grace conducted an updated evaluation of alternatives, and determined that demolition of the southwest quadrant was the most effective and implementable option for this FUSRAP site. In addition to this fundamental change, the approach to soil beneath Building 23 has been updated to include land use controls (LUCs), and the remedial goals (RGs) have been reevaluated.

This ROD Amendment is part of the Administrative Record for the site, as required by 40 CFR §300.825(a)(2), and is available at the following information repositories:

USACE Baltimore District offices
2 Hopkins Plaza
Baltimore, Maryland 21201
Available Monday through Friday 8:30 a.m. - 4:00 p.m., closed on federal holidays

Enoch Pratt Free Library, Brooklyn Branch
300 Patapsco Avenue
Baltimore, Maryland 21225
410-396-5500

Available:
Monday and Wednesday: 12:00 p.m. - 8:00 p.m.
Tuesday and Thursday: 10:00 a.m. - 5:30 p.m.
Saturday: 10:00 p.m. - 5:00 p.m.
Friday and Sunday: closed; Call for holiday closings

2.0 SUMMARY OF SITE HISTORY, CONTAMINANTS, AND THE SELECTED REMEDY

The W.R. Grace FUSRAP site is located at 5500 Chemical Road in Curtis Bay, Maryland (Figure 1, Appendix A). W.R. Grace conducted thorium-processing operations of monazite sands at the facility in the late 1950s under contract with the U.S. Atomic Energy Commission. Title to the monazite sand and all materials extracted from the monazite remained with the government during the performance of the work under the contract. The thorium-processing operations were conducted in the southwest quadrant of Building 23 (Figure 2, Appendix A), a five-story area with multiple doorways, openings, and rooms. Isotopic components of the raw monazite sand included uranium-238 (^{238}U) and thorium-232 (^{232}Th) and their decay progeny. The processing ended in the spring of 1957. As a consequence of the processing, building components and certain equipment in the southwest quadrant of Building 23 exhibit residual radiological activity. Soils beneath the southwest quadrant are also affected.

The W.R. Grace Curtis Bay site was identified by the U.S. Department of Energy (DOE) for inclusion in FUSRAP in 1984. A remedial investigation (RI) was conducted by USACE at the site from 2000 through 2002, and radiological contamination from monazite sand processing was identified (EA/USACE 2002). In 2002/2003 USACE subsequently completed a Feasibility Study for the Building 23 site to identify and screen remedial action alternatives (EA 2003). In April 2004, a Proposed Remedial Action Plan (PRAP) was completed, which identified the USACE preferred alternative for remedial action at the site (EA/USACE 2004).

On 21 April 2008, the U.S. Bankruptcy Court of Delaware approved a Site-Wide Settlement Agreement (Docket No. 18571) between W.R. GRACE Company et al. and the U.S. Government (represented by the U.S. Department of Justice [DOJ]). This agreement apportioned the liability costs for remediation of FUSRAP materials across the site. The apportionment of liability is as follows: W.R. Grace 40 percent; government 60 percent. As part of the Agreement, W.R. Grace will directly conduct the USACE-selected Remedial Action for Building 23 with oversight provided by USACE. W.R. Grace will apply periodically to the DOJ for reimbursement of the government's share from the DOJ Judgment Fund for all qualified costs as described in the Agreement. W.R. Grace and USACE are responsible to review and approve technical documents, by consensus. USACE is responsible for review and approval of costs submitted for reimbursement, manifesting the FUSRAP waste offsite to the appropriate waste facility, and certifying the completion of the remedy based on final status survey results, on behalf of the Government.

USACE finalized the ROD for the southwest quadrant of Building 23 on 17 May 2005 (USACE 2005). The selected remedy provided for either decontaminating or removing areas of radioactivity in the southwest quadrant of Building 23 to meet RGs for the radionuclides of concern, which include ^{238}U, ^{232}Th, and their decay progeny. As presented in Section 9 of the 2005 ROD, the following remedy was specified for Building 23:

> *Alternative 2, Decontamination With Removal to Industrial Use Levels is the selected remedy. The selected remedy consists of:*

- *Application of cleanup goals derived in accordance with MARSSIM from the selected chemical-specific ARAR, 10 CFR 40, Appendix A, Criterion 6(6), discussed in Section 4.*
- *Decontamination using chemical or mechanical decontamination technologies of the concrete floors and sections of the ceilings above the concrete floor areas of the fifth floor (AOCs 8 and 9). Where decontamination is assessed to be ineffective, impractical, or not cost effective, building components will be removed and replaced, as practical.*
- *Decontamination of the walls and structural steel with surface activity above RGs on the fourth and fifth floors, using chemical or mechanical decontamination technologies. If post-decontamination surveys indicate radiological activity above criteria, structural steel and walls will be decontaminated again and resurveyed. This iterative approach would continue until surface activity levels meet the RGs. Where decontamination is assessed to be ineffective, impractical, or not cost-effective, building components will be removed and replaced, as practical.*
- *Removal of floor tiles in the laboratory, break room, and motor control room (AOCs 4 and 7, respectively). A radiological survey would be conducted on the concrete surface below. If surface activity levels are above RGs, the floor surfaces would be decontaminated using chemical or mechanical decontamination technologies. Where decontamination is assessed to be ineffective, impractical, or not cost-effective, building components will be removed and replaced, as practical.*
- *Removal of the wooden floored platform (AOC 10) and abandoned-in-place piping and equipment in AOCs 8 and 9.*
- *Completion of a FSS.*

The selected remedy provides for either decontaminating or removing all areas of radioactivity to meet the RGs. Where decontamination is impractical or undesirable, removal will be undertaken to ensure RGs are met. However, in any small area where residual radioactivity may potentially exceed RGs, but the area is inaccessible for verification that RGs are met and/or removal is impractical or undesirable, a dose assessment specific to the conditions presented by the known, or estimated, residual activity in that small area will be conducted to determine whether the dose from the remaining radioactivity meets the benchmark dose established by the ARAR. Since USACE expects to meet the designated ARAR for building components, USACE has determined that no LUCs are necessary for this alternative.

The selected remedy provides for soils to meet industrial use standards, as this is the foreseeable future use for the land occupied by Building 23. As part of the closure process for the remedial action, the level of residual contamination in soil shall be evaluated to ensure the resultant dose levels meet the industrial use criteria established by the ARAR. Since USACE expects to meet the designated ARAR for soil, USACE has determined that no LUCs are necessary for soil as part of this alternative.

> *Material removed from the building, as well as waste produced during decontamination or other construction activities, shall be surveyed for radiological activity and sampled for chemical constituents, as necessary, and disposed at an appropriate offsite facility. Material surveyed for radiological activity shall be released based on criteria outlined in the NRC Policy and Guidance Directive FC 83-23. This guidance was identified as TBC criteria in the FS for implementation during the remedial action for release of systems and components not addressed by the selected ARAR. Material exceeding the criteria for unrestricted use as defined in NRC Policy Guidance Directive FC 83-23 shall be disposed at a facility licensed or permitted to accept the material.*

As indicated above, the chemical-specific Applicable or Relevant and Appropriate Requirement (ARAR) selected by USACE to develop RGs is 10 CFR §40, Appendix A, Criterion 6(6), which specifies:

> *The design requirements in this criterion for longevity and control of radon releases apply to any portion of a licensed and/or disposal site unless such portion contains a concentration of radium in land, averaged over areas of 100 square meters, which, as a result of byproduct material, does not exceed the background level by more than: (i) 5 picocuries per gram (pCi/g) of radium-226, or, in the case of thorium byproduct material, radium-228, averaged over the first 15 centimeters (cm) below the surface, and (ii) 15 pCi/g of radium-226, or, in the case of thorium byproduct material, radium-228, averaged over 15-cm thick layers more than 15 cm below the surface.*
>
> *Byproduct material containing concentrations of radionuclides other than radium in soil, and surface activity on remaining structures, must not result in a total effective dose equivalent (TEDE) exceeding the dose from cleanup of radium contaminated soil to the above standard (benchmark dose), and must be at levels which are as low as is reasonably achievable. If more than one residual radionuclide is present in the same 100-square-meter area, the sum of the ratios for each radionuclide of concentration present to the concentration limit will not exceed "1" (unity). A calculation of the potential peak annual TEDE within 1000 years to the average member of the critical group that would result from applying the radium standard (not including radon) on the site must be submitted for approval. The use of decommissioning plans with benchmark doses which exceed 100 mrem/yr, before application of ALARA, requires the approval of the Commission after consideration of the recommendation of the NRC staff. This requirement for dose criteria does not apply to sites that have decommissioning plans for soil and structures approved before June 11, 1999.*

RGs for soil and building surfaces were developed in accordance with the chemical-specific ARAR using computer modeling codes (RESRAD and RESRAD-BUILD) with site-specific modeling parameters, where available. The Industrial Worker scenario was selected as the most appropriate exposure scenario for Building 23, as it closely resembles the current and expected future use of the building. The resulting benchmark dose from exposure to Radium-228 (^{228}Ra) for an industrial worker scenario was 7.37 millirem per year (mrem/yr).

The RGs developed in the 2005 ROD for soil and building components are derived concentration guideline levels (DCGLs) that represent the maximum average activity that could be uniformly distributed over an area of 100 square meters (m^2) without resulting in an exceedance of the benchmark dose (7.37 mrem/yr). The DCGLs are applicable for radiological concentrations above background levels. DCGLs for surface and subsurface soil, which were developed using RESRAD modeling, are as follows: 5 picocuries per gram (pCi/g) radium-226 (^{226}Ra) and 2.62 pCi/g ^{232}Th in surface soil; and 15 pCi/g ^{226}Ra and 4.73 pCi/g ^{232}Th in subsurface soil. Since there are multiple radionuclides at the site, the DCGLs for soil are included in a sum of ratios calculation to demonstrate compliance with the ARAR. For building components, the following DCGLs for building surfaces were developed using RESRAD-BUILD modeling: 1,234 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) for total surface activity, which includes 740 dpm/100 cm^2 for the alpha component and 494 dpm/100 cm^2 for the beta component.

In 2008, USACE and W.R. Grace & Co. entered into a Settlement Agreement to address the FUSRAP Matters, as defined in the agreement, which include remedial actions to address contamination in the southwest quadrant of Building 23. The scope of the Settlement Agreement includes the following: applicability to the Curtis Bay FUSRAP Site or FUSRAP Material; definition of W.R. Grace and USACE roles and responsibilities; procedures for cooperation and dispute resolution; settlement of past costs; and allocation of future costs.

The first phase of a multi-phase remedial action (the Phase 1 RA) was conducted in the southwest quadrant of Building 23 in 2009, with the main objectives being to reduce uncertainty in the final RA scope and improve the building condition to support subsequent remedial activities. Specific activities conducted during the Phase 1 RA included the following:

- Pilot Decontamination Tests – Testing was conducted to determine the ability of various decontamination methods to remove both fixed and removable radiological contamination from building surfaces while preserving the structural integrity of those elements. The methods used for decontamination varied from nonabrasive techniques, primarily intended for loose or removable contamination, to more aggressive methods, which were more likely to be effective for fixed contamination.
- Hazardous Materials Surveys/Testing – Surveys/testing were performed to identify materials (asbestos-containing material, materials with leachable lead, and polychlorinated biphenyls) that would require removal or control during future radiation decontamination/removal activities and to support waste disposal profiling requirements.
- Radiological Surveys – Surveys were conducted to gather radiological data on structural steel, corrugated panel, and concrete surfaces (up to 2 meters beyond the available walking surfaces) that were inaccessible during the RI conducted 2000 through 2002.
- First Floor Concrete Slab Replacement – To ensure a reliable working surface for subsequent RA activities, the existing deteriorated concrete slab flooring of the first floor was removed and replaced. During removal, soil beneath the slab was evaluated for the presence of contaminants and removed to a depth of approximately 14 inches below the original slab elevation to facilitate placement of the new concrete slab floor.

A detailed discussion of the methodology and results of the Phase 1 RA is provided in the *Final Remedial Action Data Report for the Building 23 W.R. Grace Curtis Bay Facility Formerly Utilized Sites Remedial Action Program Project, Baltimore, Maryland*, dated December 2009, prepared by URS Corporation and Energy Services, Inc (URS 2009).

From February 2011 to September 2013, the second phase of the remedial action (the Phase 2 RA) was conducted to decontaminate and demolish contaminated building components in the southwest quadrant of Building 23 in accordance with the 2005 ROD. Remedial activities included general cleaning of radiologically-impacted areas; installation/modification of fall protection/arrest systems and material transfer systems; removal of miscellaneous materials/equipment; active utility relocations; decontamination, demolition, and/or reconstruction, as required, on the first, second, third, fourth, and fifth floors and the roof; and waste management, transportation, and disposal. Interim Final Status Survey (FSS) activities were also conducted by an independent party under USACE contract to facilitate decontamination, removal, and reconstruction activities. During the Phase 2 RA activities, in-progress radiological surveys identified areas beyond the remedial action scope that contained radioactivity above the ROD RGs. Due to funding limitations, these areas were not addressed during the Phase 2 RA; as such, contamination in excess of the RGs from the 2005 ROD still remains in the southwest quadrant of Building 23. A detailed discussion of the methodology and results of the Phase 2 RA is provided in the *Remedial Action Closure Report, W.R. Grace Curtis Bay Building 23, Formerly Utilized Sites Remedial Action Program Site Remediation, Baltimore, Maryland*, dated November 2013, prepared by Safety and Ecology Corporation (SEC 2013). A detailed discussion of the methodology and results of the Interim FSS activities is provided in *Interim Final Status Survey Report for Building 23, Report No. 2003011/G-410505, Rev. 0*, dated 11 July 2014, prepared by Integrated Environmental Management, Inc (IEM 2014).

At the completion of the Phase 2 RA, and in order to plan for final remediation, USACE compiled all existing data, evaluated and ranked data by quality, and generated visual and database information to illustrate the locations and levels of remaining residual contamination and the dimensions and materials of construction of the building components. A detailed discussion of the methodology and results of the data compilation is provided in *Assessment Report Building 23, W.R. Grace Curtis Bay Facility, Baltimore, Maryland*, dated 16 September 2015, prepared by Amec Foster Wheeler Environment & Infrastructure, Inc (AMEC 2015).

3.0 BASIS FOR THE RECORD OF DECISION AMENDMENT

Based on the persistence of residual radiological activity exceeding remedial goals on building surfaces following two phases of remediation and the difficulty of decontamination due to the complexity of the building interior, USACE and W.R. Grace reevaluated whether the remedy selected in the April 2005 ROD could be successfully completed as planned. The selected remedy was evaluated in comparison to an alternative of demolition of the southwest quadrant of Building 23. While a demolition alternative was evaluated in the 2005 ROD, that alternative included demolition followed by complete reconstruction of the southwest quadrant and reinstallation of processing equipment that was housed in the quadrant at the time, with likely disruptions to ongoing facility production in that quadrant. Currently, no production operations remain in the southwest quadrant, although select support operations remain in the southwest corner of the ground floor (i.e., an electrical substation, an electrical shop, storage area, etc.). As such, it was

determined that demolition of the southwest quadrant can be completed without reconstruction, provided that the support activities currently on the ground floor are relocated.

To support the reevaluation of a demolition alternative, in comparison to the selected remedy in the 2005 ROD, a conceptual design for demolition of the southwest quadrant of Building 23 was conducted. Pre-design investigations, including engineering surveys, geotechnical and hydrologic investigations, and additional radiological delineation of soil, were conducted in 2017 (EA 2019) and results were included in the conceptual design. Based on the design activities, the partial demolition of Building 23 (demolition of the southwest quadrant) was determined to be technically feasible. In addition, based on the results of the additional radiological delineation, which indicated exceedances of the industrial use criteria at depths not previously identified and at locations in close proximity to facility infrastructure, it was determined that excavation to remove all impacted soil (following demolition of the southwest quadrant) would not be feasible; as such, LUCs for soil will be required.

Based on these findings, a fundamental change in the ROD remedy, from decontamination/removal to complete demolition of the southwest quadrant of Building 23 with land use controls for underlying soil, was determined to be the most cost-effective and implementable option to achieve remedial goals, while providing long-term protection for human health and the environment. This determination was based on the feasibility and cost-effectiveness of demolition of the southwest quadrant of Building 23, W.R. Grace facility concurrence with demolition without complete reconstruction if determined to be more implementable and effective than decontamination, and the infeasibility of removing contaminated underlying soils due to the depth of contamination and location near facility infrastructure.

In addition to the fundamental change of selecting a new remedy that incorporates demolition and land use controls, RGs for building surfaces have been reevaluated to reflect the most up-to-date site conditions and guidance.

4.0 DESCRIPTION OF FUNDAMENTAL DIFFERENCES

USACE has identified the following fundamental differences for the ROD for Building 23, signed 17 May 2005:

- The amended remedy, Demolition of the Southwest Quadrant of Building 23, replaces the remedy selected in the 2005 ROD (Decontamination with Removal to Industrial Use Levels).
- LUCs for soil are included as part of the amended remedy, to address radionuclide concentrations in remaining soils that are exceeding RGs.
- RGs for building surfaces are revised to reflect current site conditions and guidance.

These changes do not affect the general remedial action objective for the site, as indicated in Section 4.3 of the 2005 ROD:

> "To reduce the risk to current and future human receptors from building components and soil containing residual radioactivity from monazite sand processing to an acceptable level

as defined in Title 10 of the Code of Federal Regulations (CFR), Part 40, Appendix A, Criterion 6(6)."

In addition, the following information provided in the 2005 ROD is still valid for the site:

Section No.	Section Title
1.3	Zoning and Future Land Use
2	Site History and Investigations
4.1.1	ARAR Selected for the Building 23 Site Remediation
4.2	To Be Considered Guidance
4.4.1	Remedial Goals for Soil

4.1 AMENDED REMEDY – DEMOLITION OF THE SOUTHWEST QUADRANT OF BUILDING 23

The amended remedy for the Building 23 site is Demolition of the Southwest Quadrant of Building 23. The expected outcomes resulting from this ROD Amendment for Building 23 include the following:

- Extent of Remediation – The extent of remediation includes removal of structural components and utility services within the footprint of the southwest quadrant, with the exception of structural steel along the northern and eastern perimeter of the quadrant. FSS will be conducted at the perimeter of the remediation area and in other select work areas to verify that remediation goals were achieved. Radiologically-impacted soil beneath the southwest quadrant will remain in place (except for a small quantity of soil that is removed to facilitate restoration of the site surface with a concrete slab), and land use controls will be implemented. A detailed discussion of key elements of the amended remedy and the sequence for remedy implementation is included in Sections 4.1.1 and 4.1.2.
- Duration for Remedy Implementation – USACE projects that remedy implementation, as described in this ROD Amendment, will be completed by December 2023, with the understanding that the completion date is dependent upon funding and remedy implementation without significant unexpected challenges. USACE is responsible for surveillance, operation, and maintenance at the FUSRAP site for a 2-year period after site closeout, as outlined in Article III.C.2.d of *Memorandum of Understanding Between the U.S. Department of Energy and the U.S. Army Corps of Engineers Regarding Program Administration and Execution of the Formerly Utilized Sites Remedial Action Program (FUSRAP)*, effective 17 March 1999 (USACE/DOE 1999). USACE will conduct a 2-year review (prior to transfer to DOE) to document compliance with the remedial action objective at the time of transfer.
- Increased Cost for Remedy Implementation – The 17 May 2005 ROD estimated the cost for remedy implementation to be approximately $3,970,000 (note: costs did not include oversight or plant downtime costs). RA costs to date (including the Phase 1 and Phase 2 RAs) are approximately $8,800,000. In accordance with the Settlement Agreement, USACE is responsible for FSS, post-remediation site monitoring for a 2-year period (surveillance, operation, and maintenance), followed by transfer of site surveillance

activities to DOE (5-year reviews). The estimated cost to complete RA activities in accordance with the ROD Amendment is approximately $32,400,000.

4.1.1 Amended Remedy – Key Elements

The amended remedy for the southwest quadrant of Building 23 includes the following key elements:

- Demolition of structural components in the footprint of the southwest quadrant of Building 23 (i.e., partial building demolition) while ensuring protection of the remaining building and minimizing disruptions to current plant operations, followed by reconstruction of new exterior walls along the demolished edges (Figure 3, Appendix A).
- Relocation of an active electrical substation on the ground floor of the southwest quadrant of Building 23 to another quadrant of the building (i.e., construction of a new substation to accept electrical load prior to demolition of the existing substation) (Figure 3, Appendix A).
- Relocation of existing utility lines (air, steam, water, etc.), active electrical conductors, and raw material transfer lines that traverse the southwest quadrant or that would be impacted by demolition activities.
- Coordination of relocated/temporary utility services and raw material transfer lines to ensure uninterrupted service for the facility manufacturing activities.
- Removal of *de minimis* soil and building foundations beneath the demolished quadrant, as necessary to allow regrading and construction of a new concrete slab-on-grade. As-left soil sampling will be conducted prior to installing the new concrete slab to document the as-left radiological conditions of site soil.
- Restoration of the ground surface of the southwest quadrant after demolition activities are complete (e.g., grading, concrete, etc.), construction of a new access corridor, and construction of a new electrical shop/storage building, to replace rooms that existed in the southwest quadrant prior to demolition (Figure 4, Appendix A).
- Transportation and disposal of project wastes to offsite disposal facilities licensed to accept the waste streams.
- Completion of FSS activities to verify that remediation goals were achieved.

Detailed specifications for remedy elements will be included in engineering design documents prepared by USACE.

4.1.2 Amended Remedy – Sequence for Implementation

Due to the complexity of the site and to facilitate ongoing manufacturing operations at the facility, the remedy is planned to be implemented in two distinct phases, as follows:

- Phase 1 – Utility Relocation/Construction and Structural Repair. The first phase of remedy implementation includes relocation/construction of electrical, mechanical, and process utilities in the northwest and southeast quadrants of the building and repair of structural

elements as needed to support demolition of the southwest quadrant. The majority of this work is in areas of Building 23 that are not impacted with radiological contaminants.

- Phase 2 – Demolition and Restoration of the Southwest Quadrant. The second phase of remedy implementation includes demolition of the southwest quadrant, restoration activities, and FSS activities. The majority of this work is in the southwest quadrant of Building 23, which is impacted with radiological contaminants.

4.2 REEVALUATION OF SOIL REMEDIATION AND INCORPORATION OF LUCS INTO THE REMEDY

In support of the reevaluation of the remedy, additional radiological delineation of soil was conducted by USACE in 2017. The remedy selected in the 2005 ROD stated that "As part of the closure process for the remedial action, the level of residual contamination in soil beneath the southwest quadrant of Building 23 shall be evaluated to ensure the resultant dose levels meet the industrial use criteria established by the ARAR." The additional soil data collected in 2017 indicated exceedances of industrial use criteria. Due to the depth and location of those radiological impacts in soil with respect to facility infrastructure, it was not considered feasible to remove all impacted soil following demolition of the southwest quadrant. Therefore, it was determined that *de minimis* soil excavation (to support site restoration activities) would be conducted, and LUCs for soil would be incorporated into the amended remedy. Additional detail regarding the soil excavation analysis and LUC determination is provided in Appendix B.

LUCs to limit contact with contaminated soil and groundwater are currently in place for the entirety of the Curtis Bay facility, under a RCRA Administrative Order on Consent (Docket No. RCRA-03-2015-0074). The LUCs in place include the following:

- "All intrusive earth moving activities at the Facility, including excavation, drilling and construction activities, shall be conducted in compliance with the Facility-specific health and safety protocols and an EPA-approved Soil Management Plan (that includes appropriate Personal Protective Equipment requirements sufficient to meet EPA's acceptable risk and complies with all applicable OSHA requirements)"; and
- "Groundwater at the Facility shall not be used for any purpose, including, but not limited to, use as a potable water source, other than to conduct the maintenance and monitoring activities required by EPA or other governmental parties, provided EPA gives prior written approval for such use, or to conduct such other use that the EPA may approve in writing upon request of Respondent."

Additional LUCs will be enacted as part of the Building 23 remedy to provide assurance that any future activities that disturb soil within the footprint of the southwest quadrant of Building 23 will be conducted with oversight by radiologically-trained personnel and with protections for workers appropriate to maintain acceptable dose levels.

4.3 REEVALUATION OF THE REMEDIAL GOALS FOR BUILDING 23

Remedial goals (DCGLs) for building surfaces were developed based on RESRAD-BUILD modeling using site-specific input parameters (e.g., source geometry, removable fraction of

contamination), where available. Since finalization of the 2005 ROD, significant structural changes within the building have occurred as a consequence of remedial actions, as well as facility plant reconfigurations and operational changes. The current remedial approach (demolition of the southwest quadrant) further alters the as-left conditions of the building. In addition, radiological survey and sampling data were collected during remedial actions and investigations, thereby enhancing USACE understanding of the nature and extent of remaining radiological impact on building surfaces within the southwest quadrant of Building 23. As such, and consistent with the criteria identified in NCP §300.825(c), USACE has re-examined and refined the conceptual site model (CSM) for the site and revised the DCGLs using updated site-specific input parameters, based on information obtained since issuance of the 2005 ROD.

In the ROD, USACE determined that 10 CFR §40, Appendix A, Criterion 6(6) was the radiological-specific ARAR for the site. USACE considers the selected ARAR and RESRAD modeling for determination of benchmark dose (7.37 mrem/yr), as documented in the ROD, to remain valid for the site. However, values for key site-specific parameters (Room Height, Room Area, and Removable Fraction) that are utilized during RESRAD-BUILD modeling are no longer considered valid and representative of the building conditions, as discussed below.

4.3.1 Site-Specific Parameters for Room Size (RESRAD-BUILD Model)

Modeling conducted during preparation of the 2005 ROD included use of a room size of 5 meters (m) (length) x 5 m (width) x 3 m (height), with residual ^{232}Th in equilibrium with its decay daughters homogeneously distributed over the floor, wall, and ceiling surfaces. This room size was based upon room dimensions that were anticipated to be left-in-place at the completion of RA activities specified in the 2005 ROD. However, upon completion of the amended remedy (Demolition of the Southwest Quadrant of Building 23), rooms with these or similar dimensions (i.e., 5m x 5m x 3m) will no longer be present in the southwest quadrant and, therefore, this room size is no longer representative of as-left building conditions.

Upon completion of the amended remedy, which includes demolition of the southwest quadrant of Building 23, no rooms will remain. The only remaining building components associated with the southwest quadrant that will remain in place after demolition are structural columns and beams located along the northern and eastern edges of the quadrant. Based on USACE review of the anticipated future configuration for Building 23 and coordination with W.R. Grace, it was determined reasonable that a room, with the following dimensions, might be constructed in the vicinity of the remaining structural columns/beams:

6.40 m (length) x 5.18 m (width) x 4.27 m (height)

This room configuration, which incorporates existing structural steel columns located at three corners of the room with residual ^{232}Th in equilibrium with its decay daughters distributed uniformly along those columns, was selected for use in updated RESRAD-BUILD modeling. Additional information regarding the selection of this room size is provided in Appendix C of this ROD Amendment.

4.3.2 Site-Specific Parameter Removable Fraction (RESRAD-BUILD Model)

In the 2005 ROD, the Removable Fraction parameter for RESRAD-BUILD modeling was set at 0.2, which was a conservative assumption based on RI data. However, additional data has been collected since finalization of the ROD, and the expanded data set does not support a Removable Fraction parameter of 0.2 for RESRAD-BUILD modeling. Based on USACE review of the expanded data set, a less conservative Removable Fraction parameter value of 0.1 is representative of site conditions and has been selected for use in RESRAD-BUILD modeling. A statistical approach was used to evaluate the expanded data set and generate the Removable Fraction parameter; supporting documentation and data tables are provided in Appendix C. The selected value is consistent with default RESRAD and NRC parameters for removable fraction and is a valid yet conservative value for use at the site.

4.4 REVISED DCGLS FOR BUILDING COMPONENTS

Reevaluation of DCGLs for building components is warranted based on USACE's reassessment of specific input parameters for the CSM for Building 23, as described in Section 4.3. Using the revised site-specific parameters for room size (Section 4.3.1) and revised parameter for Removable Fraction (Section 4.3.2), DCGLs were developed using RESRAD-BUILD modeling software. The detailed RESRAD analysis (including methodology, parameters, data statistics, and RESRAD-BUILD outputs) is provided in Appendix C.

The revised DCGLs for building components are presented in Table 1 below. The specific RG for building components in Building 23 is to not exceed the total surface activity of 16,300 dpm/100 cm^2 (9,780 dpm/100 cm^2 for alpha activity and 6,520 dpm/100 cm^2 for beta activity) above background levels for each type of material in accordance with the guidance provided in Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC et al. 2000), or other appropriate guidance, as needed. Material-specific background values for various media (i.e., brick, concrete, etc.) that were established during previous investigation/remediation activities at the site, as well as the protocol for establishing additional background values (if needed), are provided in Appendix D.

TABLE 1. REVISED DERIVED CONCENTRATION GUIDELINE LEVELS BASED ON CURRENT SITE CONDITIONS AND GUIDANCE[(a)]

Total Surface Activity Equivalent to the Benchmark Dose[(b)] (dpm/100 cm^2)	Decay Components[(c)]	$DCGL_W$ [(d),(e)] (dpm/100 cm^2)
16,300	Alpha (α)	9,780
	Beta (β)	6,520

$DCGL_W$ = Derived Concentration Guideline Level representing the average activity that can be uniformly distributed over a 100 square meter area.

dpm/100 cm^2 = disintegrations per minute per 100 square centimeters

Notes:

(a) Derivation of the values provided in this table is included in Appendix C of this document.

(b) Benchmark dose from exposure to ^{228}Ra for an industrial scenario was calculated to be 7.37 millirem per year (mrem/yr), as identified in the Record of Decision, signed 17 May 2005.
(c) ^{232}Th in equilibrium with its progeny includes a total of 6 alpha and 4 beta particles emitted per disintegration.
(d) Total activity (fixed and removable)
(e) Remedial Goals for Building 23 include cleanup to the appropriate $DCGL_W$ with a maximum removal fraction of 0.1 (10%).

5.0 EVALUATION OF ALTERNATIVES

5.1 DESCRIPTION OF ALTERNATIVES

The four remedial alternatives considered for Building 23 include:

1. No Action
2. Decontamination with Removal to Industrial Use Levels and Land Use Controls
3. Demolition of the Southwest Quadrant of Building 23
4. Decontamination with Removal to Industrial Use Levels (the selected remedy in the 2005 ROD)

5.1.1 Alternative 1 – No Action

The NCP and CERCLA require this alternative to be included in order to establish a baseline for comparison with the other alternatives. Under this alternative, no action would be performed to reduce the toxicity, mobility, or volume of residual radioactivity on building components. This alternative does not implement any activity, including LUCs.

5.1.2 Alternative 2 – Decontamination with Removal to Industrial Use Levels and Land Use Controls

Alternative 2 is very similar to Alternative 4 (the selected remedy in the 2005 ROD) since it includes the same decontamination approach for all remaining building components with surface activity above the RGs identified in the 2005 ROD (a detailed description of the remedy is provided in Section 2.0). In areas where decontamination is unsuccessful, or deemed inappropriate because of the identified level of radiological activity and/or structural integrity issues associated with remaining building components, the materials would be removed. This alternative was the Selected Remedy in the 2005 ROD, and a majority of the building components identified for remediation prior to 2005 were decontaminated or removed in 2009-2013. Moving forward, this alternative would target the remaining building components that have been identified as having residual radioactivity exceeding the RGs identified in the 2005 ROD. Removal activities would be designed and coordinated to minimize disruptions to the building owner's production activities.

The majority of the remaining walls, ceilings, and structural steel framing components with surface activity above RGs would be decontaminated using chemical or mechanical decontamination technologies. If post-decontamination surveys indicate activity above criteria, structural steel and walls would be decontaminated again and resurveyed. This iterative approach would continue until surface activity levels meet cleanup goals. Where decontamination is determined to be ineffective, building components would be removed and replaced (as required) with like materials.

Active piping and equipment removed because of residual radioactivity, or because of the physical proximity to work areas, would be replaced with like materials or substitute materials acceptable to the building owner. Replacement of abandoned-in- place piping is not anticipated.

Other building components likely to be removed and replaced rather than decontaminated include an existing electrical substation, the asbestos-coated east wall of the southwest quadrant, the central staircase, and selected floor/roof/decking materials for which decontamination has been determined not to be practicable.

Material removed from the building, as well as waste produced during decontamination or other construction activities, would be surveyed for radiological activity and sampled for chemical constituents as necessary, and disposed of at an appropriate offsite facility licensed or permitted to accept the waste stream. An FSS of Building 23 would be conducted as part of this alternative to document compliance with remedial goals. Although not required in the selected remedy from the 2005 ROD, LUCs would also be included as part of Alternative 2, since decontamination would be to industrial use criteria, and since soil exceeding RGs would remain under the concrete floor slab. LUCs would be used to ensure that future use of the building limits occupancy to levels consistent with industrial use scenarios for the remainder of the building's life and to ensure proper actions are taken any time the soil beneath the southwest quadrant is exposed. Five-year reviews by the government would be required.

A summary of estimated costs to implement Alternative 2 is provided in Appendix E.

5.1.3 Alternative 3 – Demolition of the Southwest Quadrant of Building 23

This option includes the complete demolition of the southwest quadrant of Building 23. Prior to demolition of building components, an active electrical substation located within the southwest quadrant would be replaced, and all active utilities that traverse the southwest quadrant or that would be impacted by demolition activities would be rerouted or replaced outside of the southwest quadrant footprint. FSS activities would be conducted following demolition and restoration of the footprint of the southwest quadrant, to confirm that the revised DCGLs identified in this ROD Amendment are met for remaining surfaces.

Following demolition activities, the southwest quadrant of Building 23 would not be rebuilt. Rather, the footprint of the southwest quadrant of the building would be restored with a new concrete slab, and soil sampling within the footprint of the southwest quadrant would be conducted prior to slab replacement to document as-left radiological conditions of soil. In addition, new exterior walls would be constructed along the eastern and northern edges of the demolition area to enclose the remainder of Building 23, and a replacement maintenance/electrical shop and a new access corridor would be constructed on the new concrete slab. Thus, the final condition of the footprint of the southwest quadrant would be a concrete slab with one-story structures.

Building components removed during demolition would be disposed of at an offsite facility licensed or permitted to accept the waste stream. Other demolition wastes (non-building components) would be surveyed and sampled for radiological and chemical constituents, as necessary. If these wastes exceeded criteria for unrestricted release, they would be disposed of at a facility licensed or permitted to accept the material.

LUCs would also be included as part of Alternative 3, because soil exceeding the cleanup goals identified in the 2005 ROD would remain under the new concrete slab. LUCs would be used to ensure that proper actions are taken any time the soil beneath the southwest quadrant is exposed. Five-year reviews by the government would be required.

A summary of estimated costs to implement Alternative 3 is provided in Appendix E.

5.1.4 Alternative 4 – Decontamination with Removal to Industrial Use Levels

Alternative 4 (the selected remedy in the 2005 ROD) includes decontamination of all remaining building components with surface activity above the RGs identified in the 2005 ROD (a detailed description of the remedy is provided in Section 2.0). In areas where decontamination is unsuccessful, or deemed inappropriate because of the identified level of radiological activity and/or structural integrity issues associated with remaining building components, the materials would be removed. This alternative was the Selected Remedy in the 2005 ROD, and a majority of the building components identified for remediation prior to 2005 were decontaminated or removed in 2009-2013. Moving forward, this alternative would target the remaining building components that have been identified as having residual radioactivity exceeding the RGs identified in the 2005 ROD. Removal activities would be designed and coordinated to minimize disruptions to the building owner's production activities.

The majority of the remaining walls, ceilings, and structural steel framing components with surface activity above RGs would be decontaminated using chemical or mechanical decontamination technologies. If post-decontamination surveys indicate activity above criteria, structural steel and walls would be decontaminated again and resurveyed. This iterative approach would continue until surface activity levels meet cleanup goals. Where decontamination is determined to be ineffective, building components would be removed and replaced (as required) with like materials.

Active piping and equipment removed because of residual radioactivity, or because of the physical proximity to work areas, would be replaced with like materials or substitute materials acceptable to the building owner. Replacement of abandoned-in-place piping is not anticipated.

Other building components likely to be removed and replaced rather than decontaminated include an existing electrical substation, the asbestos-coated east wall of the southwest quadrant, the central staircase, and selected floor/roof/decking materials for which decontamination has been determined not to be practicable.

Material removed from the building, as well as waste produced during decontamination or other construction activities, would be surveyed for radiological activity and sampled for chemical constituents as necessary, and disposed of at an appropriate offsite facility licensed or permitted to accept the waste stream.

An FSS of Building 23 would be conducted as part of this alternative to document compliance with remedial goals.

A summary of estimated costs to implement Alternative 4 is provided in Appendix E.

5.2 EVALUATION OF ALTERNATIVES

The NCP outlines the approach for comparing remedial alternatives. Evaluation of the alternatives uses "threshold," "primary balancing," and "modifying" criteria.

Threshold criteria include:

- Overall Protection of Human Health and the Environment; and
- Compliance with ARARs.

Any alternative that does not meet the threshold criteria may not be given further consideration.

All alternatives meeting the threshold criteria are evaluated against primary balancing criteria, which are technical factors used to determine which alternative provides the best combination of attributes. Primary balancing criteria include:

- Long-Term Effectiveness and Permanence;
- Reduction of Toxicity, Mobility or Volume of Contaminants Through Treatment;
- Short-Term Effectiveness;
- Implementability; and
- Cost.

Modifying criteria, which are applied at the end of the evaluation process, include the following:

- State/Support Agency Acceptance; and
- Community Acceptance

5.2.1 Threshold Criteria

5.2.1.1 Overall Protection of Human Health and the Environment

Alternative 2, "Decontamination with Removal to Industrial Use Levels and Land Use Controls" and Alternative 3, "Demolition of the Southwest Quadrant of Building 23" would protect human health and the environment by eliminating, reducing, or controlling risk through decontamination, removal, and/or LUCs. Because "No Action" (Alternative 1) and "Decontamination with Removal to Industrial Use Levels" (Alternative 4) are not protective of human health and the environment, both alternatives are eliminated from further consideration. Although Alternative 4 is similar to Alternative 2, Alternative 4 does not include LUCs for soil and therefore is no longer considered protective, given radiological impacts in soil exceeding industrial use criteria (see Section 4.2).

5.2.1.2 Compliance with ARARs

Alternatives 2 and 3 would meet the ARAR for building components with surface activity above RGs. Both alternatives would require LUCs to ensure proper actions are taken any time the soil beneath the southwest quadrant is exposed, in order to ensure compliance with the ARAR. A FSS of remaining building surfaces would be required under both Alternatives 2 and 3 to ensure compliance with ARARs.

5.2.2 Primary Balancing Criteria

5.2.2.1 Long-Term Effectiveness and Permanence

Alternative 2, decontamination of contaminated building materials to below RGs, would provide permanence and some long-term protection for human health since residual levels of radionuclides above RGs would be removed from building surfaces (residual levels of radiological activity below RGs would be allowed to remain). Alternative 3, demolition of the southwest quadrant, would be the most effective in the long-term, as it includes removal of the majority of impacted building materials at the site. As such, virtually all residual radiological activity (above and below RGs) would be removed from the site.

5.2.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Neither Alternative 2 nor Alternative 3 involves treatment.

5.2.2.3 Short-Term Effectiveness

There are several short-term impacts associated with Alternatives 2 and 3. Under either alternative, coordination with facility personnel would be necessary to minimize potential effects on workers and plant activity. Both alternatives have the potential to lead to dust generation, potential external exposure to radioactivity, and physical hazards associated with decontamination or demolition work. The short-term impacts associated with Alternative 3 would be more significant than Alternative 2, because the quantity of materials requiring removal will be greater for the demolition activities, and the estimated construction timeframe for demolition (22 months) is longer than the estimated construction timeframe for decontamination (17 months). The potential impacts would be addressed by instituting appropriate dust controls, monitoring for radioactivity, use of personal protective equipment, site-specific health and safety plans, and use of trained personnel and engineering methods appropriate to minimize risk.

Members of the community would experience short-term impacts during off-site transportation of the materials requiring off-site disposal. Those impacts, which would include nuisance, noise, and increased traffic, would also be more significant for Alternative 3 than Alternative 2, due to a larger quantity of materials requiring off-site disposal. Actions would be taken to minimize impacts to the environment and community associated with each alternative.

5.2.2.4 Implementability

Alternatives 2 and 3 would employ standard demolition techniques for removal and existing radiological techniques for decontamination. For Alternative 2, an iterative process of survey and decontamination may be required to ensure that surfaces are appropriately cleaned.

During preparation of the 2005 ROD, the technical feasibility of Alternative 2 was expected to be high, based on equipment availability and use of standard technologies. However, subsequent remedial activities have indicated that Alternative 2 is not feasible, due to challenges of accessibility, time requirements of iterative surveys and decontamination, and more widespread contamination.

The feasibility of Alternative 3 is considered high, despite the requirement for extensive logistical planning in coordination with the Curtis Bay facility, to avoid disruption of facility operations within and in areas surrounding Building 23 during utility, demolition, and restoration work. The property owner has expressed support for demolition of the southwest quadrant if determined to be more implementable and effective than decontamination.

5.2.2.5 Cost

The estimated cost to complete Alternative 2 ($35,425,126) is higher than the cost to implement Alternative 3 ($32,418,997) (Appendix E). The cost for Alternative 2 is associated with greater uncertainty due to the greater potential that additional contamination may be identified that requires decontamination, as well as higher likelihood that an iterative decontamination process could be required.

5.2.3 Modifying Criteria

5.2.3.1 State Acceptance

The MDE is the State support and regulatory agency. MDE reviewed the PRAP Amendment (dated March 4, 2019) and had no comments on the document, including USACE's identification of the preferred alternative (Alternative 3), and no objections to its submittal for general public review (see email from MDE dated May 22, 2019 in Appendix F).

5.2.3.2 Community Acceptance

No comments were received during the public comment period (July 8, 2019 through August 9, 2019) (see Appendix F).

6.0 AMENDED REMEDY

Alternative 3, Demolition of the Southwest Quadrant of Building 23, is the amended remedy to address residual radiological contamination on building components and soil at the site. This alternative achieves the best balance of reduced risk, implementability, and cost. The amended remedy ensures compliance with the ARAR for building components since the majority of building components are removed from the site. The amended remedy is technically feasible and is considered the most protective of human health and the environment in the long term. FSS will be conducted consistent with MARSSIM requirements to verify that RGs are met for remaining building components and ensure that the RAO has been achieved. LUCs would be used to ensure that proper actions are taken any time the soil beneath the southwest quadrant is exposed, and five-year reviews by the government would be required.

7.0 COORDINATION WITH SUPPORT AGENCIES

In accordance with 40 CFR §300.435(c)(2), USACE has coordinated with MDE, the support agency, during preparation of this ROD Amendment. Communications from MDE are provided in Appendix F.

8.0 STATUTORY DETERMINATIONS

The amended remedy presented in this ROD Amendment is Alternative 3: Demolition of the Southwest Quadrant of Building 23. The amended remedy satisfies CERCLA §121, is protective

of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to hazardous substances which are part of this response action, and is cost-effective.

9.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §300.435(c)(2)(ii), the following community relations have been performed for this ROD Amendment:

- An Amended Proposed Remedial Action Plan, describing the proposed amendment to the ROD, has been made available for public comment;
- A notice of availability of the Amended Proposed Remedial Action Plan, including a brief description of the proposed amendment to the ROD, has been published in the following major local newspaper of general circulation: Baltimore Sun;
- A public comment period of at least 30 calendar days was provided for submission of written or oral comments on the amendment to the ROD (no comments were received during the comment period); and
- Following finalization of the ROD Amendment, a notice of availability of the amended ROD will be published in the Baltimore Sun, and the ROD Amendment and supporting information will be made available to the public in the administrative record.

10.0 REFERENCES

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APPENDIX A

FIGURES

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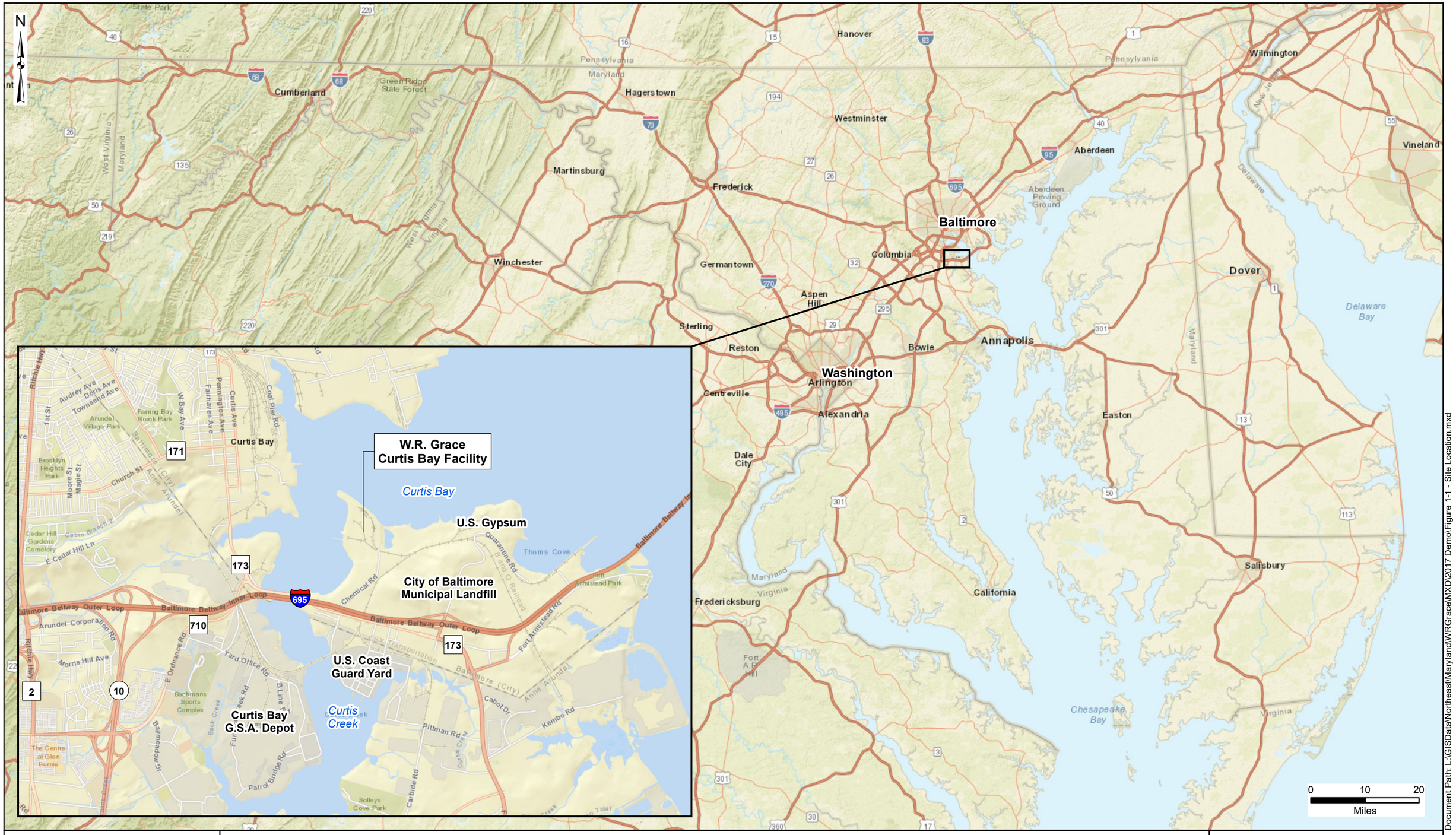


EA Engineering, Science, and Technology, Inc., PBC

SITE LOCATION

W.R. Grace Curtis Bay Facility
Baltimore, MD

Figure 1

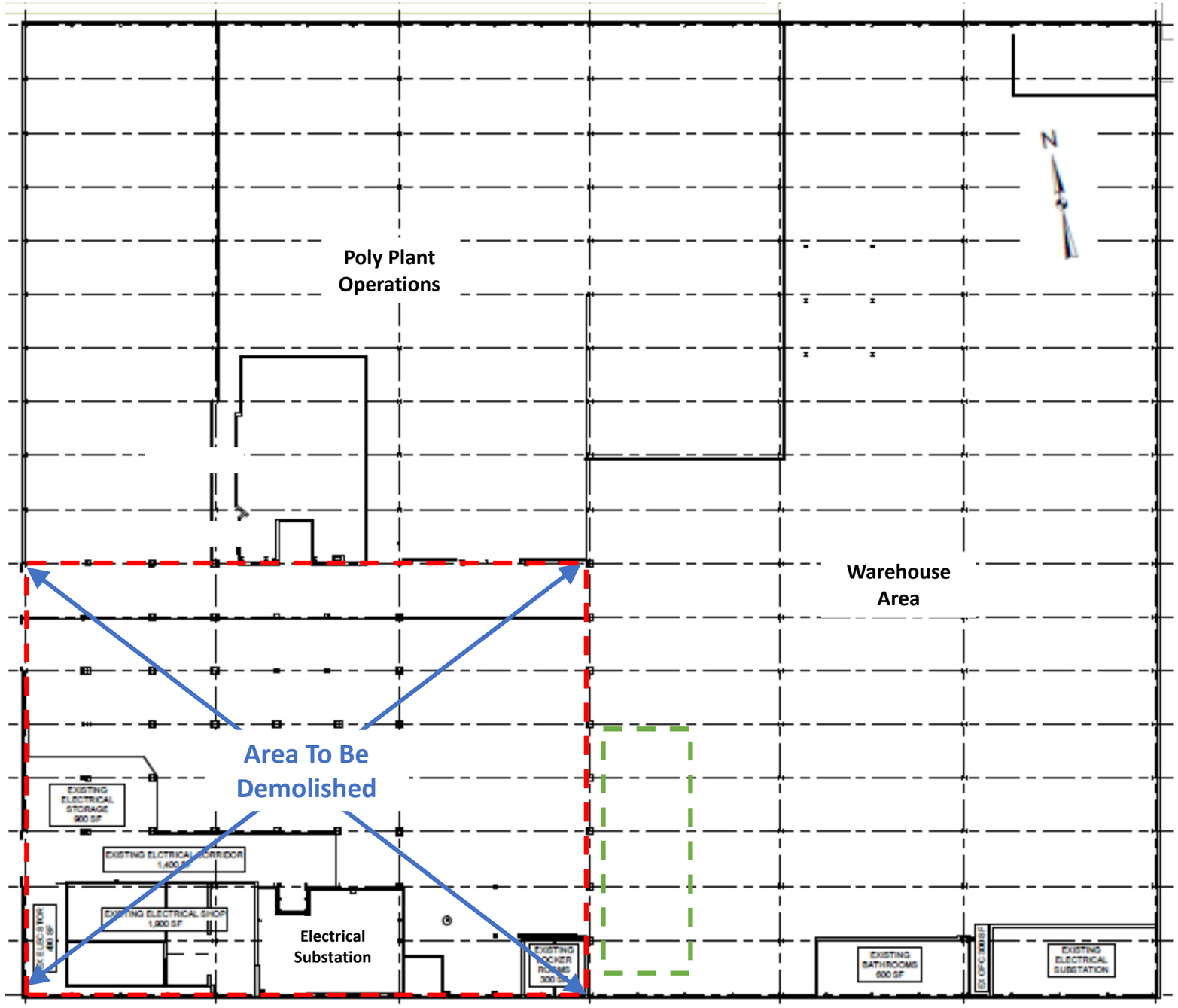
Document Path: L:\GIS\Data\Northeast\Maryland\WRGrace\MXD\2017 Demo\Figure 1-1 - Site Location.mxd

Document Path: L:\Northeast\Maryland\WRGrace\MXD\2017 Demo\Figure 1-2 - Building 23 Site Location Map.mxd

EA Engineering, Science, and Technology, Inc., PBC

BUILDING 23 SITE LOCATION MAP
W.R. Grace Curtis Bay Facility
Baltimore, MD

Figure 2



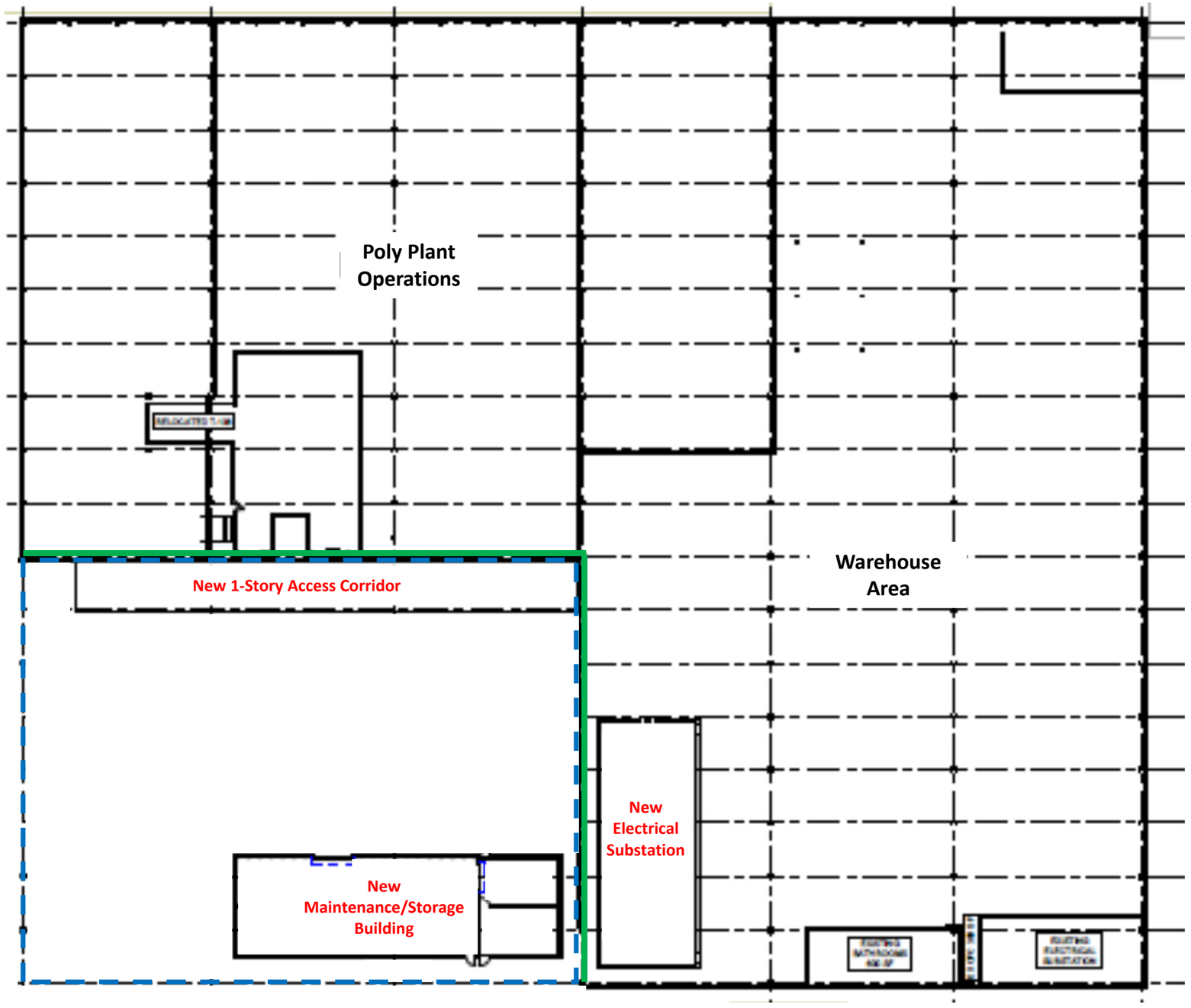
- Southwest Quadrant

- Location for New Electrical Substation

EA Engineering Science, and Technology, Inc., PBC

Area to be Demolished at Building 23
W.R. Grace Curtis Bay Facility
Baltimore, Maryland

Figure 3



- New Concrete Slab

- New Exterior Walls

EA Engineering Science, and Technology, Inc., PBC

Post-Remedy Conditions for Building 23
W.R. Grace Curtis Bay Facility
Baltimore, Maryland

Figure 4

APPENDIX B

MEMORANDUM "RECOMMENDED APPROACH FOR SOIL EXCAVATION UNDER THE SOUTHWEST QUADRANT OF BUILDING 23, DATED 21 JULY 2017

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EA Engineering, Science and Technology, Inc. PBC

225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031
Telephone: 410-584-7000
www.eaest.com

21 July 2017

MEMORANDUM

TO: Brenda Barber, PE, U.S. Army Corps of Engineers (USACE), Baltimore District

FROM: Mike O'Neill, PMP, EA Engineering, Science, and Technology, Inc., PBC (EA)

SUBJECT: Recommended Approach for Soil Excavation under the Southwest Quadrant of Building 23, W.R. Grace Formerly Utilized Site Remedial Action Program (FUSRAP) Site, Curtis Bay, Maryland

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This memorandum presents the following recommended approach to soil excavation under the southwest quadrant of Building 23 at the W.R. Grace FUSRAP Site in Curtis Bay, Maryland:

Removal of the existing concrete pad with de minimis soil excavation to allow regrading and placement of an 8-inch concrete slab overlaying approximately 6-inches of subbase materials with a vapor barrier.

Background and rationale for this recommendation are provided below.

Background Information

Residual radioactivity from thorium-processing operations conducted under U.S. Atomic Energy Commission contract in the 1950s is present within and beneath the southwest quadrant of Building 23 at the W.R. Grace FUSRAP Site. The lead agency for the W.R. Grace FUSRAP site is USACE, Baltimore District. USACE and the property owner, W.R. Grace & Co.-Conn. (W.R. Grace), are working together under the terms of a 2008 Settlement Agreement to implement the remedial action for the southwest quadrant of Building 23.

A Record of Decision (ROD) for the southwest quadrant of Building 23 was executed by USACE in April 2005. The selected remedy presented in the ROD to address residual radioactivity associated with the thorium-processing is "Decontamination with Removal to Industrial Use Levels." However, following two phases of remedial action to decontaminate building components in 2009 and 2013, residual radioactivity remained in multiple portions of the southwest quadrant of Building 23. USACE and W.R. Grace subsequently elected to prepare a conceptual design for demolition of the southwest quadrant of Building 23, such that demolition costs can be compared to the cost of further decontamination.

Although soil excavation was not included in the 2005 ROD, soil excavation was re-evaluated as part of the conceptual design for demolition, because demolition would increase the accessibility of soil beneath the southwest quadrant of Building 23. To support this evaluation, additional soil characterization for radioactive constituents was conducted by EA as part of the pre-design investigation in 2017. The characterization data obtained indicate that thorium-232 in excess of the Derived Concentration Guideline Levels (DCGLs) is present at depths of at least 16 feet below grade beneath the southwest quadrant. The pre-design investigation data also confirmed that thorium-232 is the primary concern at the site, as radium-226 did not exceed the DCGL.

Rationale for the Recommended Approach

Considerations in evaluating the potential excavation of thorium-impacted soil included the following:

Potential Dose to Industrial Workers: An evaluation was conducted to assess radiological activity in soil under the southwest quadrant and the potential dose to an industrial worker following demolition of the southwest quadrant and restoration with a new concrete slab (Attachment A). A 100 m^2 area in the center of the southwest quadrant was determined to have the highest average activity of thorium-232 in near-surface soil directly under the existing concrete slab. The thorium-232 and radium-226 activity in this location was used to evaluate the potential radioactive dose to an industrial worker following demolition of the building and restoration of the building footprint with a new concrete slab. A RESRAD v-7.2 model was developed using parameters consistent with those used in the 2003 Feasibility Study for Building 23, to determine the potential dose to an industrial worker working 7 hours a day directly above the area with the highest activity, given an 8-inch concrete slab over the existing soil. The resultant dose to the worker is 4.024 millirem per year (mrem/yr), which is below the 7.37 mrem/yr benchmark dose calculated in the Feasibility Study. The subbase materials under the concrete slab would further lower the dose. Therefore, no soil excavation is required to protect industrial workers following demolition, as a concrete slab offers sufficient protection.

The industrial worker was used in this evaluation because it is believed to be the most appropriate receptor for the Building 23 vicinity. This is consistent with the 2003 Feasibility Study for Building 23, and also with the 2012 Human Health Risk Assessment contracted by W.R. Grace in support of Resource Conservation and Recovery Act (RCRA) assessment of the facility. It is acknowledged that construction/excavation workers could be exposed to subsurface soil during potential future construction activities in the southwest quadrant of Building 23;

however, an unprotected construction/excavation worker is not considered to be a reasonable receptor, given land use controls (LUCs) already in place at the facility (see below). If the benchmark dose assessment and/or DCGLs are revised in a future ROD Amendment to support demolition of the southwest quadrant, then the design for the concrete pad and subbase can be re-evaluated to ensure that it is protective of applicable receptors, and the design can be modified as required.

Land Use Controls: LUCs are currently in place under the RCRA Administrative Order on Consent (Docket No. RCRA-03-2015-0074) for the facility, to limit contact with contaminated soil and groundwater at the site. The LUCs in place include the following:

- All intrusive earth moving activities at the Facility, including excavation, drilling and construction activities, shall be conducted in compliance with the Facility-specific health and safety protocols and an EPA-approved Soil Management Plan (that includes appropriate Personal Protective Equipment requirements sufficient to meet EPA's acceptable risk and complies with all applicable OSHA requirements); and

- Groundwater at the Facility shall not be used for any purpose, including, but not limited to, use as a potable water source, other than to conduct the maintenance and monitoring activities required by EPA or other governmental parties, provided EPA gives prior written approval for such use, or to conduct such other use that the EPA may approve in writing upon request of Respondent.

Although these LUCs do not specifically apply to media containing radiological constituents, additional LUCs to control access to subsurface soil would likely be enacted as part of the Building 23 remedy during the ROD Amendment, because soil with residual radiological activity above DCGLs is expected to be left in place after demolition. It is important to note that these LUCs would be required regardless of the soil excavation approach selected, as it would not be feasible to remove all impacted soil, e.g., soil located beneath columns that support the other three quadrants of the building and potential contamination outside the southern edge of the southwest quadrant of Building 23.

The LUCs enacted as part of the Building 23 remedy/ROD Amendment would need to include requirements to provide assurance that any future activities that disturb soil within the footprint of the southwest quadrant of Building 23, including any future excavation activities, would be conducted with oversight by radiologically-trained personnel and with protections for workers

appropriate to maintain acceptable dose levels. Given these requirements enacted via the LUCs, no remedial excavation of soil from under Building 23 is required to protect future workers engaged in excavation or construction activities.

Groundwater Protection: The 2002 Remedial Investigation (RI) for Building 23 did not identify elevated radionuclide concentrations in the groundwater associated with monazite processing activities. In addition, the RI Report indicated that radiological activity attributed to monazite sand processing was confined within the building and in soil directly under the first floor, and therefore, the groundwater pathway was not considered to be a route of migration for residual radiological materials remaining at the site from monazite sand processing operations. Based on this information, the subsequent feasibility study did not include remediation goals for groundwater.

Groundwater results from the 2017 pre-design investigation (Attachment B) were consistent with the previous results, and did not identify elevated radionuclide concentrations associated with monazite processing activities. The maximum radium concentration (Radium-226 + Radium 228) was 1.73 pCi/L and the maximum uranium concentration (total uranium) was 0.00186 µg/L, which are below the EPA maximum contaminant levels of 5 pCi/L and 30 µg/L, respectively. In addition, comparison of reported radiological concentrations in groundwater to radionuclide-specific criteria for sewer discharge identified in 10 CFR 20 Appendix B show that concentrations for all uranium, thorium, and radium isotopes are at least 2 orders of magnitude below criteria (the maximum reported thorium concentration was 1.58 pCi/L for thorium-230), indicating that radiological results alone would not prevent discharge of the water to the sewer. These concentrations are likely consistent with background levels, although limited data are available for comparison. Based on the lack of exceedances of common radiological screening criteria, groundwater was confirmed not to be a medium of concern for consideration in remediation of Building 23, and no soil excavation is required to protect groundwater quality.

Recommended Approach to Soil Excavation

The overall recommendation based on this assessment is as follows:

- No soil excavation for purposes of remediation or worker protection is recommended as part of the demolition of the southwest quadrant of Building 23. It is recommended that the existing concrete pad, subsurface structures (e.g., portions of foundations or trenches) that prevent site restoration, and a minimal amount of subsurface soil be removed to

allow regrading and placement of an 8-inch concrete slab overlaying approximately 6-inches of subbase materials with a vapor barrier.

ATTACHMENT A
Discussion of Potential Dose from A No Dig Scenario

Discussion of Potential Dose from a No Dig Scenario

Introduction

An investigation of potential soil contamination under the existing slab in relation to the possibility of using the criteria from 10 CFR 40 Appendix A Criteria 6(6) was done by establishing evaluation areas (EA) based on the existing columns and rows of the structural members existing in the southwest quadrant. Figure 1 gives a representation of the general layout. The distance between A – B and C - D columns is taken as 58 feet (17.68 meters) with between B – C is 57' (17.37 meters. The distance between the rows is 16' 8.5" (5.1 meters). This gives an area of 90 m^2 for the areas between columns and rows A-B and C-D, with 88.5 m^2 between B-C. Area EA-1 is from Column A - row 11 to Column B - row 12 i.e. - A-11 to B-12, area EA-2 is B-11 to C-12 and area EA-3 is C11 to D-12. This was continued to 24 evaluation areas in all.

We took data points from the investigation for Th-232 and Ra-226 activities in picocuries per gram (pCi/g) from each EA and averaged them over different depths to get an average concentration for each EA at intervals of every 2 feet. This is 0' – 2', 2' – 4', … , 14' – 16'. If no data was available for a depth no point was entered. Some approximations were made because not all data was exactly between the exact 2 foot levels. For this analysis background was not subtracted. No Ra-226 average was above the surface DCGL of 5 pCi/g, Table 1.

Table 1, DCGL Values, Surface and Subsurface

Th-232 DCGL - Surface (pCi/g)	2.62
Ra-226 DCGL - Surface (pCi/g)	5
Th-232 DCGL - Subsurface (pCi/g)	4.73
Ra-226 DCGL - Subsurface (pCi/g)	15

The highest Ra-226 concentration was 4.29 pCi/g at 2' – 4' feet in EA-7. The average Th-232 data was plotted for each of the 24 areas within each of the 2 foot lifts; the number of data points used in the average is given in parenthesis (N) after the concentration. Figures 2 – 9 show the data with Th-232 concentrations above the DCGL highlighted. Figure 2 used the surface DCGL even though a concrete cover will be in place.

Evaluation area 24 had concentrations above the DCGL for Th-232 beginning at the 8' – 10' depth down to the 16' depth. Two samples were taken at the 16' – 18' and 18' – 20' levels that had concentrations below the DCGL indicating the end of migration.

Modeling with Soils in Place

A RESRAD v-7.2 model was developed using the benchmark input to determine the potential dose to an industrial worker working 7 hours a day above the EA-14 area. The assumption that the contaminated material is in a one (1) meter zone at 37 pCi/g with a 20 cm (8") concrete cover. No credit was taken for a gravel bed below the concrete.

10 CFR 40 Appendix A criteria 6(6) allows an average over 100 m^2 which is the maximum area that can be used. The approximate 90 m^2 was used instead because it was easily visible in the quadrant and on maps. The contamination averaging depth is typically over a 15 cm (6 inch) soil depth that includes the concentration being modeled. The data used could not be separated into these 15 cm depth so the concentration was modeled over a one (1) meter depth. This provided a conservative assumption with more radionuclides contributing to the dose. The resultant dose from this model was 4.024 millirem per year (mrem/yr). Modeling with the radionuclide concentrations only within the first 15 cm resulted in doses of 3.05 mrem/yr, which is 25% lower. This output is in Attachment 2.

The resultant dose to the worker is 4.024 mrem/yr, page 10 of the RESRAD output Attachment 1 at the end. This is below the 7.37 benchmark dose calculated in the Feasibility Study.

Sum of ratios

The sum of the ratios (SOR) of the radionuclide calculations divide the concentration for a radionuclide by the Derived Concentration Guideline Limit (DCGL) for that nuclide and add the next radionuclide of concern concentration divided by the radionuclide DCGL. This dimensionless sum must be less than one (1) to be accepted. For our data only Th-232 and Ra-226 are the nuclides of concern. From Table 1, above the DCGL for each radionuclide has a different DCGL for surface (0 – 15 cm) activities from subsurface activities. This was taken into consideration for the 0 -2 foot depth summation.

Mathematically this is represented by the following equation.

$$SOR_n = \sum_{24}^{n=1} \frac{\text{Th-232 A}_n}{\text{Th-232 DCGL}} + \frac{\text{Ra-226 A}_n}{\text{Ra-226 DCGL}}$$

Where :

SOR_n = The sum of ratios for EA *n*

A_n = The activity of the nuclide in EA *n*

The SOR data is given in tables 3 – 10, below, for each of the different depths, Therefore there is a separate SOR for each EA at each of the different depths. If the SOR is greater than one (1.0) the EA has excess activity and is highlighted.

The established background for the site is given in Table 2. Background activities were subtracted from each EA average activity before performing the SOR.

Table 2, Background Activities

Th-232 Site Soil Background (pCi/g)	0.51
Ra-226 Site Soil Background (pCi/g)	0.35

Conclusion

Leaving the soil contamination in place is a reasonable option and provides no unusual dose to an industrial worker when a concrete pad is in place. The migration of the thorium down through the soil column shows the activity decreasing as depth increases.

Figure 1, General Evaluation Area Layout

16’ 8.5” between rows

	A	B	C	D	
11					
12	EA-1	EA-2	EA-3		12
”13	EA-4	EA-5	EA-6		13
14	EA-7	EA-8	EA-9		14
15	EA-10	EA-11	EA-12		15
16	EA-13	EA-14	EA-15		16
17	EA-16	EA-17	EA-18		17
18	EA-19	EA-20	EA-21		18
19	EA-22	EA-23	EA-24		19
	A – B = 58’	B – C = 57’	C – D = 58’		

Figure 2, Th-232 Concentrations for Evaluation Areas from 0’ to 2’

11	A	B	C	D
12	EA-1 0.481 pCi/g (6)	EA-2 1.628 pCi/g (8)	EA-3 0.172 pCi/g (3)	12
13	EA-4 1.225 pCi/g (2)	EA-5 0.409 pCi/g (2)	EA-6 0.123 pCi/g (3)	13
14	EA-7 3.813 pCi/g (3)	EA-8 0.325 pCi/g (4)	EA-9 0.406 pCi/g (6)	14
15	EA-10 1.524 pCi/g (2)	EA-11 14.34 pCi/g (6)	EA-12 0.691 pCi/g (3)	15
16	EA-13 0.587 pCi/g (3)	EA-14 36.487 pCi/g (3)	EA-15 3.553 pCi/g (3)	16
17	EA-16 0.285 pCi/g (2)	EA-17 1.935 pCi/g (5)	EA-18 3.143 pCi/g (6)	17
18	EA-19 0.0 pCi/g (2)	EA-20 0.0 pCi/g (0)	EA-21 0.108 pCi/g (5)	18
19	EA-22 0.0 pCi/g (0)	EA-23 0.0 pCi/g (1)	EA-24 0.208 pCi/g (3)	19

Figure 3, Th-232 Concentrations for Evaluation Areas from 2' to 4'

11	A	B	C	D
12	EA-1 1.217 pCi/g (5)	EA-2 0.571 pCi/g (5)	EA-3 0.0 pCi/g (1)	12
13	EA-4 9.64 pCi/g (2)	EA-5 0.609 pCi/g (1)	EA-6 0.123 pCi/g (3)	13
14	EA-7 16.015 pCi/g (2)	EA-8 2.753 pCi/g (2)	EA-9 0.170 pCi/g (2)	14
15	EA-10 3.87 pCi/g (2)	EA-11 0.145 pCi/g (3)	EA-12 4.249 pCi/g (3)	15
16	EA-13 0705 pCi/g (2)	EA-14 14.667 pCi/g (3)	EA-15 37 pCi/g (1)	16
17	EA-16 0.179 pCi/g (2)	EA-17 3.893 pCi/g (5)	EA-18 6.974 pCi/g (6)	17
18	EA-19 0.0 pCi/g (2)	EA-20 0.0 pCi/g (0)	EA-21 0.084 pCi/g (5)	18
19	EA-22 0.0 pCi/g (0)	EA-23 0.0 pCi/g (1)	EA-24 0.172 pCi/g (3)	19

Figure 4, Th-232 Concentrations for Evaluation Areas from 4' to 6'

	A	B	C	D
12	EA-1 0.210 pCi/g (4)	EA-2 2.712 pCi/g (5)	EA-3 0.0 pCi/g (0)	12
13	EA-4 1.35 pCi/g (1)	EA-5 1.71 pCi/g (1)	EA-6 0.123 pCi/g (3)	13
14	EA-7 4.040 pCi/g (1)	EA-8 1.55 pCi/g (2)	EA-9 2.907 pCi/g (4)	14
15	EA-10 0.315 pCi/g (1)	EA-11 0.0 pCi/g (1)	EA-12 1.202 pCi/g (2)	15
16	EA-13 0.0 pCi/g (0)	EA-14 22.350 pCi/g (3)	EA-15 5.020 pCi/g (2)	16
17	EA-16 0.460 pCi/g (2)	EA-17 2.077 pCi/g (3)	EA-18 3.640 pCi/g (4)	17
18	EA-19 0.0 pCi/g (0)	EA-20 0.0 pCi/g (0)	EA-21 1.229 pCi/g (3)	18
19	EA-22 0.0 pCi/g (0)	EA-23 0.0 pCi/g (0)	EA-24 1.285 pCi/g (2)	19

Figure 5, Th-232 Concentrations for Evaluation Areas from 6' to 8'

	A	B	C	D
12	EA-1 0.434 pCi/g (3)	EA-2 5.42 pCi/g (6)	EA-3 0.0 pCi/g (2)	12
13	EA-4 0.0 pCi/g (0)	EA-5 0 pCi/g (0)	EA-6 0.123 pCi/g (3)	13
14	EA-7 2.280 pCi/g (1)	EA-8 1.323 pCi/g (3)	EA-9 0.0 pCi/g (2)	14
15	EA-10 1.17 pCi/g (1)	EA-11 3.270 pCi/g (2)	EA-12 1.265 pCi/g (2)	15
16	EA-13 0.0 pCi/g (0)	EA-14 16.2 pCi/g (1)	EA-15 1.165 pCi/g (2)	16
17	EA-16 2.060 pCi/g (2)	EA-17 4.497 pCi/g (3)	EA-18 15.949 pCi/g (4)	17
18	EA-19 0.0 pCi/g (0)	EA-20 0.0 pCi/g (0)	EA-21 0.269 pCi/g (2)	18
19	EA-22 0.0 pCi/g (0)	EA-23 0.0 pCi/g (0)	EA-24 4.60 pCi/g (2)	19

Figure 6, Th-232 Concentrations for Evaluation Areas from 8' to 10'

	A	B	C	D
12	EA-1 0.734 pCi/g (1)	EA-2 1.339 pCi/g (4)	EA-3 0.0 pCi/g (0)	12
13	EA-4 0. 902 pCi/g (1)	EA-5 0.944 pCi/g (1)	EA-6 0.0 pCi/g (0)	13
14	EA-7 2.09 pCi/g (1)	EA-8 1.175 pCi/g (2)	EA-9 0.369 pCi/g (3)	14
15	EA-10 0.647 pCi/g (1)	EA-11 8.010 pCi/g (1)	EA-12 0.845 pCi/g (2)	15
16	EA-13 0.0 pCi/g (0)	EA-14 14.4 pCi/g (1)	EA-15 1.140 pCi/g (2)	16
17	EA-16 1.085 pCi/g (2)	EA-17 10.290 pCi/g (3)	EA-18 8.255 pCi/g (4)	17
18	EA-19 0.0 pCi/g (0)	EA-20 0.0 pCi/g (0)	EA-21 1.375 pCi/g (2)	18
19	EA-22 0.0 pCi/g (0)	EA-23 0.0 pCi/g (0)	EA-24 8.050 pCi/g (2)	19

Figure 7, Th-232 Concentrations for Evaluation Areas from 10’ to 12’

	A	B	C	D
12	EA-1 0.295 pCi/g (2)	EA-2 3.793 pCi/g (3)	EA-3 0.0 pCi/g (0)	12
13	EA-4 0. 899 pCi/g (1)	EA-5 0.0 pCi/g (0)	EA-6 0.0 pCi/g (0)	13
14	EA-7 1.53 pCi/g (1)	EA-8 0.805 pCi/g (2)	EA-9 0.220 pCi/g (3)	14
15	EA-10 0.423 pCi/g (1)	EA-11 0.789 pCi/g (1)	EA-12 0.907 pCi/g (2)	15
16	EA-13 0.0 pCi/g (0)	EA-14 2.690 pCi/g (1)	EA-15 2.460 pCi/g (1)	16
17	EA-16 1.077 pCi/g (2)	EA-17 3.625 pCi/g (2)	EA-18 8.083 pCi/g (4)	17
18	EA-19 0.0 pCi/g (0)	EA-20 0.0 pCi/g (0)	EA-21 6.255 pCi/g (2)	18
19	EA-22 0.0 pCi/g (0)	EA-23 0.0 pCi/g ()	EA-24 6.920 pCi/g (2)	19

Figure 8, Th-232 Concentrations for Evaluation Areas from 12' to 14'

	A	B	C	D
12	EA-1 0.270 pCi/g (2)	EA-2 3.216 pCi/g (3)	EA-3 0.0 pCi/g (0)	12
13	EA-4 0. 588 pCi/g (1)	EA-5 0.0 pCi/g (0)	EA-6 0.0 pCi/g (0)	13
14	EA-7 2.480 pCi/g (1)	EA-8 0.500 pCi/g (2)	EA-9 0.324 pCi/g (3)	14
15	EA-10 1.34 pCi/g (1)	EA-11 2.450 pCi/g (1)	EA-12 0.906 pCi/g (2)	15
16	EA-13 0.0 pCi/g (0)	EA-14 1.010 pCi/g (1)	EA-15 2.331 pCi/g (1)	16
17	EA-16 0.350 pCi/g (2)	EA-17 5.075 pCi/g (2)	EA-18 7.432 pCi/g (4)	17
18	EA-19 0.0 pCi/g (0)	EA-20 0.0 pCi/g (0)	EA-21 1.781 pCi/g (3)	18
19	EA-22 0.0 pCi/g (0)	EA-23 0.0 pCi/g ()	EA-24 5.320 pCi/g (2)	19

Figure 9, Th-232 Concentrations for Evaluation Areas from 14’ to 16’

	A	B	C	D
12	EA-1 0.644 pCi/g (2)	EA-2 4.764 pCi/g (3)	EA-3 0.0 pCi/g (0)	12
13	EA-4 0. 493 pCi/g (1)	EA-5 0.0 pCi/g (0)	EA-6 0.0 pCi/g (0)	13
14	EA-7 1.080 pCi/g (1)	EA-8 0.745 pCi/g (2)	EA-9 0.361 pCi/g (3)	14
15	EA-10 0.775 pCi/g (1)	EA-11 0.674 pCi/g (1)	EA-12 0.0 pCi/g (1)	15
16	EA-13 0.0 pCi/g (0)	EA-14 0.736 pCi/g (1)	EA-15 1.875 pCi/g (2)	16
17	EA-16 0.680 pCi/g (2)	EA-17 1.166 pCi/g (2)	EA-18 5.515 pCi/g (4)	17
18	EA-19 0.0 pCi/g (0)	EA-20 0.0 pCi/g (0)	EA-21 4.00 pCi/g (3)	18
19	EA-22 0.0 pCi/g (0)	EA-23 0.0 pCi/g ()	EA-24 7.795 pCi/g (2) 16’ – 18’ 1.561 pCi/g (2) 18’ – 20’ 0.735 pCi/g (2)	19

Table 3, Sum of Ratios for the 0' to 2' Interval

EA-1	0.0003	EA-2	0.4794	EA-3	-0.0170
EA-4	0.2433	EA-5	-0.0601	EA-6	-0.1943
EA-7	1.4441	EA-8	-0.0840	EA-9	-0.0081
EA-10	0.3854	EA-11	5.4160	EA-12	0.0273
EA-13	0.0456	EA-14	13.7095	EA-15	1.1399
EA-16	-0.0859	EA-17	0.5573	EA-18	1.0668
EA-19	-0.1571	EA-20	-0.2647	EA-21	-0.1492
EA-22	-0.2647	EA-23	-0.1187	EA-24	-0.0561

Table 4, Sum of Ratios for the 2' to 4' Interval

EA-1	0.1389	EA-2	0.0096	EA-3	-0.1007
EA-4	1.9443	EA-5	0.0255	EA-6	-0.0974
EA-7	3.4483	EA-8	0.4580	EA-9	-0.0903
EA-10	0.6885	EA-11	-0.0938	EA-12	0.7778
EA-13	0.0544	EA-14	3.0083	EA-15	7.7448
EA-16	-0.0608	EA-17	0.7230	EA-18	1.4319
EA-19	-0.0832	EA-20	0.0000	EA-21	-0.0851
EA-22	0.0000	EA-23	-0.0538	EA-24	-0.0657

Table 5, Sum of Ratios for the 4' to 6' Interval

EA-1	-0.0446	EA-2	0.4604	EA-3	0.0000
EA-4	0.2207	EA-5	0.2676	EA-6	-0.0974
EA-7	0.8243	EA-8	0.2067	EA-9	0.5138
EA-10	-0.0450	EA-11	-0.1312	EA-12	0.1561
EA-13	-0.1312	EA-14	4.6317	EA-15	0.9302
EA-16	-0.0108	EA-17	0.3178	EA-18	0.6613
EA-19	0.0000	EA-20	0.0000	EA-21	0.1492
EA-22	0.0000	EA-23	0.0000	EA-24	0.1544

Table 6, Sum of Ratios for the 6’ to 8’ Interval

EA-1	0.0220	EA-2	1.0883	EA-3	0.0000
EA-4	0.0000	EA-5	0.0000	EA-6	-0.0974
EA-7	0.4849	EA-8	0.1979	EA-9	-0.1096
EA-10	0.1318	EA-11	0.6102	EA-12	0.1460
EA-13	0.0000	EA-14	3.2938	EA-15	0.1216
EA-16	0.3564	EA-17	0.8421	EA-18	3.2578
EA-19	0.0000	EA-20	0.0000	EA-21	-0.0618
EA-22	0.0000	EA-23	0.0000	EA-24	0.8553

Table 7, Sum of Ratios for the 8’ to 10’ Interval

EA-1	0.0821	EA-2	0.1727	EA-3	0.0000
EA-4	-0.1312	EA-5	0.0000	EA-6	0.0000
EA-7	0.3690	EA-8	0.1329	EA-9	-0.0531
EA-10	-0.1312	EA-11	1.5808	EA-12	0.0475
EA-13	0.0000	EA-14	2.9706	EA-15	0.1099
EA-16	0.1882	EA-17	2.1113	EA-18	1.6495
EA-19	0.0000	EA-20	0.0000	EA-21	0.1710
EA-22	0.0000	EA-23	0.0000	EA-24	1.6013

Table 8, Sum of Ratios for the 10’ to 12’ Interval

EA-1	-0.0382	EA-2	0.7334	EA-3	0.0000
EA-4	0.1369	EA-5	0.0000	EA-6	0.0000
EA-7	0.2823	EA-8	0.0502	EA-9	-0.0632
EA-10	-0.0073	EA-11	0.0857	EA-12	0.0853
EA-13	0.0000	EA-14	0.4884	EA-15	0.4057
EA-16	0.1815	EA-17	0.6836	EA-18	1.6099
EA-19	0.0000	EA-20	0.0000	EA-21	1.2067
EA-22	0.0000	EA-23	0.0000	EA-24	1.3762

Table 9, Sum of Ratios for the 12’ to 14’ Interval

EA-1	-0.0477	EA-2	0.5841	EA-3	0.0000
EA-4	0.0435	EA-5	0.0000	EA-6	0.0000
EA-7	0.4765	EA-8	-0.0166	EA-9	-0.0491
EA-10	0.1953	EA-11	0.4101	EA-12	0.1204
EA-13	0.0000	EA-14	0.1258	EA-15	0.3725
EA-16	-0.0110	EA-17	0.9904	EA-18	1.4616
EA-19	0.0000	EA-20	0.0000	EA-21	0.2510
EA-22	0.0000	EA-23	0.0000	EA-24	1.0190

Table 10, Sum of Ratios for the 14’ to 16’ Interval

EA-1	0.0609	EA-2	0.9205	EA-3	0.0000
EA-4	0.0162	EA-5	0.0000	EA-6	0.0000
EA-7	0.1972	EA-8	0.0393	EA-9	-0.0370
EA-10	0.0905	EA-11	0.0304	EA-12	0.1973
EA-13	0.0000	EA-14	0.1024	EA-15	0.2793
EA-16	0.0667	EA-17	0.1392	EA-18	1.0719
EA-19	0.0000	EA-20	0.0000	EA-21	0.7525
EA-22	0.0000	EA-23	0.0000	EA-24	1.5478
			16' - 18'	EA-24	0.2190
			18' - 20'	EA-24	0.0647

Attachment 1

RESRAD Output with One Meter Contaminated Zone

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Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PCI.RAD

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Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-228 (Source: FGR 12)	5.978E+00	5.978E+00	DCF1(1)
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-212 (Source: FGR 12)	1.171E+00	1.171E+00	DCF1(4)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(5)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(6)
A-1	Pb-212 (Source: FGR 12)	7.043E-01	7.043E-01	DCF1(7)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(8)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(9)
A-1	Po-212 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(10)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(11)
A-1	Po-216 (Source: FGR 12)	1.042E-04	1.042E-04	DCF1(12)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(13)
A-1	Ra-224 (Source: FGR 12)	5.119E-02	5.119E-02	DCF1(14)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(15)
A-1	Ra-228 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(16)
A-1	Rn-220 (Source: FGR 12)	2.298E-03	2.298E-03	DCF1(17)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(18)
A-1	Th-228 (Source: FGR 12)	7.940E-03	7.940E-03	DCF1(19)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(20)
A-1	Th-232 (Source: FGR 12)	5.212E-04	5.212E-04	DCF1(21)
A-1	Tl-208 (Source: FGR 12)	2.298E+01	2.298E+01	DCF1(22)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(23)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(1)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(2)
B-1	Ra-228+D	5.078E-03	4.770E-03	DCF2(3)
B-1	Th-228+D	3.454E-01	3.420E-01	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(6)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(1)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(2)
D-1	Ra-228+D	1.442E-03	1.440E-03	DCF3(3)
D-1	Th-228+D	8.086E-04	3.960E-04	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(6)
D-34	Food transfer factors:			
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(1,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(1,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(1,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(2,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value‡	Base Case*	Parameter Name
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(4,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(4,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(2,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(3,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(4,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)

‡For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PCI.RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.000E+00	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pb-210	3.700E+01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	5.000E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Ra-228	5.000E+00	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Th-228	3.700E+01	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-230	3.700E+01	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Th-232	3.700E+01	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Pb-210	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-230	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(6)
R013	Cover depth (m)	2.000E-01	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	2.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-05	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	2.000E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.956E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	1.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.496E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.419E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.419E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.500E-07	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.500E-07	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.500E-07	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	1.000E-04	---	MLINH
R017	Exposure duration	2.500E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.998E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.850E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.60OE+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.40OE+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.20OE+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.30OE+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.40OE+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.00OE-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.65OE+01	3.65OE+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.10OE+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.00OE+00	---	FDW
R018	Contamination fraction of household water	not used	1.00OE+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.00OE+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.00OE+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.00OE-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.80OE+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.50OE+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.00OE+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.60OE+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.00OE-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.00OE-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.50OE-01	1.50OE-01	---	DM
R019	Depth of roots (m)	not used	9.00OE-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.00OE+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.00OE+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.00OE+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.00OE+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.00OE-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.50OE+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.10OE+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.70OE-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.50OE-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.00OE-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.00OE-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.00OE+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.00OE+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.50OE-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.50OE-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.50OE-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.50OE-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.50OE-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.50OE-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.00OE+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.00OE-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.00OE-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.00OE-02	---	CSOIL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	suppressed
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	100.00 square meters	Pb-210	3.700E+01
Thickness:	1.00 meters	Ra-226	5.000E+00
Cover Depth:	0.20 meters	Ra-228	5.000E+00
		Th-228	3.700E+01
		Th-230	3.700E+01
		Th-232	3.700E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.340E+00	1.947E+00	1.670E+00	2.209E+00	3.065E+00	3.220E+00	3.405E+00	4.024E+00
M(t):	9.360E-02	7.789E-02	6.681E-02	8.838E-02	1.226E-01	1.288E-01	1.362E-01	1.610E-01

Maximum TDOSE(t): 4.024E+00 mrem/yr at t = 1.000E+03 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	3.148E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	2.028E-01	0.0867	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	1.249E-01	0.0534	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.962E+00	0.8385	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	3.258E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	4.973E-02	0.0213	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.340E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.148E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.028E-01	0.0867
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.249E-01	0.0534
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.962E+00	0.8385
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.258E-04	0.0001
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.973E-02	0.0213
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.340E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PCI.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	3.052E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	2.026E-01	0.1041	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	1.863E-01	0.0957	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.366E+00	0.7015	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	9.757E-04	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.913E-01	0.0982	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.947E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.052E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.026E-01	0.1041
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.863E-01	0.0957
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.366E+00	0.7015
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.757E-04	0.0005
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.913E-01	0.0982
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.947E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PCI.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	2.867E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	2.023E-01	0.1211	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	2.296E-01	0.1375	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	6.620E-01	0.3963	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	2.274E-03	0.0014	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	5.741E-01	0.3437	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.670E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.867E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.023E-01	0.1211
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.296E-01	0.1375
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.620E-01	0.3963
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.274E-03	0.0014
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.741E-01	0.3437
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.670E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PCI.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	2.304E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	2.010E-01	0.0910	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	1.454E-01	0.0658	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	5.247E-02	0.0237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	6.805E-03	0.0031	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.804E+00	0.8164	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.209E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.304E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.010E-01	0.0910
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.454E-01	0.0658
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.247E-02	0.0237
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.805E-03	0.0031
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.804E+00	0.8164
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.209E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	1.234E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.975E-01	0.0644	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	1.386E-02	0.0045	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	3.752E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	1.963E-02	0.0064	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.834E+00	0.9246	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.065E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.234E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.975E-01	0.0644
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.386E-02	0.0045
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.752E-05	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.963E-02	0.0064
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.834E+00	0.9246
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.065E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	1.389E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.856E-01	0.0577	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	2.903E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	3.668E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	6.312E-02	0.0196	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.971E+00	0.9227	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.220E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.389E-06	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.856E-01	0.0577
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.903E-06	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.668E-16	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.312E-02	0.0196
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.971E+00	0.9227
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.220E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PCI.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	2.701E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.555E-01	0.0457	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	8.934E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	1.765E-01	0.0518	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.073E+00	0.9025	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.405E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.701E-09	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.555E-01	0.0457
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.934E-17	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.765E-01	0.0518
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.073E+00	0.9025
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.405E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	8.769E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	8.366E-02	0.0208	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	4.792E-01	0.1191	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.461E+00	0.8601	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.024E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.769E-19	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.366E-02	0.0208
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.792E-01	0.1191
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.461E+00	0.8601
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.024E+00	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pb-210+D	Pb-210+D	1.000E+00	8.509E-07	8.248E-07	7.749E-07	6.228E-07	3.336E-07	3.753E-08	7.300E-11	2.370E-20
Ra-226+D	Ra-226+D	1.000E+00	4.056E-02	4.052E-02	4.045E-02	4.020E-02	3.950E-02	3.712E-02	3.110E-02	1.673E-02
Ra-226+D	Pb-210+D	1.000E+00	1.329E-08	3.931E-08	8.892E-08	2.395E-07	5.215E-07	7.793E-07	7.029E-07	4.145E-07
Ra-226+D	∑DSR(j)		4.056E-02	4.052E-02	4.045E-02	4.020E-02	3.950E-02	3.712E-02	3.110E-02	1.673E-02
Ra-228+D	Ra-228+D	1.000E+00	1.521E-02	1.348E-02	1.058E-02	4.537E-03	4.036E-04	8.473E-08	2.628E-18	0.000E+00
Ra-228+D	Th-228+D	1.000E+00	9.775E-03	2.379E-02	3.533E-02	2.454E-02	2.368E-03	4.959E-07	1.524E-17	0.000E+00
Ra-228+D	∑DSR(j)		2.499E-02	3.727E-02	4.592E-02	2.907E-02	2.772E-03	5.806E-07	1.787E-17	0.000E+00
Th-228+D	Th-228+D	1.000E+00	5.303E-02	3.692E-02	1.789E-02	1.418E-03	1.014E-06	9.914E-18	0.000E+00	0.000E+00
Th-230	Th-230	1.000E+00	1.709E-08	1.710E-08	1.712E-08	1.717E-08	1.733E-08	1.789E-08	1.961E-08	2.702E-08
Th-230	Ra-226+D	1.000E+00	8.788E-06	2.635E-05	6.145E-05	1.839E-04	5.304E-04	1.706E-03	4.771E-03	1.295E-02
Th-230	Pb-210+D	1.000E+00	1.924E-12	1.335E-11	6.916E-11	5.763E-10	4.018E-09	2.559E-08	9.456E-08	3.043E-07
Th-230	∑DSR(j)		8.805E-06	2.637E-05	6.147E-05	1.839E-04	5.305E-04	1.706E-03	4.771E-03	1.295E-02
Th-232	Th-232	1.000E+00	2.435E-09	2.437E-09	2.439E-09	2.448E-09	2.474E-09	2.565E-09	2.846E-09	4.093E-09
Th-232	Ra-228+D	1.000E+00	9.355E-04	2.663E-03	5.551E-03	1.159E-02	1.577E-02	1.640E-02	1.710E-02	1.976E-02
Th-232	Th-228+D	1.000E+00	4.087E-04	2.507E-03	9.966E-03	3.716E-02	6.083E-02	6.389E-02	6.597E-02	7.378E-02
Th-232	∑DSR(j)		1.344E-03	5.170E-03	1.552E-02	4.875E-02	7.659E-02	8.030E-02	8.307E-02	9.354E-02

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pb-210	2.938E+07	3.031E+07	3.226E+07	4.014E+07	7.494E+07	6.662E+08	3.425E+11	*7.634E+13
Ra-226	6.164E+02	6.169E+02	6.180E+02	6.218E+02	6.330E+02	6.734E+02	8.039E+02	1.494E+03
Ra-228	1.000E+03	6.708E+02	5.445E+02	8.599E+02	9.018E+03	4.306E+07	*2.726E+14	*2.726E+14
Th-228	4.714E+02	6.772E+02	1.397E+03	1.763E+04	2.465E+07	*8.195E+14	*8.195E+14	*8.195E+14
Th-230	2.839E+06	9.480E+05	4.067E+05	1.359E+05	4.713E+04	1.465E+04	5.239E+03	1.930E+03
Th-232	1.860E+04	4.835E+03	1.611E+03	5.128E+02	3.264E+02	3.113E+02	3.010E+02	2.673E+02

*At specific activity limit

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PCI.RAD

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 1.000E+03 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pb-210	3.700E+01	0.000E+00	8.509E-07	2.938E+07	2.370E-20	*7.634E+13
Ra-226	5.000E+00	0.000E+00	4.056E-02	6.164E+02	1.673E-02	1.494E+03
Ra-228	5.000E+00	3.417 ± 0.007	4.610E-02	5.423E+02	0.000E+00	*2.726E+14
Th-228	3.700E+01	0.000E+00	5.303E-02	4.714E+02	0.000E+00	*8.195E+14
Th-230	3.700E+01	1.000E+03	1.295E-02	1.930E+03	1.295E-02	1.930E+03
Th-232	3.700E+01	1.000E+03	9.354E-02	2.673E+02	9.354E-02	2.673E+02

*At specific activity limit

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PCI.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pb-210	Pb-210	1.000E+00	3.148E-05	3.052E-05	2.867E-05	2.304E-05	1.234E-05	1.389E-06	2.701E-09	8.769E-19
Pb-210	Ra-226	1.000E+00	6.645E-08	1.966E-07	4.446E-07	1.197E-06	2.607E-06	3.896E-06	3.515E-06	2.073E-06
Pb-210	Th-230	1.000E+00	7.120E-11	4.940E-10	2.559E-09	2.132E-08	1.487E-07	9.469E-07	3.499E-06	1.126E-05
Pb-210	∑DOSE(j)		3.155E-05	3.071E-05	2.912E-05	2.426E-05	1.510E-05	6.232E-06	7.016E-06	1.333E-05
Ra-226	Ra-226	1.000E+00	2.028E-01	2.026E-01	2.023E-01	2.010E-01	1.975E-01	1.856E-01	1.555E-01	8.365E-02
Ra-226	Th-230	1.000E+00	3.251E-04	9.751E-04	2.274E-03	6.804E-03	1.963E-02	6.312E-02	1.765E-01	4.792E-01
Ra-226	∑DOSE(j)		2.031E-01	2.036E-01	2.045E-01	2.078E-01	2.171E-01	2.487E-01	3.320E-01	5.628E-01
Ra-228	Ra-228	1.000E+00	7.606E-02	6.740E-02	5.291E-02	2.269E-02	2.018E-03	4.237E-07	1.314E-17	0.000E+00
Ra-228	Th-232	1.000E+00	3.461E-02	9.854E-02	2.054E-01	4.288E-01	5.834E-01	6.069E-01	6.326E-01	7.311E-01
Ra-228	∑DOSE(j)		1.107E-01	1.659E-01	2.583E-01	4.514E-01	5.854E-01	6.069E-01	6.326E-01	7.311E-01
Th-228	Ra-228	1.000E+00	4.887E-02	1.189E-01	1.767E-01	1.227E-01	1.184E-02	2.480E-06	7.620E-17	0.000E+00
Th-228	Th-228	1.000E+00	1.962E+00	1.366E+00	6.620E-01	5.247E-02	3.752E-05	3.668E-16	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	1.512E-02	9.277E-02	3.687E-01	1.375E+00	2.251E+00	2.364E+00	2.441E+00	2.730E+00
Th-228	∑DOSE(j)		2.026E+00	1.578E+00	1.207E+00	1.550E+00	2.262E+00	2.364E+00	2.441E+00	2.730E+00
Th-230	Th-230	1.000E+00	6.325E-07	6.327E-07	6.333E-07	6.354E-07	6.412E-07	6.621E-07	7.255E-07	9.996E-07
Th-232	Th-232	1.000E+00	9.011E-08	9.015E-08	9.025E-08	9.058E-08	9.152E-08	9.491E-08	1.053E-07	1.514E-07

THF(i) is the thread fraction of the parent nuclide.

Summary : Sub Surface 37 pCi Industrial Worker 20 cm concrete cover
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\INDUS WRKR TH IN EQ W 20CM CONCRETE W 37 PC

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pb-210	Pb-210	1.000E+00	3.700E+01	3.585E+01	3.366E+01	2.699E+01	1.437E+01	1.580E+00	2.883E-03	7.479E-13
Pb-210	Ra-226	1.000E+00	0.000E+00	1.529E-01	4.441E-01	1.325E+00	2.959E+00	4.365E+00	3.695E+00	1.741E+00
Pb-210	Th-230	1.000E+00	0.000E+00	2.464E-04	2.171E-03	2.240E-02	1.656E-01	1.054E+00	3.671E+00	9.452E+00
Pb-210	∑S(j):		3.700E+01	3.600E+01	3.411E+01	2.834E+01	1.749E+01	6.999E+00	7.369E+00	1.119E+01
Ra-226	Ra-226	1.000E+00	5.000E+00	4.995E+00	4.984E+00	4.947E+00	4.841E+00	4.490E+00	3.622E+00	1.706E+00
Ra-226	Th-230	1.000E+00	0.000E+00	1.602E-02	4.801E-02	1.594E-01	4.731E-01	1.519E+00	4.104E+00	9.765E+00
Ra-226	∑S(j):		5.000E+00	5.011E+00	5.032E+00	5.106E+00	5.314E+00	6.009E+00	7.725E+00	1.147E+01
Ra-228	Ra-228	1.000E+00	5.000E+00	4.429E+00	3.476E+00	1.488E+00	1.318E-01	2.728E-05	8.117E-16	0.000E+00
Ra-228	Th-232	1.000E+00	0.000E+00	4.201E+00	1.122E+01	2.585E+01	3.583E+01	3.680E+01	3.680E+01	3.678E+01
Ra-228	∑S(j):		5.000E+00	8.630E+00	1.469E+01	2.734E+01	3.596E+01	3.680E+01	3.680E+01	3.678E+01
Th-228	Ra-228	1.000E+00	0.000E+00	1.426E+00	2.689E+00	2.036E+00	1.979E-01	4.099E-05	1.220E-15	0.000E+00
Th-228	Th-228	1.000E+00	3.700E+01	2.575E+01	1.248E+01	9.878E-01	7.041E-04	6.807E-15	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	0.000E+00	6.897E-01	4.597E+00	2.084E+01	3.535E+01	3.680E+01	3.680E+01	3.678E+01
Th-228	∑S(j):		3.700E+01	2.787E+01	1.976E+01	2.386E+01	3.554E+01	3.680E+01	3.680E+01	3.678E+01
Th-230	Th-230	1.000E+00	3.700E+01	3.700E+01	3.700E+01	3.700E+01	3.699E+01	3.696E+01	3.689E+01	3.664E+01
Th-232	Th-232	1.000E+00	3.700E+01	3.700E+01	3.700E+01	3.700E+01	3.700E+01	3.700E+01	3.699E+01	3.697E+01

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 0.97 seconds

Attachment 2

RESRAD Output with 15 Centimeter Contaminated Zone

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-228 (Source: FGR 12)	5.978E+00	5.978E+00	DCF1(1)
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-212 (Source: FGR 12)	1.171E+00	1.171E+00	DCF1(4)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(5)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(6)
A-1	Pb-212 (Source: FGR 12)	7.043E-01	7.043E-01	DCF1(7)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(8)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(9)
A-1	Po-212 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(10)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(11)
A-1	Po-216 (Source: FGR 12)	1.042E-04	1.042E-04	DCF1(12)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(13)
A-1	Ra-224 (Source: FGR 12)	5.119E-02	5.119E-02	DCF1(14)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(15)
A-1	Ra-228 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(16)
A-1	Rn-220 (Source: FGR 12)	2.298E-03	2.298E-03	DCF1(17)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(18)
A-1	Th-228 (Source: FGR 12)	7.940E-03	7.940E-03	DCF1(19)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(20)
A-1	Th-232 (Source: FGR 12)	5.212E-04	5.212E-04	DCF1(21)
A-1	Tl-208 (Source: FGR 12)	2.298E+01	2.298E+01	DCF1(22)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(23)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(1)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(2)
B-1	Ra-228+D	5.078E-03	4.770E-03	DCF2(3)
B-1	Th-228+D	3.454E-01	3.420E-01	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(6)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(1)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(2)
D-1	Ra-228+D	1.442E-03	1.440E-03	DCF3(3)
D-1	Th-228+D	8.086E-04	3.960E-04	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(6)
D-34	Food transfer factors:			
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(1,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(1,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(1,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(2,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 11

Menu	Parameter	Current Value‡	Base Case*	Parameter Name
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(4,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(4,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(2,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(3,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(4,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)

‡For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pb-210	3.700E+01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.500E+01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Ra-228	1.500E+01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Th-228	3.700E+01	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-230	3.700E+01	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Th-232	3.700E+01	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Pb-210	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-230	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(6)
R013	Cover depth (m)	2.000E-01	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	2.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-05	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	2.000E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.956E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	1.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+02	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.997E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.280E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.280E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.000E-06	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.000E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.000E-06	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	1.000E-04	---	MLINH
R017	Exposure duration	2.500E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.998E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.850E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	suppressed
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : Sub Surface 37 pCi Ind Wrkr 20 cm conc cont in 1st 15 cm at 15 pCi 5-8-17
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\IND WRKR SSUB CON IN 1ST 15 CM W 20 CM CC 37 PCI.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	100.00 square meters	Pb-210	3.700E+01
Thickness:	0.15 meters	Ra-226	1.500E+01
Cover Depth:	0.20 meters	Ra-228	1.500E+01
		Th-228	3.700E+01
		Th-230	3.700E+01
		Th-232	3.700E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.594E+00	2.363E+00	2.195E+00	2.480E+00	2.913E+00	2.889E+00	2.818E+00	3.050E+00
M(t):	1.038E-01	9.452E-02	8.780E-02	9.922E-02	1.165E-01	1.155E-01	1.127E-01	1.220E-01

Maximum TDOSE(t): 3.050E+00 mrem/yr at t = 1.000E+03 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	3.068E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	5.442E-01	0.2098	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	3.337E-01	0.1286	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.672E+00	0.6443	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	2.917E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	4.458E-02	0.0172	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.594E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.068E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.442E-01	0.2098
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.337E-01	0.1286
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.672E+00	0.6443
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.917E-04	0.0001
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.458E-02	0.0172
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.594E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	2.966E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	5.418E-01	0.2293	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	4.875E-01	0.2063	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.164E+00	0.4925	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	8.720E-04	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.690E-01	0.0715	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.363E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.966E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.418E-01	0.2293
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.875E-01	0.2063
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.164E+00	0.4925
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.720E-04	0.0004
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.690E-01	0.0715
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.363E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	2.773E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	5.369E-01	0.2446	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	5.920E-01	0.2697	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	5.640E-01	0.2570	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	2.025E-03	0.0009	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	5.000E-01	0.2278	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.195E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.773E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.369E-01	0.2446
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.920E-01	0.2697
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.640E-01	0.2570
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.025E-03	0.0009
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.000E-01	0.2278
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.195E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	2.189E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	5.202E-01	0.2097	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	3.655E-01	0.1474	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	4.470E-02	0.0180	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	5.983E-03	0.0024	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.544E+00	0.6225	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.480E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.189E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.202E-01	0.2097
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.655E-01	0.1474
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.470E-02	0.0180
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.983E-03	0.0024
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.544E+00	0.6225
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.480E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	1.049E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	3.462E-01	0.1199	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	5.273E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	3.124E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	4.752E-02	0.0165	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.495E+00	0.8637	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.889E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.049E-06	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.462E-01	0.1199
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.273E-06	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.124E-16	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.752E-02	0.0165
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.495E+00	0.8637
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.889E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : Sub Surface 37 pCi Ind Wrkr 20 cm conc cont in 1st 15 cm at 15 pCi 5-8-17
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\IND WRKR SSUB CON IN 1ST 15 CM W 20 CM CC 37 PCI.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	1.114E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	4.752E-01	0.1631	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	3.247E-02	0.0111	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	3.196E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	1.665E-02	0.0057	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.389E+00	0.8200	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.913E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.114E-05	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.752E-01	0.1631
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.247E-02	0.0111
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.196E-05	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.665E-02	0.0057
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.389E+00	0.8200
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.913E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	1.226E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	1.401E-01	0.0497	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	7.840E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	9.892E-02	0.0351	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.579E+00	0.9152	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.818E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.226E-09	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.401E-01	0.0497
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.840E-17	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.892E-02	0.0351
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.579E+00	0.9152
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.818E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	6.693E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-226	5.909E-03	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	1.466E-01	0.0481	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.897E+00	0.9500	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.050E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pb-210	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.693E-20	0.0000
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.909E-03	0.0019
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.466E-01	0.0481
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.897E+00	0.9500
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.050E+00	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pb-210+D	Pb-210+D	1.000E+00	8.293E-07	8.018E-07	7.494E-07	5.917E-07	3.012E-07	2.835E-08	3.313E-11	1.809E-21
Ra-226+D	Ra-226+D	1.000E+00	3.628E-02	3.612E-02	3.579E-02	3.468E-02	3.168E-02	2.308E-02	9.341E-03	3.939E-04
Ra-226+D	Pb-210+D	1.000E+00	1.294E-08	3.818E-08	8.582E-08	2.262E-07	4.619E-07	5.441E-07	2.385E-07	1.102E-08
Ra-226+D	∑DSR(j)		3.628E-02	3.612E-02	3.579E-02	3.468E-02	3.168E-02	2.308E-02	9.341E-03	3.939E-04
Ra-228+D	Ra-228+D	1.000E+00	1.393E-02	1.229E-02	9.583E-03	4.005E-03	3.313E-04	5.391E-08	8.080E-19	0.000E+00
Ra-228+D	Th-228+D	1.000E+00	8.318E-03	2.021E-02	2.989E-02	2.036E-02	1.834E-03	2.976E-07	4.419E-18	0.000E+00
Ra-228+D	∑DSR(j)		2.224E-02	3.250E-02	3.947E-02	2.437E-02	2.165E-03	3.515E-07	5.227E-18	0.000E+00
Th-228+D	Th-228+D	1.000E+00	4.518E-02	3.145E-02	1.524E-02	1.208E-03	8.638E-07	8.443E-18	0.000E+00	0.000E+00
Th-230	Th-230	1.000E+00	1.703E-08	1.704E-08	1.705E-08	1.711E-08	1.726E-08	1.782E-08	1.951E-08	2.680E-08
Th-230	Ra-226+D	1.000E+00	7.866E-06	2.355E-05	5.472E-05	1.617E-04	4.501E-04	1.284E-03	2.673E-03	3.961E-03
Th-230	Pb-210+D	1.000E+00	1.875E-12	1.298E-11	6.699E-11	5.504E-10	3.687E-09	2.062E-08	5.581E-08	9.544E-08
Th-230	∑DSR(j)		7.883E-06	2.357E-05	5.474E-05	1.617E-04	4.501E-04	1.284E-03	2.673E-03	3.961E-03
Th-232	Th-232	1.000E+00	2.431E-09	2.432E-09	2.434E-09	2.443E-09	2.468E-09	2.559E-09	2.837E-09	4.068E-09
Th-232	Ra-228+D	1.000E+00	8.569E-04	2.436E-03	5.061E-03	1.047E-02	1.407E-02	1.460E-02	1.520E-02	1.752E-02
Th-232	Th-228+D	1.000E+00	3.479E-04	2.132E-03	8.453E-03	3.126E-02	5.049E-02	5.283E-02	5.450E-02	6.079E-02
Th-232	∑DSR(j)		1.205E-03	4.568E-03	1.351E-02	4.173E-02	6.456E-02	6.743E-02	6.971E-02	7.831E-02

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pb-210	3.015E+07	3.118E+07	3.336E+07	4.225E+07	8.300E+07	8.818E+08	7.545E+11	*7.634E+13
Ra-226	6.890E+02	6.922E+02	6.984E+02	7.209E+02	7.892E+02	1.083E+03	2.676E+03	6.347E+04
Ra-228	1.124E+03	7.692E+02	6.334E+02	1.026E+03	1.155E+04	7.111E+07	*2.726E+14	*2.726E+14
Th-228	5.533E+02	7.948E+02	1.640E+03	2.069E+04	2.894E+07	*8.195E+14	*8.195E+14	*8.195E+14
Th-230	3.172E+06	1.061E+06	4.567E+05	1.546E+05	5.555E+04	1.946E+04	9.351E+03	6.311E+03
Th-232	2.075E+04	5.473E+03	1.850E+03	5.991E+02	3.872E+02	3.708E+02	3.587E+02	3.192E+02

*At specific activity limit

Summary : Sub Surface 37 pCi Ind Wrkr 20 cm conc cont in 1st 15 cm at 15 pCi 5-8-17
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\IND WRKR SSUB CON IN 1ST 15 CM W 20 CM CC 37 PCI.RAD

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 1.000E+03 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pb-210	3.700E+01	0.000E+00	8.293E-07	3.015E+07	1.809E-21	*7.634E+13
Ra-226	1.500E+01	0.000E+00	3.628E-02	6.890E+02	3.939E-04	6.347E+04
Ra-228	1.500E+01	3.313 ± 0.007	3.956E-02	6.319E+02	0.000E+00	*2.726E+14
Th-228	3.700E+01	0.000E+00	4.518E-02	5.533E+02	0.000E+00	*8.195E+14
Th-230	3.700E+01	1.000E+03	3.961E-03	6.311E+03	3.961E-03	6.311E+03
Th-232	3.700E+01	1.000E+03	7.831E-02	3.192E+02	7.831E-02	3.192E+02

*At specific activity limit

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pb-210	Pb-210	1.000E+00	3.068E-05	2.966E-05	2.773E-05	2.189E-05	1.114E-05	1.049E-06	1.226E-09	6.693E-20
Pb-210	Ra-226	1.000E+00	1.941E-07	5.726E-07	1.287E-06	3.392E-06	6.929E-06	8.161E-06	3.577E-06	1.654E-07
Pb-210	Th-230	1.000E+00	6.937E-11	4.804E-10	2.479E-09	2.036E-08	1.364E-07	7.629E-07	2.065E-06	3.531E-06
Pb-210	∑DOSE(j)		3.088E-05	3.024E-05	2.902E-05	2.530E-05	1.821E-05	9.973E-06	5.643E-06	3.697E-06
Ra-226	Ra-226	1.000E+00	5.442E-01	5.418E-01	5.369E-01	5.202E-01	4.752E-01	3.462E-01	1.401E-01	5.908E-03
Ra-226	Th-230	1.000E+00	2.910E-04	8.714E-04	2.025E-03	5.983E-03	1.665E-02	4.752E-02	9.891E-02	1.466E-01
Ra-226	∑DOSE(j)		5.445E-01	5.427E-01	5.389E-01	5.262E-01	4.918E-01	3.937E-01	2.390E-01	1.525E-01
Ra-228	Ra-228	1.000E+00	2.089E-01	1.844E-01	1.437E-01	6.008E-02	4.969E-03	8.087E-07	1.212E-17	0.000E+00
Ra-228	Th-232	1.000E+00	3.171E-02	9.012E-02	1.873E-01	3.873E-01	5.207E-01	5.402E-01	5.625E-01	6.482E-01
Ra-228	∑DOSE(j)		2.406E-01	2.745E-01	3.310E-01	4.474E-01	5.257E-01	5.402E-01	5.625E-01	6.482E-01
Th-228	Ra-228	1.000E+00	1.248E-01	3.031E-01	4.483E-01	3.054E-01	2.750E-02	4.464E-06	6.628E-17	0.000E+00
Th-228	Th-228	1.000E+00	1.672E+00	1.164E+00	5.640E-01	4.470E-02	3.196E-05	3.124E-16	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	1.287E-02	7.888E-02	3.128E-01	1.157E+00	1.868E+00	1.955E+00	2.017E+00	2.249E+00
Th-228	∑DOSE(j)		1.809E+00	1.546E+00	1.325E+00	1.507E+00	1.895E+00	1.955E+00	2.017E+00	2.249E+00
Th-230	Th-230	1.000E+00	6.301E-07	6.304E-07	6.310E-07	6.330E-07	6.388E-07	6.594E-07	7.220E-07	9.917E-07
Th-232	Th-232	1.000E+00	8.993E-08	8.998E-08	9.007E-08	9.039E-08	9.133E-08	9.468E-08	1.050E-07	1.505E-07

THF(i) is the thread fraction of the parent nuclide.

Summary : Sub Surface 37 pCi Ind Wrkr 20 cm conc cont in 1st 15 cm at 15 pCi 5-8-17
File : C:\USERS\WGAUL\DOCUMENTS\TIDEH2O\WR GRACE\DCGL\7.2\USERFILES\4-11-17\IND WRKR SSUB CON IN 1ST 15 CM W 20 CM CC 37 PCI.RAD

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pb-210	Pb-210	1.000E+00	3.700E+01	3.576E+01	3.340E+01	2.631E+01	1.331E+01	1.225E+00	1.343E-03	5.855E-14
Pb-210	Ra-226	1.000E+00	0.000E+00	4.573E-01	1.320E+00	3.854E+00	8.072E+00	9.384E+00	3.861E+00	1.426E-01
Pb-210	Th-230	1.000E+00	0.000E+00	2.459E-04	2.157E-03	2.195E-02	1.559E-01	8.710E-01	2.221E+00	3.037E+00
Pb-210	∑S(j):		3.700E+01	3.622E+01	3.473E+01	3.019E+01	2.154E+01	1.148E+01	6.083E+00	3.179E+00
Ra-226	Ra-226	1.000E+00	1.500E+01	1.493E+01	1.479E+01	1.431E+01	1.302E+01	9.363E+00	3.648E+00	1.347E-01
Ra-226	Th-230	1.000E+00	0.000E+00	1.599E-02	4.775E-02	1.566E-01	4.483E-01	1.277E+00	2.567E+00	3.333E+00
Ra-226	∑S(j):		1.500E+01	1.495E+01	1.484E+01	1.447E+01	1.347E+01	1.064E+01	6.215E+00	3.468E+00
Ra-228	Ra-228	1.000E+00	1.500E+01	1.324E+01	1.031E+01	4.305E+00	3.546E-01	5.688E-05	8.177E-16	0.000E+00
Ra-228	Th-232	1.000E+00	0.000E+00	4.193E+00	1.116E+01	2.548E+01	3.488E+01	3.571E+01	3.568E+01	3.555E+01
Ra-228	∑S(j):		1.500E+01	1.743E+01	2.148E+01	2.978E+01	3.524E+01	3.571E+01	3.568E+01	3.555E+01
Th-228	Ra-228	1.000E+00	0.000E+00	4.270E+00	8.019E+00	5.957E+00	5.405E-01	8.677E-05	1.247E-15	0.000E+00
Th-228	Th-228	1.000E+00	3.700E+01	2.575E+01	1.248E+01	9.878E-01	7.040E-04	6.804E-15	0.000E+00	0.000E+00
Th-228	Th-232	1.000E+00	0.000E+00	6.888E-01	4.580E+00	2.059E+01	3.444E+01	3.571E+01	3.568E+01	3.555E+01
Th-228	∑S(j):		3.700E+01	3.071E+01	2.508E+01	2.753E+01	3.498E+01	3.571E+01	3.568E+01	3.555E+01
Th-230	Th-230	1.000E+00	3.700E+01	3.700E+01	3.700E+01	3.699E+01	3.698E+01	3.695E+01	3.684E+01	3.649E+01
Th-232	Th-232	1.000E+00	3.700E+01	3.700E+01	3.700E+01	3.700E+01	3.699E+01	3.698E+01	3.694E+01	3.682E+01

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 0.96 seconds

ATTACHMENT B

Pre-Design Investigation Groundwater Results for Building 23 and Background Groundwater Results (Same Analyses) from the Remedial Investigation at the RWDA

Pre-Design Investigation Groundwater Results for Building 23 and Background Groundwater Results (Same Analyses) from the Remedial Investigation at the RWDA
W.R. Grace Curtis Bay

				Pre-Design Investigation (2017)			RWDA Remedial Investigation - Groundwater Background Location MW-9D					
			Location ID	MW-2-GW1	PW-1-GW1	PW-1-GW2	MW-9D-GW [1]		MW-9D		DUP-1	
			Sample Date	2/27/2017	2/27/2017	2/28/2017	11/17/1999	11/17/1999	5/31/2000	5/31/2000	5/31/2000	5/31/2000
			Parent Sample								MW-9D	
Analyte	Unit	EPA MCL	10 CFR 20 Appendix B, Table 3[2]				total	dissolved	total	dissolved	total	dissolved
Isotopic Uranium (Isotopic Uranium)												
Uranium-234	pCi/L	Total U (see below)	3,000	0.546	0.801	0.532	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed
Uranium-235	pCi/L		3,000	< 0.453 U	< 0.471 U	< 0.284 U	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed
Uranium-238	pCi/L		3,000	< 0.421 U	0.624	0.227	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed
Total Uranium (calculated)	ug/L	30	n/a	8.74E-08	1.86E-03	6.77E-04	n/a	n/a	n/a	n/a	n/a	n/a
Isotopic Thorium (A-01-R MOD)												
Thorium-228	pCi/L	none	2,000	1.09	0.862	< 0.895 U	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed
Thorium-230	pCi/L	none	1,000	0.882	1.32	1.58	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed
Thorium-232	pCi/L	none	300	< 0.413 U	< 0.493 U	< 0.482 U	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed
Radium-226 (E903.0) and Radium-228 (E904.0)												
Radium-226	pCi/L	Total Ra (see below)	600	< 0.282 U	0.235	0.435	3.05	not analyzed	<0.12	<0.16	<0.13	<0.16
Radium-228	pCi/L		600	< 0.851 U	< 0.807 U	1.29	7.21	not analyzed	2.21	0.71	1.83	0.96
Radium-226 + Radium-228 (calculated)	pCi/L	5	n/a	U	0.235	1.73	10.26	n/a	2.21	0.71	1.83	0.96
Flash Point (SW1010)												
Flash Point	deg C	n/a	n/a	>60	>60	>60	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed	not analyzed
Metals (SW6010C & SW7470A)												
Arsenic	ug/L	10	n/a	3100	2400	1200 F1	<1.7 U	<1.7 U	not analyzed	not analyzed	not analyzed	not analyzed
Barium	ug/L	2,000	n/a	< 110 U	< 110 U	< 560 U	60 B	218	not analyzed	not analyzed	not analyzed	not analyzed
Cadmium	ug/L	5	n/a	< 11 U	< 11 U	< 56 U F1	<0.2 U	<0.2 U	not analyzed	not analyzed	not analyzed	not analyzed
Chromium	ug/L	100	n/a	9.8 J	10 J	< 110 U F1	<0.7 U	<0.7 U	not analyzed	not analyzed	not analyzed	not analyzed
Lead	ug/L	15	n/a	12 J	19 J	< 110 U F1	1.9B	<1.1 U	not analyzed	not analyzed	not analyzed	not analyzed
Mercury	ug/L	2	n/a	4.5 B	1.4 JB	0.12 J	0.17 B	0.17 B	not analyzed	not analyzed	not analyzed	not analyzed
Selenium	ug/L	50	n/a	230	76	< 180 U F1	2 B	1.9 B	not analyzed	not analyzed	not analyzed	not analyzed
Silver	ug/L	none	n/a	< 23 U	< 23 U	< 110 U	<3.2 U	<3.2 U	not analyzed	not analyzed	not analyzed	not analyzed
Organochlorine Pesticides (SW8081B)												
Chlordane, Technical	ug/L	2	n/a	< 5 U	< 5 U	< 5 U	<0.01 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Endrin	ug/L	2	n/a	0.25 J	< 0.05 U	< 0.05 U	<0.03 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Gamma-BHC (Lindane)	ug/L	0.2	n/a	0.26 J	< 0.02 U	< 0.02 U	<0.0081 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Heptachlor	ug/L	0.4	n/a	< 0.05 U	< 0.05 U	< 0.05 U	<0.02 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Heptachlor epoxide	ug/L	0.2	n/a	0.31 J	< 0.05 U	< 0.05 U	<0.01 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Methoxychlor	ug/L	40	n/a	0.35 J	< 0.05 U	< 0.05 U	<0.08 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Toxaphene	ug/L	3	n/a	< 20 U	< 20 U	< 20 U	<0.49 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Polychlorinated Biphenyls (SW8082A)												
Aroclor 1016	ug/L	0.5	n/a	< 1 U	< 0.77 U	< 0.77 U	<0.33 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Aroclor 1221	ug/L	0.5	n/a	< 1 U	< 0.77 U	< 0.77 U	<0.32 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Aroclor 1232	ug/L	0.5	n/a	< 1 U	< 0.77 U	< 0.77 U	<0.29 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Aroclor 1242	ug/L	0.5	n/a	< 1 U	< 0.77 U	< 0.77 U	<0.3 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Aroclor 1248	ug/L	0.5	n/a	< 1 U	< 0.77 U	< 0.77 U	<0.09 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Aroclor 1254	ug/L	0.5	n/a	< 0.38 U	< 0.29 U	< 0.29 U	<0.44 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Aroclor 1260	ug/L	0.5	n/a	< 0.38 U	< 0.29 U	< 0.29 U	<0.41 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Volatile Organic Compounds (SW8260C)												
1,1-dichloroethene	ug/L	7	n/a	< 10 U	< 10 U	< 10 U	<0.6 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed

Pre-Design Investigation Groundwater Results for Building 23 and Background Groundwater Results (Same Analyses) from the Remedial Investigation at the RWDA
W.R. Grace Curtis Bay

				Pre-Design Investigation (2017)			RWDA Remedial Investigation - Groundwater Background Location MW-9D					
Location ID				MW-2-GW1	PW-1-GW1	PW-1-GW2	MW-9D-GW [1]		MW-9D		DUP-1	
Sample Date				2/27/2017	2/27/2017	2/28/2017	11/17/1999	11/17/1999	5/31/2000	5/31/2000	5/31/2000	5/31/2000
Parent Sample											MW-9D	
1,2-dichloroethane	ug/L	5	n/a	< 10 U	< 10 U	< 10 U	<0.2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
2-butanone	ug/L	none	n/a	< 50 U	< 50 U	< 50 U	<0.4 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Benzene	ug/L	5	n/a	< 10 U	< 10 U	< 10 U	<0.3 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Carbon tetrachloride	ug/L	5	n/a	< 10 U	< 10 U	< 10 U	<0.4 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Chlorobenzene	ug/L	100	n/a	< 10 U	< 10 U	< 10 U	<0.2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Chloroform	ug/L	none	n/a	< 10 U	< 10 U	< 10 U	8	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Tetrachloroethene	ug/L	5	n/a	< 10 U	< 10 U	< 10 U	<0.3 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Trichloroethene	ug/L	5	n/a	< 10 U	< 10 U	< 10 U	<0.4 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Vinyl chloride	ug/L	2	n/a	< 10 U	< 10 U	< 10 U	<0.6 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Semivolatile Organic Compounds (SW8270D)												
1,4-dichlorobenzene	ug/L	75	n/a	< 15 U	< 15 U	< 15 U	<2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
2,4,5-trichlorophenol	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<3 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
2,4,6-trichlorophenol	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
2,4-dinitrotoluene	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<23 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
2-methylphenol	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
3- And 4- Methylphenol (Total)	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Hexachloro-1,3-butadiene	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Hexachlorobenzene	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<3 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Hexachloroethane	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Nitrobenzene	ug/L	none	n/a	< 15 U	< 15 U	< 15 U	<3 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Pentachlorophenol	ug/L	1	n/a	< 50 U	< 50 U	< 50 U	<2 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Pyridine	ug/L	none	n/a	< 50 U	< 50 U F2	< 50 U	not analyzed	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Herbicides (SW846 8151A)												
2,4,5-TP (silvex)	ug/L	50	n/a	< 5 U*	< 5 U*	< 5 U*	not analyzed	n/a	not analyzed	not analyzed	not analyzed	not analyzed
2,4-D	ug/L	70	n/a	< 25 U*	< 25 U*	< 25 U*	not analyzed	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Cyanide (SW846 9012B)												
Cyanide	ug/L	200	n/a	< 5 U	5 J	3.7 J	<10 U	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Sulfide (SW9034)												
Sulfide	mg/L	none	n/a	< 5.5 U	< 5.5 U	< 5.5 U	not analyzed	n/a	not analyzed	not analyzed	not analyzed	not analyzed
Ph (SW9040C)												
pH	pH units	none		9.6 HF	10 HF	8.3 HF	not analyzed	n/a	not analyzed	not analyzed	not analyzed	not analyzed

Notes:
degC = degrees Celsius
mg/L = milligrams per liter
pCi/g = picocuries per gram
ug/L = micrograms per liter
* = Laboratory control sample outside acceptance limits
B = Analyte was detected in laboratory method blank as well as sample (Hg in blank = 0.339 ug/L)
F1 = Matrix spike percent recovery outside control limits
F2 = Matrix spike and duplicate percent difference exceeds control limits
HF = Field parameter with holding time of 15 minutes tested at the laboratory
J = Approximate value, less than reporting limit but greater than or equal to detection limit
U = Not detected; value listed is limit of detection

[1] From Page 5-45 (last bullet) from the RWDA RI: "The background sample (MW-9D) showed low levels of total and dissolved gross alpha and beta radioactivity ranging from 4.82 to 6.41 pCi/L. Total 228Ra was also reported slightly above the detection limit at 30.9 pCi/L. Isotopic analysis of MW-9D showed radioactivity levels of 3.05 pCi/L 226Ra and 7.21 pCi/L 228Ra for the total aliquot. Isotopic analysis was not performed on the dissolved aliquot for the MW-9D sample. As a result of the elevated 226Ra and 228Ra reported in the total aliquots, MW-9D was resampled in May 2000. The reanalysis of MW-9D and its duplicate showed elevated levels of gross alpha and beta in the total and dissolved aliquots (37.4 to 49 pCi/L total alpha and 2.12 to 7.0 pCi/L dissolved alpha, and 58.7 to 64.4 pCi/L total beta and 19.7 to 29.5 pCi/L dissolved beta)."

[2] Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage

APPENDIX C

DERIVATION OF REVISED DCGL VALUES FOR BUILDING COMPONENTS

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DERIVATION OF REVISED DCGL VALUES FOR BUILDING COMPONENTS

C.1 INTRODUCTION

The purpose of this attachment is to develop derived concentration guideline levels (DCGLs) for building components based on the benchmark dose (7.37 millirem per year [mrem/yr]) identified in the Record of Decisions (ROD) for Building 23, signed 17 May 2005, to reflect current and anticipated site conditions at Building 23. Results of the DCGL analyses and the underlying methodology of development will be documented (consistent with the text of this attachment) in an appendix to the ROD Amendment for Building 23, which is currently being prepared by the U.S. Army Corps of Engineers (USACE), Baltimore District. Dose modeling consists of ascertaining that an acceptable dose modeling computer code or other type of calculation has been used; the input parameter values are appropriate, reasonable considering long-term conditions, and representative of the application for the site; and that a realistic dose estimate is provided. Detailed discussion regarding development of the benchmark dose was included in the ROD for Building 23, signed 17 May 2005. This attachment documents the methodology, input parameters, and output of the RESRAD-BUILD modeling used to establish revised DCGLs for building components in Building 23.

C.2 SITE BACKGROUND

A summary of the site background is provided in the Proposed Remedial Action Plan (PRAP). The radionuclides of concern for the site, associated with the monazite sand processing that occurred in the southwest quadrant of Building 23, are thorium-232 (^{232}Th) and uranium-238 (^{238}U) together with their decay progeny. As outlined in the PRAP, the purpose of the ROD Amendment currently being prepared by USACE is to clarify the rationale for a fundamental change in the remedy from decontamination and removal of components within the southwest quadrant of Building 23 to demolition of the southwest quadrant of Building 23. In addition to this fundamental change, the remedial goals for building surfaces have been updated to reflect the most up-to-date site conditions and guidance, as described in this attachment.

C.3 SELECTION OF COMPUTER CODE/MODEL

The RESRAD family of codes was developed by Argonne National Laboratory under sponsorship of the Department of Energy. The RESRAD code is a pathway analysis model designed to evaluate potential radiological doses to an average member of a specific critical group. The RESRAD deterministic code has been widely utilized by Nuclear Regulatory Commission staff and Licensees, USACE, and the U.S. Environmental Protection Agency to estimate doses. RESRAD-BUILD (Version 3.1) was previously utilized for dose modeling to determine DCGLs for building surfaces at the site, as documented in the ROD for Building 23, signed 17 May 2005. The updated DCGLs in this attachment were developed using RESRAD-BUILD Version 3.5.

C.4 INPUT PARAMETERS FOR RESRAD-BUILD

The conceptual model for the DCGL calculation is an industrial worker in an enclosed room, with residual ^{232}Th in equilibrium with its decay daughters and uniformly distributed on potentially

impacted elements within the room. The assumption that the total residual activity remaining from monazite processing operations is from ^{232}Th and its decay daughters is conservative, as the ^{232}Th with decay daughters results in 3.25 times the dose per picocurie (pCi) as ^{238}U with decay daughters (NUREG 5512 Vol. 3 Table 5.19). In addition, this assumption is reasonable since literature values for the composition of monazite sand and site-specific characterization data for the W.R. Grace FUSRAP site indicate a radiological profile that is dominated by thorium-232 and decay progeny (the literature value for the Th-232:U-238 ratio for monazite sand is, at a minimum, 2:1, and site-specific characterization data for radiologically-impacted building surfaces in the southwest quadrant of Building 23 indicates an average Th-232:U-238 ratio of 12.5[1]).

Table C-1 summarizes the exposure parameters that were input into the RESRAD-BUILD model to calculate updated DCGLs for building surfaces that would provide a dose equivalent to the benchmark dose of 7.37 mrem/year. The exposure parameters presented in Table C-1 are consistent with those used previously for the calculation of the DCGLs documented in the ROD for Building 23, signed 17 May 2005, except for the following changes:

- The input parameter for removable fraction was updated to reflect new site-specific data collected during remedial actions and interim FSS activities (conducted from 2011 through 2013) and during additional characterization activities conducted by USACE (2015/2016) (see Section C.4.2).
- The input parameters for source geometry (see Section C.4.3) were updated to reflect the anticipated as-left (future use) conditions based on a building demolition remedy (versus the decontamination remedy identified in the ROD). In addition, multiple receptor locations were modeled to assess sensitivity of a receptor's geometry to the total modeled dose.
- The dose/risk library provided in RESRAD-BUILD Version 3.5 (FGR 12) was used for modeling.

The specifics of the site-specific exposure parameters input to RESRAD-BUILD are detailed in Sections C.4.1 through C.4.4.

C.4.1 Exposure Duration

The industrial worker is assumed to work 250 days per year (5 days per week for 50 weeks) for 25 years, which was determined to be a reasonable assumed length of a worker's employment at W.R. Grace. Because no exposure is allocated for time spent outside the building, it was assumed the industrial worker would spend 8 hours a day in the southwest quadrant of Building 23, and no time outdoors. Thus, the indoor fraction is 0.229. This exposure duration is consistent with the duration specified in the ROD for Building 23, signed 17 May 2005.

[1] Evaluation included analytical data from concrete core sampling conducted during the remedial investigation of the southwest quadrant of Building (EA Engineering, Science, and Technology, Inc., *Final Remedial Investigation Report of Building 23 at W.R. Grace Curtis Bay Facility, Baltimore, Maryland*, April 2002). The data set was screened to include only locations with Th-232 results greater than the 1 pCi/g.

TABLE C-1. INPUT PARAMETERS FOR RESRAD-BUILD

Input Parameter	Unit	Value	Site-Specific or Default Value
Dose/Risk Library	NA	FGR 12	Site-Specific
Exposure Duration	d	250	Site-Specific
Indoor Fraction	Unitless	0.229	Site-Specific
Evaluation Times	yr	0, 1, 10, 100, 1000	Site-Specific
Number of Rooms	NA	1	Site-Specific
Room area	m^2	33.2	Site-Specific
Room height	m	4.27	Site-Specific
Deposition Velocity	m/s	0.01	Default
Resuspension Rate	1/s	5E-07	Default
Building Exchange Rate	1/h	0.8	Default
Activity	dpm	Unit specified	Site-Specific
Dose	mrem	Unit specified	Site-Specific
Number of Receptors	--	1	Site-Specific
Time Fraction	Unitless	1	Site-Specific
Breathing Rate	m^3/d	18	Default
Ingestion Rate (Dust Inhalation)	1/h	0.0001	Default
Receptor Location: Scenario 1 Scenario 1A Scenario 1B	 -- -- --	 Center of room, standing on floor Equidistant between 2 existing columns, standing on floor Next to one existing column, standing on floor	Site-Specific
Shielding thickness	cm	0	Site-Specific
Density (g/cc)	g/cc	2.4	Default
Material	--	Concrete	Default
Source Type	--	Line	Site-Specific
Air Fraction	Unitless	0.1	Default
Direct Ingestion Rate	1/h	0	Site-Specific
Removable Fraction	Unitless	0.1	Site-Specific
Lifetime	d	3650	Site-Specific
Radon release fraction	Unitless	0.1	Default
Source geometry	--	Area	Site-Specific
Contamination: Thorium-232 Thorium-228 Radium-228	 dpm/m^2 dpm/m^2 dpm/m^2	 1.630E+05 1.630E+05 1.630E+05	Site-Specific

1/h = per hour
1/s = per second
cm = centimeter(s)
d = day(s)
dpm/m^2 = disintegrations per minute per square meter
m = meter
m^2 = square meter
m/s = meter(s) per second
m^3/d = cubic meter(s) per day
NA = not applicable
yr = year

C.4.2 Removable Activity Parameters

The removable activity parameters in RESRAD-BUILD include the removable fraction and lifetime. The removable fraction is a decimal percentage of the surface activity that is removable. The balance of activity is assumed to be fixed on the surface. The lifetime is the time period over which the removable fraction is linearly removed. After a period of time equal to the lifetime, only fixed activity remains.

In the 2005 ROD, the Removable Fraction parameter for RESRAD-BUILD modeling was set at 0.2, which was a conservative assumption based on RI data. However, additional data has been collected by the RACs since finalization of the ROD, and the expanded data set does not support a Removable Fraction parameter of 0.2 for RESRAD-BUILD modeling. An updated removable fraction was calculated from co-located direct measurements and removable activity wipes collected and analyzed during the remedial action and interim FSS activities (conducted from 2011 through 2013) and during additional characterization activities conducted by USACE (2015/2016).

A summary of statistics for the total and removable activity results is provided in Table C-2. Paired measurements (co-located direct measurements and removable activity) were evaluated. The data set was screened to include only locations with results greater than the minimum detectable concentration. In addition, one location with removable fraction of 1.3 was revised to 1.0 (since a fractional result greater than 1 is not physically possible). Results for the removable fraction for alpha activity ranged from 0.00032 to 1, with an average of 0.029 for the 354 paired measurements evaluated. Results for the removable fraction for beta activity ranged from 0.00081 to 0.28, with an average of 0.028 for the 90 paired measurements evaluated. As shown in Table C-2 and Figures C-1 and C-2, the distribution of the removable fraction for both the alpha and beta activity is similar. The 95th percentile of the removable fractions for alpha and beta are 0.087 and 0.106, respectively. Based on these results and to be conservative, the RESRAD-BUILD removable fraction parameter for alpha and beta activity was set to 0.1. This value is consistent with default RESRAD and NRC parameters for removable fraction and is a valid and conservative value for use at this site.

Table C-2. Summary of Statistics for Total and Removable Activity[(a),(b)]

Removed Fraction	Alpha	Beta
Number of Samples (N)	354	90
Average	0.029	0.028
Minimum	0.00032	0.00081
Maximum	1	0.28
90th Percentile	0.063	0.071
95th Percentile	0.087	0.106

Notes:

(a) Data used to develop the summary of statistics is provided in Attachment C-1 (end of this attachment).
(b) Paired measurements (co-located direct measurements and removable activity) were evaluated. The data set was screened to include only locations with results greater than the minimum detectable concentration. In addition, one location with removable fraction of 1.3 was revised to 1.0 (since a fractional result greater than 1 is not physically possible).

Figure C-1. Distribution of Removable: Total Fractions for Alpha Activity for the Southwest Quadrant of Building 23 (Historical Data)

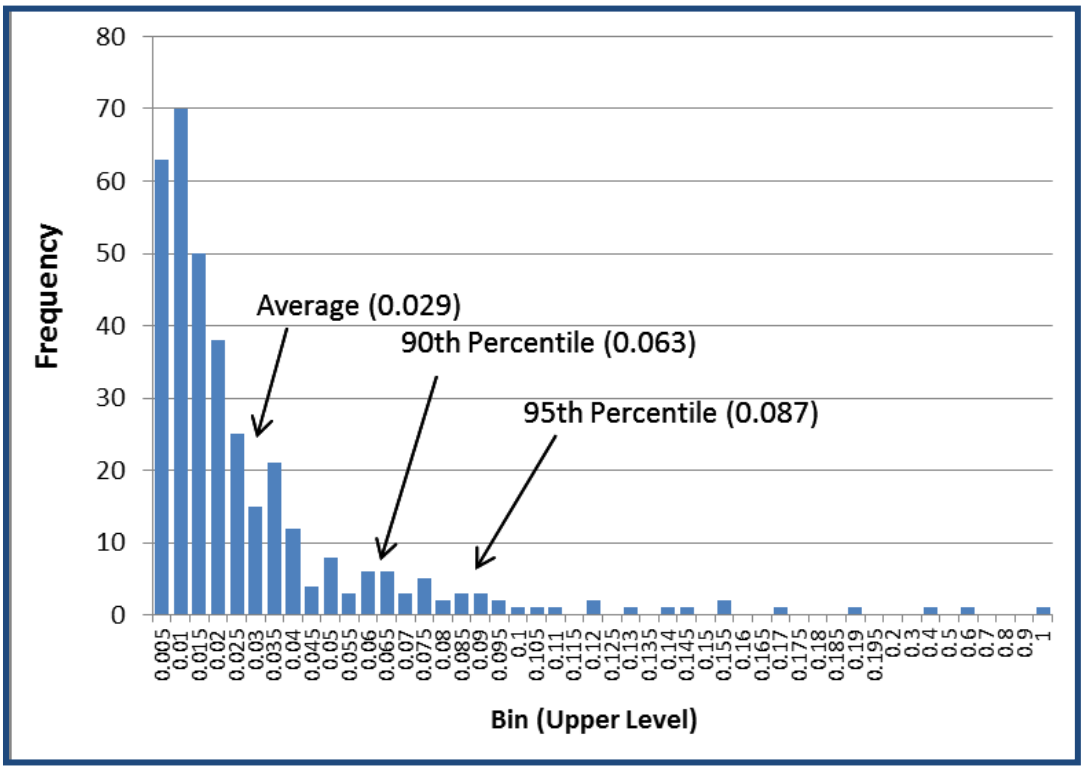
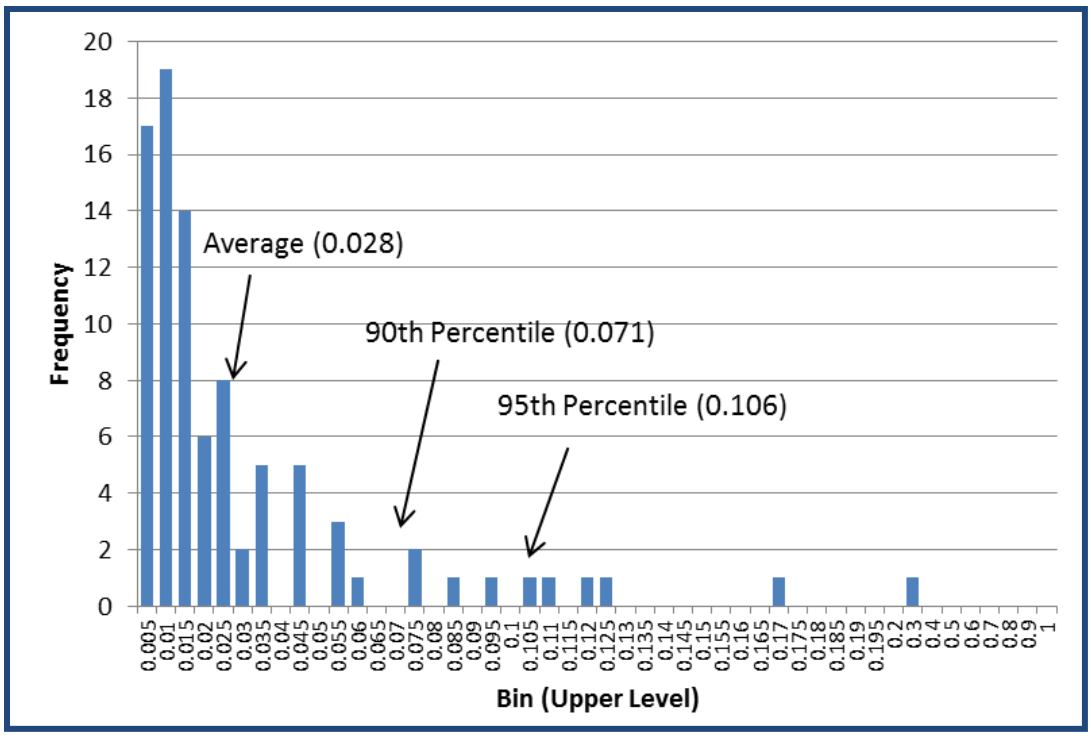


Figure C-2. Distribution of Removable: Total Fractions for Beta Activity for the Southwest Quadrant of Building 23 (Historical Data)



The remaining lifetime of removable activity was set to 10 years (3,650 days), consistent with the value used in the ROD for Building 23. This is a conservative estimate, based on the fact that monazite sand processing activities in the southwest quadrant of Building 23 ended before 1960, and removable activity remains on surfaces to the present (approximately 60 years).

C.4.3 Source and Receptor Geometry

Modeling conducted during preparation of the 2005 ROD included use of a room size of 5m (l) x 5m (w) x 3m (h), with residual ^{232}Th in equilibrium with its decay daughters homogeneously distributed over the floor, wall, and ceiling surfaces. This room size was based upon room dimensions that were currently present within the southwest quadrant and that were anticipated to be left-in-place at the completion of decontamination activities (the remedy selected in the ROD).

However, upon completion of the amended remedy, which includes demolition of the southwest quadrant of Building 23, no rooms will remain. The only remaining building components associated with the southwest quadrant that will remain in place after demolition are structural columns and beams located along the northern and eastern edges of the quadrant. Therefore, the room size used in the modeling from the 2005 ROD is no longer representative of as-left building conditions. Based on USACE review of the anticipated future configuration for Building 23, it was determined reasonable that the property owner might construct a room in the vicinity of the remaining structural columns/beams, and that the room size would be similar to the process control room that is currently present in the northern quadrant of Building 23. As such, the following room size was selected for use in RESRAD-BUILD modeling:

6.40 m (length) x 5.18 m (width) x 4.27 m (height)

To be both reasonable and conservative, the modeled room configuration was based on a hypothetical new room of this size constructed in the corner where the northern and eastern edges of the southwest quadrant meet (where the northeast corner of the southwest quadrant is currently located), on top of the new slab placed following demolition of the southwest quadrant. For this room configuration, existing structural steel columns are located at three corners of the room. Note that no existing structural beams would be located within the room because the first beam in this location is at a height of 5.5m above ground surface, and the most likely hypothetical room configuration was determined to be on the concrete slab, with a wall height of less than 5m.

To model this updated room configuration, residual ^{232}Th in equilibrium with its decay daughters was distributed uniformly along the three existing structural steel columns within the room (note: this is a change from the ROD, where residual ^{232}Th in equilibrium with its decay daughters was assumed to be homogeneously distributed over the floor, wall, and ceiling surfaces of the room, because these surfaces were to remain within Building 23).

C.4.4 Shielding, Direct Ingestion, and Radon Release Fraction

No shielding was incorporated into the RESRAD-BUILD model (i.e., the shielding parameter was set to 0). Based on the industrial use of the building, the direct ingestion parameter was also set to 0. The radon release fraction was set to 0.1, the default value, consistent with the RESRAD-BUILD model presented in the 2005 ROD.

C.5 RESULTS OF RESRAD-BUILD CALCULATIONS

C.5.1 Calculation of DCGL$_W$

To calculate the DCGL$_W$ for building surfaces that would provide a dose equivalent to the benchmark dose of 7.37 mrem/year, RESRAD-BUILD was run for the scenario described above (designated Scenario 1), with the receptor standing on the floor in the center of the room (see Section C.5.2 for sensitivity analysis relative to receptor position). Using a source activity of 163,000 disintegrations per minute per square meter (dpm/m^2) for each of the 3 longest lived members of the thorium decay series (^{232}Th, ^{228}Th and ^{228}Ra) distributed uniformly along the three existing structural steel columns (at the corners of the room) results in a peak dose of 7.34 mrem/yr at time zero under this scenario, slightly less than the modeled benchmark dose of 7.37 mrem/yr (note: the remaining seven thorium decay chain members are short lived and are accounted for in the calculation of exposure from the three longer-lived members of the decay series, as described below). The RESRAD-BUILD output for this scenario is included as Attachment C-2 (end of this attachment).

To properly represent the exposure from the entire thorium series, the source activity (163,000 dpm/m^2) is multiplied by 10, yielding 1,630,000 dpm/m^2 (16,300 dpm/100 cm^2). This activity is the DCGL$_W$ for ^{232}Th in equilibrium with its daughters and is the average activity that could be uniformly distributed over 100 square meters (m^2), as defined in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) without resulting in an exceedance of the benchmark dose (7.37 mrem/yr). Utilizing the 6:4 ratio of alpha to beta decays in the ^{232}Th decay series, the DCGL$_W$ values (in dpm/100 cm^2) for alpha and beta components for 100 m^2 areas in Building 23 are the following:

Alpha activity: DCGL$_W$ = 16,300 dpm/100 cm^2 x 0.6 = **9,780 dpm/100 cm^2**

Beta activity: DCGL$_W$ = 16,300 dpm/100 cm^2 x 0.4 = **6,520 dpm/100 cm^2**

The complete RESRAD-BUILD output is included as Attachment C-2 (end of this attachment).

C.5.2 Sensitivity Analysis of DCGL$_W$ Calculation Relative to Receptor Position

In addition to Scenario 1, with the receptor in the center of the room (equidistant between the three existing columns), two additional modeling scenarios were evaluated as part of the DCGL$_W$ development for Building 23, to assess sensitivity of the total modeled dose to the receptor's location:

- Scenario 1A – the receptor was placed equidistant between two of the three existing structural steel columns; and
- Scenario 1B – the receptor was placed next to one of the three existing structural columns.

Modeling evaluation of Scenarios 1A and 1B used the modeling parameters identified in Table C-1 and the calculated activity of 163,000 dpm/m^2 (see Section C.5.1), with only the receptor location varied relative to Scenario 1. Results for these scenarios are discussed below.

Scenario 1A – Using a source activity of 163,000 dpm/m^2 for each of the 3 longest lived members of the thorium decay series (^{232}Th, ^{228}Th and ^{228}Ra) uniformly distributed along the three existing structural steel columns (at the corners of the room), and with the receptor standing on the floor equidistant between two existing columns, results in a peak dose of 7.35 mrem/yr at time zero, slightly higher than was modeled for Scenario 1 and slightly less than the modeled benchmark dose of 7.37 mrem/yr. The RESRAD-BUILD output for this scenario is included as Attachment C-3 (end of this attachment).

Scenario 1B – Using a source activity of 163,000 dpm/m^2 for each of the 3 longest lived members of the thorium decay series (^{232}Th, ^{228}Th and ^{228}Ra) uniformly distributed along the three existing structural steel columns (at the corners of the room), and with the receptor standing on the floor next to one of the existing columns, results in a peak dose of 7.37 mrem/yr at time zero, slightly higher than was modeled for Scenarios 1 or 1A, and equal to the modeled benchmark dose of 7.37 mrem/yr. The RESRAD-BUILD output for this scenario is included as Attachment C-4 (end of this attachment).

A review of the modeling results for the three scenarios (see page 9 of each RESRAD-BUILD output, Attachments C-2, C-3, and C-4) indicates that there is minimal sensitivity for receptor position relative to the sources within the modeled room, due to the following factors:

1) The external dose, although fluctuating based on the receptor's position, is a very small component of the total dose (less than 0.1%); and
2) The inhalation dose (the main dose driver) and the radon dose, which together account for greater than 99% of the total dose, do not fluctuate based on the receptor's position (i.e., the RESRAD model calculates the same doses no matter where the receptor is positioned with respect to the sources in the modeled room).

Based on this sensitivity analysis, the source activity of 163,000 dpm/m^2 is appropriate for calculation of the $DCGL_W$ values for alpha and beta activity, and the DCGL values presented in Section C.5.1 are appropriate for use at Building 23.

C.5.3 Calculation of $DCGL_{EMC}$

As specified in the 2005 ROD (Section 4.4.2), DCGL-Elevated Measurement Criteria ($DCGL_{EMC}$) values for localized areas of elevated radionuclide concentrations on various media will be calculated, if needed, in accordance with MARSSIM and documented in the work plan for demolition of the southwest quadrant of Building 23. $DCGL_{EMC}$ values will be reviewed and approved by USACE prior to implementation.

ATTACHMENT C-1

HISTORICAL DATA FOR REMOVABLE FRACTION EVALUATION

ATTACHMENT C-1

Attachment C-1 includes a statistical summary of the total and removable activity results for the southwest quadrant of Building 23 (shown below), as well as the data tables for alpha and beta activity (subsequent pages of this attachment) that were used to prepare the statistical summary.

Removed Fraction	Alpha	Beta
N (number of samples)	354	90
Average	0.029	0.028
Minimum	0.00032	0.00081
Maximum	1	0.28
90^{th} Percentile	0.063	0.071
95^{th} Percentile	0.087	0.106

The following alpha and beta data tables present the co-located direct measurements and removable activity wipes for the southwest quadrant of Building 23 that were collected and analyzed during the remedial action and interim FSS activities (conducted from 2011 through 2013) and during additional characterization activities conducted by USACE (2015/2016). These data tables are a subset of the historical data for the southwest quadrant collected since 1999 (RI conducted by USACE) through January 2016 (characterization activities conducted by USACE). The 1999-2016 historical data set was screened to include only paired measurements (co-located direct measurements and removable activity) and to include only locations with results greater than the minimum detectable concentration. In addition, one location with removable fraction of 1.3 was revised to 1.0 (since a fractional result greater than 1 is not physically possible).

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Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP12041-XXX2	2/15/2012	5473	42.1	10	8.1	0.001827151	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX11	4/3/2012	7985	164.5	42	8.4	0.005259862	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX12	4/3/2012	2324	156	18	8.4	0.007745267	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX7	4/3/2012	4782	160.3	39	8.4	0.008155583	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12093-XXX1	5/2/2012	4631	113.6	44	7.8	0.009501188	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12042-XXX2	2/15/2012	5779	44.3	55	8.1	0.009517218	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12093-XXX5	5/2/2012	1723	87.4	17	7.8	0.009866512	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12099-XXX3	5/3/2012	972	51	10	7.5	0.010288066	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12033-XXX1	2/8/2012	938	23.2	10	8.2	0.010660981	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12105-XXX2	5/4/2012	829	71.4	9	7.6	0.010856454	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12033-XXX2	2/8/2012	1189	23.2	14	8.2	0.011774601	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12042-XXX1	2/15/2012	5244	44.3	66	8.1	0.012585812	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12041-XXX1	2/15/2012	6258	42.1	79	8.1	0.012623841	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12105-XXX1	5/4/2012	2284	65.5	30	7.6	0.013134851	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX10	4/3/2012	6495	172.5	88	8.4	0.013548884	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX21	4/3/2012	4328	117	64	8.4	0.014787431	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX26	4/3/2012	3555	63.2	53	8.4	0.014908579	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12097-XXX1	5/2/2012	1220	66.5	19	7.3	0.01557377	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12093-XXX2	5/2/2012	8464	77.8	134	7.8	0.015831758	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12099-XXX2	5/3/2012	1206	65.5	21	7.5	0.017412935	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12041-XXX3	2/15/2012	14884	42.1	267	8.1	0.017938726	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP13084-XXX6	7/30/2013	13067	140.5	243	6.7	0.018596464	dpm/100 cm2	1ST FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX19	4/3/2012	1812	107.2	34	8.4	0.018763797	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12096-XXX6	5/2/2012	1057	98.1	20	7.3	0.018921476	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX8	4/3/2012	4367	142.2	85	8.4	0.019464163	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX3	4/3/2012	717	105.2	15	8.4	0.020920502	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12093-XXX4	5/2/2012	1766	82.8	38	7.8	0.021517554	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX4	4/3/2012	456	98.1	10	8.4	0.021929825	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX27	4/3/2012	3541	58	99	8.4	0.027958204	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX9	4/3/2012	3707	170.6	107	8.4	0.028864311	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12033-XXX5	2/8/2012	288	23.2	10	8.2	0.034722222	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12099-XXX1	5/3/2012	339	65.5	12	7.5	0.03539823	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12034-XXX3	2/8/2012	265	20.4	10	8.2	0.037735849	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP13084-XXX5	7/30/2013	1354	46.6	54	6.7	0.039881832	dpm/100 cm2	1ST FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12100-XXX8	5/3/2012	214	58	9	7.5	0.042056075	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12033-XXX4	2/8/2012	159	23.2	9	8.2	0.056603774	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12033-XXX3	2/8/2012	1179	23.2	71	8.2	0.060220526	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12041-XXX4	2/15/2012	28387	42.1	1840	8.1	0.064818403	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12277-XXX1	12/18/2012	441	76.7	30	6.6	0.068027211	dpm/100 cm2	HIGH ROOF	CEILING - CONCRETE
RAC-D-RP-SP12277-XXX3	12/18/2012	744	40.8	55	6.6	0.073924731	dpm/100 cm2	HIGH ROOF	CEILING - CONCRETE
RAC-D-RP-SP12059-XX20	4/3/2012	1694	36.1	185	8.4	0.109208973	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX28	4/3/2012	224	101.8	34	8.4	0.151785714	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX6	4/3/2012	318	139.7	164	8.4	0.51572327	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP13101-XXX1	9/5/2013	55758	86.9	18	6.7	0.000322824	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13077-XX11	5/31/2013	21818	78.2	9	7.4	0.000412503	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12043-XXX2	2/16/2012	25248	24.3	12	7.7	0.000475285	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12043-XXX1	2/16/2012	18322	24.3	12	7.7	0.00065495	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12043-XXX3	2/16/2012	154517	24.3	117	7.7	0.000757198	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12132-XXX1	5/15/2012	100441	190.9	87	6.8	0.00086618	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX18	5/15/2012	10268	108.7	9	7.8	0.00087651	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12038-XXX1	2/14/2012	23051	126.1	25	8.1	0.001084552	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12132-XXX2	5/15/2012	30043	119.4	41	6.8	0.001364711	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12078-XX21	4/21/2012	6442	169.2	9	9	0.001397082	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP11036-XXX3	12/20/2011	27986	32	43	6.9	0.001536483	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13112-XXX1	9/10/2013	37948	218	61	7.1	0.001607463	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12038-XXX2	2/14/2012	40753	149.1	66	8.1	0.001619513	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12138-XX18	5/16/2012	5452	149.3	9	7.8	0.00165077	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX25	5/15/2012	38923	137.4	75	7.8	0.001926881	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13108-XXX3	9/9/2013	6471	50.2	13	7.3	0.002008963	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13092-XXX1	8/27/2013	22275	126.9	46	6.7	0.002065095	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX29	5/15/2012	5138	137.4	12	7.8	0.002335539	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP11036-XXX2	12/20/2011	11527	32	27	6.9	0.002342327	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX20	5/15/2012	3716	207.9	9	7.8	0.002421959	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX28	5/15/2012	4803	94.3	12	7.8	0.002498438	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX27	5/15/2012	4947	121.1	13	7.8	0.002627855	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12038-XXX3	2/14/2012	15906	140.7	45	8.1	0.002829121	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP13105-XXX6	9/6/2013	6740	55.6	20	7.3	0.002967359	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP11036-XXX4	12/20/2011	28678	32	88	6.9	0.003068554	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX23	5/15/2012	8110	108.7	27	7.8	0.003329223	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX26	5/15/2012	6262	137.4	21	7.8	0.003353561	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12036-XXX2	2/9/2012	5046	46.5	18	8.1	0.003567182	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12126-XX14	5/14/2012	5712	128.6	21	7.9	0.003676471	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX21	5/15/2012	8925	115.1	33	7.8	0.003697479	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13095-XXX4	8/28/2013	3723	33.5	14	6.7	0.003760408	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP11036-XXX1	12/20/2011	7513	32	29	6.9	0.003859976	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12126-XX11	5/14/2012	2297	101.8	9	7.9	0.003918154	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13099-XXX4	8/29/2013	9771	200.5	43	7.1	0.004400778	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13095-XXX3	8/28/2013	2017	33.9	11	6.7	0.005453644	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12043-XXX6	2/16/2012	1623	24.3	9	7.7	0.005545287	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12138-XX19	5/16/2012	1574	71.3	9	7.8	0.005717916	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12121-XXX4	5/10/2012	1916	79.5	12	8.2	0.006263048	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13104-XXX8	9/6/2013	7263	48.5	46	6.7	0.006333471	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12126-XX23	5/14/2012	1446	97.9	10	7.9	0.006915629	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX30	5/15/2012	1181	132.2	10	7.8	0.008467401	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13095-XXX2	8/28/2013	802	29.5	7	6.7	0.00872818	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12030-XXX1	2/7/2012	1789	35.7	16	6.4	0.008943544	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13101-XXX5	9/5/2013	23669	54	218	6.7	0.00921036	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12012-XXX3	1/27/2012	5241	27.9	50	7.5	0.009540164	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12126-XX24	5/14/2012	800	93.7	9	7.9	0.01125	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12061-XXX9	4/16/2012	888	90.3	11	7.5	0.012387387	dpm/100 cm2	4TH FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12125-XXX6	5/12/2012	1194	90.4	16	8.3	0.013400335	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13101-XXX4	9/5/2013	885	54.4	14	6.7	0.015819209	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12130-XXX3	5/14/2012	607	46.7	12	7.9	0.019769357	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX12	5/15/2012	441	142.3	9	7.8	0.020408163	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13080-XX10	6/13/2013	184	68.5	7	6.7	0.038043478	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12150-XXX1	5/22/2012	308	52.1	12	6.5	0.038961039	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12030-XXX2	2/7/2012	803	35.7	41	6.4	0.051058531	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12202-XXX1	9/18/2012	11490	118.6	27	8.4	0.002349869	dpm/100 cm2	1ST FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XX14	4/19/2012	7269	107.2	20	9.2	0.00275141	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP12202-XXX3	9/18/2012	7012	113.6	27	8.4	0.003850542	dpm/100 cm2	1ST FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12006-XX16	1/23/2012	4513	31.5	18	6.4	0.003988478	dpm/100 cm2	1ST FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XX12	4/19/2012	6958	86.9	28	8.4	0.004024145	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XX17	4/19/2012	4385	99.1	18	9.2	0.004104903	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12060-XXX7	4/13/2012	11881	142.3	59	8.5	0.004965912	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XXX6	4/19/2012	6143	93.2	31	8.4	0.005046394	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XXX8	4/19/2012	7986	132.2	42	8.4	0.005259204	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XX16	4/19/2012	1548	86.9	10	9.2	0.006459948	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XXX5	4/19/2012	7905	58	53	8.4	0.006704617	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XXX4	4/19/2012	4069	130.2	33	8.4	0.008110101	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12066-XX11	4/19/2012	1227	83.5	10	8.4	0.008149959	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12202-XXX2	9/18/2012	23032	163.5	193	8.4	0.008379646	dpm/100 cm2	1ST FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX8	4/18/2012	11066	139.7	112	8.4	0.010121092	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12039-XXX2	2/14/2012	937	23.5	11	7.4	0.011739594	dpm/100 cm2	2ND FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12060-XXX1	4/13/2012	4310	63.2	55	8.5	0.012761021	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12061-XXX5	4/16/2012	861	16	12	7.5	0.013937282	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX7	4/18/2012	15062	149.3	229	8.4	0.015203824	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX5	4/18/2012	38080	139.7	616	8.4	0.016176471	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12060-XXX6	4/13/2012	654	86.1	13	8.5	0.019877676	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX6	4/18/2012	13093	101.7	301	8.4	0.022989384	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12060-XXX3	4/13/2012	615	83.5	15	8.5	0.024390244	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12060-XXX2	4/13/2012	3367	79.9	105	8.5	0.031185031	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12050-XXX1	2/28/2012	372	18.9	12	8.1	0.032258065	dpm/100 cm2	2ND FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12061-XXX2	4/16/2012	441	51	15	7.5	0.034013605	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX2	4/18/2012	227	108.6	9	8.4	0.039647577	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX4	4/18/2012	983	101.7	47	8.4	0.047812818	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12101-XXX8	5/3/2012	182	51.8	9	7.5	0.049450549	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12022-XXX6	2/2/2012	262	47.8	15	7.5	0.057251908	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XX11	4/18/2012	121	105.2	9	8.4	0.074380165	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX1	4/18/2012	201	58.8	15	8.4	0.074626866	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12022-XXX4	2/2/2012	187	47.8	14	7.5	0.07486631	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12061-XXX7	4/16/2012	627	58.9	80	7.5	0.127591707	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-OP11Z37-XXX2	1/30/2011	2422	25.2	12	7.6	0.004954583	dpm/100 cm2	3RD FLOOR	WALL - CMU

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-OP11Z37-XXX1	1/30/2011	1950	25.2	15	7.6	0.007692308	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11Z39-XXX2	1/30/2011	2785	33.8	24	7.6	0.008617594	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11Z37-XXX3	1/30/2011	2922	25.2	28	7.6	0.009582478	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11Z39-XXX1	1/30/2011	2635	33.8	34	7.6	0.012903226	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11514-XXX1	6/11/2011	10179	53.2	171	11.6	0.016799293	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11Z39-XXX3	1/30/2011	6794	33.8	124	7.6	0.018251398	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11Z39-XXX4	1/30/2011	5918	33.8	116	7.6	0.019601217	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11514-XXX2	6/11/2011	17116	53.2	351	11.6	0.020507128	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-SP12112-XXX2	5/9/2012	14576	151.1	9	7.9	0.000617453	dpm/100 cm2	PENTHOUSE	FLOOR - STEEL PLATE
RAC-D-RP-SP13109-XXX2	9/9/2013	5879	73	10	7.1	0.00170097	dpm/100 cm2	1ST FLOOR	FLOOR - STEEL PLATE
RAC-D-RP-SP12210-XXX6	9/28/2012	1118	51	21	7.5	0.018783542	dpm/100 cm2	2ND FLOOR	FLOOR - STEEL PLATE
RAC-D-RP-SP12059-XX16	4/3/2012	5671	108.6	26	8.4	0.004584729	dpm/100 cm2	4TH FLOOR	CEILING - METAL DECK
RAC-D-RP-SP12059-XX15	4/3/2012	8278	137.2	71	8.4	0.008576951	dpm/100 cm2	4TH FLOOR	CEILING - METAL DECK
RAC-D-RP-SP12059-XX14	4/3/2012	33111	144.6	451	8.4	0.013620851	dpm/100 cm2	4TH FLOOR	CEILING - METAL DECK
FSS-X-E8-XXXX051-XX11	2/4/2013	798	116	3	2	0.003759398	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12064-XXX1	4/17/2012	2094	70.9	10	8.6	0.004775549	dpm/100 cm2	PENTHOUSE	STEEL - BEAM
RAC-D-RP-SP12152-XXX9	5/22/2012	1442	58.8	8	6.5	0.00554785	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12180-XXX3	6/21/2012	1604	76.7	9	7.9	0.005610973	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12176-XXX2	6/15/2012	1451	65.7	9	6.7	0.006202619	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12157-XXX2	5/23/2012	4256	76.7	33	8.2	0.007753759	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12071-XXX2	4/19/2012	1283	97.9	13	9.2	0.010132502	dpm/100 cm2	PENTHOUSE	STEEL - BEAM
RAC-D-RP-SP12152-XX11	5/22/2012	820	51	9	6.5	0.01097561	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12180-XXX4	6/21/2012	1034	51	12	7.9	0.011605416	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12064-XXX2	4/17/2012	2059	60.6	26	8.6	0.012627489	dpm/100 cm2	PENTHOUSE	STEEL - BEAM
RAC-D-RP-SP12089-XXX1	4/25/2012	1432	86	21	8.5	0.014664804	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12152-XXX2	5/22/2012	453	111.8	8	6.5	0.017660044	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP13003-XXX4	1/5/2013	1569	87.4	28	6.6	0.017845762	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12131-XXX1	5/15/2012	964	58.8	18	7.8	0.018672199	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP13030-XXX1	1/16/2013	828	40.9	16	6.9	0.019323671	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12146-XXX3	5/21/2012	442	51	9	7.5	0.020361991	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12265-XXX4	12/10/2012	302	46.7	7	6.8	0.023178808	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12068-XXX6	4/18/2012	857	47.2	20	8.4	0.023337223	dpm/100 cm2	PENTHOUSE	STEEL - BEAM
RAC-D-RP-SP12055-XXX5	3/2/2012	532	24.3	14	7.8	0.026315789	dpm/100 cm2	PENTHOUSE	STEEL - BEAM

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP12008-XXX4	1/24/2012	1190	18.7	34	6.6	0.028571429	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12152-XXX4	5/22/2012	394	132.1	12	6.5	0.030456853	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12153-XXX3	5/22/2012	256	94.3	8	6.5	0.03125	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12246-XXX1	11/14/2012	220	47	7	7	0.031818182	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP13011-XXX2	1/8/2013	2987	66.4	109	7.6	0.036491463	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
FSS-X-E8-XXXX042-XX18	2/11/2013	49	32	2	2	0.040816327	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP13084-XX10	7/30/2013	1108	92.9	58	6.7	0.05234657	dpm/100 cm2	1ST FLOOR	STEEL - BEAM
RAC-D-RP-SP12149-XXX1	5/21/2012	395	65.5	30	7.5	0.075949367	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12149-XXX2	5/21/2012	229	58.9	20	7.5	0.087336245	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12152-XXX1	5/22/2012	133	86	12	6.5	0.090225564	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP13036-XXX9	2/5/2013	107	65.7	10	6.1	0.093457944	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP12088-XXX2	4/25/2012	86	82.2	9	8.5	0.104651163	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12228-XXX3	10/26/2012	204	46.7	24	7.8	0.117647059	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12188-XXX1	7/24/2012	64	51	9	8.3	0.140625	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP12177-XXX1	6/16/2012	1525	65.7	12	8.4	0.007868852	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
RAC-D-RP-SP12177-XXX3	6/16/2012	1745	119.3	16	8.4	0.009169054	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
RAC-D-RP-SP13034-XXX2	1/17/2013	4198	62.8	42	6.4	0.010004764	dpm/100 cm2	2ND FLOOR	STEEL - BRACE
RAC-D-RP-SP12045-XXX2	2/16/2012	3196	28.4	34	7.7	0.010638298	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
RAC-D-RP-SP12064-XXX7	4/17/2012	867	54.5	10	8.6	0.011534025	dpm/100 cm2	PENTHOUSE	STEEL - BRACE
RAC-D-RP-SP12068-XXX9	4/18/2012	675	66	9	8.4	0.013333333	dpm/100 cm2	PENTHOUSE	STEEL - BRACE
RAC-D-RP-SP13034-XXX3	1/17/2013	2053	78.2	40	6.4	0.019483682	dpm/100 cm2	2ND FLOOR	STEEL - BRACE
RAC-D-RP-SP12068-XX11	4/18/2012	901	60.6	23	8.4	0.025527192	dpm/100 cm2	PENTHOUSE	STEEL - BRACE
FSS-X-E8-XXXX510-XX10	2/7/2013	78	52	2	2	0.025641026	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
FSS-X-E8-XXXX510-XXX8	2/7/2013	78	64	2	2	0.025641026	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
RAC-D-RP-SP12271-XXX3	12/13/2012	604	46.7	18	6.4	0.029801325	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
RAC-D-RP-SP12045-XXX1	2/16/2012	625	28.4	19	7.7	0.0304	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
RAC-D-RP-SP12271-XXX4	12/13/2012	1668	46.7	80	6.4	0.047961631	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
FSS-X-E8-XXXX510-XX11	2/7/2013	87	47	5	2	0.057471264	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
RAC-D-RP-SP12177-XXX5	6/16/2012	980	90.4	151	8.4	0.154081633	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
FSS-X-E8-XXXX413-XXX5	2/19/2013	3620	131	4	2	0.001104972	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP13067-XXX6	4/29/2013	4097	65.1	7	6.7	0.001708567	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12111-XXX5	5/8/2012	4189	63.2	10	7.5	0.002387205	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX20	4/23/2012	8784	99.6	23	8.1	0.002618397	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP12083-XXX1	4/24/2012	7106	78.7	22	7.8	0.003095975	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX14	4/23/2012	2330	59.8	9	8.1	0.003862661	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XXX8	4/20/2012	2606	66.5	11	7.7	0.004221028	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12014-XXX4	1/30/2012	7974	14.9	35	6.6	0.004389265	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12083-XXX2	4/24/2012	6356	87.1	28	7.8	0.004405286	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12091-XXX3	4/26/2012	2040	52.1	9	8.7	0.004411765	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12165-XXX9	6/4/2012	3706	90.1	17	7.7	0.004587156	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX23	4/23/2012	3238	91.7	18	8.1	0.005558987	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12111-XXX4	5/8/2012	4085	52.1	24	7.5	0.005875153	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12221-XXX1	10/12/2012	6141	37.3	37	7.5	0.006025077	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12279-XXX1	12/18/2012	8061	116.1	49	6.6	0.00607865	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX21	4/23/2012	6687	82.8	42	8.1	0.006280843	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12068-XXX2	4/18/2012	2173	54.5	14	8.4	0.006442706	dpm/100 cm2	PENTHOUSE	STEEL - COLUMN
RAC-D-RP-SP12082-XX22	4/23/2012	6660	95.7	44	8.1	0.006606607	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13048-XXX4	1/24/2013	1511	47.5	10	7.1	0.006618134	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX11	4/23/2012	2028	59.8	14	8.1	0.006903353	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX413-XX12	2/19/2013	2540	92	18	2	0.007086614	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XXX7	4/20/2012	3103	77.8	22	7.7	0.007089913	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12080-XXX1	4/23/2012	1274	56.8	10	8.2	0.007849294	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX19	4/23/2012	6190	95.7	49	8.1	0.007915994	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX049-XXX3	2/18/2013	247	69	2	2	0.008097166	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12215-XXX2	10/3/2012	2643	74.7	24	7.1	0.00908059	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12173-XXX1	6/14/2012	1961	53.9	18	7.9	0.00917899	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XXX6	4/20/2012	1190	59.8	11	7.7	0.009243697	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12259-XXX2	12/1/2012	3580	98.2	34	6.9	0.009497207	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12003-XXX4	1/12/2012	2736	27.4	26	6.7	0.009502924	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12031-XXX5	2/7/2012	3658	23.2	35	6.4	0.00956807	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12080-XXX5	4/23/2012	1459	74	14	8.2	0.009595613	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12111-XXX3	5/8/2012	3228	76.2	32	7.5	0.009913259	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13048-XXX1	1/24/2013	9218	61	93	7.1	0.010088956	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12166-XXX1	6/4/2012	3620	68	41	8.2	0.011325967	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX12	4/23/2012	4579	72.5	52	8.1	0.011356191	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XXX9	4/20/2012	2552	41.4	30	7.7	0.011755486	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP12091-XXX4	4/26/2012	1931	63.2	23	8.7	0.011910927	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12004-XXX1	1/17/2012	743	26.2	9	8	0.012113055	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX413-XXX8	2/19/2013	985	62	12	2	0.012182741	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX13	4/23/2012	5536	95.7	72	8.1	0.01300578	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX413-XXX6	2/19/2013	150	62	2	2	0.013333333	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12079-XX12	4/21/2012	970	71.4	13	9	0.013402062	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XX12	4/20/2012	3638	72.5	49	7.7	0.013468939	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP13067-XXX2	4/29/2013	1098	65.1	15	6.7	0.013661202	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX048-XX16	2/18/2013	142	36	2	2	0.014084507	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12068-XXX1	4/18/2012	4469	70.9	69	8.4	0.015439696	dpm/100 cm2	PENTHOUSE	STEEL - COLUMN
FSS-X-E8-XXXX413-XX17	2/19/2013	514	46	8	2	0.015564202	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12014-XXX5	1/30/2012	9061	14.9	145	6.6	0.016002649	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12166-XXX4	6/4/2012	680	68	12	8.2	0.017647059	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12079-XX17	4/21/2012	485	16	9	9	0.018556701	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12064-XXX8	4/17/2012	2794	70.9	55	8.6	0.019685039	dpm/100 cm2	PENTHOUSE	STEEL - COLUMN
RAC-D-RP-SP12173-XXX2	6/14/2012	1346	46.7	27	7.9	0.020059435	dpm/100 cm2	2ND FLOOR	STEEL - COLUMN
RAC-D-RP-SP12003-XXX5	1/12/2012	2367	27.4	49	6.7	0.02070131	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12111-XXX2	5/8/2012	7394	83.5	156	7.5	0.021098188	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13067-XXX8	4/29/2013	3941	70	91	6.7	0.023090586	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13048-XX11	1/24/2013	2630	54.8	61	7.1	0.023193916	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX049-XXX2	2/18/2013	85	64	2	2	0.023529412	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX413-XX13	2/19/2013	3945	99	93	2	0.023574144	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12048-XXX2	2/20/2012	592	22.5	14	4.8	0.023648649	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XX15	4/20/2012	3828	59.8	95	7.7	0.024817137	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX055-XXX3	2/6/2013	74	47	2	2	0.027027027	dpm/100 cm2	5TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12166-XXX9	6/4/2012	537	89.3	16	8.2	0.029795158	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX413-XX15	2/19/2013	100	72	3	2	0.03	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12173-XXX3	6/14/2012	1429	82.7	44	7.9	0.030790763	dpm/100 cm2	2ND FLOOR	STEEL - COLUMN
RAC-D-RP-SP12014-XXX6	1/30/2012	444	14.9	14	6.6	0.031531532	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13048-XXX2	1/24/2013	9372	37.9	299	7.1	0.031903542	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12021-XXX1	2/2/2012	246	18.1	8	7.5	0.032520325	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX047-XX16	2/14/2013	61	46	2	2	0.032786885	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX048-XXX1	2/18/2013	60	38	2	2	0.033333333	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
FSS-X-E8-XXXX413-XXX1	2/19/2013	11185	207	385	2	0.0344211	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12019-XXX4	2/1/2012	403	28.1	14	7.1	0.034739454	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12215-XXX3	10/3/2012	1268	60	45	7.1	0.035488959	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12a20-XXX2	2/1/2012	367	20.8	14	7.1	0.038147139	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12166-XXX8	6/4/2012	465	74.1	18	8.2	0.038709677	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13079-XXX1	6/5/2013	695	53.7	32	6.2	0.046043165	dpm/100 cm2	1ST FLOOR	STEEL - COLUMN
RAC-D-RP-SP12003-XXX6	1/12/2012	321	27.4	15	6.7	0.046728972	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XX14	4/20/2012	2898	77.8	136	7.7	0.046928916	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12272-XXX6	12/13/2012	145	59.1	7	6.4	0.048275862	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12079-XX13	4/21/2012	256	58.9	15	9	0.05859375	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12180-XXX2	6/21/2012	1343	40.8	84	7.9	0.062546538	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX413-XXX3	2/19/2013	385	81	29	2	0.075324675	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12081-XXX1	4/23/2012	123	14.8	10	8.1	0.081300813	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13036-XX22	2/5/2013	134	51.2	16	7.1	0.119402985	dpm/100 cm2	2ND FLOOR	STEEL - COLUMN
RAC-D-RP-SP12081-XXX4	4/23/2012	133	54.5	25	8.1	0.187969925	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12079-XXX6	4/21/2012	544	58.9	167	9	0.306985294	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12081-XXX3	4/23/2012	98	47.2	131	8.1	1	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12177-XXX2	6/16/2012	3864	65.7	135	8.4	0.034937888	dpm/100 cm2	5TH FLOOR	STEEL - PLATE
RAC-D-RP-SP12275-XX12	12/17/2012	1062	56.5	16	7.1	0.015065913	dpm/100 cm2	5TH FLOOR	STEEL - STAIR
RAC-D-RP-SP12045-XXX3	2/16/2012	1208	28.4	31	7.7	0.025662252	dpm/100 cm2	5TH FLOOR	STEEL - WALL GIRT
RAC-D-RP-SP12175-XXX5	6/15/2012	1980	60	64	8.5	0.032323232	dpm/100 cm2	5TH FLOOR	STEEL - WALL GIRT
RAC-D-RP-SP12174-XX10	6/15/2012	459	76.7	15	8.5	0.032679739	dpm/100 cm2	5TH FLOOR	STEEL - WALL GIRT
RAC-D-RP-SP12073-XXX9	4/19/2012	147	47.2	12	9.2	0.081632653	dpm/100 cm2	5TH FLOOR	STEEL - WALL GIRT
RAC-D-RP-SP12175-XXX4	6/15/2012	424	46.7	36	8.5	0.08490566	dpm/100 cm2	5TH FLOOR	STEEL - WALL GIRT
RAC-D-RP-SP12073-XXX5	4/19/2012	74	37.7	10	9.2	0.135135135	dpm/100 cm2	5TH FLOOR	STEEL - WALL GIRT
RAC-D-RP-SP12044-XXX1	2/16/2012	3021	42.1	19	7.7	0.006289308	dpm/100 cm2	5TH FLOOR	WALL - METAL
RAC-D-RP-SP12217-XXX9	10/4/2012	2264	94.2	24	7	0.010600707	dpm/100 cm2	3RD FLOOR	WALL - METAL
RAC-D-RP-SP12217-XX10	10/4/2012	771	54.5	11	7	0.014267185	dpm/100 cm2	3RD FLOOR	WALL - METAL
RAC-D-RP-SP12217-XXX2	10/4/2012	1529	70.9	23	7	0.015042511	dpm/100 cm2	3RD FLOOR	WALL - METAL
RAC-D-RP-SP12044-XXX3	2/16/2012	5437	42.1	84	7.7	0.015449697	dpm/100 cm2	5TH FLOOR	WALL - METAL
RAC-D-RP-SP12217-XXX6	10/4/2012	692	37.7	11	7	0.015895954	dpm/100 cm2	3RD FLOOR	WALL - METAL
RAC-D-RP-SP13017-XXX7	1/9/2013	1562	135.2	27	7.9	0.017285531	dpm/100 cm2	4TH FLOOR	WALL - METAL
RAC-D-RP-SP12217-XXX7	10/4/2012	766	60.6	18	7	0.023498695	dpm/100 cm2	3RD FLOOR	WALL - METAL

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP12217-XXX4	10/4/2012	1539	83.6	37	7	0.024041585	dpm/100 cm2	3RD FLOOR	WALL - METAL
FSS-X-E8-XXXX058-XXX1	2/7/2013	49	46	2	2	0.040816327	dpm/100 cm2	5TH FLOOR	WALL - METAL
FSS-X-E8-XXXX058-XXX3	2/7/2013	49	46	2	2	0.040816327	dpm/100 cm2	5TH FLOOR	WALL - METAL
FSS-X-E8-XXXX410-XXX8	2/20/2013	82	53	4	2	0.048780488	dpm/100 cm2	4TH FLOOR	WALL - METAL
FSS-X-E8-XXXX410-XXX9	2/20/2013	92	53	5	2	0.054347826	dpm/100 cm2	4TH FLOOR	WALL - METAL
RAC-D-RP-SP12217-XXX8	10/4/2012	293	47.2	28	7	0.09556314	dpm/100 cm2	3RD FLOOR	WALL - METAL
RAC-D-RP-SP12129-XX17	5/14/2012	5393	93.7	14	7.4	0.002595958	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12129-XX13	5/14/2012	3471	77.8	11	7.4	0.003169116	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12128-XX11	5/14/2012	1994	72.2	10	7.9	0.005015045	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12006-XXX1	1/23/2012	3586	24	18	6.4	0.00501952	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12129-XXX6	5/14/2012	2663	68.1	14	7.4	0.005257229	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12170-XXX2	6/6/2012	2762	36.1	15	8	0.005430847	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12190-XXX8	8/23/2012	1575	52.1	9	7.6	0.005714286	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12006-XXX5	1/23/2012	2030	24	12	6.4	0.00591133	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12129-XXX7	5/14/2012	5942	56.2	37	7.4	0.00622686	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12129-XXX2	5/14/2012	5236	77.8	34	7.4	0.006493506	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12007-XXX2	1/23/2012	1049	27.9	7	6.4	0.006673022	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12129-XX16	5/14/2012	3883	82.2	26	7.4	0.006695854	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12170-XXX1	6/6/2012	5194	45.1	36	8	0.006931074	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12007-XXX1	1/23/2012	7022	27.9	66	6.4	0.009399032	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12129-XX12	5/14/2012	4798	73.2	49	7.4	0.010212589	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12128-XX12	5/14/2012	5062	58	52	7.9	0.01027262	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12129-XXX1	5/14/2012	8200	48.7	85	7.4	0.010365854	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12011-XXX3	1/27/2012	2442	21.6	28	7.5	0.011466011	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12128-XXX8	5/14/2012	1528	83.5	24	7.9	0.015706806	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12170-XXX8	6/6/2012	623	63.2	10	8	0.016051364	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12191-XXX4	8/27/2012	1240	72.2	37	7.6	0.02983871	dpm/100 cm2	2ND FLOOR	WALL - MASONRY
RAC-D-RP-SP12190-XXX7	8/23/2012	298	52.1	9	7.6	0.030201342	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12191-XXX3	8/27/2012	1118	101.8	68	7.6	0.060822898	dpm/100 cm2	2ND FLOOR	WALL - MASONRY
RAC-D-RP-SP12191-XXX1	8/27/2012	250	52.1	17	7.6	0.068	dpm/100 cm2	2ND FLOOR	WALL - MASONRY
RAC-D-RP-SP12140-XX56	5/17/2012	550	65.7	10	8.2	0.018181818	dpm/100 cm2	4TH FLOOR	ROOF - RUBBER (OCR)
RAC-D-RP-SP12140-XX60	5/17/2012	709	47.0	18	8.2	0.02538787	dpm/100 cm2	4TH FLOOR	ROOF - RUBBER (OCR)
RAC-D-RP-SP12140-XX55	5/17/2012	1614	47.0	46	8.2	0.02850062	dpm/100 cm2	4TH FLOOR	ROOF - RUBBER (OCR)

Attachment C-1. Historical Data (Alpha) for Removable Fraction Evaluation

Location ID	Survey Date	Net Alpha (total)	Net Alpha (total) MDC	Net Alpha (Removed)	Net Alpha (Removed) MDC	Removed: Total Alpha	Unit	Floor	Material
RAC-D-RP-SP12140-XX59	5/17/2012	1552	75.1	86	8.2	0.055412371	dpm/100 cm2	4TH FLOOR	ROOF - RUBBER (OCR)
RAC-D-RP-SP12140-XX61	5/17/2012	204	75.1	13	8.2	0.06372549	dpm/100 cm2	4TH FLOOR	ROOF - RUBBER (OCR)
RAC-D-RP-SP12140-XX58	5/17/2012	116	60.3	10	8.2	0.086206897	dpm/100 cm2	4TH FLOOR	ROOF - RUBBER (OCR)
RAC-D-RP-SP12022-XXX3	2/2/2012	72	47.8	12	7.5	0.166666667	dpm/100 cm2	4TH FLOOR	ROOF - RUBBER (OCR)
RAC-D-RP-SP13050-XXX5	1/28/2013	1052	40.9	12	6.9	0.011406844	dpm/100 cm2	3RD FLOOR	PLUMBING - PIPE
RAC-D-RP-SP13050-XXX6	1/28/2013	1800	40.9	22	6.9	0.012222222	dpm/100 cm2	3RD FLOOR	PLUMBING - PIPE
RAC-D-RP-SP11034-XXX3	2/8/2012	265	20.4	10	8.2	0.037735849	dpm/100 cm2	CONTROL ROOM	CEILING - ACT
B23 - SW-7 - DS169	12/1/2015	45	38.0	4	2.4	0.086034281	dpm/100 cm2		
B23 - SW-6 - DS090	12/1/2015	139	51.1	10	3.1	0.072588069	dpm/100 cm2		
B23 - PC-7 - DS020	12/1/2015	81	61.4	5	2.4	0.066080232	dpm/100 cm2		
B23 - SW-7 - DS165	12/1/2015	78	42.4	5	2.4	0.06239553	dpm/100 cm2		
B23 - SW-6 - DS188	12/1/2015	69	68.4	4	3.5	0.055584016	dpm/100 cm2		
B23 - SW-9 - DS146	12/1/2015	351	115.8	13	3.3	0.038254486	dpm/100 cm2		
B23 - SW-6 - DS092	12/1/2015	160	53.9	5	3.1	0.031860671	dpm/100 cm2		
B23 - SW-6 - DS089	12/1/2015	247	65.6	6	3.1	0.024588744	dpm/100 cm2		
B23 - PC-7 - DS031	12/1/2015	1323	217.3	32	2.4	0.023934965	dpm/100 cm2		
B23 - PC-7 - DS034	12/1/2015	450	148.2	10	2.4	0.021820355	dpm/100 cm2		
B23 - PC-7 - DS037	12/1/2015	509	153.4	10	2.4	0.020239361	dpm/100 cm2		
B23 - SW-6 - DS088	12/1/2015	200	59.9	4	3.1	0.017987374	dpm/100 cm2		
B23 - PC-7 - DS036	12/1/2015	321	123.5	5	2.4	0.015100489	dpm/100 cm2		
B23 - SW-7 - DS171	12/1/2015	687	106.3	7	2.4	0.010662415	dpm/100 cm2		
B23 - SW-7 - DS173	12/1/2015	741	111.1	5	2.4	0.007210372	dpm/100 cm2		
B23 - PC-7 - DS021	12/1/2015	6010	454.7	29	2.4	0.004773183	dpm/100 cm2		
B23 - Fig 7 - DS029	12/1/2015	919	261.7	2	1.5	0.00216317	dpm/100 cm2		

Attachment C-1. Historical Data (Beta) for Removable Fraction Evaluation

Location ID	Survey Date	Net Beta (total)	Net Beta (total) MDC	Net Beta (Removed)	Net Beta (Removed) MDC	Removed: Total Beta	Unit	Floor	Material
RAC-D-RP-SP12041-XXX1	2/15/2012	21379	257	76	71.1	0.004	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX8	4/3/2012	16884	394.8	93	71.3	0.006	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12042-XXX1	2/15/2012	9751	221.5	80	71.1	0.008	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12042-XXX2	2/15/2012	9772	221.5	94	71.1	0.010	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12041-XXX3	2/15/2012	35611	257	384	71.1	0.011	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP13084-XXX6	7/30/2013	34404	368.6	406	67.7	0.012	dpm/100 cm2	1ST FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12041-XXX4	2/15/2012	324106	257	3829	71.1	0.012	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX27	4/3/2012	10282	272.7	149	71.3	0.014	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12033-XXX3	2/8/2012	8002	212.2	136	70.6	0.017	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX10	4/3/2012	9546	345.8	167	71.3	0.017	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX9	4/3/2012	6717	336.5	135	71.3	0.020	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX21	4/3/2012	5409	239.3	125	71.3	0.023	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12093-XXX2	5/2/2012	10258	294.4	250	71.1	0.024	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XX28	4/3/2012	2807	284	97	71.3	0.035	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12059-XXX6	4/3/2012	6244	390.7	254	71.3	0.041	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12277-XXX3	12/18/2012	1393	279.8	104	69.8	0.075	dpm/100 cm2	HIGH ROOF	CEILING - CONCRETE
RAC-D-RP-SP12277-XXX1	12/18/2012	1135	277.7	116	69.8	0.102	dpm/100 cm2	HIGH ROOF	CEILING - CONCRETE
RAC-D-RP-SP12059-XX20	4/3/2012	2744	236.7	298	71.3	0.109	dpm/100 cm2	4TH FLOOR	CEILING - CONCRETE
RAC-D-RP-SP12038-XXX3	2/14/2012	138929	579.8	113	69.5	0.001	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12038-XXX2	2/14/2012	192525	851.2	157	69.5	0.001	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12043-XXX1	2/16/2012	51639	328.9	77	71.5	0.001	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP11036-XXX4	12/20/2011	213940	270.8	340	92.2	0.002	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP11036-XXX2	12/20/2011	57641	270.8	95	92.2	0.002	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12036-XXX2	2/9/2012	34170	354.4	103	68.8	0.003	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13101-XXX5	9/5/2013	77284	351.4	358	70.8	0.005	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12043-XXX3	2/16/2012	77360	328.9	390	71.5	0.005	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13104-XXX8	9/6/2013	28855	152	161	70.8	0.006	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12132-XXX2	5/15/2012	13365	814.2	87	71.6	0.007	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12012-XXX3	1/27/2012	12204	290.2	81	73.3	0.007	dpm/100 cm2	2ND FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13112-XXX1	9/10/2013	27001	300.6	182	70.4	0.007	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP13092-XXX1	8/27/2013	17981	364.4	136	67.5	0.008	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12133-XX25	5/15/2012	21983	564	225	70.1	0.010	dpm/100 cm2	1ST FLOOR	FLOOR - CONCRETE
RAC-D-RP-SP12132-XXX1	5/15/2012	31654	905.9	366	71.6	0.012	dpm/100 cm2	3RD FLOOR	FLOOR - CONCRETE

Attachment C-1. Historical Data (Beta) for Removable Fraction Evaluation

Location ID	Survey Date	Net Beta (total)	Net Beta (total) MDC	Net Beta (Removed)	Net Beta (Removed) MDC	Removed: Total Beta	Unit	Floor	Material
RAC-D-RP-SP12067-XXX7	4/18/2012	144587	643.5	291	71.6	0.002	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12047-XXX2	2/20/2012	41228	253.1	85	14.5	0.002	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX8	4/18/2012	65384	524.9	194	71.6	0.003	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12006-XX16	1/23/2012	16817	271.2	76	71.9	0.005	dpm/100 cm2	1ST FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12061-XXX7	4/16/2012	33246	432.3	155	69.7	0.005	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12060-XXX1	4/13/2012	17760	293.5	90	71.2	0.005	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12060-XXX2	4/13/2012	22574	370	132	71.2	0.006	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX6	4/18/2012	71942	491.8	436	71.6	0.006	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12067-XXX5	4/18/2012	127876	794.7	1091	71.6	0.009	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12202-XXX2	9/18/2012	32667	394.6	443	69.1	0.014	dpm/100 cm2	1ST FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12047-XXX1	2/20/2012	3116	246.8	100	14.5	0.032	dpm/100 cm2	4TH FLOOR	ROOF - CONCRETE
RAC-D-RP-SP12190-XX14	8/23/2012	4439	271.4	13	7.6	0.003	dpm/100 cm2	1ST FLOOR	WALL - CMU
RAC-D-RP-OP11Z39-XXX3	1/30/2011	20587	270	157	69.5	0.008	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11Z39-XXX4	1/30/2011	16071	270	130	69.5	0.008	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11514-XXX1	6/11/2011	20683	685.8	476	123.6	0.023	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-OP11514-XXX2	6/11/2011	28714	685.8	896	123.6	0.031	dpm/100 cm2	3RD FLOOR	WALL - CMU
RAC-D-RP-SP12059-XX14	4/3/2012	60521	457.7	635	71.3	0.010	dpm/100 cm2	4TH FLOOR	CEILING - METAL DECK
RAC-D-RP-SP12059-XX16	4/3/2012	7680	331.4	91	71.3	0.012	dpm/100 cm2	4TH FLOOR	CEILING - METAL DECK
RAC-D-RP-SP13084-XX10	7/30/2013	7517	323.1	89	67.7	0.012	dpm/100 cm2	1ST FLOOR	STEEL - BEAM
RAC-D-RP-SP12048-XXX1	2/20/2012	5557	236.8	100	14.5	0.018	dpm/100 cm2	3RD FLOOR	STEEL - BEAM
RAC-D-RP-SP13011-XXX2	1/8/2013	6337	362.8	135	68.9	0.021	dpm/100 cm2	4TH FLOOR	STEEL - BEAM
RAC-D-RP-SP13034-XXX3	1/17/2013	3410	261.4	106	68.8	0.031	dpm/100 cm2	2ND FLOOR	STEEL - BRACE
RAC-D-RP-SP12177-XXX5	6/16/2012	4199	247.1	181	70.9	0.043	dpm/100 cm2	5TH FLOOR	STEEL - BRACE
RAC-D-RP-SP12014-XXX4	1/30/2012	24173	214.4	83	72.9	0.003	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13048-XX11	1/24/2013	10281	232.4	89	67.6	0.009	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12111-XXX3	5/8/2012	10767	217.2	98	70	0.009	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XX15	4/20/2012	10344	215.3	96	71.8	0.009	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
FSS-X-E8-XXXX413-XX13	2/19/2013	7207	819	83	64	0.012	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12014-XXX5	1/30/2012	18388	214.4	212	72.9	0.012	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13048-XXX1	1/24/2013	15781	236.4	187	67.6	0.012	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12082-XX13	4/23/2012	5105	230.5	94	74.9	0.018	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13048-XXX2	1/24/2013	20284	235.2	383	67.6	0.019	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12048-XXX2	2/20/2012	5810	236.8	110	14.5	0.019	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN

Attachment C-1. Historical Data (Beta) for Removable Fraction Evaluation

Location ID	Survey Date	Net Beta (total)	Net Beta (total) MDC	Net Beta (Removed)	Net Beta (Removed) MDC	Removed: Total Beta	Unit	Floor	Material
RAC-D-RP-SP13067-XXX8	4/29/2013	6326	241.9	135	70.4	0.021	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12111-XXX2	5/8/2012	13521	216.6	303	70	0.022	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XX12	4/20/2012	4739	242.2	110	71.8	0.023	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12075-XX14	4/20/2012	5451	228.5	138	71.8	0.025	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12068-XXX1	4/18/2012	4776	251.8	122	71.6	0.026	dpm/100 cm2	PENTHOUSE	STEEL - COLUMN
RAC-D-RP-SP12003-XXX5	1/12/2012	4457	247.3	138	93.6	0.031	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP13079-XXX1	6/5/2013	1587	223.3	69	68.7	0.043	dpm/100 cm2	1ST FLOOR	STEEL - COLUMN
RAC-D-RP-SP12064-XXX8	4/17/2012	2747	245.7	158	72.9	0.058	dpm/100 cm2	PENTHOUSE	STEEL - COLUMN
FSS-X-E8-XXXX413-XXX1	2/19/2013	7855	1130	555	64	0.071	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12236-XXX1	11/5/2012	1036	192.8	94	69.3	0.091	dpm/100 cm2	4TH FLOOR	STEEL - COLUMN
RAC-D-RP-SP12081-XXX3	4/23/2012	1582	349.8	186	74.9	0.118	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12079-XXX6	4/21/2012	995	267.2	279	71.9	0.280	dpm/100 cm2	3RD FLOOR	STEEL - COLUMN
RAC-D-RP-SP12177-XXX2	6/16/2012	3484	207.5	140	70.9	0.040	dpm/100 cm2	5TH FLOOR	STEEL - PLATE
RAC-D-RP-SP12044-XXX3	2/16/2012	71414	264.1	138	71.5	0.002	dpm/100 cm2	5TH FLOOR	WALL - METAL
RAC-D-RP-SP12007-XXX1	1/23/2012	13810	305.2	93	71.9	0.007	dpm/100 cm2	1ST FLOOR	WALL - MASONRY
RAC-D-RP-SP12191-XXX3	8/27/2012	2702	325	148	69.8	0.055	dpm/100 cm2	2ND FLOOR	WALL - MASONRY
RAC-D-RP-SP12140-XX59	5/17/2012	2943	231.8	119	70.7	0.040	dpm/100 cm2	4TH FLOOR	ROOF - RUBBER (OCR)
B23 - Fig 6 - DS130	12/1/2015	195	178.1	32	28	0.166	dpm/100 cm2		
B23 - Fig 6 - DS129	12/1/2015	248	176.8	30	28	0.123	dpm/100 cm2		
B23 - PC-7 - DS037	12/1/2015	888	198	74	28	0.083	dpm/100 cm2		
B23 - SW-6 - DS188	12/1/2015	588	273.0	31	29	0.052	dpm/100 cm2		
B23 - PC-7 - DS031	12/1/2015	1106	215.7	56	29	0.051	dpm/100 cm2		
B23 - SW-9 - DS146	12/1/2015	2210	261.8	31	29	0.014	dpm/100 cm2		
B23 - PC-7 - DS021	12/1/2015	13979	594	38	29	0.003	dpm/100 cm2		

ATTACHMENT C-2

RESRAD-BUILD OUTPUT (SCENARIO 1) DATED 10/18/2018

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld

RESRAD-BUILD Table of Contents

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld

RESRAD-BUILD Input Parameters

Number of Sources : 3
Number of Receptors: 1
Total Time : 2.500000E+02 days
Fraction Inside : 2.290000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.200	2.560	1.500	1.000	1.80E+01	1.00E-04

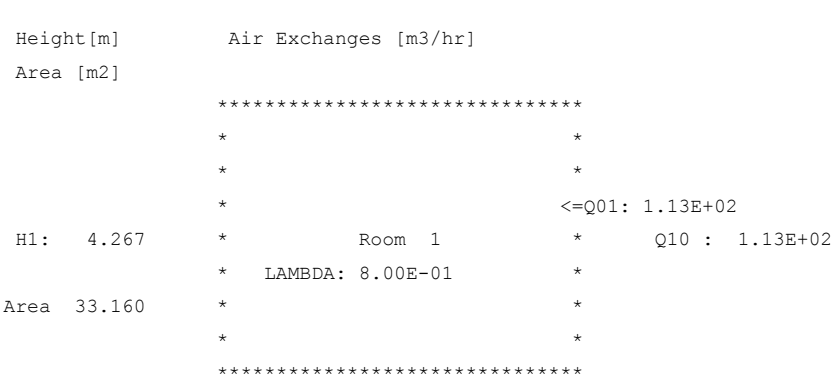
Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	4.06E+01	Concrete
1	2	2.40E+00	4.06E+01	Concrete
1	3	2.40E+00	4.06E+01	Concrete

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld

═══ Building Information ═══

Building Air Exchange Rate: 8.00E-01 1/hr



Deposition velocity: 1.00E-02 [m/s]   Resuspension Rate: 5.00E-07 [1/s]

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 0.00000000E+00 years

Assessment for Time: 1
Time =0.00E+00 yr

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.630E+05
TH-228	1.630E+05
RA-228	1.630E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.630E+05
TH-228	1.630E+05
RA-228	1.630E+05

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 0.00000000E+00 years

 Source: 3
         Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
         Geometry:: Type: Line   Length:4.27E+00 [m] Direction: z
         Pathway ::
              Direct Ingestion Rate: 0.000E+00 [1/hr]
              Fraction released to air: 1.000E-01
              Removable fraction: 1.000E-01
              Time to Remove: 3.650E+03 [day]

          Contamination::   Nuclide   Concentration
                                            [pCi/m]
                              TH-232   1.630E+05
                              TH-228   1.630E+05
                              RA-228   1.630E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 0.00000000E+00 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	1.68E+00	1.68E+00	1.68E+00	5.03E+00
Total	1.68E+00	1.68E+00	1.68E+00	5.03E+00

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 0.00000000E+00 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.63E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	1.63E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.63E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	1.63E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.61E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	1.61E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.50E-03	1.50E-03
RA-228	2.54E-04	2.54E-04
TH-228	4.24E-01	4.24E-01
TH-228	5.32E-02	5.32E-02
RA-228	6.07E-03	6.07E-03

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.50E-03	1.50E-03
RA-228	2.54E-04	2.54E-04
TH-228	4.24E-01	4.24E-01
TH-228	5.32E-02	5.32E-02
RA-228	6.07E-03	6.07E-03

Source: 3

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.50E-03	1.50E-03
RA-228	2.53E-04	2.53E-04
TH-228	4.24E-01	4.24E-01
TH-228	5.32E-02	5.32E-02
RA-228	6.07E-03	6.07E-03

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 1.00000000 years

Assessment for Time: 2
Time =1.00E+00 yr

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.614E+05
	TH-228	1.614E+05
	RA-228	1.614E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.614E+05
	TH-228	1.614E+05
	RA-228	1.614E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 1.00000000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.614E+05
	TH-228	1.614E+05
	RA-228	1.614E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 1.00000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	1.67E+00	1.67E+00	1.67E+00	5.02E+00
Total	1.67E+00	1.67E+00	1.67E+00	5.02E+00

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 1.00000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.62E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	1.62E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.62E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	1.62E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.59E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	1.59E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 1.00000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.54E-02	1.54E-02
RA-228	9.42E-04	9.42E-04
TH-228	2.93E-01	2.93E-01
TH-228	1.67E-01	1.67E-01
RA-228	5.38E-03	5.38E-03

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.54E-02	1.54E-02
RA-228	9.42E-04	9.42E-04
TH-228	2.93E-01	2.93E-01
TH-228	1.67E-01	1.67E-01
RA-228	5.38E-03	5.38E-03

Source: 3

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.54E-02	1.54E-02
RA-228	9.42E-04	9.42E-04
TH-228	2.93E-01	2.93E-01
TH-228	1.67E-01	1.67E-01
RA-228	5.37E-03	5.37E-03

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 10.0000000 years

═══ Assessment for Time: 3 ═══
═══ Time =1.00E+01 yr ═══

═══ Source Information ═══

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 10.0000000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 10.0000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.49E-01	2.49E-01	2.49E-01	7.47E-01
Total	2.49E-01	2.49E-01	2.49E-01	7.47E-01

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 10.0000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.45E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.45E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 10.0000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	3.55E-15	3.55E-15
TH-228	1.45E-01	1.45E-01
RA-228	2.05E-04	2.05E-04
TH-228	5.88E-03	5.88E-03
TH-228	9.84E-02	9.84E-02
RA-228	8.28E-05	8.28E-05

Source: 2

Nuclide	Receptor 1	Total
TH-232	3.55E-15	3.55E-15
TH-228	1.45E-01	1.45E-01
RA-228	2.05E-04	2.05E-04
TH-228	5.88E-03	5.88E-03
TH-228	9.84E-02	9.84E-02
RA-228	8.28E-05	8.28E-05

Source: 3

Nuclide	Receptor 1	Total
TH-232	3.49E-15	3.49E-15
TH-228	1.45E-01	1.45E-01
RA-228	2.02E-04	2.02E-04
TH-228	5.88E-03	5.88E-03
TH-228	9.84E-02	9.84E-02
RA-228	8.15E-05	8.15E-05

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 100.000008 years

═══ Assessment for Time: 4 ═══
═══ Time =1.00E+02 yr ═══

═══ Source Information ═══

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 100.000008 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 100.000008 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.49E-01	2.49E-01	2.49E-01	7.47E-01
Total	2.49E-01	2.49E-01	2.49E-01	7.47E-01

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 100.000008 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.45E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.45E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 100.000008 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	3.55E-15	3.55E-15
TH-228	2.49E-01	2.49E-01
RA-228	2.88E-04	2.88E-04
TH-228	3.84E-17	3.84E-17
TH-228	2.08E-06	2.08E-06
RA-228	1.61E-09	1.61E-09

Source: 2

Nuclide	Receptor 1	Total
TH-232	3.55E-15	3.55E-15
TH-228	2.49E-01	2.49E-01
RA-228	2.88E-04	2.88E-04
TH-228	3.84E-17	3.84E-17
TH-228	2.08E-06	2.08E-06
RA-228	1.61E-09	1.61E-09

Source: 3

Nuclide	Receptor 1	Total
TH-232	3.49E-15	3.49E-15
TH-228	2.49E-01	2.49E-01
RA-228	2.83E-04	2.83E-04
TH-228	3.84E-17	3.84E-17
TH-228	2.08E-06	2.08E-06
RA-228	1.58E-09	1.58E-09

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 1000.00000 years

═══ Assessment for Time: 5 ═══
═══ Time =1.00E+03 yr ═══

═══ Source Information ═══

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 1000.00000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Evaluation Time: 1000.00000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.49E-01	2.49E-01	2.49E-01	7.47E-01
Total	2.49E-01	2.49E-01	2.49E-01	7.47E-01

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 1000.00000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.48E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.45E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.45E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1 Corner room
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
 Evaluation Time: 1000.00000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	3.55E-15	3.55E-15
TH-228	2.49E-01	2.49E-01
RA-228	2.88E-04	2.88E-04

Source: 2

Nuclide	Receptor 1	Total
TH-232	3.55E-15	3.55E-15
TH-228	2.49E-01	2.49E-01
RA-228	2.88E-04	2.88E-04

Source: 3

Nuclide	Receptor 1	Total
TH-232	3.49E-15	3.49E-15
TH-228	2.49E-01	2.49E-01
RA-228	2.83E-04	2.83E-04

Title : Scenario 1 Corner room
Input File : C:\RESRAD_Family\BUILD\3.5\B-23Scenario1.bld
Full Summary

RESRAD-BUILD Dose (Time) Tables

Receptor Dose Received for the Exposure Duration

(mrem)

	Evaluation Time [yr]				
	0.00E+00	1.00E+00	1.00E+01	1.00E+02	1.00E+03
1	5.03E+00	5.02E+00	7.47E-01	7.47E-01	7.47E-01

Receptor Dose/Yr Averaged Over Exposure Duration

(mrem/yr)

	Evaluation Time [yr]				
	0.00E+00	1.00E+00	1.00E+01	1.00E+02	1.00E+03
1	7.34E+00	7.33E+00	1.09E+00	1.09E+00	1.09E+00

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ATTACHMENT C-3

RESRAD-BUILD OUTPUT (SCENARIO 1A) DATED 1/2/2019

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld

RESRAD-BUILD Table of Contents

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld

RESRAD-BUILD Input Parameters

Number of Sources : 3
Number of Receptors: 1
Total Time : 2.500000E+02 days
Fraction Inside : 2.290000E-01

Receptor Information

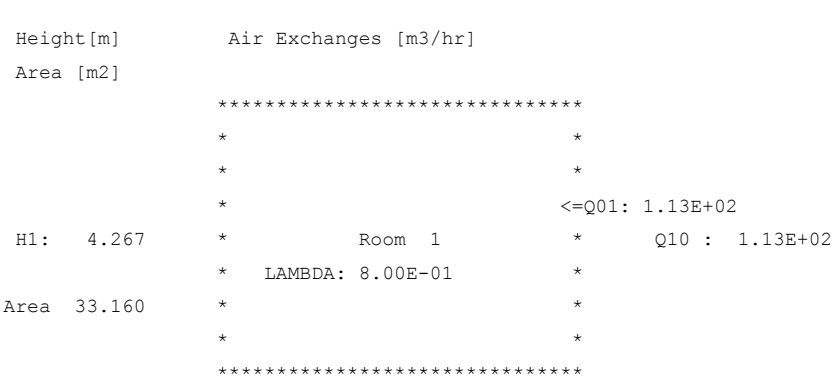
Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.500	2.590	1.500	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	4.06E+01	Concrete
1	2	2.40E+00	4.06E+01	Concrete
1	3	2.40E+00	4.06E+01	Concrete

═══ Building Information ═══

Building Air Exchange Rate: 8.00E-01 1/hr



Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s]

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 0.00000000E+00 years

═══════════════════════════════════════
═══════════════════════════════════════
═══   Assessment for Time: 1   ═══
═══   Time =0.00E+00 yr   ═══
═══════════════════════════════════════
═══════════════════════════════════════

═══════ Source Information ═══════

Source: 1
        Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
        Geometry:: Type: Line   Length:4.27E+00 [m] Direction: z
        Pathway ::
             Direct Ingestion Rate: 0.000E+00 [1/hr]
             Fraction released to air: 1.000E-01
             Removable fraction: 1.000E-01
             Time to Remove: 3.650E+03 [day]

         Contamination::   Nuclide   Concentration
                                           [pCi/m]
                             TH-232   1.630E+05
                             TH-228   1.630E+05
                             RA-228   1.630E+05

Source: 2
        Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
        Geometry:: Type: Line   Length:4.27E+00 [m] Direction: z
        Pathway ::
             Direct Ingestion Rate: 0.000E+00 [1/hr]
             Fraction released to air: 1.000E-01
             Removable fraction: 1.000E-01
             Time to Remove: 3.650E+03 [day]

         Contamination::   Nuclide   Concentration
                                           [pCi/m]
                             TH-232   1.630E+05
                             TH-228   1.630E+05
                             RA-228   1.630E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 0.00000000E+00 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.630E+05
	TH-228	1.630E+05
	RA-228	1.630E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 0.00000000E+00 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	1.68E+00	1.67E+00	1.68E+00	5.03E+00
Total	1.68E+00	1.67E+00	1.68E+00	5.03E+00

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 0.00000000E+00 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.43E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	3.43E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.16E-04	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	7.16E-04	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.42E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	3.42E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.51E-03	1.51E-03
RA-228	2.68E-04	2.68E-04
TH-228	4.25E-01	4.25E-01
TH-228	5.34E-02	5.34E-02
RA-228	6.41E-03	6.41E-03

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.50E-03	1.50E-03
RA-228	2.46E-04	2.46E-04
TH-228	4.23E-01	4.23E-01
TH-228	5.32E-02	5.32E-02
RA-228	5.90E-03	5.90E-03

Source: 3

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.51E-03	1.51E-03
RA-228	2.68E-04	2.68E-04
TH-228	4.25E-01	4.25E-01
TH-228	5.34E-02	5.34E-02
RA-228	6.41E-03	6.41E-03

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 1.00000000 years

Assessment for Time: 2
Time =1.00E+00 yr

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.614E+05
TH-228	1.614E+05
RA-228	1.614E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.614E+05
TH-228	1.614E+05
RA-228	1.614E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 1.00000000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.614E+05
	TH-228	1.614E+05
	RA-228	1.614E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 1.00000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	1.67E+00	1.67E+00	1.67E+00	5.02E+00
Total	1.67E+00	1.67E+00	1.67E+00	5.02E+00

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 1.00000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.39E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	3.39E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.09E-04	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	7.09E-04	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.39E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	3.39E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 1.00000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.54E-02	1.54E-02
RA-228	9.94E-04	9.94E-04
TH-228	2.94E-01	2.94E-01
TH-228	1.68E-01	1.68E-01
RA-228	5.67E-03	5.67E-03

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.54E-02	1.54E-02
RA-228	9.16E-04	9.16E-04
TH-228	2.93E-01	2.93E-01
TH-228	1.67E-01	1.67E-01
RA-228	5.23E-03	5.23E-03

Source: 3

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.54E-02	1.54E-02
RA-228	9.94E-04	9.94E-04
TH-228	2.94E-01	2.94E-01
TH-228	1.68E-01	1.68E-01
RA-228	5.67E-03	5.67E-03

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 10.0000000 years

Assessment for Time: 3
Time =1.00E+01 yr

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.467E+05
TH-228	1.467E+05
RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.467E+05
TH-228	1.467E+05
RA-228	1.467E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 10.0000000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 10.0000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.51E-01	2.48E-01	2.51E-01	7.50E-01
Total	2.51E-01	2.48E-01	2.51E-01	7.50E-01

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 10.0000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.47E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	6.47E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 10.0000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	7.60E-15	7.60E-15
TH-228	1.45E-01	1.45E-01
RA-228	4.31E-04	4.31E-04
TH-228	5.91E-03	5.91E-03
TH-228	9.89E-02	9.89E-02
RA-228	1.74E-04	1.74E-04

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.50E-15	1.50E-15
TH-228	1.44E-01	1.44E-01
RA-228	8.95E-05	8.95E-05
TH-228	5.86E-03	5.86E-03
TH-228	9.81E-02	9.81E-02
RA-228	3.62E-05	3.62E-05

Source: 3

Nuclide	Receptor 1	Total
TH-232	7.59E-15	7.59E-15
TH-228	1.45E-01	1.45E-01
RA-228	4.31E-04	4.31E-04
TH-228	5.91E-03	5.91E-03
TH-228	9.89E-02	9.89E-02
RA-228	1.74E-04	1.74E-04

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 100.000008 years

Assessment for Time: 4
Time =1.00E+02 yr

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.467E+05
TH-228	1.467E+05
RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.467E+05
TH-228	1.467E+05
RA-228	1.467E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 100.000008 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 100.000008 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.51E-01	2.48E-01	2.51E-01	7.50E-01
Total	2.51E-01	2.48E-01	2.51E-01	7.50E-01

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 100.000008 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.47E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	6.47E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 100.000008 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	7.60E-15	7.60E-15
TH-228	2.50E-01	2.50E-01
RA-228	6.05E-04	6.05E-04
TH-228	3.86E-17	3.86E-17
TH-228	2.09E-06	2.09E-06
RA-228	3.38E-09	3.38E-09

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.50E-15	1.50E-15
TH-228	2.48E-01	2.48E-01
RA-228	1.26E-04	1.26E-04
TH-228	3.83E-17	3.83E-17
TH-228	2.08E-06	2.08E-06
RA-228	7.02E-10	7.02E-10

Source: 3

Nuclide	Receptor 1	Total
TH-232	7.59E-15	7.59E-15
TH-228	2.50E-01	2.50E-01
RA-228	6.04E-04	6.04E-04
TH-228	3.86E-17	3.86E-17
TH-228	2.09E-06	2.09E-06
RA-228	3.38E-09	3.38E-09

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 1000.00000 years

═══ Assessment for Time: 5 ═══
═══ Time =1.00E+03 yr ═══

═══ Source Information ═══

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 1000.00000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Evaluation Time: 1000.00000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.51E-01	2.48E-01	2.51E-01	7.50E-01
Total	2.51E-01	2.48E-01	2.51E-01	7.50E-01

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 1000.00000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.47E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	6.47E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	3.09E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1A Bld 23 Between 2 columns
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
 Evaluation Time: 1000.00000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	7.60E-15	7.60E-15
TH-228	2.50E-01	2.50E-01
RA-228	6.05E-04	6.05E-04

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.50E-15	1.50E-15
TH-228	2.48E-01	2.48E-01
RA-228	1.26E-04	1.26E-04

Source: 3

Nuclide	Receptor 1	Total
TH-232	7.59E-15	7.59E-15
TH-228	2.50E-01	2.50E-01
RA-228	6.04E-04	6.04E-04

Title : Scenario 1A Bld 23 Between 2 columns
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1A.bld
Full Summary

RESRAD-BUILD Dose (Time) Tables

Receptor Dose Received for the Exposure Duration

(mrem)

	Evaluation Time [yr]				
	0.00E+00	1.00E+00	1.00E+01	1.00E+02	1.00E+03
1	5.03E+00	5.02E+00	7.50E-01	7.50E-01	7.50E-01

Receptor Dose/Yr Averaged Over Exposure Duration

(mrem/yr)

	Evaluation Time [yr]				
	0.00E+00	1.00E+00	1.00E+01	1.00E+02	1.00E+03
1	7.35E+00	7.34E+00	1.10E+00	1.10E+00	1.10E+00

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ATTACHMENT C-4

RESRAD-BUILD OUTPUT (SCENARIO 1B) DATED 1/2/2019

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld

RESRAD-BUILD Table of Contents

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld

RESRAD-BUILD Input Parameters

Number of Sources : 3
Number of Receptors: 1
Total Time : 2.500000E+02 days
Fraction Inside : 2.290000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.500	0.500	1.500	1.000	1.80E+01	1.00E-04

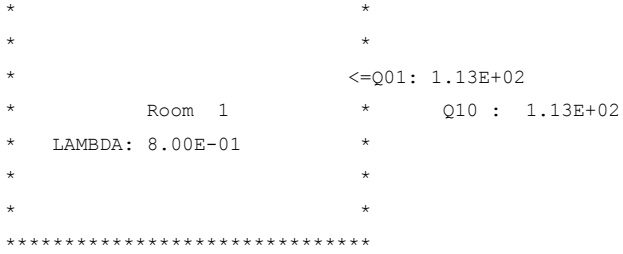
Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	4.06E+01	Concrete
1	2	2.40E+00	4.06E+01	Concrete
1	3	2.40E+00	4.06E+01	Concrete

═══ Building Information ═══

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]
Area [m2]



Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s]

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00[m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 12)		
		Ingestion	Inhalation	Submersion
	[pCi/m]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
TH-232	1.630E+05	2.730E-03	1.640E+00	1.018E-06
TH-228	1.630E+05	8.086E-04	3.454E-01	9.378E-03
RA-228	1.630E+05	1.442E-03	5.078E-03	5.583E-03

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 0.00000000E+00 years

═══════════════════════════════════════
═══════════════════════════════════════
═══   Assessment for Time: 1   ═══
═══   Time =0.00E+00 yr   ═══
═══════════════════════════════════════
═══════════════════════════════════════

═══════ Source Information ═══════

Source: 1
        Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
        Geometry:: Type: Line   Length:4.27E+00 [m] Direction: z
        Pathway ::
             Direct Ingestion Rate: 0.000E+00 [1/hr]
             Fraction released to air: 1.000E-01
             Removable fraction: 1.000E-01
             Time to Remove: 3.650E+03 [day]

         Contamination::   Nuclide   Concentration
                                           [pCi/m]
                             TH-232   1.630E+05
                             TH-228   1.630E+05
                             RA-228   1.630E+05

Source: 2
        Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
        Geometry:: Type: Line   Length:4.27E+00 [m] Direction: z
        Pathway ::
             Direct Ingestion Rate: 0.000E+00 [1/hr]
             Fraction released to air: 1.000E-01
             Removable fraction: 1.000E-01
             Time to Remove: 3.650E+03 [day]

         Contamination::   Nuclide   Concentration
                                           [pCi/m]
                             TH-232   1.630E+05
                             TH-228   1.630E+05
                             RA-228   1.630E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 0.00000000E+00 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.630E+05
	TH-228	1.630E+05
	RA-228	1.630E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 0.00000000E+00 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	1.70E+00	1.67E+00	1.68E+00	5.05E+00
Total	1.70E+00	1.67E+00	1.68E+00	5.05E+00

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 0.00000000E+00 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.31E-02	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	2.31E-02	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.39E-04	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	8.39E-04	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.28E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03
Total	1.28E-03	1.16E-04	1.40E-06	1.39E+00	2.74E-01	9.05E-03

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.56E-03	1.56E-03
RA-228	4.23E-04	4.23E-04
TH-228	4.39E-01	4.39E-01
TH-228	5.52E-02	5.52E-02
RA-228	1.01E-02	1.01E-02

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.50E-03	1.50E-03
RA-228	2.47E-04	2.47E-04
TH-228	4.23E-01	4.23E-01
TH-228	5.32E-02	5.32E-02
RA-228	5.92E-03	5.92E-03

Source: 3

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.50E-03	1.50E-03
RA-228	2.51E-04	2.51E-04
TH-228	4.24E-01	4.24E-01
TH-228	5.32E-02	5.32E-02
RA-228	6.00E-03	6.00E-03

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 1.00000000 years

═══ Assessment for Time: 2 ═══
═══ Time =1.00E+00 yr ═══

═══ Source Information ═══

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.614E+05
	TH-228	1.614E+05
	RA-228	1.614E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.614E+05
	TH-228	1.614E+05
	RA-228	1.614E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 1.00000000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 9.090E-02
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.614E+05
	TH-228	1.614E+05
	RA-228	1.614E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 1.00000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	1.69E+00	1.67E+00	1.67E+00	5.04E+00
Total	1.69E+00	1.67E+00	1.67E+00	5.04E+00

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 1.00000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.29E-02	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	2.29E-02	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.31E-04	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	8.31E-04	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.26E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03
Total	1.26E-03	1.16E-04	1.40E-06	1.39E+00	2.71E-01	9.05E-03

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 1.00000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.59E-02	1.59E-02
RA-228	1.56E-03	1.56E-03
TH-228	3.04E-01	3.04E-01
TH-228	1.73E-01	1.73E-01
RA-228	8.93E-03	8.93E-03

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.54E-02	1.54E-02
RA-228	9.20E-04	9.20E-04
TH-228	2.93E-01	2.93E-01
TH-228	1.67E-01	1.67E-01
RA-228	5.25E-03	5.25E-03

Source: 3

Nuclide	Receptor 1	Total
TH-232	1.19E+00	1.19E+00
TH-228	1.54E-02	1.54E-02
RA-228	9.32E-04	9.32E-04
TH-228	2.93E-01	2.93E-01
TH-228	1.67E-01	1.67E-01
RA-228	5.32E-03	5.32E-03

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 10.0000000 years

Assessment for Time: 3
Time =1.00E+01 yr

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.467E+05
TH-228	1.467E+05
RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m]
TH-232	1.467E+05
TH-228	1.467E+05
RA-228	1.467E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 10.0000000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 10.0000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.68E-01	2.48E-01	2.49E-01	7.66E-01
Total	2.68E-01	2.48E-01	2.49E-01	7.66E-01

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 10.0000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.09E-02	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	2.09E-02	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.58E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	7.58E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.15E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.15E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 10.0000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	5.29E-14	5.29E-14
TH-228	1.54E-01	1.54E-01
RA-228	2.92E-03	2.92E-03
TH-228	6.25E-03	6.25E-03
TH-228	1.05E-01	1.05E-01
RA-228	1.18E-03	1.18E-03

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.77E-15	1.77E-15
TH-228	1.44E-01	1.44E-01
RA-228	1.05E-04	1.05E-04
TH-228	5.86E-03	5.86E-03
TH-228	9.82E-02	9.82E-02
RA-228	4.24E-05	4.24E-05

Source: 3

Nuclide	Receptor 1	Total
TH-232	2.75E-15	2.75E-15
TH-228	1.44E-01	1.44E-01
RA-228	1.60E-04	1.60E-04
TH-228	5.87E-03	5.87E-03
TH-228	9.83E-02	9.83E-02
RA-228	6.47E-05	6.47E-05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 100.000008 years

Assessment for Time: 4
Time =1.00E+02 yr

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 100.000008 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 100.000008 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.68E-01	2.48E-01	2.49E-01	7.66E-01
Total	2.68E-01	2.48E-01	2.49E-01	7.66E-01

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 100.000008 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.09E-02	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	2.09E-02	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.58E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	7.58E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.15E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.15E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 100.000008 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	5.29E-14	5.29E-14
TH-228	2.64E-01	2.64E-01
RA-228	4.10E-03	4.10E-03
TH-228	4.08E-17	4.08E-17
TH-228	2.21E-06	2.21E-06
RA-228	2.29E-08	2.29E-08

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.77E-15	1.77E-15
TH-228	2.48E-01	2.48E-01
RA-228	1.47E-04	1.47E-04
TH-228	3.83E-17	3.83E-17
TH-228	2.08E-06	2.08E-06
RA-228	8.23E-10	8.23E-10

Source: 3

Nuclide	Receptor 1	Total
TH-232	2.75E-15	2.75E-15
TH-228	2.49E-01	2.49E-01
RA-228	2.25E-04	2.25E-04
TH-228	3.84E-17	3.84E-17
TH-228	2.08E-06	2.08E-06
RA-228	1.26E-09	1.26E-09

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 1000.00000 years

Assessment for Time: 5
Time =1.00E+03 yr

Source Information

Source: 1
Location:: Room : 1 x: 0.00 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Source: 2
Location:: Room : 1 x: 6.40 y: 0.00 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 1000.00000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 5.18 z: 0.00 [m]
Geometry:: Type: Line Length:4.27E+00 [m] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m]
	TH-232	1.467E+05
	TH-228	1.467E+05
	RA-228	1.467E+05

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Evaluation Time: 1000.00000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Total
Receptor 1	2.68E-01	2.48E-01	2.49E-01	7.66E-01
Total	2.68E-01	2.48E-01	2.49E-01	7.66E-01

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 1000.00000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.09E-02	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	2.09E-02	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.58E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	7.58E-04	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.15E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00
Total	1.15E-03	0.00E+00	0.00E+00	0.00E+00	2.48E-01	0.00E+00

 Title : Scenario 1B Bld 23 Next to a column
 Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
 Evaluation Time: 1000.00000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232	5.29E-14	5.29E-14
TH-228	2.64E-01	2.64E-01
RA-228	4.10E-03	4.10E-03

Source: 2

Nuclide	Receptor 1	Total
TH-232	1.77E-15	1.77E-15
TH-228	2.48E-01	2.48E-01
RA-228	1.47E-04	1.47E-04

Source: 3

Nuclide	Receptor 1	Total
TH-232	2.75E-15	2.75E-15
TH-228	2.49E-01	2.49E-01
RA-228	2.25E-04	2.25E-04

Title : Scenario 1B Bld 23 Next to a column
Input File : C:\RESRAD_Family\BUILD\3.5\B-23-Scenario-1B.bld
Full Summary

RESRAD-BUILD Dose (Time) Tables

Receptor Dose Received for the Exposure Duration

(mrem)

	Evaluation Time [yr]				
	0.00E+00	1.00E+00	1.00E+01	1.00E+02	1.00E+03
1	5.05E+00	5.04E+00	7.66E-01	7.66E-01	7.66E-01

Receptor Dose/Yr Averaged Over Exposure Duration

(mrem/yr)

	Evaluation Time [yr]				
	0.00E+00	1.00E+00	1.00E+01	1.00E+02	1.00E+03
1	7.37E+00	7.36E+00	1.12E+00	1.12E+00	1.12E+00

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APPENDIX D

MATERIAL-SPECIFIC REFERENCE VALUES ESTABLISHED FOR BUILDING 23 AND BASIS FOR ESTABLISHING NEW REFERENCE VALUES

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MATERIAL-SPECIFIC REFERENCE VALUES ESTABLISHED FOR BUILDING 23 AND REQUIREMENTS FOR ESTABLISHING NEW REFERENCE VALUES

Background alpha and beta reference values for interior building surfaces and structural materials have been established for Building 23, as provided in Table D-1 below. The measurements were collected in non-impacted areas of Building 23 and other structures at the Curtis Bay facility, from surfaces as similar as possible to the impacted areas to be surveyed.

TABLE D-1. ESTABLISHED BACKGROUND ALPHA/BETA REFEFERENCE VALUES FOR BUILDING 23

Building Material	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)
Bare concrete	12.1	260
Steel columns/beams	10.2	51
Metal floor plates/diamond steel plates	6.0	73
Red brick	41.7	787
Tile floor	0.0	8
Painted cinderblock	3.8	285
Unpainted cinderblock	26.7	419
Glass windows	2.5	46
Painted metal door	3.5	35
Corrugated fiberglass wall	0.6	114
Corrugated metal wall	8.0	117
Piping	0.0	68
Piping wrap (metal)	4.5	66
Ductwork	0.0	33
Rubber roof material	31.5	61
Painted brick	0.0	579

dpm/100 cm^2 = disintegrations per minute per 100 square centimeters

The process for collecting appropriate average material-specific background reference measurements and FSS instrument calibration and beta efficiency determination protocols are provided in the following site-specific guidance documents:

- *Protocol for Determination of Material-Specific Background Values for W.R. Grace Building 23 Post-Remedial and Final Status Surveys*, dated October 201; and
- *Radiological Instrumentation Calibration Protocols and Considerations, W.R. Grace Building 23 FUSRAP Site*, dated April 17, 2012.

If additional background values are required during remedy implementation, the values shall be developed in accordance with the methodologies in the above guidance documents and submitted to U.S. Army Corps of Engineers for review and approval prior to use.

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APPENDIX E

SUMMARY OF COSTS FOR IMPLEMENTATION OF ALTERNATIVES 2, 3, AND 4

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COST SUMMARY ALTERNATIVE 2: DECONTAMINATION WITH REMOVAL TO INDUSTRIAL USE LEVELS AND LAND USE CONTROLS	
TASK	**COST[1],[2]**
Project Design	
Remedial Design	$400,000
Construction [3]	
Planning Documents, Coordination, and Project Website	$164,568
Mobilization and Construction of Scaffolding	$558,458
Removal and Reconstruction (select walls, staircase, inactive utilities, select roofing materials)	$1,635,592
Construction of Electrical Substation and Relocation of Other Electrical Utilities	$4,820,569
Decontamination and Pre-Final Status Survey	$11,716,384
Transportation and Disposal of Project Wastes	$67,572
General Requirements (includes Project Manager; Onsite Management Team; Testing/Monitoring for Quality Control, Health & Safety and Radiation).	$3,859,480
Reporting	$661,823
Demobilization	$239,713
Engineering Construction Oversight Services (Engineer of Record)	$450,000
USACE/DOE Surveillance, Operation, and Maintenance	
Final Status Survey (USACE Independent Contractor)	$10,755,746
Implementation of Land Use Controls/Long-Term Surveillance (5-Year Reviews)	$95,222
TOTAL COST[4] =	$35,425,126

Notes:

(1) Includes costs for contingency, bond, and fee.

(2)Tasks and costs above will be reviewed and adjusted, if necessary, during preparation of the remedial action design to address budgetary constraints, escalation factors, and remedial design specifications.

(3) Estimated time for completion is 17 months.

(4) Due to uncertainties associated with the efficacy of decontamination in certain areas, additional Removal and Reconstruction, Transportation, and Disposal costs may be incurred.

(5) For costing purposes, assumes 30-year duration for surveillance; present-value costs

COST SUMMARY ALTERNATIVE 3: DEMOLITION OF THE SOUTHWEST QUADRANT OF BUIDLING 23	
TASK	**COST[(1),(2)]**
Project Design	
Pre-design Investigations (Structural Analysis, Building Surveys, Geotechnical Investigations, Utility Surveys, and Radiological Delineation of Soil)	$700,000
Remedial Design	$900,000
Phase 1 Construction (Utility Relocation/Construction and Structural Repair) [(3)]	
Planning Documents, Coordination, and Project Website	$90,694
Mobilization	$10,771
Repair of Structural Elements	$290,228
Construction of Electrical Substation and Relocation of Other Electrical Utilities	$4,820,569
Relocation of Mechanical and Process Utilities	$1,807,765
Transportation and Disposal of Non-Radiological Project Wastes	$95,294
General Requirements (includes Project Manager; Onsite Management Team; Testing/Monitoring for Quality Control, Health & Safety and Radiation; and Temporary Office Trailers, Equipment, and Supplies.)	$2,104,617
Reporting	$21,879
Demobilization	$6,395
Engineering Construction Oversight Services (Engineer of Record)	$450,000
Phase 2 Construction (Demolition and Restoration) [(4)]	
Planning Documents, Coordination, and Project Website	$164,568
Mobilization	$32,961
Final Connections for Electrical, Mechanical, and Process Utility Lines	$485,316
Cleaning, Surface Preparation, and Pre-FSS	$1,341,042
Demolition of Structural Components	$3,003,553
Removal of Soil/Building Foundations and Grading	$171,987
Installation of Concrete Slab	$506,259
Construction of New Corridor, Electrical Shop, and Building 23 Exterior Walls	$2,400,288
Transportation and Disposal of Project Wastes	$3,964,151
General Requirements - includes Project Manager; Onsite Management Team; Testing/Monitoring (Quality Control, Health & Safety and Radiation); and Temporary Office Trailers, Equipment, and Supplies.	$7,927,092
Reporting	$34,310
Demobilization	$32,961
Engineering Construction Oversight Services (Engineer of Record)	$450,000
USACE/DOE Surveillance, Operation, and Maintenance	
Final Status Survey (USACE Independent Contractor)	$511,075
Implementation of Land Use Controls/Long-Term Surveillance (5-Year Reviews)	$95,222
TOTAL COST =	$32,418,997

Notes:

(1) Includes costs for contingency, bond, and fee.

(2)Tasks and costs above may be reviewed and adjusted, if necessary, during preparation of the remedial action design to address budgetary constraints, escalation factors, and remedial design specifications.

(3) Estimated time for completion of Phase 1 Construction (mobilization through demobilization) is 11 months.

(4) Estimated time for completion of Phase 2 Construction (mobilization through demobilization is 23 months.

(5) For costing purposes, assumes 30-year duration for surveillance; present-value costs

COST SUMMARY ALTERNATIVE 4: DECONTAMINATION WITH REMOVAL TO INDUSTRIAL USE LEVELS (The Remedy Selected in the 2005 Record of Decision)	
TASK	**COST[(1),(2)]**
Project Design	
Remedial Design	$400,000
Construction [(3)]	
Planning Documents, Coordination, and Project Website	$164,568
Mobilization and Construction of Scaffolding	$558,458
Removal and Reconstruction (select walls, staircase, inactive utilities, select roofing materials)	$1,635,592
Construction of Electrical Substation and Relocation of Other Electrical Utilities	$4,820,569
Decontamination and Pre-Final Status Survey	$11,716,384
Transportation and Disposal of Project Wastes	$67,572
General Requirements (includes Project Manager; Onsite Management Team; Testing/Monitoring for Quality Control, Health & Safety and Radiation).	$3,859,480
Reporting	$661,823
Demobilization	$239,713
Engineering Construction Oversight Services (Engineer of Record)	$450,000
USACE/DOE Surveillance, Operation, and Maintenance	
Final Status Survey (USACE Independent Contractor)	$10,755,746
TOTAL COST[(4)] =	$35,329,904

Notes:

(1) Includes costs for contingency, bond, and fee.

(2)Tasks and costs above will be reviewed and adjusted, if necessary, during preparation of the remedial action design to address budgetary constraints, escalation factors, and remedial design specifications.

(3) Estimated time for completion is 17 months.

(4) Due to uncertainties associated with the efficacy of decontamination in certain areas, additional Removal and Reconstruction, Transportation, and Disposal costs may be incurred.

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APPENDIX F

RESPONSIVENESS SUMMARY

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RESPONSIVENESS SUMMARY

This Responsiveness Summary has been prepared for the W.R. Grace Building 23 site to summarize the significant comments, criticisms, and new relevant information submitted during the public comment period, and to present the responses provided by the U.S. Army Corps of Engineers (USACE).

The Responsiveness Summary documents that the public participation requirements set forth in NCP Section 300.435(c)(2)(ii) have been met.

1.0 Overview

The Amended Proposed Remedial Action Plan (PRAP) for the W.R. Grace Building 23 site was issued in June 2019. Public notification of the PRAP was through a press release to the *Baltimore Sun* and posting on the internet at the following link:

www.nab.usace.army.mil/EnvironmentalNotices

A copy of the public notice is attached.

The comment period for the PRAP was from July 8, 2019 through August 9, 2019.

2.0 Public Comments Received and USACE Responses

No questions or comments were received during the public comment period. A memorandum documenting Maryland Department of the Environment concurrence on the Record of Decision Amendment is attached.

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LEGAL NOTICES

Notice of Publication of the Amended Proposed Remedial Action Plan for the Proposed Remedial Action of Building 23 W.R. Grace Curtis Bay Facility, Baltimore, Maryland

The U. S. Army Corps of Engineers, Baltimore District, is publishing an Amended Proposed Remedial Action Plan (PRAP) that includes an amended preferred remedial alternative to address the threat to human health and/or the environment created by the presence of residual radiological activity in the southwest quadrant of Building 23 at the W.R. Grace Curtis Bay Facility, Baltimore, Maryland.

In the 1950s, W.R. Grace processed monazite sand to extract the radioactive element thorium under a contract with the Atomic Energy Commission (AEC). Processing occurred in the southwest quadrant of Building 23 and as a result of the processing operations, low levels of radioactive contamination remain on building surfaces and equipment in this quadrant of the building. As part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), the Corps of Engineers previously completed a Record of Decision (ROD) for Building 23 in 2005. The selected alternative from the 2005 ROD included either decontamination or removal of building components that contained residual radiological activity. Based on site conditions and activities completed since 2005, the Corps of Engineers has determined that the selected remedy requires revision. The Amended PRAP presents the amended remedial action alternative proposed by the Corps of Engineers, which includes demolition and removal of the southwest quadrant of Building 23. A copy of the PRAP is available in the project's Administrative Record File, which is located at:

Enoch Pratt Library – Brooklyn Branch
300 East Patapsco Avenue
Baltimore, Maryland 21201
410-396-1120

This full public notice, with a link to the PRAP, is also available on the internet at the following link: https://www.nab.usace.army.mil/Missions/Environmental/Formerly-Used-Defense-Sites/Public-Notices/

Written comments may be submitted to the U.S. Army Corps of Engineers Baltimore District, Attn: Becca Nappi, 2 Hopkins Plaza, Baltimore, Maryland 21201, or by email to Rebecca.A.Nappi@ usace.army.mil. If requested, a public meeting will be held during the comment period to present the amended remedial alternative. All written comments must be received by August 9, 2019.

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PUBLIC AUCTION SALE
Waverly Townhouse

723 Melville Ave,
Baltimore, MD 21218
Auction on the premises:
Thurs., July 11th
12:00 pm
Opening Bid: $50,000
Deposit: $5,000

JHL AUCTIONEERS
Jeff Baughman
443-956-2628
jeff@jhlauctioneers.com
www.jhlauctioneers.com
410-424-5456

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On behalf of
Roger Schlossberg, Esq.

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Turn-key opportunity includes all 3 businesses totaling 56,000 sq.ft. on 9.6 acres
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mike@agrealtypartners.com

Michael Stanford
Broker
(301) 733-4183
mstanford@cesproperties.com
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John G. Rolker, Attorney at Law
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www.stevedanceauctions.com

Candie C. Deming, Attorney at Law
Dulany, Leahy, Curtis & Brophy LLP
ESTATE AUCTION
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2449 N. CALVERT ST. BALTIMORE, MD 21218
Charles Village - Barclay Area
Gross Rent $30,500 | Call Jared Block 443-470-1457

@ 1:00 PM
2429 SAINT PAUL ST. BALTIMORE, MD 21218
Gross Rent $45,750 | Call Jared Block 443-470-1457

THURS., JULY 11TH @ 12:00 NOON
5250-5270 FAIRLAWN AVE. BALTIMORE, MD 21215
Woodmere Area Parallels Reisterstown Rd.
Multi-Building Industrial Property
Annual Potential Gross Rent $124,920
Call Matthew Cooper 410-977-4711

WED., JULY 24TH @ 12:00 NOON
6103-6109 BELLONA AVENUE, BALTIMORE, MD 21212
Lake Evesham Area | 24 Unit Apartment Complex
Annual Potential Gross Rent $361,284
Call Nick Luciani 443-465-4761

@ 1:30 PM
6200-6246 CHINQUAPIN PARKWAY, BALTIMORE, MD 21239
Glen Oaks Area | 24 Unit Apartment Complex
Annual Potential Gross Rent $293,472
Call Nick Luciani 443-465-4761

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Call Scott Frank 410-977-4712

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Call Scott Frank 410-977-4712

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Colonial Style Home Located in "Greenspring East"
Call Jared Block 443-470-1457

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, BALTIMORE DISTRICT
2 HOPKINS PLAZA
BALTIMORE, MD 21201

CENAB-ENE-C 6 February 2020

MEMORANDUM FOR RECORD

SUBJECT: Maryland Department of Environment Concurrence on the Record of Decision Amendment for Building 23, W.R. Grace, Curtis Bay, Maryland

1. W.R. Grace Project Manager, Paul Bucens, and US Army Corps of Engineers (USACE) – Baltimore District Program Manager, Brenda Barber engaged with the Maryland Department of Environment (MDE) to review the Amended Proposed Remedial Action Plan (PRAP) for Building 23.

2. The Amended PRAP for Building 23 dated 4 March 2019 describes the history of the W.R. Grace Building 23, as well as the type and extent of radiological contamination in the southwest quadrant of the building. The Amended PRAP includes an evaluation of updated remedial alternatives to remediate Building 23 and identifies an amended preferred alternative selected by USACE – Baltimore.

3. The amended preferred alternative selected by USACE – Baltimore is Alternative 3, Demolition of Southwest Quadrant of Building 23.

4. With USACE concurrence, on 14 March 2019, Paul Bucens emailed the Amended Proposed Remedial Action Plan dated 4 March 2019 to Charlie Cox (Supervisor, Radioactive Materials Licensing, MDE) for review by MDE personnel. On 22 May 2019, Mr. Cox replied to Mr. Bucens via email with the following message:

   "The Radiological Health Program staff concur with the remedial action plan for Curtis Bay."

5. With no comments on the report and no objections to its submittal to the general public for comment, USACE and W.R. Grace representatives acknowledge Mr. Cox's email response as MDE concurrence on the selected remedy for Building 23.

6. The point of contact for this concurrence is Brenda M. Barber at 410-962-0030 or brenda.m.barber@usace.army.mil.

Encls:
MDE concurrence email

Brenda M. Barber
Program Manager
USACE – Baltimore District

Goldsberry, Ivanna S CIV USARMY CENAB (USA)

From: Charles Cox -MDE- <charles.cox@maryland.gov>
Sent: Wednesday, May 22, 2019 8:06 AM
To: Bucens, Paul
Subject: [INTERNET]Re: Curtis Bay FUSRAP - Building 23 - DRAFT Proposed Remedial Action Plan

The Radiological Health Program staff concur with the remedial action plan for Curtis Bay

On Tue, May 21, 2019 at 6:43 AM Bucens, Paul G. <Paul.G.Bucens@grace.com> wrote:

> Charlie,
>
> USACE is wrapping this up now (they have received the full complement of internal comments). Will you please forward you concurrence or comments?
>
> Regards,
>
> **Paul Bucens**
>
> **M** +1 617.899.0354

From: Charles Cox -MDE- [mailto:charles.cox@maryland.gov]
Sent: Monday, May 6, 2019 8:36 AM
To: Bucens, Paul G. <Paul.G.Bucens@grace.com>
Subject: Re: [INTERNET]Re: Curtis Bay FUSRAP - Building 23 - DRAFT Proposed Remedial Action Plan

No problem got and reading it.

On Mon, May 6, 2019 at 8:31 AM Bucens, Paul G. <Paul.G.Bucens@grace.com> wrote:

> Charlie,
>
> USACE is hoping to finalize the PRAP – and ROD – by June and is requesting feedback on the PRAP by May 17th.

Please advise if you are in agreement with the PRAP or have any questions that you would like us to follow up on, either in person or via e-mail.

Regards.

Paul Bucens

M +1 617.899.0354

From: Bucens, Paul G.
Sent: Wednesday, April 10, 2019 2:03 PM
To: Charles Cox -MDE- <charles.cox@maryland.gov>
Cc: Barber, Brenda M CIV USARMY CENAB (US) <Brenda.M.Barber@usace.army.mil>
Subject: RE: [INTERNET]Re: Curtis Bay FUSRAP - Building 23 - DRAFT Proposed Remedial Action Plan

Charlie,

Did you/your team finish its review and have any questions/comments that we should discuss?

Regards,

Paul Bucens

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From: Charles Cox -MDE- [mailto:charles.cox@maryland.gov]
Sent: Thursday, March 14, 2019 2:49 PM
To: Bucens, Paul G. <Paul.G.Bucens@grace.com>
Subject: [INTERNET]Re: Curtis Bay FUSRAP - Building 23 - DRAFT Proposed Remedial Action Plan

Got it and will review

On Thu, Mar 14, 2019 at 2:42 PM Bucens, Paul G. <Paul.G.Bucens@grace.com> wrote:

> Charlie,

Thanks for your time earlier today. As promised I attach the draft PRAP for the FUSRAP Building 23 remediation, reflecting demolition of the southwest quadrant (as revised from the current ROD of decontamination). The PRAP is going through final review by USACE CX.

After you have had an opportunity to review please let Brenda Barber/USACE and me know that MDE is in concurrence with this remedial approach. We are happy to come in to your office and review the overall status of work and discuss any specific questions you have on planned activities, schedule or the PRAP.

In the near term we are preparing to contract for preliminary work – primarily establishing critical manufacturing equipment outside of the footprint of the area that may be impacted by the planned demolition activities to ensure uninterrupted manufacturing operations.

Regards,

Paul Bucens

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Charles Cox, Program Manager III

Radioactive Material Division

Maryland Department of the Environment

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Click here to complete a three question customer experience survey.

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APPENDIX G

ACRONYMS, ABBREVIATIONS, AND SYMBOLS

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1/h	Per hour
1/s	Per second
ANSI	American National Standards Institute
ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	Centimeter(s)
cm^2	Centimeters Squared
CSM	Conceptual Site Model
d	Day
DCGL	Derived Concentration Guideline Level
$DCGL_W$	Derived Concentration Guideline Level that applies to the average concentration over an entire survey unit
$DCGL_{EMC}$	Derived Concentration Guideline Level that applies over small areas as an elevated measurement comparison
DOE	U.S. Department of Energy
DOJ	U.S. Department of Justice
dpm	Disintegrations per Minute
dpm/100 cm^2	Disintegrations per Minute per 100 Square Centimeters
FSS	Final Status Survey
FUSRAP	Formerly Utilized Sites Remedial Action Program
HPS	Health Physics Society
hr	Hour(s)
LUC	Land Use Control
m	Meter(s)
m^2	Square meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDE	Maryland Department of the Environment
mrem	Millirem
mrem/yr	Millirem per Year
NCP	National Contingency Plan
NRC	U.S. Nuclear Regulatory Commission
pCi	Picocurie
pCi/g	Picocuries per Gram
PRAP	Proposed Remedial Action Plan
RA	Remedial Action
^{226}Ra	Radium-226

^{228}Ra	Radium-228
RG	Remedial Goal
RI	Remedial Investigation
ROD	Record of Decision
TBC	To Be Considered
TEDE	Total Effective Dose Equivalent
^{232}Th	Thorium-232
^{238}U	Uranium-238
USACE	United States Army Corps of Engineers
Yr	Years(s)