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August, 18 2007

Mr. John Nicholson
Division of Nuclear Materials Safety
US Nuclear Regulatory Commission – Region 1
475 Allendale Road
King of Prussia, Pennsylvania, 19406

Subject: Submittal of dose assessment for materials disposed at WCS facility

Dear, Mr. Nicholson,

The Homer Laughlin China Company (Homer Laughlin) is pleased to provide this dose assessment to the Nuclear Regulatory Commission (NRC). This dose assessment has been performed at the NRC's request to demonstrate that the dose to members of the public from the disposal of Homer Laughlin's legacy waste materials at WCS are very low compared to the 100 mrem/yr public dose limit and the 25 mrem/yr unrestricted use limit in 10 CFR 20, Subpart E.

As previously indicated, Homer Laughlin intends to ship all remaining waste materials to WCS for treatment and ultimate disposal. Submission of this dose assessment satisfies the NRC request for additional characterization data and dose assessment of the legacy waste materials at the Homer Laughlin site.

Please contact Mr. Glenn Boucher @ (304)- 387-1300 ext 447 if you require any additional information.

Sincerely,

Glenn Bouscher

Glenn Bouscher
Homer Laughlin China Company

TSD-DOSE: A Radiological Dose Assessment Model for Treatment, Storage, and Disposal Facilities

Version 2.22 - September 1998

Site: wcs
Shipment: Homer Laughlin source material
User: wpd

	TOTAL	EXTERNAL	INTERNAL
Dose to:			
Driver:	1.8E-02 mrem	1.8E-02 mrem	0.0E+00 mrem
Receiving worker:	2.2E-02 mrem	2.2E-02 mrem	0.0E+00 mrem
Incineration worker:	not applicable	not applicable	not applicable
Landfill worker:	7.5E-04 mrem	7.5E-04 mrem	0.0E+00 mrem
Offsite individual:	4.8E-05 mrem		
Offsite population:	1.6E-04 p-rem		
Worker Population:	6.3E-05 p-rem	6.3E-05 p-rem	0.0E+00 p-rem
Dose from:			
Transport to TSD facility:	1.8E-02 mrem	1.8E-02 mrem	not applicable
Receiving and sampling waste:	2.2E-02 mrem	2.2E-02 mrem	0.0E+00 mrem
Storage before processing:	not applicable	not applicable	not applicable
Incineration of waste:	not applicable	not applicable	not applicable
Burial at onsite landfill:	7.5E-04 mrem	7.5E-04 mrem	0.0E+00 mrem
Transport to offsite landfill:	not applicable	not applicable	not applicable
Incinerator maintenance:	not applicable	not applicable	not applicable

Doses due to each isotope (mrem - population dose in p-rem).

Isotope	U234	U235+D	U238+D
Activity	1.5E-02 Ci	1.0E-03 Ci	1.0E-02 Ci
Release Fraction	5.00E-04	5.00E-04	5.00E-04
Driver	1.6 E-05	6.9 E-03	1.1 E-02
Receiving worker	3.9 E-05	8.3 E-03	1.3 E-02
Incineration worker	not applicable		
Landfill worker	5.7 E-07	2.8 E-04	4.7 E-04
Offsite Individual	2.9 E-05	1.9 E-06	1.8 E-05
Offsite population	9.8 E-05	6.3 E-06	5.9 E-05
Worker population	9.4 E-08	2.4 E-05	3.9 E-05

Site Description

Operations included:

Transport to TSD facility
Receiving and sampling waste
Burial at onsite landfill

Operations excluded:

Storage before processing
Incineration of waste
Transport to offsite landfill
Incinerator maintenance

Parameters

The following are the adjustable parameters used to model each operation.
A (D) after a value indicates the default value was used.

Fraction solid waste = 1.000
Fraction liquid waste = 0.000
Pre-processed waste density = 1.4 E+00 g/cc
Post-processed waste density = 1.4 E+00 g/cc

Transport to TSD facility (4 steps)

Number of Workers: 1.0E+00 (D)
Truck bed dimensions (for all steps)
length: 2.80E+01 feet
width: 8.00E+00 feet
height: 1.00E+01 feet

Step A: Load and secure shipment
average distance: 5.00E+00 feet
duration: 2.00E+00 hours
shielding thickness: 6.25E-02 inches (D)

Step B: Drive
average distance: 7.00E+00 feet (D)
duration: 3.00E+01 hours
shielding thickness: 1.25E-01 inches (D)

Step C: Rest
average distance: 5.00E+00 feet
duration: 8.00E+00 hours
shielding thickness: 1.25E-01 inches (D)

Step D: Maintenance in transit
average distance: 3.00E+00 feet (D)
duration: 0.00E+00 hours
shielding thickness: 6.25E-02 inches (D)

Receiving and sampling waste (5 steps)

Number of Workers: 2.0E+00 (D)

Step A: Weight truck, inspect manifest
average distance: 3.00E+00 feet
duration: 5.00E-01 hours

Receiving and sampling waste (cont'd)

Step B: Unload drums
average distance: 3.00E+00 feet (D)
time per drum or pallet: 5.00E-01 hours

Step C: Inspect and sample drums
average distance: 5.00E-01 feet (D)
time per drum: 0.00E+00 hours
airborne respirable dust concentration: 1.0E+01 mg/m3 (D)
respiratory protection factor: 1.0E+01 (D)

Step D: Transfer solids to storage
average distance: 3.00E+00 feet (D)
time per drum or pallet: 0.00E+00 hours

Step E: Pump drummed oil to storage tank
average distance: 5.00E-01 feet (D)
time per drum: 0.00E+00 hours

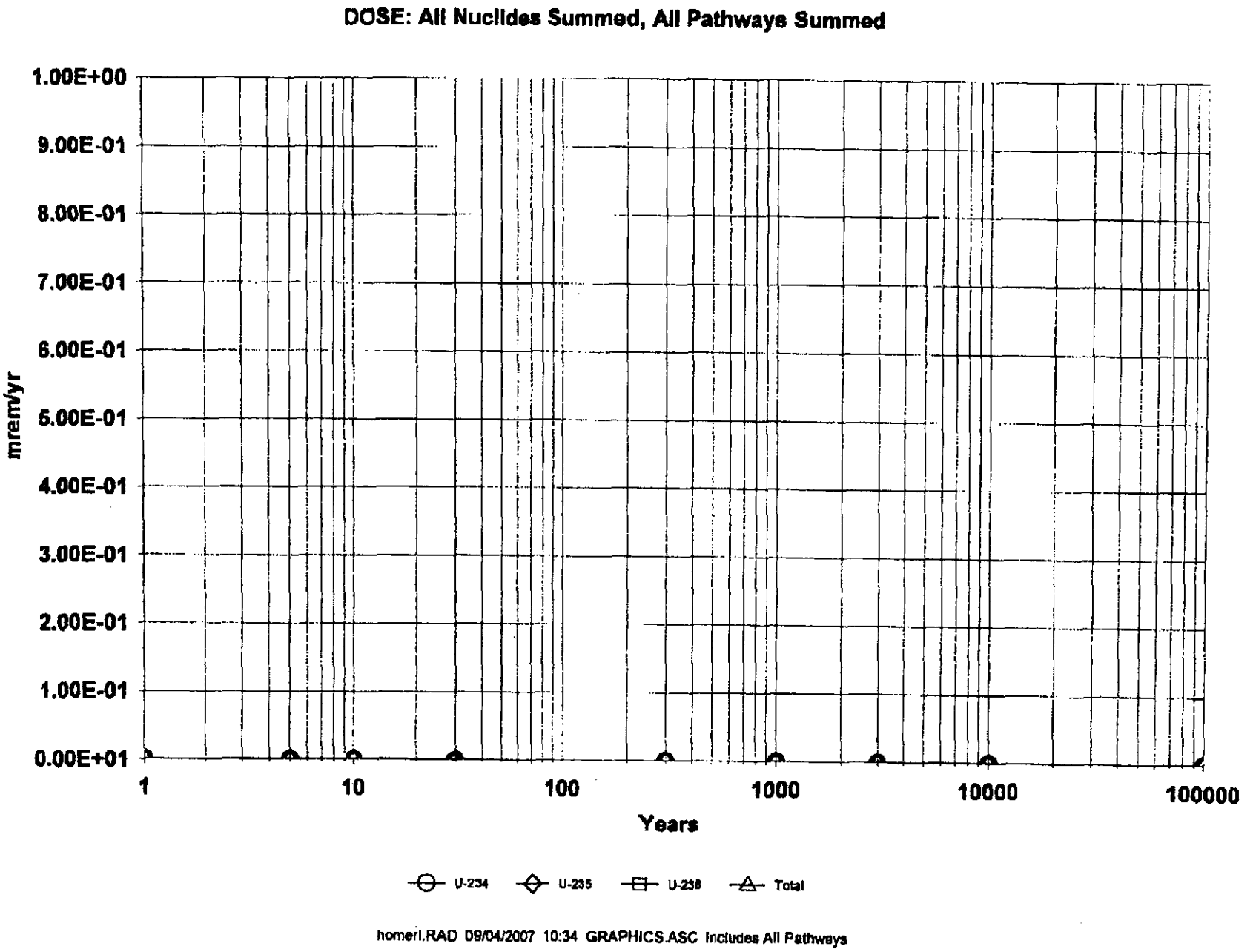
Burial at onsite landfill (4 steps)
Number of Workers: 1.0E+00 (D)
Dump truck bed dimensions for steps A, C, and D):
length: 2.50E+01 feet (D)
width: 6.00E+00 feet (D)
height: 3.00E+00 feet (D)

Step A: Unload waste to mixing pit
average distance: 5.00E+00 feet (D)
duration: 0.00E+00 hours
shielding thickness: 1.25E-01 inches (D)
airborne respirable dust concentration: 1.0E+00 mg/m3 (D)
respiratory protection factor: 1.0E+00 (D)

Step B: Mix waste in mixing pit
average distance: 1.00E+01 feet (D)
duration: 0.00E+00 hours
cover thickness: 2.00E+00 inches (D)
Mixing pit dimensions:
length: 1.00E+01 feet (D)
width: 1.00E+01 feet (D)
depth: 1.00E+01 feet (D)
cover thickness: 2.00E+00 inches (D)

Step C: Load truck and transport to landfill
average distance: 1.00E+01 feet
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)

Step D: Unload truck at landfill
average distance: 1.00E+01 feet
duration: 2.50E-01 hours (D)
shielding thickness: 1.25E-01 inches (D)



homerl.RAD 09/04/2007 10:34 GRAPHICS.ASC Includes All Pathways

DOSE ASSESSMENT FOR TRANSFER AND DISPOSAL OF SOURCE MATERIAL AT WCS ANDREWS FACILITY

1. INTRODUCTION

Previous decommissioning activities at the Homer Laughlin China Company (Homer Laughlin) Newell, WV site, have generated waste contaminated with low levels of natural uranium. Homer Laughlin proposes to transfer these waste materials to the WCS facility in Andrews, TX for treatment and ultimate disposal. This submittal provides a dose assessment demonstrating that the dose to members of the public from the disposal of this waste at WCS are very low compared to the 100 mrem/yr public dose limit and the 25 mrem/yr unrestricted use limit in 10 CFR 20, Subpart E.

The detailed assessments supporting these conclusions are presented in Attachments 1 and 2.

2. DESCRIPTION OF THE WCS ANDREWS FACILITY

2.1. ENVIRONMENTAL

Waste Control Specialists' Andrews facility is located in the extreme western part of Andrews County, Texas, adjacent to the border with New Mexico. The location is also about 30 miles east of the USDOE Waste Isolation Pilot Plant facility. The closest communities to the facility are the city of Andrews and the city of Eunice. The city of Andrews (1990 population 10,678) is approximately 30 miles east of the facility and is the major population center for Andrews County (1990 population was 14,338). The city of Eunice (1990 population was 2676) is located 6 miles west of the facility within the State of New Mexico. There is no residential area, school, day care center, highway rest area, or national monument within a five-mile radius of the facility. The facility is located on a 15,215 acre site (1500 acres in New Mexico), 1338 acres of which are fully permitted for the treatment, storage and disposal of RCRA and TSCA wastes (The permits allow acceptance of all RCRA and TSCA waste codes). The currently permitted disposal area can accommodate more than 11,000,000 cubic yards of waste.

The climate at the facility is classified as being arid to semi-arid and characterized by hot summers and dry winters. The average yearly total precipitation is approximately 14 inches, while the average yearly evaporation rate is approximately 63.25 inches per year. The prevailing winds from December to May are toward the north or south with wind velocities above 18 knots only 5 percent of the time. The wind velocity increases from March to May to approximately 12 percent above 18 knots and the wind direction slightly increases toward the South. During the months of June to November, the wind direction is predominantly to the south with wind velocity greater than 18 knots only 5 percent of the time. Tornadoes pose a natural threat to many areas in Texas; however, the probability of a tornado impacting a building at the facility appears to be very unlikely since Andrews County is in the area of lowest level of occurrence in Texas, and there is no record of a tornado in Andrews County. During the winter months, snow and icy conditions are possible, since the average monthly low temperature from November to

February is below 32 degrees. However, as with most areas in Texas, snow and ice does not remain for extended periods of time, limiting its effect on the facility. Normal operations at the facility are expected to continue throughout the winter months.

The Andrews site sits on an ancient erosional feature called the Redbed Ridge. This ridge is composed of a thick (about 800 to 1,000 foot) layer of continuous, predominately low permeability (about 10^{-8} to 10^{-9} cm/sec) red-bed clay, called the Dockum formation, that comes to within about 12 to 40 feet of the surface at the site. Migration times through this natural barrier have been conservatively calculated to be greater than 150,000 years. This clay layer protects the only aquifer at the site, the Santa Rosa Sandstone located below the clay formation, from any infiltration of water from the surface. The Santa Rosa aquifer is at least 900 feet below the surface, contains high levels of TDS, and is considered to be non-potable. None of the rainfall that falls on the site now, and probably none of the rainfall that has fallen on the site during the entire Pleistocene and Holocene geologic time periods, has reached the Santa Rosa aquifer.

Surface deposits at the site, identified as the Antlers, Caprock Caliche, and Blackwater Draw Formations, are about 12 to 40 feet thick and consist primarily of eolian sand, caliche and a thin sand and gravel deposit at the base of the caliche. The high ratio of annual evapotranspiration to precipitation combined with the waste cell design[1] will preclude significant hydrogeologic transport from the cells to the surficial deposits even after the engineered cover (15 foot thick compacted clay with other engineered barriers) has hypothetically degraded.

Sandy and silty lenses in the upper part of the Dockum formation, appear to be isolated hydrogeologically and have been observed to exhibit very low rates of diffusive flow. The high iron oxide clays are expected to be very effective sorbents of radionuclides. These isolated sandy and silty lenses are unlikely to result in any transport of radionuclides off-site. At about 200 feet below the surface there is a layer of sand and silt that is saturated. But wells drilled into this layer are non-productive; consequently, it is not classified as an aquifer. Due to its low permeability, this layer serves as a ground water monitoring zone. Site monitoring wells drilled into this layer serve as an excellent, natural warning system for migration.

The Dockum surface is a smooth, gently rolling eroded surface which contains shallow depressions called "buffalo wallows". The only water wells in the vicinity of the site are shallow wells, which tap into these shallow depressions and tend to collect water after a large precipitation event. These shallow wells contain high TDS, are typically pumped by windmill, and the water is only used for livestock watering or process water. The shallow formation is not classified as an aquifer.

There is no surface water or wetland anywhere near the Andrews facility. The nearest potable groundwater aquifer is the Ogallala aquifer, which is located at least 10 miles northeast of the site and on the opposite side of the Redbed ridge. Potable water for site use is piped in from west of Hobbs, NM, about 20 miles northwest of the site.

The only commercial activities within the vicinity of the facility consist of oil well penetrations and a gravel and crushing operation located approximately 1 mile to the west of the facility. Adjacent land

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[1] Waste cell design includes removal of the surface deposits, excavation into the redbed clay, construction of a 10 foot sidewall natural clay layer above the Dockum to the surface, and the RCRA engineered barriers

use is not expected to change during the active life of the facility. These activities will have no adverse impact upon the facility.

The following additional analyses have been performed on Andrews site:

- An evaluation has been performed with respect to its stability against potential seismic and fault activity. These studies show that there are no faults within the survey area with displacements in the Holocene time, and a review of probabilistic earthquake acceleration maps indicate that the project site does not fall within a seismic impact zone.
- An analysis has been performed to determine the effects of the 100 year flood with a conclusion that the 100 year flood has no effect upon the facility.
- An analysis has been performed to assess the potential for long term erosion at the site. Utilizing the highest estimated erosion rates, it is extremely unlikely (if not impossible) that the WCS facility could be breached by erosion within the next 25,000 to 50,000 years, and more likely in excess of 100,000 years. The WCS facility is situated atop a prominent buried ridge (Redbed), which has not been breached by erosion and has been a stable topographic feature, persisting as a drainage divide for at least the past 11 to 13 million years.
- An archeological survey was conducted with the results indicating that no cultural artifacts worthy of site designation were found and that the study area offered few enticements to prehistoric people or early settlers.
- An ecological study has been performed which has determined that there are no threatened or endangered species present at the site.

The nearest population center to the site is the town of Eunice more than five miles west of the site. Eunice has no municipal well; instead it brings water by pipe from Hobbs, New Mexico, more than twenty miles northwest of the site. There is no municipal well nearer to the site than those at Hobbs.

2.2. Facility Design and Operation

All waste currently authorized for disposal is placed in a RCRA cell with double plastic and clay liners and a double leachate collection system. The bottom of this cell extends well into the natural clay formation. An additional ten feet of compacted clay has been placed under the sidewall double liner from the surface down to the natural redbed clay, which provides an additional natural barrier for lateral migration near the surface.

The WCS Andrews facility has received a radioactive waste storage and treatment license from the Texas Commission on Environmental Quality (TCEQ). This license allows for the long term storage of hundreds of thousands of curies of various radionuclides for the term of the license, which is currently seven years and renewable. Storage capability includes pre-packaged and treated low level waste and mixed waste, including greater than Class C waste and sealed sources, in a drum storage facility that can accommodate 5,000 drums (36,750 cubic feet) and a bin storage area that can accommodate about 262,000 cubic feet of waste.

The treatment facility includes a state of the art treatment/stabilization building, half of which is for treatment and stabilization of a variety of RCRA and TSCA wastes, with the remaining half dedicated to the treatment of radioactive and mixed waste. The current low-level radioactive waste (LLRW) treatment capabilities include consolidation, repackaging, stabilization of mixed waste, capabilities for in-drum compaction, and a variety of other waste management services. Current hazardous waste treatment

capabilities include consolidation, repackaging, and stabilization for a wide variety of RCRA and TSCA wastes. The TSCA permit uniquely allows the direct disposal of PCB contaminated materials and/or treatment, if necessary.

In view of the radioactive waste storage and treatment license, all operations involving the handling of any radioactive material are performed under the existing radiation safety program, regardless of the exemption status of the materials to be disposed or handled. All on site personnel are trained and badged as radiation workers. All work on site involving handling of radioactive material is controlled by specific procedures and an approved Radiation Work Permit (RWP). All site design, operations and record keeping activities are controlled under a Quality Assurance Program

A comprehensive environmental monitoring program is being conducted under the requirements of the various existing RCRA/TSCA permits and radioactive material license.

All material will be shipped to the WCS site in DOT approved containers or meet DOT bulk shipping requirements. A shipping manifest will be prepared to document and certify the contents of the packages. The shipping manifest will be used to certify that all waste packages contain only radionuclides that meet the limits specified in TRCR Part 40 and unimportant concentration criteria in 10 CFR Part 40.13. After receipt surveys are performed, random samples may be taken on suspect packages based on external surveys, to verify compliance with all waste acceptance requirements.

Exempt level material that does not contain RCRA or TSCA regulated materials, or meets the RCRA requirements for disposal will be transported directly to the WCS onsite RCRA/TSCA disposal cell for final disposition. The WCS RCRA/TSCA permit allows disposal of radioactive material that is exempt from licensing under particular laws and regulations, and is therefore not classified as low level radioactive waste. Once received, the material will not leave the WCS licensed facility and will be handled only by appropriately trained WCS radiation workers and WCS transport vehicles under an approved radiation work permit.

Exempt level material containing RCRA materials that require treatment will be stored temporarily in the transport containers in approved buildings awaiting staging for treatment and then moved to the Stabilization building for treatment and/or stabilization to meet the land disposal restrictions (LDR) prior to disposal. Treatment will be performed in accordance with the radiation safety program. Again, the material will not leave the WCS facility and will be handled only by appropriately trained WCS radiation workers and WCS transport vehicles under an approved radiation work permit.

The current RCRA requirements applicable to the WCS facility exceed the Part 61 requirements in several areas related to design and institutional control. This includes: a minimum of 30 versus 5 years for active maintenance, deed restrictions which prevent disturbing the cover after the facility has been closed, a 5 meter engineered cover which satisfies the Part 61 intruder barrier requirement for Class C waste, and a double lined-double leachate collection system RCRA engineered cell. There is no requirement under RCRA for long term government ownership.

Existing site permits and licenses require various financial assurance instruments that provide for site decommissioning and closure, site maintenance and monitoring after closure, liability protection, and cleanup and removal of all waste stored on site under the license, if WCS cannot perform this activity.

The radiation dose to the general public from all facility operations will be maintained below all

applicable radiation protection limits and ALARA, and is expected to be far less than 1 mrem/yr. The radiation dose to workers will also be maintained below applicable limits and ALARA for all facility operations. All work will be performed under the existing radiation safety program and procedures. All workers are badged and trained as radiation workers. With these practices, radiological dose to workers from treatment and disposal of exempt level material is expected to be less than the standard for members of the public.

3. SAFETY ANALYSIS AND DOSE ASSESSMENT FOR TRANSFER AND DISPOSAL OF WASTE MATERIAL AT THE WCS ANDREWS FACILITY

3.1. SOURCE TERM

Based on sampling results of the waste material at the Homer Laughlin facility, the average concentration of total uranium is well below 500 mg/kg. To provide conservatism in the results, it is assumed that waste material is at the maximum allowable source material concentration (0.05% by weight U). Dose to WCS Workers

The WCS workers are classified as radiation workers under a Texas Commission of Environmental Control (TCEQ) license. WCS is committed to operations that are in compliance with the standards for protection against radiation as established in state radiation regulations and standard industry practices. These criteria for operation are specified in the WCS Radiological Control Program and the implementing procedures for radiation safety. The requirements for operation are imparted to the workers and visitors through the training programs in the Radiological Training Manual. All work on site involving handling of radioactive material will be in accordance with approved operating procedures that embrace and implement the radiological safety program. All on site personnel are trained and badged.

Notwithstanding the ongoing application of a radiation protection program at the site, a dose assessment was performed to specifically estimate the impact to WCS workers from the disposal of source material. In order to assess the impact to workers from the transport, receipt, processing, and disposal of source material, an analysis was performed using the TSD-DOSE computer program, version 2.22. TSD-DOSE is a program developed by Argonne National Laboratory for estimating doses to facility workers and the surrounding public at Treatment, Storage, and Disposal (TSD) facilities from shipments of hazardous waste which may contain small amounts of radionuclides.

TSD-DOSE can estimate worker and public doses from seven operations. Each of these operations can be evaluated, or not, to reflect the actual TSD facility operations. Many of the parameters used to model the typical operations may be adjusted to fit the WCS facility. A radiological dose is calculated for each operation based on waste characteristics, including radionuclide concentration, and site-specific information entered by the user. Doses to various receptors are calculated by summing the doses from those operations that would potentially contribute to the exposure.

Based on information provided by the project team, the driving time from the Homer Laughlin Facility to the WCS Facility, this is estimated to take 30 hours, with rest stops. Results of the TSD-DOSE analysis can be found in Attachment 1.

3.2. DOSE TO MEMBERS OF THE PUBLIC

The WCS workers are radiation workers permitted under the State of Texas and not classified as members of the public. However, there are three categories of individual members of the public that may be exposed as a result of the transport and disposal of exempt quantity waste. These are 1) transport truck drivers, 2) off-site residents in the vicinity of WCS during disposal, and 3) future onsite resident after the WCS facility closes. The doses to these members of the public are calculated below.

3.3.1 Transport Truck Driver

Based on the above assumptions the estimated dose to a transport truck driver is calculated to be 0.018mrem/shipment using the results of the TSD-DOSE analysis. For the two anticipated shipments the total dose is 0.036 mrem.

3.2.2. Offsite Resident During WCS Operations

Releases of radioactivity in effluents to the general environment are maintained at release levels below the allowable limits and as low as reasonable achievable through the implementation of an effective radiation control program. Appropriate design features are incorporated into the disposal cell design, operation, and closure to help achieve this goal include but are not limited to, a multi-layer thick disposal cell cover system, leachate collection system, long term maintenance specifications, and RCRA financial assurance.

Processing of radioactive waste material occurs inside enclosed buildings where there are precautions to prevent or reduce airborne radioactivity. Containers of radioactive waste materials are opened under controlled conditions. Bins containing bulk materials are kept covered.

During operation, effluents and radiation fields are monitored. The entire facility is surrounded by a restricted buffer area of approximately 1mile. The nearest industrial area is located more than 1 mile to the west of the facility and winds toward that direction occur less than 5 percent of the time.

Wastewater is not discharged from the facility. There is no connection to a municipal sewer system. Radioactive wastewater is collected in a storage container for use in stabilization processes or processed through the radioactive wastewater treatment system. Treated water is reused in the facility. Should the treated water exceed WCS requirements, upon approval by the Andrews Waterworks Department, it may be transferred via tank truck to the Andrews sanitary sewer system.

The radiological dose to an offsite resident during the disposal of the source material was assumed to occur from airborne radioactivity generated during waste handling operations at WCS, i.e., the loading, and unloading of trucks. This is a conservative assessment based on perimeter air samples at the facility that indicate non-detectable concentrations the majority of the time.

3.2.3. Dose to Future Onsite Resident After Site Closure

In the operation of the facility for disposal of exempt level material, WCS is committed to ensuring that concentrations of radioactive material which may be released to the general environment in groundwater, surface water, air, soil, plants, or animals shall not result in an annual dose above background exceeding an equivalent of 1 millirem effective whole body dose to of any member of the

public after site closure.

WCS has prepared a bounding analysis that assesses releases to the general environment from the disposal of unimportant concentration of source material[2] after disposal site closure. An analysis using the RESRAD computer code (V 6.3) has been performed to demonstrate that source material can be disposed at the WCS facility without exceeding a 1 mrem/yr effective dose to the maximum exposed individual.

3.2.3.1. Land Use and Exposure Pathways.

After closure of the landfill, it is possible that people could be exposed to radioactive materials from unrestricted use of the landfill site in a number of ways, depending on potential uses of land and groundwater resources. Over the long term, assumed for this analysis to be 1,000 years, use of the site for residential and agricultural purposes, though unlikely, would be the possible uses most likely to maximize radiation exposure. Use of groundwater containing landfill constituents for domestic and agricultural purposes or for irrigation is unlikely. The landfill siting and construction requirements are designed to minimize the potential for migration of landfill constituents to groundwater. Nevertheless, such use is assumed to be possible for purposes of this analysis.

Given assumed potential land and water uses, exposure of hypothetical future inhabitants of the landfill site to residual radioactive material in fill materials on the landfill site could hypothetically occur through one or more of three terrestrial pathways (water independent pathways), depending on the location of soils containing residual radioactive material with respect to the ground surface. If residual radioactive material were contained within soils at or near the ground surface, exposure could occur from radiation emitted directly from radioactive material in place in the soil, from inhalation of air containing residual radioactive material (either resuspended from soil at the ground surface or produced from the radioactive decay of radon gas emitted from the soil), or from ingestion of residual radioactive material taken up from soils into garden products produced on the site. For significant exposure through terrestrial pathways, removal of the 5-meter earthen cover and exposure of the fill material would be required. For the pathways involving groundwater use (water dependent pathways), radiation exposure could result from ingestion of water and from ingestion of radioactive material taken up from irrigation water into garden products produced on the site. Domestic animals might drink well water or eat vegetation irrigated by well water.

A hypothetical landfill site inhabitant scenario that incorporates almost all possible exposure pathways would be a resident farmer who uses groundwater for domestic and agricultural purposes. Because this scenario incorporates almost all of the potential exposure pathways, it is most likely to result in the highest dose, and, for that reason, is selected as the scenario that represents maximum potential impact from habitation of the site. More realistic exposure scenarios would exclude some potential pathways and would result in lower calculated doses. The pathways included for analysis are:

1. Ground
   -Direct radiation from material in soil
2. Dust
   -Resuspension of surface particulate material--air--inhalation

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[2] 10 CFR Part 40.13

3. Radon (water independent)
   -Release of radon gas from radioactive material in near-surface soils to residence interior--ingrowth of airborne particulate radon daughter products--inhalation
4. Plant (water independent)
   -Resuspension of surface particulate material--air--deposition or uptake in edible plant tissue--ingestion
   -Uptake of material in soil through roots of edible plants--ingestion
5. Meat or Milk (water independent)
   -Resuspension of surface particulate material--air--deposition or uptake in edible plant tissue--ingestion by animal--ingestion of animal product
   -Uptake of material in soil through roots of edible plants--ingestion by animal--ingestion of animal product
6. Soil
   -Ingestion of soil
7. Water
   -Release of materials in soil to infiltrating water--groundwater--ingestion
   -Release of materials in soil to infiltrating water--groundwater--transport to surface water--ingestion
9. Radon (water dependent)
   -Release of radon gas from groundwater brought into residence--ingrowth of airborne particulate radon daughter products--inhalation
10. Plant (water dependent)
   -Release of materials in soil to infiltrating water--groundwater--transport to surface as irrigation water--deposition or uptake in edible plant tissue--ingestion
11. Meat or Milk (water dependent)
   -Release of materials in soil to infiltrating water--groundwater--transport to surface water--ingestion by animal--ingestion of animal product
   -Release of materials in soil to infiltrating water--groundwater--transport to surface as irrigation water--deposition or uptake in edible plant tissue--ingestion by animal--ingestion of animal product

3.2.3.2. Parameters.

Some values of parameters in RESRAD were entered specifically describing the WCS Andrews site.

The calculations include an analysis using the HELP model to estimate infiltration through the disposal cell cover. That analysis takes no credit for the geotextile, HPDE liner, asphalt, and bottom soil layer. The infiltration through the cover is conservatively calculated to be less than 0.00028 m/yr. These infiltration results are used in the RESRAD model to estimate radiological dose.

An analysis also has been performed using a conservative mathematical model to estimate the transport time to the nearest saturated zone at 225 feet below the surface. The nearest aquifer, the Santa Rosa, is about 1000 feet below the surface. Since the infiltration rate is very low, the bottom of the disposal cell is more than 50% into the clay layer, and the presence of the 10 foot compacted clay layer along the sides of the cell; transport is assumed only to occur in a vertical direction down through the clay.

A detailed analysis has been performed to estimate potential radiation exposure from radioactive gases emanating through the cover system. As before, no credit is taken for geotextile, HPDE liner,

asphalt, and bottom soil layer. The results of this analysis show that it would require the disposal of over 100,000 curies of Ra-226, Th-230, U-234, or U-238 to result in greater than 1 mrem/yr exposure to a worker directly on top of a disposal cell. Disposal of exempt level material will never begin to approach these inventories. Assuming 1000 pCi/gm, it would require about 10^8 m^3 of waste to create an inventory of 100,000 curies, which is about ten times greater than the currently permitted disposal capacity.

The following assumptions were made in developing input data for the RESRAD analysis.

- Even though erosion analysis indicates that it is likely that the cover depth will increase over time, cover erosion rate was conservatively calculated using the USDA's universal soil loss equation: $A = R*K*L_s*C*P$. For an established final cover; R=90 (for Western Andrews Co), K =0.27 (for sandy clay loam-conservative since most of cover is hard compacted clay), L_s=0.4 (for L =300 ft, s =3%), C =0.01 (for moderate, grass legume meadow), and P =1.0 (for no supportive practice for long term); so A =0.0972 tons/acre/yr ≈0.01 yd^3/acre/yr = 1.83 x 10^{-6} m/yr.
- The cover depth is assumed to be 5 meters of clay with no credit taken for any engineered layers or barriers.
- Since the infiltration rate is very low, the bottom of the disposal cell is more than 50% into the redbed clay formation, and there is a 10 foot compacted clay layer along the sides of the cell to the surface, the permeability is assumed to be the same as was measured from drillings in the Dockum Formation. The permeability of the Dockum has been measured to be between 10^{-9} and 10^{-8} cm/sec, so a value of about 3 x 10^{-9} cm/sec (≈1 x 10^{-3} m/yr) was chosen as the unsaturated zone hydraulic conductivity. An unsaturated zone thickness of 50 m (160 ft) was used as the depth to the first saturated, but non productive zone. (This zone is used for monitoring and compliance purposes. The actual depth to the first aquifer is about 300 m.)
- Other values such as annual rainfall (0.355m), cover porosity (0.427), and cover volumetric water content (0.418) for calculation of radon diffusion rate are actual site data.
- The evapotranspiration coefficient was conservatively assumed to be 0.8. For purposes of sensitivity analysis, the calculated infiltration from the HELP model was used to calculate the evapotranspiration coefficient using Equation E.4 in the RESRAD manual as follows: $I=(1-C_e)[(1-C_r)P_r+I_{rr}]$. For the WCS disposal cell; I=2.74E-04 m/yr[3], C_r=0.5, P_r=0.355 m/yr and I_{rr}=0, so C_e=0.9985.
- Other values used for the RESRAD calculations are default values.

3.2.3.3. Results

Detailed results of the RESRAD calculations are in Attachment 2. The maximum potential radiological dose to a hypothetical future resident farmer on the WCS Andrews site from all exposure pathways is estimated by RESRAD to be zero within the next 1000 years.

Sensitivity calculations have also been performed as follows:

- If the waste volume is assumed to increase ten times, the dose remains insignificant.

4. EVALUATION OF INADVERTENT INTRUSION SCENARIO

4.1. INTRODUCTION

[3] From WCS RCRA subtitle C permit application.

In addition to the onsite resident, the dose to an additional onsite intruder was evaluated as described below.

Facility design and operation include appropriate features to protect against intrusion into the WCS facility. These measures include but are not limited posted warning signs, a fence around the property boundary, and security guards to prevent intrusion onto the facility.

WCS intends make a reasonable effort to protect against inadvertent intrusion into the disposal site, occupation of the site, or human contact with the waste at any time after active institutional controls over the disposal site are removed. Planned controls after site closure include a 5 meter-thick, engineered cover of compacted clay. Deed restrictions will prohibit excavation.

Because of the presence of the 5 meter-thick, compacted clay cover, the only intrusion scenario of potential concern is believed to be drilling to try to establish a water well. Radiological dose was estimated to a person who intrudes into buried waste by entering the burial site after its closure and drills through buried waste while trying to establish a water well.

Calculation of external exposure from exhumed waste was based on the guidance document IMPACTS (NUREG/CR-4370, 1986). The waste exhumed by drilling was assumed to be collected in a pit with the drilling cuttings and drilling fluid. The drilling was estimated to occur for 8 hours a day for three days; thus, the intruder was assumed to be exposed to the radiation for 24 hours. After drilling, the pit is assumed to be filled to the top with soil from the surrounding area. Inhalation impacts are discounted because of the liquid nature of the contaminated mud would suppress dust and mitigate inhalation.

Initial computations estimates potential exposure from unit radionuclide concentrations of 1.0 Ci/m^3 disposed of in the RCRA landfill. Because waste exhumation is a concentration scenario, results are presented in units of $mrem \cdot m^3/Ci \cdot yr$. The estimated radiological dose compute per unit concentration of each radionuclide was subsequently scaled to the radionuclide concentration equivalent to the concentration in the NMI Site waste stream.

4.2. METHODOLOGY

4.2.1. Exposure Scenario

At the end of the institutional control period, 100 years after site closure, it is possible, although unlikely, that an intruder might build a house on or near the landfill. In order to secure a supply of water for living needs, a well is assumed to be drilled to the Santa Rosa aquifer. The drilling crew is assumed to drill inadvertently through the landfill and exhume a quantity of waste, which is presumed to be diverted into a pit with the drilling cuttings. The drilling crew is assumed to be exposed to the waste for the duration of the drilling, a total of 24 hours (8 hr/day for 3 days).

4.2.2. Source

Waste containing source material is assumed to be buried in the engineered landfill cell penetrated by drilling. For the source material, the radionuclide concentrations are 90.3 pCi/g U-238 (68.2% of the total uranium activity), 40.4 pCi/g U-234 (30.5% of the total uranium activity), and 1.7 pCi/g of U-235 (1.3% of the total uranium activity).

4.2.3. Equations Used for Calculation of Exposure from Unit Concentration

Potential exposure to a unit waste concentration was estimated with the following equation:

$$H_{j,k} = R_j \cdot f_D \cdot DF_k \tag{1}$$

where $H_{j,k}$ = exposure from unit concentration (mrem-m^3/Ci-yr)
R_j = exposure rate (mrem-m^3/Ci-hr)
f_D = exposure duration factor (24 hr/yr)
DF_k = dilution factor
j = radionuclide j
k = landfill k

The exposure duration factor (f_D) was assumed to be 24 hr/yr based on the 24 hr drilling time. The dilution factor (DF_k) accounts for the mixing of the exhumed waste with the drilling cuttings in the pit and is calculated in section 3.2.4. The exposure rate (R_j) was calculated based on guidance provided in section 4.2.1 of IMPACTS (NUREG/CR-4370, 1986), dose conversion factors listed in Federal Guidance Document No. 12 (FGR 12, 1993), and gamma ray energies provided in the computer model RADDECAY 2.02 (Grove Engineering, 1987)

4.2.4. Dilution Factor

Drilling cuttings consisting of exhumed waste were assumed to be completely mixed with cuttings from the remainder of the drilling. Assuming that the cuttings settle to the bottom of the drill mud pit and the drilling fluid (water) overlies the cuttings, the radionuclide concentration in the cuttings can be calculated as follows:

$$DF_k = \frac{V_{waste}}{V_{shaft}} = \frac{T_k}{T_H + T_k} \tag{2}$$

where V_{waste} = volume of waste exhumed by drilling (m^3)
V_{shaft} = total volume of well shaft (m^3)
T_k = thickness of waste in landfill (m)
T_H = thickness of soils between landfill and aquifer (m)

Equation 2 is valid for a constant well hole diameter, assumed to be 8 inches. The soil thickness (T_H) was estimated to be 330 m based on the geotechnical report. The thickness of the RCRA landfill is 65 feet, and subtracting 5 meters for the cap yields a waste thickness of 14.6 meters. Thus, the dilution factor (DF_k) was calculated to be 0.0430 for the RCRA landfill. The value of T_H does not include the thickness of the landfill cover systems, therefore calculation of the dilution factor is conservative.

4.2.5. Exposure Rate

The exposure rate was calculated based on site specific characteristics and methods described in Section 4.2.1 of IMPACTS and Section 3.1 of NUREG/CR-3585 (1985). The exposure rate is given by

Equation 3, which accounts for shielding provided by water overlaying the exhumed waste, the finite size of the cuttings pit, and decay and ingrowth of radionuclides over time.

Equation 3 provides correction for several important physical phenomena. Decay of parent and ingrowth of progeny radionuclides was accounted for by summing the dose conversion factors for each radionuclide in a decay chain. The activity ratio ($AR_{j,i}$) is the ratio of radionuclide parent or progeny activity after 100 years of decay to the initial concentration of the parent radionuclide. The shielding provided by the layer of drilling fluid overlying the exhumed waste was accounted for by the shielding factor (SF_i). The finite, rectangular shape of the pit was accounted for by the areal exposure correction factor (CF_i).

$$R_j = \sum_{i=0}^{n} AR_{j,i} \cdot DCF_i \cdot CF_i \cdot SF_i \tag{3}$$

where DCF_i = dose conversion factor (mrem-m^3/Ci-hr)
SF_i = shielding factor provided by water
Cf_i = areal exposure correction factor
$AR_{j,i}$ = activity ratio, i=0 for parent
n = number of radionuclides in decay chain including parent
i = progeny or parent radionuclide *i* present after decay period

4.2.5.1. Dose Conversion Factors

The does conversion factors (DCF) are based on FGR 12[4], Table III.7, factors for exposure to soil contaminated to an infinite depth. The factors in Table III.7, when multiplied by 1.33 x 10^{19}, convert from Sv-m^3/Bq-s to mrem-m^3/Ci-hr. For many of the radionuclides, these DCF are conservative because they include exposure from both gamma rays and beta particles even though no beta particles could penetrate the water that overlays the waste. Additionally, these DCF include Bremsstrahlung radiation caused by deceleration of beta particles.

Preliminary calculations show that for radionuclides with multiple progeny in their decay chains, over 95% of the exposure rate results from only one, two, or three of the radionuclides in the decay chain. As a simplification, exposure from the other radionuclides that contribute less then 5% to the total exposure rate was not calculated.

4.2.5.2. Areal Exposure Correction Factors

The dose factors in Table III.7 of FGR 12 are for a source with infinite area, therefore an areal correction factor (CF_i) was used to account for the finite size of the drill mud pit. Based on Section 3.1 of NUREG/CR-3585 (1985), the shape correction factor is given by the following equation:

$$CF_i = \frac{A_{pit}}{A_{cir}} CF_{circle,i} = \frac{A_{pit}}{A_{circle}} \left(1 - \frac{E_1\left(\mu_{a,i}\sqrt{z^2 + r^2}\right)}{E_1(\mu_{a,i} z)} \right) \tag{4}$$

where

[4] USEPA. *External Exposure to Radionuclides in Air, Water, and Soil*. Fed. Guidance Rpt. No 12. EPA 402-R-93-081. Sept. 93.

A_{pit} = area of drill mud pit (m^2)
R = maximum horizontal distance from a person to an element of the source
Z = maximum vertical distance from a person to an element of the source
A_{circle} = area of circle with radius equal to the maximum distance from a person to an element of the source (m^2)
$CF_{circle,i}$ = correction factor for a person located a distance z above a source of radius *r*
$E_1(x)$ = exponential integral of x (calculated using a Taylor series approximation (Jeffrey, 1995))
$\mu_{a,I}$ = linear attenuation coefficient of air (m^{-1})

The pit containing the cuttings and drilling fluid was assumed to be rectangular in shape and the cuttings were assumed to be shielded by an overlying layer of drilling fluid (water). The cuttings were assumed to be completely mixed with exhumed waste (the initial portion of these cuttings). That is, drill cuttings settle to the bottom of the pit and the drilling water rises to the surface. IMPACTS suggests that the volume of the pit should be three times the volume of the cuttings.

For the RCRA landfill, the volume of the cuttings were calculated to be 11.1 m^3, thus the total volume of cuttings and drilling fluid was assumed to be 33.3 m^3. The pit was assumed to be 17 ft (5.2 m) on each side and 5 ft (1.52 m) deep. The dose point was assumed to be 1.0 m above the top of the pit. This results in a source (cuttings) thickness of 0.41 m and shield thicknesses of 0.83 m of water.

Given that the mud pit was 5.2 m on each side, r = 5.2 m, A_{pit} = 27 m^2, and, A_{circle} = 84 m^2. The dose point was assumed to be 1.0 m above the top of the pit and there is 0.3 m of air between the surface of the water and the top of the pit;therefore z = 1.3 m. The mass attenuation coefficients in air, as a function of gamma ray energy in MeV, are taken from page 139 of the Radiological Health Handbook (1970). These values are given in units of cm^2/g. An air density of 0.00122 g/cm^3 was assumed, thus the values were multiplied by 0.122 to convert to units of m^{-1}.

Because attention coefficients are given for each gamma ray rather than for each radionuclide, it was assumed that all gamma rays for a single radionuclide penetrate identically to the most energetic gamma ray emitted by that radionuclide. This is a very conservative assumption because in reality the DCF are dependent on the entire range of gamma rays emitted by a radionuclide but the lower energy gamma rays are more attenuated than the higher energy ones.

For some radionuclides, there is a higher yield (probability of emission) for a gamma ray that is slightly lower in energy than the maximum energy gamma ray. In order to be more reflective of reality for these instances, the gamma ray with the higher yield and slightly lower energy was used instead of the gamma with the lower yield and maximum energy. This was done for U-235, for instance.

4.2.5.3. Shielding Factors

The 0.83 m of water estimated to overlay the exhumed waste in drill mud shields against radiation. This thickness of water completely blocks alpha and beta particles but is not sufficient to completely block high energy gamma rays. Therefore, following formula from IMPACTS was used to calculate the gamma ray shielding factor:

$$SF_i = e^{-\mu_{w,i}L} B(\mu_{w,i}L) = e^{-\mu_{w,i}L}(1 + 0.95\mu_{w,i}L + 0.35(\mu_{w,i}L)^2) \qquad (5)$$

where $\mu_{w,i}$ = linear attenuation coefficient for gamma in water (m^{-1})
L = thickness of water layer (0.83 m)
$B(x)$ = polynomial buildup factor

The mass attenuation coefficients in water were taken from page 138 of the Radiological Health Handbook (1970). These values are given in units of cm^2/g, and an water density of 1.0 g/cm^3 was assumed. Therefore, the values were multiplied by 100 to convert to units of m^{-1}.

4.2.5.4. Activity Ratios

A number of radionuclides, such as U^{234}, have both short-lived and long-lived progeny. In order to properly calculate exposure from these nuclides it was necessary to account for exposure due to the progeny as well as the parent. Ingrowth and decay of radionuclides was calculated using the following formula:

$$AR_{j,i} = \frac{A_i}{A_j} = \prod_{a=1}^{n} \lambda_a \sum_{b=0}^{n} \frac{e^{-t\lambda_b}}{\prod_{\substack{c=0 \\ c \neq b}}^{n} (\lambda_c - \lambda_b)} \qquad (6)$$

where A_i = activity of progeny/parent at time t (Ci)
A_j = activity of parent at time 0 (Ci)
λ_x = decay constant for radionuclide x (yr^{-1})
j = parent radionuclide
i = daughter or parent radionuclide (i=0 for parent; i=n for final daughter)
n = number or radionuclides in decay chain including parent

Each radionuclide was analyzed separately. The source was assumed to have an initial concentration of 1.0 Ci/m^3 for each parent radionuclide analyzed. The activity of the parents and the progeny were calculated after 100 years of decay and ingrowth.

A 100-year time frame was evaluated because intrusion was assumed to occur 100 years after the closure of the landfill. This assumes that all the radionuclides were assumed to be placed in the landfill during the last year of operational waste acceptance.

4.2.6. Summary of Parameters Used to Estimate Potential Exposure

Equations 1 through 6 can be used to estimate the potential exposure from a unit concentration of 1.0 Ci/m^3 in either landfill via the intruder-driller scenario. Parameters used in these equations are summarized in Table 1.

Table 1. Summary of Parameters

Parameter	Symbol	RCRA Landfill
Espouse duration factor (hr/yr)	f_D	24
Waste thickness in landfill (m)	T_k	14.6
Depth of well shaft (m)	T_H	330
Dilution factor	DF_k	0.0430
Rate of exposure	R_k	Specific
Activity ratio	$AR_{j,i}$	Specific
Dose conversion factor	DCF_i	Specific
Vertical source-intruder distance (m)	z	1.28
Horizontal source-intruder distance (m)	r	5.28
Gamma attenuation in air	$\mu_{a,i}$	Specific
Areal exposure correction factor	CF_i	Specific
Thickness of water shield (m)	L	0.83
Gamma attenuation in water	$\mu w,i$	Specific
Shielding factor for water	SF_i	Specific

4.3. Results of Inadvertent Intrusion Analysis

The driller-intruder analyses incorporated site parameters, federal guidance documents, geotechnical reports, and other sources of information to determine the potential exposure from radionuclides disposed of in the landfills.

The estimated unit exposure from 1.0 Ci/m^3 of each key U series and Th series radionuclide was calculated. Decay chain calculations were performed so that exposure rates for radionuclides include the activities of progeny present after 100 years of institutional control. The analysis estimated the potential exposure from a unit radionuclide activity of 1.0 Ci/m^3 disposed of in the Main Landfill and the Condo Landfills. Parent radionuclides analyzed are listed in Table 6. An estimate of potential exposure from a unit concentration of 1.0 Ci/m^3 of each was calculated for both landfills and is also shown in Table 2.

Table 2. Potential Intruder-Driller Exposure from Unit Activity in Each Landfill

Radionuclide	Unit Source in Landfill ($mrem \cdot m^3/yr \cdot Ci$)
U-234	3.1E-4
U-235	4.7E-3
U-238	8.5E-2

Note: Tc-99 has no significant direct exposure component

The unit exposure rates in Table 2 were multiplied by the radionuclide concentrations in the source material to yield an estimate of the exposure rate for each radionuclide. The concentrations and exposure rates are shown in Table 3.

The specific focus of the analysis of intrusion is the scenario under which a person enters the closed landfill site after the end of institutional control and drills a well to the aquifer below the landfill.

To estimate potential exposure, spreadsheet calculations were carried out for the intruder-driller scenario described in IMPACTS. The calculations estimated external exposure to gamma radiation from exhumed waste. The exhumed waste was assumed to be collected in a pit with the drilling cuttings and drilling fluid. The drilling was estimated to occur for 8 hours a day for three days, thus the intruder was assumed to be exposed to the radiation for 24 hours. Site parameters were based on a number of sources including landfill design drawings, geophysical analyses of the site and surrounding area, and federal regulatory guidance documents such as IMPACTS.

Table 3. Potential Intruder-Driller Exposure from Projected Maximum Concentration in Each Landfill

Radionuclide	Maximum Concentration		RCRA Landfill Potential Exposure
	(pCi/g)	(Ci/m^3)	(mrem)
U^{238}	167	2.4e-04	7.4e-08
U^{235}	8	7.0e-06	5.6e-08
U^{234}	167	2.4e-04	2.0e-05
		Total dose	2.0e-05

The intruder-driller analysis indicates that exposure from radionuclides will be below 1 mrem/yr. There is a considerable margin of safety associated with this estimate because it assumes that the entire quantity of waste removed by drilling contains the maximum concentration. The waste will be placed in the landfill in layers and it is highly unlikely that a cross sectional core of waste would be homogeneous.

4.4. COLLECTIVE DOSE

The collective dose from disposal of the source material at WCS was calculated for members of the public including transportation, off-site resident, and future on-site resident. The WCS workers are not considered members of the public since they are classified as radiation workers under the TCEQ license. However, the collective doses to the WCS workers are also calculated.

The collective dose to the future onsite resident is zero since the RESRAD result for the resident farmer was zero. However, the collective dose from the well digging scenario is calculated in place of the future onsite resident assuming a 2-person crew and well replacement every 50 years over a 1000-year period. The worker collective dose is primarily based on the TSD_DOSEresults. The collective dose for WCS workers is calculated based on the RP technician and driver exposure scenarios and the number of workers exposed. The transportation collective dose calculation assumes one driver and two truck shipments of exempt source material.

- Truck Transportation – 3.6e-05 person-rem
- Off-Site population – 3.2e-04 person-rem
- Future On-Site Resident – 0.0 person-rem during first 1000 years
- Well Diggers – 8.0e-07 person-rem
- WCS Workers – 1.3e-04 person-rem

5. CONCLUSIONS OF ANALYSES

The Homer Laughlin site proposes to transfer and dispose of approximately 30 tons of source material at the WCS Andrews facility. Estimates of individual and collective dose to members of the public and to WCS workers were made to evaluate the consequence of disposing the source material at the WCS facility. The doses are listed in Table 4.

In conclusion, the doses from the shipment of source material and disposal at WCS are very low compared to the 100 mrem/yr public dose limit and the 25 mrem/yr unrestricted use limit in 10 CFR 20, Subpart E. **The maximum individual public dose for the disposal of the source material is 4.4E-02 mrem to a WCS worker for the assumed 2 shipments.**

Table 4 – Summary of Doses from Disposal of Source Material at WCS

Exposure Scenario	Individual Dose (mrem)	Collective Dose (person-rem)
Truck Transport	0.036	3.6e-05
WCS workers	0..044	1.3e-04
Off-Site population	N/A	3.2e-03
Future On-Site Resident(1)	4.0e-05	8.0e-07

Notes:

(1) The future onsite resident is assumed to be the intruder since the resident farmer dose is zero.

REFERENCES

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6. U.S. Nuclear Regulatory Commission, *Update of Part 61 Impacts Analysis Methodology*, NUREG/CR-4370, Vol. 1, 1986.

Attachment 1

TSD-DOSE Analysis for Disposal of Source Material at the WCS Andrews Facility

Attachment 2

RESRAD Analysis for Disposal
of Source Material at the WCS Andrews Facility

August, 18 2007

Mr. John Nicholson
Division of Nuclear Materials Safety
US Nuclear Regulatory Commission – Region 1
475 Allendale Road
King of Prussia, Pennsylvania, 19406

Subject: Submittal of dose assessment for materials disposed at WCS facility

Dear, Mr. Nicholson,

The Homer Laughlin China Company (Homer Laughlin) is pleased to provide this dose assessment to the Nuclear Regulatory Commission (NRC). This dose assessment has been performed at the NRC's request to demonstrate that the dose to members of the public from the disposal of Homer Laughlin's legacy waste materials at WCS are very low compared to the 100 mrem/yr public dose limit and the 25 mrem/yr unrestricted use limit in 10 CFR 20, Subpart E.

As previously indicated, Homer Laughlin intends to ship all remaining waste materials to WCS for treatment and ultimate disposal. Submission of this dose assessment satisfies the NRC request for additional characterization data and dose assessment of the legacy waste materials at the Homer Laughlin site.

Please contact Mr. Glenn Boucher @ (304)- 387-1300 ext 447 if you require any additional information.

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Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 MORBIDITY

0 Base Menu Case*	Parameter Name	Parameter	Current Value
B-1	Dose conversion factors for inhalation, mrem/pCi:		
B-1	Ac-227+D		6.724E+00
6.700E+00	DCF2(1)		
B-1	Pa-231		1.280E+00
1.280E+00	DCF2(2)		
B-1	Pb-210+D		2.320E-02
1.360E-02	DCF2(3)		
B-1	Ra-226+D		8.594E-03
8.580E-03	DCF2(4)		
B-1	Th-230		3.260E-01
3.260E-01	DCF2(5)		
B-1	U-234		1.320E-01
1.320E-01	DCF2(6)		
B-1	U-235+D		1.230E-01
1.230E-01	DCF2(7)		
B-1	U-238		1.180E-01
1.180E-01	DCF2(8)		
B-1	U-238+D		1.180E-01
1.180E-01	DCF2(9)		
D-1	Dose conversion factors for ingestion, mrem/pCi:		

```
 D-1  ³ Ac-227+D                                                    ³ 1.480E-02 ³
1.410E-02 ³ DCF3(  1)
 D-1  ³ Pa-231                                                      ³ 1.060E-02 ³
1.060E-02 ³ DCF3(  2)
 D-1  ³ Pb-210+D                                                    ³ 7.276E-03 ³
5.370E-03 ³ DCF3(  3)
 D-1  ³ Ra-226+D                                                    ³ 1.321E-03 ³
1.320E-03 ³ DCF3(  4)
 D-1  ³ Th-230                                                      ³ 5.480E-04 ³
5.480E-04 ³ DCF3(  5)
 D-1  ³ U-234                                                       ³ 2.830E-04 ³
2.830E-04 ³ DCF3(  6)
 D-1  ³ U-235+D                                                     ³ 2.673E-04 ³
2.660E-04 ³ DCF3(  7)
 D-1  ³ U-238                                                       ³ 2.550E-04 ³
2.550E-04 ³ DCF3(  8)
 D-1  ³ U-238+D                                                     ³ 2.687E-04 ³
2.550E-04 ³ DCF3(  9)
       ³                                                            ³           ³
       ³
 D-34 ³ Food transfer factors:                                      ³           ³
       ³
 D-34 ³ Ac-227+D  , plant/soil concentration ratio, dimensionless   ³ 2.500E-03 ³
2.500E-03 ³ RTF(  1,1)
 D-34 ³ Ac-227+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   ³ 2.000E-05 ³
2.000E-05 ³ RTF(  1,2)
 D-34 ³ Ac-227+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    ³ 2.000E-05 ³
2.000E-05 ³ RTF(  1,3)
 D-34 ³                                                             ³           ³
       ³
 D-34 ³ Pa-231    , plant/soil concentration ratio, dimensionless   ³ 1.000E-02 ³
1.000E-02 ³ RTF(  2,1)
 D-34 ³ Pa-231    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   ³ 5.000E-03 ³
5.000E-03 ³ RTF(  2,2)
 D-34 ³ Pa-231    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    ³ 5.000E-06 ³
5.000E-06 ³ RTF(  2,3)
 D-34 ³                                                             ³           ³
       ³
 D-34 ³ Pb-210+D  , plant/soil concentration ratio, dimensionless   ³ 1.000E-02 ³
1.000E-02 ³ RTF(  3,1)
 D-34 ³ Pb-210+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   ³ 8.000E-04 ³
8.000E-04 ³ RTF(  3,2)
 D-34 ³ Pb-210+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    ³ 3.000E-04 ³
3.000E-04 ³ RTF(  3,3)
 D-34 ³                                                             ³           ³
       ³
 D-34 ³ Ra-226+D  , plant/soil concentration ratio, dimensionless   ³ 4.000E-02 ³
4.000E-02 ³ RTF(  4,1)
 D-34 ³ Ra-226+D  , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   ³ 1.000E-03 ³
1.000E-03 ³ RTF(  4,2)
 D-34 ³ Ra-226+D  , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    ³ 1.000E-03 ³
1.000E-03 ³ RTF(  4,3)
 D-34 ³                                                             ³           ³
       ³
 D-34 ³ Th-230    , plant/soil concentration ratio, dimensionless   ³ 1.000E-03 ³
1.000E-03 ³ RTF(  5,1)
 D-34 ³ Th-230    , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   ³ 1.000E-04 ³
1.000E-04 ³ RTF(  5,2)
 D-34 ³ Th-230    , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    ³ 5.000E-06 ³
5.000E-06 ³ RTF(  5,3)
 D-34 ³                                                             ³           ³
       ³
 D-34 ³ U-234     , plant/soil concentration ratio, dimensionless   ³ 2.500E-03 ³
```

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2.500E-03 ³ RTF(  6,1)
 D-34 ³ U-234       , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 3.400E-04 ³
3.400E-04 ³ RTF(  6,2)
 D-34 ³ U-234       , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 6.000E-04 ³
6.000E-04 ³ RTF(  6,3)
 D-34 ³                                                                ³           ³
      ³

 D-34 ³ U-235+D     , plant/soil concentration ratio, dimensionless    ³ 2.500E-03 ³
2.500E-03 ³ RTF(  7,1)
 D-34 ³ U-235+D     , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 3.400E-04 ³
3.400E-04 ³ RTF(  7,2)
 D-34 ³ U-235+D     , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 6.000E-04 ³
6.000E-04 ³ RTF(  7,3)
 D-34 ³                                                                ³           ³
      ³

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                       Dose Conversion Factor (and Related) Parameter Summary
(continued)
                                       File: HEAST 2001 MORBIDITY
0      ³                                                               ³  Current  ³
Base    ³  Parameter
 Menu ³                           Parameter                            ³   Value   ³
Case*   ³    Name

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ÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 D-34 ³ U-238       , plant/soil concentration ratio, dimensionless    ³ 2.500E-03 ³
2.500E-03 ³ RTF(  8,1)
 D-34 ³ U-238       , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 3.400E-04 ³
3.400E-04 ³ RTF(  8,2)
 D-34 ³ U-238       , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 6.000E-04 ³
6.000E-04 ³ RTF(  8,3)
 D-34 ³                                                                ³           ³
      ³

 D-34 ³ U-238+D     , plant/soil concentration ratio, dimensionless    ³ 2.500E-03 ³
2.500E-03 ³ RTF(  9,1)
 D-34 ³ U-238+D     , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)    ³ 3.400E-04 ³
3.400E-04 ³ RTF(  9,2)
 D-34 ³ U-238+D     , milk/livestock-intake ratio, (pCi/L)/(pCi/d)     ³ 6.000E-04 ³
6.000E-04 ³ RTF(  9,3)
      ³                                                                ³           ³
      ³

 D-5    ³ Bioaccumulation factors, fresh water, L/kg:                  ³           ³
      ³

 D-5    ³ Ac-227+D    , fish                                           ³ 1.500E+01 ³
1.500E+01 ³ BIOFAC(  1,1)
 D-5    ³ Ac-227+D    , crustacea and mollusks                         ³ 1.000E+03 ³
1.000E+03 ³ BIOFAC(  1,2)
 D-5    ³                                                              ³           ³
      ³

 D-5    ³ Pa-231      , fish                                           ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC(  2,1)
 D-5    ³ Pa-231      , crustacea and mollusks                         ³ 1.100E+02 ³
1.100E+02 ³ BIOFAC(  2,2)
 D-5    ³                                                              ³           ³
      ³

 D-5    ³ Pb-210+D    , fish                                           ³ 3.000E+02 ³
3.000E+02 ³ BIOFAC(  3,1)
 D-5    ³ Pb-210+D    , crustacea and mollusks                         ³ 1.000E+02 ³
1.000E+02 ³ BIOFAC(  3,2)
 D-5    ³                                                              ³           ³
```

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         ³
 D-5   ³ Ra-226+D   , fish                                               ³ 5.000E+01 ³
5.000E+01 ³ BIOFAC(  4,1)
 D-5   ³ Ra-226+D   , crustacea and mollusks                             ³ 2.500E+02 ³
2.500E+02 ³ BIOFAC(  4,2)
 D-5   ³                                                                 ³           ³
         ³
 D-5   ³ Th-230     , fish                                               ³ 1.000E+02 ³
1.000E+02 ³ BIOFAC(  5,1)
 D-5   ³ Th-230     , crustacea and mollusks                             ³ 5.000E+02 ³
5.000E+02 ³ BIOFAC(  5,2)
 D-5   ³                                                                 ³           ³
         ³
 D-5   ³ U-234      , fish                                               ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC(  6,1)
 D-5   ³ U-234      , crustacea and mollusks                             ³ 6.000E+01 ³
6.000E+01 ³ BIOFAC(  6,2)
 D-5   ³                                                                 ³           ³
         ³
 D-5   ³ U-235+D    , fish                                               ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC(  7,1)
 D-5   ³ U-235+D    , crustacea and mollusks                             ³ 6.000E+01 ³
6.000E+01 ³ BIOFAC(  7,2)
 D-5   ³                                                                 ³           ³
         ³
 D-5   ³ U-238      , fish                                               ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC(  8,1)
 D-5   ³ U-238      , crustacea and mollusks                             ³ 6.000E+01 ³
6.000E+01 ³ BIOFAC(  8,2)
 D-5   ³                                                                 ³           ³
         ³
 D-5   ³ U-238+D    , fish                                               ³ 1.000E+01 ³
1.000E+01 ³ BIOFAC(  9,1)
 D-5   ³ U-238+D    , crustacea and mollusks                             ³ 6.000E+01 ³
6.000E+01 ³ BIOFAC(  9,2)

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 *Base Case means Default.Lib w/o Associate Nuclide contributions.
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                                                   Site-Specific Parameter Summary
0      ³                                                      ³    User      ³           ³
      Used by RESRAD          ³  Parameter
 Menu ³                    Parameter                           ³   Input     ³  Default  ³
(If different from user input) ³     Name

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 R011 ³ Area of contaminated zone (m**2)                      ³ 2.000E+02 ³ 1.000E+04 ³
          ---                  ³ AREA
 R011 ³ Thickness of contaminated zone (m)                    ³ 5.000E+00 ³ 2.000E+00 ³
          ---                  ³ THICK0
 R011 ³ Length parallel to aquifer flow (m)                   ³ 2.500E+01 ³ 1.000E+02 ³
          ---                  ³ LCZPAQ
 R011 ³ Basic radiation dose limit (mrem/yr)                  ³ 1.000E+00 ³ 3.000E+01 ³
          ---                  ³ BRDL
 R011 ³ Time since placement of material (yr)                 ³ 0.000E+00 ³ 0.000E+00 ³
          ---                  ³ TI
 R011 ³ Times for calculations (yr)                           ³ 1.000E+00 ³ 1.000E+00 ³
          ---                  ³ T( 2)
 R011 ³ Times for calculations (yr)                           ³ 5.000E+00 ³ 3.000E+00 ³
```

```
          ---                    ³ T( 3)
R011 ³ Times for calculations (yr)                    ³ 1.000E+01 ³ 1.000E+01 ³
          ---                    ³ T( 4)
R011 ³ Times for calculations (yr)                    ³ 3.000E+01 ³ 3.000E+01 ³
          ---                    ³ T( 5)
R011 ³ Times for calculations (yr)                    ³ 3.000E+02 ³ 1.000E+02 ³
          ---                    ³ T( 6)
R011 ³ Times for calculations (yr)                    ³ 1.000E+03 ³ 3.000E+02 ³
          ---                    ³ T( 7)
R011 ³ Times for calculations (yr)                    ³ 3.000E+03 ³ 1.000E+03 ³
          ---                    ³ T( 8)
R011 ³ Times for calculations (yr)                    ³ 1.000E+04 ³ 0.000E+00 ³
          ---                    ³ T( 9)
R011 ³ Times for calculations (yr)                    ³ 1.000E+05 ³ 0.000E+00 ³
          ---                    ³ T(10)
     ³                                                ³           ³           ³
                                 ³
R012 ³ Initial principal radionuclide (pCi/g):  U-234 ³ 1.670E+02 ³ 0.000E+00 ³
          ---                    ³ S1( 6)
R012 ³ Initial principal radionuclide (pCi/g):  U-235 ³ 5.000E+00 ³ 0.000E+00 ³
          ---                    ³ S1( 7)
R012 ³ Initial principal radionuclide (pCi/g):  U-238 ³ 1.670E+02 ³ 0.000E+00 ³
          ---                    ³ S1( 8)
R012 ³ Concentration in groundwater   (pCi/L):  U-234 ³ not used  ³ 0.000E+00 ³
          ---                    ³ W1( 6)
R012 ³ Concentration in groundwater   (pCi/L):  U-235 ³ not used  ³ 0.000E+00 ³
          ---                    ³ W1( 7)
R012 ³ Concentration in groundwater   (pCi/L):  U-238 ³ not used  ³ 0.000E+00 ³
          ---                    ³ W1( 8)
     ³                                                ³           ³           ³
                                 ³
R013 ³ Cover depth (m)                                ³ 5.000E+00 ³ 0.000E+00 ³
          ---                    ³ COVER0
R013 ³ Density of cover material (g/cm**3)            ³ 2.350E+00 ³ 1.500E+00 ³
          ---                    ³ DENSCV
R013 ³ Cover depth erosion rate (m/yr)                ³ 1.830E-06 ³ 1.000E-03 ³
          ---                    ³ VCV
R013 ³ Density of contaminated zone (g/cm**3)         ³ 1.500E+00 ³ 1.500E+00 ³
          ---                    ³ DENSCZ
R013 ³ Contaminated zone erosion rate (m/yr)          ³ 1.000E-03 ³ 1.000E-03 ³
          ---                    ³ VCZ
R013 ³ Contaminated zone total porosity               ³ 4.000E-01 ³ 4.000E-01 ³
          ---                    ³ TPCZ
R013 ³ Contaminated zone field capacity               ³ 2.000E-01 ³ 2.000E-01 ³
          ---                    ³ FCCZ
R013 ³ Contaminated zone hydraulic conductivity (m/yr) ³ 1.000E+01 ³ 1.000E+01 ³
          ---                    ³ HCCZ
R013 ³ Contaminated zone b parameter                  ³ 5.300E+00 ³ 5.300E+00 ³
          ---                    ³ BCZ
R013 ³ Average annual wind speed (m/sec)              ³ 2.000E+00 ³ 2.000E+00 ³
          ---                    ³ WIND
R013 ³ Humidity in air (g/m**3)                       ³ not used  ³ 8.000E+00 ³
          ---                    ³ HUMID
R013 ³ Evapotranspiration coefficient                 ³ 8.000E-01 ³ 5.000E-01 ³
          ---                    ³ EVAPTR
R013 ³ Precipitation (m/yr)                           ³ 3.550E-01 ³ 1.000E+00 ³
          ---                    ³ PRECIP
R013 ³ Irrigation (m/yr)                              ³ 0.000E+00 ³ 2.000E-01 ³
          ---                    ³ RI
R013 ³ Irrigation mode                                ³ overhead  ³ overhead  ³
          ---                    ³ IDITCH
R013 ³ Runoff coefficient                             ³ 5.000E-01 ³ 2.000E-01 ³
          ---                    ³ RUNOFF
```

```
R013 ³ Watershed area for nearby stream or pond (m**2)  ³ 1.000E+06 ³ 1.000E+06 ³
       ---                  ³ WAREA
R013 ³ Accuracy for water/soil computations             ³ 1.000E-03 ³ 1.000E-03 ³
       ---                  ³ EPS
     ³                                                  ³           ³           ³
                            ³
R014 ³ Density of saturated zone (g/cm**3)              ³ 1.500E+00 ³ 1.500E+00 ³
       ---                  ³ DENSAQ
R014 ³ Saturated zone total porosity                    ³ 4.000E-01 ³ 4.000E-01 ³
       ---                  ³ TPSZ
R014 ³ Saturated zone effective porosity                ³ 2.000E-01 ³ 2.000E-01 ³
       ---                  ³ EPSZ
R014 ³ Saturated zone field capacity                    ³ 2.000E-01 ³ 2.000E-01 ³
       ---                  ³ FCSZ
R014 ³ Saturated zone hydraulic conductivity (m/yr)     ³ 1.000E+02 ³ 1.000E+02 ³
       ---                  ³ HCSZ
R014 ³ Saturated zone hydraulic gradient                ³ 2.000E-02 ³ 2.000E-02 ³
       ---                  ³ HGWT
R014 ³ Saturated zone b parameter                       ³ 5.300E+00 ³ 5.300E+00 ³
       ---                  ³ BSZ
R014 ³ Water table drop rate (m/yr)                     ³ 1.000E-03 ³ 1.000E-03 ³
       ---                  ³ VWT
R014 ³ Well pump intake depth (m below water table)     ³ 1.000E+01 ³ 1.000E+01 ³
       ---                  ³ DWIBWT
R014 ³ Model: Nondispersion (ND) or Mass-Balance (MB)   ³ ND        ³ ND        ³
       ---                  ³ MODEL
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                                           Site-Specific Parameter Summary
(continued)
0     ³                                                 ³  User     ³           ³
     Used by RESRAD          ³  Parameter
 Menu ³                   Parameter                     ³  Input    ³  Default  ³
(If different from user input) ³    Name

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R014 ³ Well pumping rate (m**3/yr)                      ³ 2.500E+02 ³ 2.500E+02 ³
       ---                  ³ UW
     ³                                                  ³           ³           ³
                            ³
R015 ³ Number of unsaturated zone strata                ³ 1         ³ 1         ³
       ---                  ³ NS
R015 ³ Unsat. zone 1, thickness (m)                     ³ 5.000E+01 ³ 4.000E+00 ³
       ---                  ³ H(1)
R015 ³ Unsat. zone 1, soil density (g/cm**3)            ³ 2.350E+00 ³ 1.500E+00 ³
       ---                  ³ DENSUZ(1)
R015 ³ Unsat. zone 1, total porosity                    ³ 4.000E-01 ³ 4.000E-01 ³
       ---                  ³ TPUZ(1)
R015 ³ Unsat. zone 1, effective porosity                ³ 6.000E-02 ³ 2.000E-01 ³
       ---                  ³ EPUZ(1)
R015 ³ Unsat. zone 1, field capacity                    ³ 2.000E-01 ³ 2.000E-01 ³
       ---                  ³ FCUZ(1)
R015 ³ Unsat. zone 1, soil-specific b parameter         ³ 5.300E+00 ³ 5.300E+00 ³
       ---                  ³ BUZ(1)
R015 ³ Unsat. zone 1, hydraulic conductivity (m/yr)     ³ 1.000E-03 ³ 1.000E+01 ³
       ---                  ³ HCUZ(1)
     ³                                                  ³           ³           ³
                            ³
R016 ³ Distribution coefficients for U-234              ³           ³           ³
                            ³
R016 ³   Contaminated zone (cm**3/g)                    ³ 5.000E+01 ³ 5.000E+01 ³
```

```
        ---                 ³ DCNUCC( 6)
R016 ³   Unsaturated zone 1 (cm**3/g)                    ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCU( 6,1)
R016 ³   Saturated zone (cm**3/g)                        ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCS( 6)
R016 ³   Leach rate (/yr)                                ³ 0.000E+00 ³ 0.000E+00 ³
      9.433E-05             ³ ALEACH( 6)
R016 ³   Solubility constant                             ³ 0.000E+00 ³ 0.000E+00 ³
      not used              ³ SOLUBK( 6)
     ³                                                   ³           ³           ³
                            ³
R016 ³ Distribution coefficients for U-235               ³           ³           ³
                            ³
R016 ³   Contaminated zone (cm**3/g)                     ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCC( 7)
R016 ³   Unsaturated zone 1 (cm**3/g)                    ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCU( 7,1)
R016 ³   Saturated zone (cm**3/g)                        ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCS( 7)
R016 ³   Leach rate (/yr)                                ³ 0.000E+00 ³ 0.000E+00 ³
      9.433E-05             ³ ALEACH( 7)
R016 ³   Solubility constant                             ³ 0.000E+00 ³ 0.000E+00 ³
      not used              ³ SOLUBK( 7)
     ³                                                   ³           ³           ³
                            ³
R016 ³ Distribution coefficients for U-238               ³           ³           ³
                            ³
R016 ³   Contaminated zone (cm**3/g)                     ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCC( 8)
R016 ³   Unsaturated zone 1 (cm**3/g)                    ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCU( 8,1)
R016 ³   Saturated zone (cm**3/g)                        ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCS( 8)
R016 ³   Leach rate (/yr)                                ³ 0.000E+00 ³ 0.000E+00 ³
      9.433E-05             ³ ALEACH( 8)
R016 ³   Solubility constant                             ³ 0.000E+00 ³ 0.000E+00 ³
      not used              ³ SOLUBK( 8)
     ³                                                   ³           ³           ³
                            ³
R016 ³ Distribution coefficients for daughter Ac-227     ³           ³           ³
                            ³
R016 ³   Contaminated zone (cm**3/g)                     ³ 2.000E+01 ³ 2.000E+01 ³
        ---                 ³ DCNUCC( 1)
R016 ³   Unsaturated zone 1 (cm**3/g)                    ³ 2.000E+01 ³ 2.000E+01 ³
        ---                 ³ DCNUCU( 1,1)
R016 ³   Saturated zone (cm**3/g)                        ³ 2.000E+01 ³ 2.000E+01 ³
        ---                 ³ DCNUCS( 1)
R016 ³   Leach rate (/yr)                                ³ 0.000E+00 ³ 0.000E+00 ³
      2.346E-04             ³ ALEACH( 1)
R016 ³   Solubility constant                             ³ 0.000E+00 ³ 0.000E+00 ³
      not used              ³ SOLUBK( 1)
     ³                                                   ³           ³           ³
                            ³
R016 ³ Distribution coefficients for daughter Pa-231     ³           ³           ³
                            ³
R016 ³   Contaminated zone (cm**3/g)                     ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCC( 2)
R016 ³   Unsaturated zone 1 (cm**3/g)                    ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCU( 2,1)
R016 ³   Saturated zone (cm**3/g)                        ³ 5.000E+01 ³ 5.000E+01 ³
        ---                 ³ DCNUCS( 2)
R016 ³   Leach rate (/yr)                                ³ 0.000E+00 ³ 0.000E+00 ³
      9.433E-05             ³ ALEACH( 2)
```

```
 R016 ³   Solubility constant                                ³ 0.000E+00 ³ 0.000E+00 ³
     not used              ³ SOLUBK( 2)
      ³                                                      ³           ³           ³
                           ³
 R016 ³ Distribution coefficients for daughter Pb-210       ³           ³           ³
                           ³
 R016 ³   Contaminated zone (cm**3/g)                        ³ 1.000E+02 ³ 1.000E+02 ³
       ---                 ³ DCNUCC( 3)
 R016 ³   Unsaturated zone 1 (cm**3/g)                       ³ 1.000E+02 ³ 1.000E+02 ³
       ---                 ³ DCNUCU( 3,1)
 R016 ³   Saturated zone (cm**3/g)                           ³ 1.000E+02 ³ 1.000E+02 ³
       ---                 ³ DCNUCS( 3)
 R016 ³   Leach rate (/yr)                                   ³ 0.000E+00 ³ 0.000E+00 ³
     4.725E-05             ³ ALEACH( 3)
 R016 ³   Solubility constant                                ³ 0.000E+00 ³ 0.000E+00 ³
     not used              ³ SOLUBK( 3)
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                                     Site-Specific Parameter Summary
(continued)
0     ³                                                      ³   User    ³           ³
     Used by RESRAD          ³  Parameter
 Menu ³                  Parameter                           ³   Input   ³  Default  ³
(If different from user input) ³    Name

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 R016 ³ Distribution coefficients for daughter Ra-226       ³           ³           ³
                           ³
 R016 ³   Contaminated zone (cm**3/g)                        ³ 7.000E+01 ³ 7.000E+01 ³
       ---                 ³ DCNUCC( 4)
 R016 ³   Unsaturated zone 1 (cm**3/g)                       ³ 7.000E+01 ³ 7.000E+01 ³
       ---                 ³ DCNUCU( 4,1)
 R016 ³   Saturated zone (cm**3/g)                           ³ 7.000E+01 ³ 7.000E+01 ³
       ---                 ³ DCNUCS( 4)
 R016 ³   Leach rate (/yr)                                   ³ 0.000E+00 ³ 0.000E+00 ³
     6.745E-05             ³ ALEACH( 4)
 R016 ³   Solubility constant                                ³ 0.000E+00 ³ 0.000E+00 ³
     not used              ³ SOLUBK( 4)
      ³                                                      ³           ³           ³
                           ³
 R016 ³ Distribution coefficients for daughter Th-230       ³           ³           ³
                           ³
 R016 ³   Contaminated zone (cm**3/g)                        ³ 6.000E+04 ³ 6.000E+04 ³
       ---                 ³ DCNUCC( 5)
 R016 ³   Unsaturated zone 1 (cm**3/g)                       ³ 6.000E+04 ³ 6.000E+04 ³
       ---                 ³ DCNUCU( 5,1)
 R016 ³   Saturated zone (cm**3/g)                           ³ 6.000E+04 ³ 6.000E+04 ³
       ---                 ³ DCNUCS( 5)
 R016 ³   Leach rate (/yr)                                   ³ 0.000E+00 ³ 0.000E+00 ³
     7.889E-08             ³ ALEACH( 5)
 R016 ³   Solubility constant                                ³ 0.000E+00 ³ 0.000E+00 ³
     not used              ³ SOLUBK( 5)
      ³                                                      ³           ³           ³
                           ³
 R017 ³ Inhalation rate (m**3/yr)                            ³ 8.400E+03 ³ 8.400E+03 ³
       ---                 ³ INHALR
 R017 ³ Mass loading for inhalation (g/m**3)                 ³ 1.000E-04 ³ 1.000E-04 ³
       ---                 ³ MLINH
 R017 ³ Exposure duration                                    ³ 3.000E+01 ³ 3.000E+01 ³
       ---                 ³ ED
 R017 ³ Shielding factor, inhalation                         ³ 4.000E-01 ³ 4.000E-01 ³
```

```
          ---                    ³ SHF3
R017 ³ Shielding factor, external gamma                    ³ 7.000E-01 ³ 7.000E-01 ³
          ---                    ³ SHF1
R017 ³ Fraction of time spent indoors                      ³ 5.000E-01 ³ 5.000E-01 ³
          ---                    ³ FIND
R017 ³ Fraction of time spent outdoors (on site)           ³ 2.500E-01 ³ 2.500E-01 ³
          ---                    ³ FOTD
R017 ³ Shape factor flag, external gamma                   ³ 1.000E+00 ³ 1.000E+00 ³
>0 shows circular AREA.          ³ FS
R017 ³ Radii of shape factor array (used if FS = -1):      ³           ³           ³
                                 ³
R017 ³   Outer annular radius (m), ring  1:                ³ not used  ³ 5.000E+01 ³
          ---                    ³ RAD_SHAPE( 1)
R017 ³   Outer annular radius (m), ring  2:                ³ not used  ³ 7.071E+01 ³
          ---                    ³ RAD_SHAPE( 2)
R017 ³   Outer annular radius (m), ring  3:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE( 3)
R017 ³   Outer annular radius (m), ring  4:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE( 4)
R017 ³   Outer annular radius (m), ring  5:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE( 5)
R017 ³   Outer annular radius (m), ring  6:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE( 6)
R017 ³   Outer annular radius (m), ring  7:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE( 7)
R017 ³   Outer annular radius (m), ring  8:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE( 8)
R017 ³   Outer annular radius (m), ring  9:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE( 9)
R017 ³   Outer annular radius (m), ring 10:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE(10)
R017 ³   Outer annular radius (m), ring 11:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE(11)
R017 ³   Outer annular radius (m), ring 12:                ³ not used  ³ 0.000E+00 ³
          ---                    ³ RAD_SHAPE(12)
      ³                          ³                        ³           ³           ³
                                 ³
R017 ³ Fractions of annular areas within AREA:             ³           ³           ³
                                 ³
R017 ³   Ring  1                                           ³ not used  ³ 1.000E+00 ³
          ---                    ³ FRACA( 1)
R017 ³   Ring  2                                           ³ not used  ³ 2.732E-01 ³
          ---                    ³ FRACA( 2)
R017 ³   Ring  3                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA( 3)
R017 ³   Ring  4                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA( 4)
R017 ³   Ring  5                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA( 5)
R017 ³   Ring  6                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA( 6)
R017 ³   Ring  7                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA( 7)
R017 ³   Ring  8                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA( 8)
R017 ³   Ring  9                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA( 9)
R017 ³   Ring 10                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA(10)
R017 ³   Ring 11                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA(11)
R017 ³   Ring 12                                           ³ not used  ³ 0.000E+00 ³
          ---                    ³ FRACA(12)
```

```
      ³                                                          ³            ³            ³
                                   ³
 R018 ³ Fruits, vegetables and grain consumption (kg/yr) ³ 1.600E+02 ³ 1.600E+02 ³
          ---                      ³ DIET(1)
1RESRAD, Version 6.3     T« Limit = 180 days       09/04/2007  12:45  Page   7
 Summary : Homer Laughlin                                         File: homerl.RAD

                                                Site-Specific Parameter Summary
(continued)
0     ³                                                          ³  User     ³            ³
      Used by RESRAD          ³  Parameter
 Menu ³                    Parameter                             ³  Input    ³  Default   ³
(If different from user input) ³    Name

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 R018 ³ Leafy vegetable consumption (kg/yr)                      ³ 1.400E+01 ³ 1.400E+01 ³
          ---                      ³ DIET(2)
 R018 ³ Milk consumption (L/yr)                                  ³ 9.200E+01 ³ 9.200E+01 ³
          ---                      ³ DIET(3)
 R018 ³ Meat and poultry consumption (kg/yr)                     ³ 6.300E+01 ³ 6.300E+01 ³
          ---                      ³ DIET(4)
 R018 ³ Fish consumption (kg/yr)                                 ³ 5.400E+00 ³ 5.400E+00 ³
          ---                      ³ DIET(5)
 R018 ³ Other seafood consumption (kg/yr)                        ³ 9.000E-01 ³ 9.000E-01 ³
          ---                      ³ DIET(6)
 R018 ³ Soil ingestion rate (g/yr)                               ³ 3.650E+01 ³ 3.650E+01 ³
          ---                      ³ SOIL
 R018 ³ Drinking water intake (L/yr)                             ³ 5.100E+02 ³ 5.100E+02 ³
          ---                      ³ DWI
 R018 ³ Contamination fraction of drinking water                 ³ 1.000E+00 ³ 1.000E+00 ³
          ---                      ³ FDW
 R018 ³ Contamination fraction of household water                ³ 1.000E+00 ³ 1.000E+00 ³
          ---                      ³ FHHW
 R018 ³ Contamination fraction of livestock water                ³ 1.000E+00 ³ 1.000E+00 ³
          ---                      ³ FLW
 R018 ³ Contamination fraction of irrigation water               ³ 1.000E+00 ³ 1.000E+00 ³
          ---                      ³ FIRW
 R018 ³ Contamination fraction of aquatic food                   ³ 5.000E-01 ³ 5.000E-01 ³
          ---                      ³ FR9
 R018 ³ Contamination fraction of plant food                     ³-1         ³-1          ³
        0.100E+00                  ³ FPLANT
 R018 ³ Contamination fraction of meat                           ³-1         ³-1          ³
        0.100E-01                  ³ FMEAT
 R018 ³ Contamination fraction of milk                           ³-1         ³-1          ³
        0.100E-01                  ³ FMILK
      ³                                                          ³           ³            ³
                                   ³
 R019 ³ Livestock fodder intake for meat (kg/day)                ³ 6.800E+01 ³ 6.800E+01 ³
          ---                      ³ LFI5
 R019 ³ Livestock fodder intake for milk (kg/day)                ³ 5.500E+01 ³ 5.500E+01 ³
          ---                      ³ LFI6
 R019 ³ Livestock water intake for meat (L/day)                  ³ 5.000E+01 ³ 5.000E+01 ³
          ---                      ³ LWI5
 R019 ³ Livestock water intake for milk (L/day)                  ³ 1.600E+02 ³ 1.600E+02 ³
          ---                      ³ LWI6
 R019 ³ Livestock soil intake (kg/day)                           ³ 5.000E-01 ³ 5.000E-01 ³
          ---                      ³ LSI
 R019 ³ Mass loading for foliar deposition (g/m**3)              ³ 1.000E-04 ³ 1.000E-04 ³
          ---                      ³ MLFD
 R019 ³ Depth of soil mixing layer (m)                           ³ 1.500E-01 ³ 1.500E-01 ³
          ---                      ³ DM
 R019 ³ Depth of roots (m)                                       ³ 9.000E-01 ³ 9.000E-01 ³
```

```
          ---                 ³ DROOT
R019 ³ Drinking water fraction from ground water        ³ 1.000E+00 ³ 1.000E+00 ³
          ---                 ³ FGWDW
R019 ³ Household water fraction from ground water       ³ 1.000E+00 ³ 1.000E+00 ³
          ---                 ³ FGWHH
R019 ³ Livestock water fraction from ground water       ³ 1.000E+00 ³ 1.000E+00 ³
          ---                 ³ FGWLW
R019 ³ Irrigation fraction from ground water            ³ 1.000E+00 ³ 1.000E+00 ³
          ---                 ³ FGWIR
     ³                                                  ³           ³           ³
                              ³
R19B ³ Wet weight crop yield for Non-Leafy (kg/m**2)    ³ 7.000E-01 ³ 7.000E-01 ³
          ---                 ³ YV(1)
R19B ³ Wet weight crop yield for Leafy     (kg/m**2)    ³ 1.500E+00 ³ 1.500E+00 ³
          ---                 ³ YV(2)
R19B ³ Wet weight crop yield for Fodder    (kg/m**2)    ³ 1.100E+00 ³ 1.100E+00 ³
          ---                 ³ YV(3)
R19B ³ Growing Season for  Non-Leafy (years)            ³ 1.700E-01 ³ 1.700E-01 ³
          ---                 ³ TE(1)
R19B ³ Growing Season for  Leafy     (years)            ³ 2.500E-01 ³ 2.500E-01 ³
          ---                 ³ TE(2)
R19B ³ Growing Season for  Fodder    (years)            ³ 8.000E-02 ³ 8.000E-02 ³
          ---                 ³ TE(3)
R19B ³ Translocation Factor for  Non-Leafy              ³ 1.000E-01 ³ 1.000E-01 ³
          ---                 ³ TIV(1)
R19B ³ Translocation Factor for  Leafy                  ³ 1.000E+00 ³ 1.000E+00 ³
          ---                 ³ TIV(2)
R19B ³ Translocation Factor for  Fodder                 ³ 1.000E+00 ³ 1.000E+00 ³
          ---                 ³ TIV(3)
R19B ³ Dry Foliar Interception Fraction for  Non-Leafy  ³ 2.500E-01 ³ 2.500E-01 ³
          ---                 ³ RDRY(1)
R19B ³ Dry Foliar Interception Fraction for  Leafy      ³ 2.500E-01 ³ 2.500E-01 ³
          ---                 ³ RDRY(2)
R19B ³ Dry Foliar Interception Fraction for  Fodder     ³ 2.500E-01 ³ 2.500E-01 ³
          ---                 ³ RDRY(3)
R19B ³ Wet Foliar Interception Fraction for  Non-Leafy  ³ 2.500E-01 ³ 2.500E-01 ³
          ---                 ³ RWET(1)
R19B ³ Wet Foliar Interception Fraction for  Leafy      ³ 2.500E-01 ³ 2.500E-01 ³
          ---                 ³ RWET(2)
R19B ³ Wet Foliar Interception Fraction for  Fodder     ³ 2.500E-01 ³ 2.500E-01 ³
          ---                 ³ RWET(3)
R19B ³ Weathering Removal Constant for Vegetation       ³ 2.000E+01 ³ 2.000E+01 ³
          ---                 ³ WLAM
     ³                                                  ³           ³           ³
                              ³
C14  ³ C-12 concentration in water (g/cm**3)            ³ not used  ³ 2.000E-05 ³
          ---                 ³ C12WTR
C14  ³ C-12 concentration in contaminated soil (g/g)    ³ not used  ³ 3.000E-02 ³
          ---                 ³ C12CZ
C14  ³ Fraction of vegetation carbon from soil          ³ not used  ³ 2.000E-02 ³
          ---                 ³ CSOIL
C14  ³ Fraction of vegetation carbon from air           ³ not used  ³ 9.800E-01 ³
          ---                 ³ CAIR
C14  ³ C-14 evasion layer thickness in soil (m)         ³ not used  ³ 3.000E-01 ³
          ---                 ³ DMC
```


Site-Specific Parameter Summary

(continued)

```
0    ³                                                  ³   User   ³           ³
     Used by RESRAD          ³  Parameter
Menu ³                       Parameter                  ³   Input  ³  Default  ³
```

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(If different from user input) ³   Name

ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 C14  ³ C-14 evasion flux rate from soil (1/sec)       ³ not used  ³ 7.000E-07 ³
          ---                ³ EVSN
 C14  ³ C-12 evasion flux rate from soil (1/sec)       ³ not used  ³ 1.000E-10 ³
          ---                ³ REVSN
 C14  ³ Fraction of grain in beef cattle feed          ³ not used  ³ 8.000E-01 ³
          ---                ³ AVFG4
 C14  ³ Fraction of grain in milk cow feed             ³ not used  ³ 2.000E-01 ³
          ---                ³ AVFG5
 C14  ³ DCF correction factor for gaseous forms of C14 ³ not used  ³ 0.000E+00 ³
          ---                ³ CO2F
      ³                                                ³           ³           ³
                             ³
 STOR ³ Storage times of contaminated foodstuffs (days): ³         ³           ³
                             ³
 STOR ³   Fruits, non-leafy vegetables, and grain      ³ 1.400E+01 ³ 1.400E+01 ³
          ---                ³ STOR_T(1)
 STOR ³   Leafy vegetables                             ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ STOR_T(2)
 STOR ³   Milk                                         ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ STOR_T(3)
 STOR ³   Meat and poultry                             ³ 2.000E+01 ³ 2.000E+01 ³
          ---                ³ STOR_T(4)
 STOR ³   Fish                                         ³ 7.000E+00 ³ 7.000E+00 ³
          ---                ³ STOR_T(5)
 STOR ³   Crustacea and mollusks                       ³ 7.000E+00 ³ 7.000E+00 ³
          ---                ³ STOR_T(6)
 STOR ³   Well water                                   ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ STOR_T(7)
 STOR ³   Surface water                                ³ 1.000E+00 ³ 1.000E+00 ³
          ---                ³ STOR_T(8)
 STOR ³   Livestock fodder                             ³ 4.500E+01 ³ 4.500E+01 ³
          ---                ³ STOR_T(9)
      ³                                                ³           ³           ³
                             ³
 R021 ³ Thickness of building foundation (m)           ³ 1.500E-01 ³ 1.500E-01 ³
          ---                ³ FLOOR1
 R021 ³ Bulk density of building foundation (g/cm**3)  ³ 2.400E+00 ³ 2.400E+00 ³
          ---                ³ DENSFL
 R021 ³ Total porosity of the cover material           ³ 4.270E-01 ³ 4.000E-01 ³
          ---                ³ TPCV
 R021 ³ Total porosity of the building foundation      ³ 1.000E-01 ³ 1.000E-01 ³
          ---                ³ TPFL
 R021 ³ Volumetric water content of the cover material ³ 4.180E-01 ³ 5.000E-02 ³
          ---                ³ PH2OCV
 R021 ³ Volumetric water content of the foundation     ³ 3.000E-02 ³ 3.000E-02 ³
          ---                ³ PH2OFL
 R021 ³ Diffusion coefficient for radon gas (m/sec):   ³           ³           ³
                             ³
 R021 ³   in cover material                            ³-1.000E+00 ³ 2.000E-06 ³
        1.943E-09            ³ DIFCV
 R021 ³   in foundation material                       ³ 3.000E-07 ³ 3.000E-07 ³
          ---                ³ DIFFL
 R021 ³   in contaminated zone soil                    ³ 2.000E-06 ³ 2.000E-06 ³
          ---                ³ DIFCZ
 R021 ³ Radon vertical dimension of mixing (m)         ³ 2.000E+00 ³ 2.000E+00 ³
          ---                ³ HMIX
 R021 ³ Average building air exchange rate (1/hr)      ³ 5.000E-01 ³ 5.000E-01 ³
          ---                ³ REXG
 R021 ³ Height of the building (room) (m)              ³ 2.500E+00 ³ 2.500E+00 ³
```

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        ---                ³ HRM
 R021 ³ Building interior area factor                       ³ 0.000E+00 ³ 0.000E+00 ³
code computed (time dependent) ³ FAI
 R021 ³ Building depth below ground surface (m)             ³-1.000E+00 ³-1.000E+00 ³
code computed (time dependent) ³ DMFL
 R021 ³ Emanating power of Rn-222 gas                       ³ 2.500E-01 ³ 2.500E-01 ³
        ---                ³ EMANA(1)
 R021 ³ Emanating power of Rn-220 gas                       ³ not used  ³ 1.500E-01 ³
        ---                ³ EMANA(2)
      ³                                                     ³           ³           ³
                           ³
 TITL ³ Number of graphical time points                     ³     32    ³    ---    ³
        ---                ³ NPTS
 TITL ³ Maximum number of integration points for dose       ³     17    ³    ---    ³
        ---                ³ LYMAX
 TITL ³ Maximum number of integration points for risk       ³    257    ³    ---    ³
        ---                ³ KYMAX

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 Summary : Homer Laughlin                                       File: homerl.RAD



                              Summary of Pathway Selections

                             Pathway               ³   User Selection
          ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
             1 -- external gamma          ³       active
             2 -- inhalation (w/o radon)³        active
             3 -- plant ingestion         ³       active
             4 -- meat ingestion          ³       active
             5 -- milk ingestion          ³       active
             6 -- aquatic foods           ³       active
             7 -- drinking water          ³       active
             8 -- soil ingestion          ³       active
             9 -- radon                   ³       active
             Find peak pathway doses      ³       active
          ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÏÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
1RESRAD, Version 6.3      T« Limit = 180 days        09/04/2007  12:45  Page  10
 Summary : Homer Laughlin                                       File: homerl.RAD

      Contaminated Zone Dimensions           Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ           ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:    200.00 square meters               U-234      1.670E+02
   Thickness:      5.00 meters                      U-235      5.000E+00

 Cover Depth:      5.00 meters                      U-238      1.670E+02

0
                                                       Total Dose TDOSE(t), mrem/yr

                                                 Basic Radiation Dose Limit = 1.000E+00
mrem/yr
                                Total Mixture Sum M(t) = Fraction of Basic Dose Limit
Received at Time (t)

ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

    t (years):  0.000E+00  1.000E+00  5.000E+00  1.000E+01  3.000E+01  3.000E+02
1.000E+03  3.000E+03  1.000E+04  1.000E+05
```

```
     TDOSE(t):  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
0.000E+00  0.000E+00  0.000E+00  0.000E+00
         M(t):  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
0.000E+00  0.000E+00  0.000E+00  0.000E+00
0Maximum TDOSE(t):  0.000E+00 mrem/yr   at t = 0.000E+00 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
0                                    Water Independent Pathways (Inhalation
excludes radon)
0            Ground          Inhalation          Radon             Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+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
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 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  0.000E+00 0.0000
0
                        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
0                                                   Water Dependent Pathways
0            Water             Fish              Radon             Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+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
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 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  0.000E+00 0.0000
0*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
0
Water Independent Pathways (Inhalation excludes radon)
0

Radio- Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
U-234	0.000E+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
U-235	0.000E+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
U-238	0.000E+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
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	0.000E+00	0.0000

0
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
0
Water Dependent Pathways
0

Radio- Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
U-234	0.000E+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
U-235	0.000E+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
U-238	0.000E+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
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	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.3 T« Limit = 180 days 09/04/2007 12:45 Page 13
Summary : Homer Laughlin File: homerl.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 = 5.000E+00 years
0
Water Independent Pathways (Inhalation excludes radon)
0

Radio- Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.

```
 U-234    0.000E+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
 U-235    0.000E+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
 U-238    0.000E+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
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 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  0.000E+00 0.0000
0
                        Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
                                  As mrem/yr and Fraction of Total Dose At t =
5.000E+00 years
0                                                   Water Dependent Pathways
0              Water              Fish                Radon              Plant
  Meat              Milk           All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234    0.000E+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
 U-235    0.000E+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
 U-238    0.000E+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
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 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  0.000E+00 0.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.3      T« Limit = 180 days        09/04/2007  12:45  Page  14
 Summary : Homer Laughlin                                          File: homerl.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
0                                     Water Independent Pathways (Inhalation
excludes radon)
0              Ground            Inhalation           Radon              Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234    0.000E+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
 U-235    0.000E+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
 U-238    0.000E+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
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ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 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  0.000E+00 0.0000
0
```

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

```
0                                                    Water Dependent Pathways
0              Water              Fish               Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄ
 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+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
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 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  0.000E+00 0.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.3      T« Limit = 180 days        09/04/2007  12:45  Page  15
 Summary : Homer Laughlin                                          File: homerl.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

```
0                                    Water Independent Pathways (Inhalation
excludes radon)
0             Ground           Inhalation           Radon              Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+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
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ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 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  0.000E+00 0.0000
0
```

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

```
0                                                    Water Dependent Pathways
0              Water              Fish               Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+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
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 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  0.000E+00 0.0000
0*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
0                                    Water Independent Pathways (Inhalation
excludes radon)
0            Ground          Inhalation          Radon             Plant
  Meat              Milk              Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+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
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ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 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  0.000E+00 0.0000
0
                        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
0                                                   Water Dependent Pathways
0            Water           Fish              Radon             Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.3      T« Limit = 180 days        09/04/2007  12:45  Page  17
 Summary : Homer Laughlin                                          File: homerl.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+03 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
0             Ground          Inhalation          Radon             Plant
  Meat                Milk                Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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0
                        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
0                                                   Water Dependent Pathways
0             Water             Fish              Radon             Plant
  Meat                Milk             All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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 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  0.000E+00 0.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.3      T« Limit = 180 days        09/04/2007  12:45  Page  18
 Summary : Homer Laughlin                                          File: homerl.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+03 years
0                                       Water Independent Pathways (Inhalation
excludes radon)
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0              Ground          Inhalation           Radon              Plant
  Meat                Milk                Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+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
 U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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 Total   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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0
                        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+03 years
0                                                   Water Dependent Pathways
0              Water             Fish              Radon              Plant
  Meat                Milk             All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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 U-235   0.000E+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
 U-238   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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 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  0.000E+00 0.0000
0*Sum of all water independent and dependent pathways.
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                        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+04 years
0                                     Water Independent Pathways (Inhalation
excludes radon)
0              Ground          Inhalation           Radon              Plant
  Meat                Milk                Soil
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-234   0.000E+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
 U-235   0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000  0.000E+00 0.0000
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 Total 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000 0.000E+00 0.0000
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0
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+04 years
0
Water Dependent Pathways
0 Water Fish Radon Plant
 Meat Milk All Pathways*
 Radio- ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide mrem/yr fract. mrem/yr fract. mrem/yr fract. mrem/yr fract.
mrem/yr fract. mrem/yr fract. mrem/yr fract.
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 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 0.000E+00 0.0000
0*Sum of all water independent and dependent pathways.
1RESRAD, Version 6.3 T« Limit = 180 days 09/04/2007 12:45 Page 20
 Summary : Homer Laughlin File: homerl.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+05 years
0
Water Independent Pathways (Inhalation
excludes radon)
0 Ground Inhalation Radon Plant
 Meat Milk Soil
 Radio- ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide mrem/yr fract. mrem/yr fract. mrem/yr fract. mrem/yr fract.
mrem/yr fract. mrem/yr fract. mrem/yr fract.
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 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 0.000E+00 0.0000
0
Total Dose Contributions TDOSE(i,p,t) for Individual
Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t =

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1.000E+05 years
0                                                                    Water Dependent Pathways
0              Water              Fish              Radon              Plant
  Meat              Milk          All Pathways*
 Radio-  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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 Nuclide  mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
mrem/yr  fract.   mrem/yr  fract.   mrem/yr  fract.
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 U-235   0.000E+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
 U-238   0.000E+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
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ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍ
 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  0.000E+00 0.0000
0*Sum of all water independent and dependent pathways.
```



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                                        Dose/Source Ratios Summed Over All
Pathways
                                   Parent and Progeny Principal Radionuclide
Contributions Indicated
0  Parent    Product    Thread                                  DSR(j,t) At Time in
Years   (mrem/yr)/(pCi/g)
    (i)        (j)      Fraction   0.000E+00 1.000E+00 5.000E+00 1.000E+01 3.000E+01
3.000E+02 1.000E+03 3.000E+03 1.000E+04 1.000E+05
 ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 U-234      U-234      1.000E+00  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-234      Th-230     1.000E+00  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-234      Ra-226+D   1.000E+00  0.000E+00 0.000E+00 1.401E-45 5.605E-45 5.185E-44
4.805E-42 4.753E-41 3.176E-40 1.619E-39 2.623E-38
 U-234      Pb-210+D   1.000E+00  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-234      äDSR(j)               0.000E+00 0.000E+00 1.401E-45 5.605E-45 5.185E-44
4.805E-42 4.753E-41 3.176E-40 1.619E-39 2.623E-38
0U-235+D    U-235+D    1.000E+00  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-235+D    Pa-231     1.000E+00  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-235+D    Ac-227+D   1.000E+00  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-235+D    äDSR(j)               0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0U-238      U-238      5.400E-05  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0U-238+D    U-238+D    9.999E-01  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-238+D    U-234      9.999E-01  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-238+D    Th-230     9.999E-01  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-238+D    Ra-226+D   9.999E-01  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1.401E-45 4.624E-44 9.585E-43 1.694E-41 8.706E-40
 U-238+D    Pb-210+D   9.999E-01  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-238+D    äDSR(j)              0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1.401E-45 4.624E-44 9.585E-43 1.694E-41 8.706E-40
 ÍÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ  ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ
ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ ÍÍÍÍÍÍÍÍÍ
 The DSR includes contributions from associated (half-life ó 180 days) daughters.

0
                                        Single Radionuclide Soil Guidelines G(i,t)
in pCi/g
                                          Basic Radiation Dose Limit = 1.000E+00
mrem/yr
0Nuclide
   (i)     t= 0.000E+00   1.000E+00   5.000E+00   1.000E+01   3.000E+01   3.000E+02
1.000E+03   3.000E+03   1.000E+04   1.000E+05
 ÄÄÄÄÄÄÄ     ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄ
 U-234      *6.247E+09  *6.247E+09  *6.247E+09  *6.247E+09  *6.247E+09  *6.247E+09
*6.247E+09  *6.247E+09  *6.247E+09  *6.247E+09
 U-235      *2.161E+06  *2.161E+06  *2.161E+06  *2.161E+06  *2.161E+06  *2.161E+06
*2.161E+06  *2.161E+06  *2.161E+06  *2.161E+06
 U-238      *3.361E+05  *3.361E+05  *3.361E+05  *3.361E+05  *3.361E+05  *3.361E+05
*3.361E+05  *3.361E+05  *3.361E+05  *3.361E+05
 ÍÍÍÍÍÍÍ     ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ
ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ   ÍÍÍÍÍÍÍÍÍ
 *At specific activity limit
0
             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 = 0.000E+00 years
0Nuclide  Initial        tmin       DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
   (i)    (pCi/g)      (years)                  (pCi/g)                (pCi/g)
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄ
 U-234   1.670E+02     0.000E+00      0.000E+00 *6.247E+09  0.000E+00 *6.247E+09
 U-235   5.000E+00     0.000E+00      0.000E+00 *2.161E+06  0.000E+00 *2.161E+06
 U-238   1.670E+02     0.000E+00      0.000E+00 *3.361E+05  0.000E+00 *3.361E+05
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 *At specific activity limit

1RESRAD, Version 6.3      T« Limit = 180 days        09/04/2007  12:45  Page  22
 Summary : Homer Laughlin                                          File: homerl.RAD

                                        Individual Nuclide Dose Summed Over All
Pathways
                                          Parent Nuclide and Branch Fraction
Indicated
0Nuclide Parent   THF(i)                                                DOSE(j,t),
mrem/yr
   (j)     (i)             t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 3.000E+01
3.000E+02 1.000E+03 3.000E+03 1.000E+04 1.000E+05
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 U-234   U-234   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-234   U-238   9.999E-01    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-234   äDOSE(j)             0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0Th-230  U-234   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Th-230  U-238   9.999E-01    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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 Th-230  äDOSE(j)              0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0Ra-226  U-234   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Ra-226  U-238   9.999E-01    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Ra-226  äDOSE(j)              0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0Pb-210  U-234   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Pb-210  U-238   9.999E-01    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Pb-210  äDOSE(j)              0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0U-235   U-235   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0Pa-231  U-235   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0Ac-227  U-235   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0U-238   U-238   5.400E-05    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-238   U-238   9.999E-01    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 U-238   äDOSE(j)              0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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 THF(i) is the thread fraction of the parent nuclide.
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                                          Individual Nuclide Soil Concentration
                                        Parent Nuclide and Branch Fraction
Indicated
0Nuclide Parent   THF(i)                                                  S(j,t),
pCi/g
   (j)     (i)              t= 0.000E+00 1.000E+00 5.000E+00 1.000E+01 3.000E+01
3.000E+02 1.000E+03 3.000E+03 1.000E+04 1.000E+05
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ    ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄ
 U-234   U-234   1.000E+00    1.670E+02 1.670E+02 1.669E+02 1.668E+02 1.665E+02
1.622E+02 1.515E+02 1.248E+02 6.320E+01 1.006E-02
 U-234   U-238   9.999E-01    0.000E+00 4.734E-04 2.366E-03 4.730E-03 1.416E-02
1.380E-01 4.302E-01 1.066E+00 1.817E+00 3.298E-03
 U-234   äS(j):               1.670E+02 1.670E+02 1.669E+02 1.668E+02 1.665E+02
1.623E+02 1.520E+02 1.258E+02 6.502E+01 1.336E-02
0Th-230  U-234   1.000E+00    0.000E+00 1.503E-03 7.515E-03 1.503E-02 4.503E-02
4.439E-01 1.426E+00 3.857E+00 9.126E+00 6.882E+00
 Th-230  U-238   9.999E-01    0.000E+00 2.131E-09 5.325E-08 2.129E-07 1.914E-06
1.880E-04 1.993E-03 1.572E-02 1.116E-01 2.285E-01
 Th-230  äS(j):               0.000E+00 1.503E-03 7.515E-03 1.503E-02 4.503E-02
4.441E-01 1.428E+00 3.872E+00 9.238E+00 7.110E+00
0Ra-226  U-234   1.000E+00    0.000E+00 3.256E-07 8.133E-06 3.250E-05 2.913E-04
2.760E-02 2.675E-01 1.677E+00 6.822E+00 6.064E+00
 Ra-226  U-238   9.999E-01    0.000E+00 3.076E-13 3.843E-11 3.072E-10 8.264E-09
7.885E-06 2.591E-04 5.063E-03 7.136E-02 2.013E-01
 Ra-226  äS(j):               0.000E+00 3.256E-07 8.133E-06 3.250E-05 2.913E-04
2.760E-02 2.677E-01 1.682E+00 6.893E+00 6.266E+00
0Pb-210  U-234   1.000E+00    0.000E+00 3.347E-09 4.055E-07 3.122E-06 7.291E-05
2.240E-02 2.519E-01 1.648E+00 6.794E+00 6.057E+00
 Pb-210  U-238   9.999E-01    0.000E+00 2.376E-15 1.448E-12 2.246E-11 1.618E-09
5.851E-06 2.365E-04 4.920E-03 7.085E-02 2.010E-01
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 Pb-210  äS(j):                0.000E+00 3.347E-09 4.055E-07 3.122E-06 7.291E-05
2.240E-02 2.522E-01 1.653E+00 6.865E+00 6.258E+00
0U-235   U-235   1.000E+00    5.000E+00 5.000E+00 4.998E+00 4.995E+00 4.986E+00
4.860E+00 4.550E+00 3.768E+00 1.947E+00 4.000E-04
0Pa-231  U-235   1.000E+00    0.000E+00 1.058E-04 5.287E-04 1.057E-03 3.164E-03
3.075E-02 9.526E-02 2.317E-01 3.712E-01 3.518E-04
0Ac-227  U-235   1.000E+00    0.000E+00 1.666E-06 3.992E-05 1.516E-04 1.125E-03
2.744E-02 9.190E-02 2.284E-01 3.685E-01 3.502E-04
0U-238   U-238   5.400E-05    9.018E-03 9.017E-03 9.014E-03 9.009E-03 8.993E-03
8.766E-03 8.206E-03 6.795E-03 3.511E-03 7.215E-07
 U-238   U-238   9.999E-01    1.670E+02 1.670E+02 1.669E+02 1.668E+02 1.665E+02
1.623E+02 1.520E+02 1.258E+02 6.501E+01 1.336E-02
 U-238   äS(j):                1.670E+02 1.670E+02 1.669E+02 1.668E+02 1.665E+02
1.623E+02 1.520E+02 1.258E+02 6.502E+01 1.336E-02
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 THF(i) is the thread fraction of the parent nuclide.
0RESCALC.EXE execution time =    1.61 seconds
```