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CUSHING REFINERY SITE
SITE DECOMMISSIONING PLAN

Kerr-McGee Corporation

Prepared by
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April 25, 1994

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ROY R. SMITH
VICE PRESIDENT, ENVIRONMENTAL OPERATIONS

27 April 1994

Dr. John H. Austin
Chief, Decommissioning and Regulatory Issues Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Cushing Site Decommissioning Plan
Docket 70-3073, License SNM-1999

Dear Dr. Austin:

Materials License SNM-1999 specifies that Kerr-McGee submit a proposed plan to decommission its Cushing site. A plan developed to meet requirements of 10 CFR Part 70.38 (c)(2)(iii) and generally conforming to Regulatory Guide 3.65 is included herewith. Kerr-McGee requests that its license, SNM-1999, be amended to approve this plan. The plan includes the following elements:

- historical licensed material and decommissioning activities,
- planned cleanup and restoration activities,
- radiation safety program for protecting workers and the environment,
- final radiation survey plan, and
- organization and administration established to carry out the plan.

A cost estimate and provisions to assure decommissioning funding were submitted with the revised application for a Materials License on September 25, 1992. Condition 11.B of License SNM-1999 requests descriptions of methods KMC proposes 1) to measure and control sorting of contaminated material to be transported to temporary storage areas, 2) to neutralize acidic, contaminated sludge in Pit 4, 3) to demolish potentially contaminated structures, and 4) an analysis of the ability of the storage areas to resist erosion by wind and water. Items 1, 2, and 4 are described in section 3 of the plan. License condition 11.b.3 requires a description of methods to be used to demolish potentially contaminated structures prior to demolition. KMC intends to provide the specifics of such a plan to the Commission at a later date as an amendment to this decommissioning plan. It has long been realized that the amount of contaminated soil at formerly used uranium and thorium processing sites is very large, yet the concentration of radioactive material is often low enough to justify their disposal onsite rather than to transport it to a commercial disposal site.

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[1]W.J. Dircks, NRC, branch technical position on Disposal or Onsite Storage of Residual Thorium or Uranium from Past Operations, SECY 81-576 & 46 FR 52061, October 23, 1981.

An integral part of the Cushing site decommissioning plan is an engineered cell onsite in which qualified radioactively contaminated material may be disposed. A preliminary analysis supports the feasibility of such an engineered cell onsite for this purpose. When KMC has the information and analyses confirming the safety of the engineered cell, we intend to provide that to the Commission along with a request for its approval pursuant to 10 CFR Part 20.2002.

KMC will presently submit a final survey plan for delineated areas that are not affected by licensed material. While KMC wants to obtain recognition that certain designated areas are demonstrated by a final radioactivity survey to be free of contamination by licensed material, please note that KMC is not requesting that the four unaffected areas be deleted as authorized places of use after it has been determined that they are suitable for unrestricted use. We plan to use a portion or portions of unaffected areas to dispose of soil meeting the branch technical position[2] Option 1 specifications for unrestricted release and to site the engineered cell. Once the designated areas are recognized as such by the Commission, KMC would want to discontinue radiation monitoring until we begin placing licensed material in the engineered cell. In all four unaffected areas, we need NRC concurrence that the land is clean before grading or restoration activities are begun.

Kerr-McGee is interested in completing decommissioning at its Cushing site as soon as is practicable. To facilitate approval of the plan, we will provide whatever information is necessary to expedite approval of this plan.

Sincerely yours,

Roy Smith
Vice President, Environmental Operations

Enc.

cc: Bob Evans, NRC Region IV
Gene Smith, ODEQ
Scott Thompson, ODEQ
Rick Reiley, Cushing Citizens Oversight Committee

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[2] Ibid.

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CUSHING SITE DECOMMISSIONING PLAN

1. INTRODUCTORY INFORMATION

1.1 Licensee Identification

The Kerr-McGee Corporation, whose principal address is at the Kerr-McGee Center, Oklahoma City, Oklahoma 73125, holds U.S. Nuclear Regulatory Commission Materials License SNM-1999. The license is assigned NRC docket number 70-3073.

1.2 Introduction

Kerr-McGee Corporation (KMC) owns portions of a former refinery site located near the city of Cushing, in Payne County Oklahoma. Kerr-McGee used part of the site during 1962 through 1966 to process natural thorium and natural, depleted, and enriched uranium under two Atomic Energy Commission (AEC) licenses, SNM-695 and SMB-664. The site was released, and the licenses were terminated in 1966.

During past cleanup activities, some radioactively contaminated materials were placed in burial trenches, old petroleum storage tank dike areas, and part of a hydrocarbon waste impoundment (Pit 4) on the site. The materials placed in the trenches and the waste impoundment were covered with native soil and were naturally re-vegetated.

KMC has been remediating and restoring the former refinery site under a consent order with the Oklahoma State Department of Health, now the Oklahoma Department of Environmental Quality. A radioactivity survey of the Cushing site was conducted beginning in June, 1990 and culminated with the issuance of a characterization report in May, 1991. It identified localized areas contaminated by former processing and waste management activities. About 7600 yd^3 of soil and other materials contaminated with licensed uranium or thorium to NRC Branch Technical Position [1] (BTP) Option 2 or 4 concentration are estimated to remain onsite. About 1800 yd^3 of material averaging Option 1 concentration is buried in trenches onsite.

Contaminated material recovered during decontamination of the former process buildings, contaminated soil immediately surrounding those buildings, and contaminated soil from the northern tank farm area have been packaged and shipped to a licensed disposal facility in Barnwell, South Carolina.

The Nuclear Regulatory Commission (NRC) issued Special Nuclear Materials License SNM-1999 on April 6, 1993, to Kerr-McGee Corporation, Kerr-McGee Center, Oklahoma City, Oklahoma 73125, for decommissioning the site for release for unrestricted use. This site decommissioning plan is

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1 USNRC, Branch Technical Position on *Disposal or Onsite Storage of Thorium or Uranium Wastes From Past Operations*, 40 Fed Reg 52061, 1981.

intended to fulfill license condition number 11 (A and B) requiring a plan meeting the requirements of 10 CFR Part 70.38(c)(2)(iii).

1.3 Categorical Exclusion

Pursuant to 10 CFR Part 51.22(c)(11), decommissioning activities at the Cushing site qualify for a *categorical exclusion* from a requirement to perform an environmental impact statement or an environmental assessment. Benefits of cleaning up and restoring the Cushing site to unrestricted use is expected to far out-weigh any impact of site cleanup and restoration.

2 SITE INFORMATION

2.1 Site and Grounds

The Cushing site is located in Payne County, Oklahoma, 2 miles N of the City of Cushing. Cushing lies about midway between Tulsa and Oklahoma City. The terrain is rolling, oil producing pasture land. Several oil fields were developed in the immediate area. The elevation of the refinery site ranges from 820 to 920 feet above mean sea level (MSL). Skull Creek runs through the Cushing site before joining the Cimarron River 4 miles ENE at an elevation of 760 ft. Neighboring communities include Yale (7 mi NNE), Ripley (8 mi WNW), Agra (10 mi SW), Oilton (11 mi ENE), Quay (10 mi NNE), Jennings (14 mi NE), and Drumright (8 mi E).[1] Geography in the vicinity of the Cushing site is shown in Figure 2.1, and the main features and buildings on the site are identified in Figure 2.2.

2.2 Operating History

2.2.1 Ownership

The Cushing refinery site operated from 1915 until 1972, when the refinery was closed and dismantled.

Kerr-McGee Corporation purchased the entire NE quarter of Section 27, Township 18N, Range 5E (160 acres) near Cushing, Oklahoma, from General American Oil Co. of Texas on June 4, 1956. Additional adjoining land, less small areas, to a total of 440 acres encompassing the site[2] was owned or acquired by Kerr-McGee, and the company operated an oil refinery on this Cushing site from 1956 to 1972. Kerr-McGee also processed nuclear fuel materials at the Cushing site from 1963 to 1966 under two Atomic Energy Commission (AEC) licenses, both terminated in 1966.

After the refinery was decommissioned during 1972 through 1974, portions of the refinery were sold. The site of the thorium plant, in Section 27, was owned by Kerr-McGee until July 24, 1972, when it sold the NE quarter section (less 14.72 acres in the SE corner) to Dewey Enterprises. Sometime between 1972 and 1979, Nolan and Mae Vinson obtained title to the property. On August 6, 1979, J.F. Boydston purchased 115.05 acres from Nolan Vinson. In 1985 and 1986, Boydston sold the 71.98 acres west of the former MKT Railway right-of-way to Torando Resources, Inc., of Cushing, Ok. and the remaining land to private individuals.[3]

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1 Kerr-McGee license application dated 7/3/62.

2 The 1/30/90 consent order between Kerr-McGee and the State of Oklahoma references a 335 acre site, whereas the 1/24/91 ORAU *Assessment of Decontamination and Decommissioning Activities* refers to a 435 acre site.

3 Memorandum from Gene McDonald, Ecology and Environment, Inc., to Keith Bradley, EPA Region VI, dated 10/28/86

Kerr-McGee retained ownership of the major portion of the site area known formerly as the tank farm area (the site of the 4 tanks on the north end of the property), the region of known waste disposal in the NE corner, and the former disposal area in the NW corner. Since 1986, Kerr-McGee has repurchased most of the site. At present, Kerr-McGee does not own eight small tracts totalling approximately 12 acres within the "Kerr-McGee Property" area; however, they are not within the area of concern for decommissioning.

2.2.2 Licensing and Operations

Source materials license SMB-664 was issued to Kerr-McGee on November 7, 1962.[4] The license authorized unlimited quantities in a variety of chemical forms of uranium and thorium. Kerr-McGee's license application stated that:

> Both normal and depleted uranium may be in our possession in a variety of chemical forms. The bulk of the material will be received as UF_6 in the case of depleted and as UF_6 or mill concentrate in the case of normal. Typical products will be oxides, carbides, fluorides, nitrates, metal, etc. At intermediate points in our processing, a variety of compounds may be encountered, for example, uranyl nitrate. . . Thorium will normally be received as concentrates. Typical products will be oxide or carbide or combinations of uranium and thorium compounds at various ratios of thorium to uranium.[5]

Special nuclear materials license SNM-695, issued April 23, 1963, authorized possession of any enrichment of uranium in any form, except metal, including scrap recovery. It authorized Kerr-McGee to possess up to 1000 kg of U^{235} at any one time.[6] Kerr-McGee's license application stated that:

> The uranium will be received in the form of UF_6 or other chemical compounds and/or scrap fuel elements uniradiated [sic], and will be converted to other compounds of uranium suitable for nuclear fuels. This includes, but is not limited to, the following compounds: UO_2, UO_3, Uranium Carbide, Uranium Sulphate, Uranium Nitrate, Uranium Tetrafluoride, and U_3O_8.[7]

Later, KMC's license, SNM-695, was amended to permit reduction of high enriched UF_4 to uranium metal buttons,[8] done by thermite reaction with magnesium in a ceramic-lined steel vessel that was bolted closed. The slag was roasted to oxidize any residual uranium or magnesium, and the uranium was recovered from the scrap.[9]

Enriched uranium was processed at Cushing from early 1963 until September, 1965. Thorium processing dated from December, 1964, until February, 1966, when operations ceased following an accident that resulted in the death of one employee.

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4 AEC Source Material License issued to Kerr-McGee Oil Industries, Inc., dated 11/7/6'

5 Kerr-McGee license application dated 7/3/62

6 AEC Special Nuclear Material License issued to Kerr-McGee Oil Industries, Inc., dated 4/23/63

7 Kerr-McGee license application dated 10/12/62

8 AEC Special Nuclear Materials License SNM-695 amendment issued 12/23/63.

9 Kerr-McGee SNM license amendment application to AEC dated 9/9/63.

Kerr-McGee reported to the AEC in 1966 that as of April 26, 1966, all special nuclear material had been transferred from the Cushing site to KMC's new Cimarron facility at Crescent, Oklahoma, and that all Cushing buildings in which licensed activities had been performed were cleaned and decontaminated. The letter to the AEC stated that "Our final health physics surveys have shown that the residual radioactivity contamination is well below the AEC limits for abandonment of facilities..." [10]

On July 6, 1966, the AEC conducted a close-out survey of the Cushing facility. AEC inspectors noted that the Cushing facilities had been completely stripped of all process equipment, i.e., the hoods, fans, duct work, stacks, and the sinks and work benches from the analytical laboratory, apparently having been transferred to Cimarron. The inspectors further noted that "The facilities appeared to have been thoroughly cleaned."[11] Building 31, the site of thorium processing, had been dismantled; only the concrete slab floor and brick wall common to Building 31 and the adjoining Building A6 remained. The building materials were reportedly surveyed to determine that they were not contaminated and were then buried within the boundaries of the refinery site. During the survey, the AEC inspectors collected smears and obtained direct alpha and beta plus gamma readings within the former process area. Based on the results of these data and other information gathered during the course of the survey, the inspectors recommended that the licensee be authorized to transfer control of the facility to an unlicensed recipient. Thus, on the basis of this survey, and in response to Kerr-McGee's request for authorization to release the facility for unrestricted use, licenses SNM-695 and SMB-664 were terminated on July 25, 1966.[12,13]

2.2.3 Process Buildings

The processing of nuclear fuel materials occupied four buildings. Building 30, the largest of the buildings at 50 feet by 200 feet (50 x 100 feet upstairs), was used for enriched uranium processing. The southwestern part of Building 30, a 50 x 100 foot room separated by a brick wall, was never used for nuclear processing. Building 31, at 40 feet by 134 feet, was originally used for miscellaneous maintenance activities and for equipment storage but was used for thorium processing beginning in 1964. Building A6, at 52 feet by 134 feet, joined Buildings 30 and 31. The northeastern 49 feet of Building A6, separated by a wall, was used for depleted uranium processing. By June, 1990, only the portion of Building 30 that had been used for nuclear material processing remained standing. The remainder of it had been torn down during some phase of decommissioning. Figure 2.3 shows a plan view of these former process buildings.[14]

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10 Kerr-McGee letter to AEC dated 6/9/66.

11 AEC internal memo dated 7/29/66.

12 D.L. Walker, Dir., NRC Region IV., *Close-out Inspection*, to L. Dubinski, Asst. Dir. NRC HQ, July 29, 1966.

13 D.A. Nussbaumer, NRC: Div. Mat'l Lic.: S & SNM Br., letter to G.E. Wuller, Kerr-McGee, July 25, 1966.

14 Kerr-McGee, Plot Plan (Process Areas), dwg. A-NPD-78, May 1, 1964.

2.2.4 Processes Performed

At the Cushing site, Kerr-McGee converted feed materials, such as uranium and thorium concentrates and uranium hexafluoride (UF_6) from the AEC, into usable chemical and physical forms of nuclear fuel materials for use by customers both inside and outside the United States.

Kerr-McGee processed enriched uranium in Building 30 from the beginning of 1963 through September, 1965. The processes entailed the conversion of UF_6 or other compounds and/or scrap to nuclear fuel materials--UO_2, UO_3, U_3O_8, uranium carbide, uranium sulphate, uranium nitrate, and uranium tetrafluoride (UF_4), and the reduction of high enriched UF_4 to uranium metal. By early 1964, most uranium processing work was aimed at producing UO_2, U_3O_8, and uranium metal for the AEC. Additionally, residues from metal reduction operations were reclaimed. In February, 1965, Kerr-McGee was testing a new solvent extraction development system using depleted uranium and applied for authorization to add a scrap dissolving facility and raffinate holding tanks to be located in Building 30.

To make ceramic-grade UO_2 in Building 30, enriched UF_6 was bubbled into a 5-inch diameter reactor containing an organic reductant, perchloroethylene, to form UF_4 precipitate. The UF_4 cake was filtered, dried in a furnace and then contacted with a hydrogen-steam mixture to form ceramic UO_2. Fused uranium carbide was formed by mixing UO_2 with carbon followed by an arc melting operation. Uranium buttons were formed by placing UF_4 and magnesium in a magnesium oxide crucible in the reduction reactor and heating to ignition temperature by an air-cooled induction coil. This process produced a 4.7 kg button of material.

For the recovery of enriched uranium contained in metal reduction residues, the residues were dissolved in nitric acid. Batches of the aqueous uranium solution were then contacted with an organic solution, composed of 25% tributylphosphate (TBP) and 75% amsco, a kerosene-type diluent, to solvent extract and concentrate the uranium.

Building A6, which adjoined Building 30, was used for processing depleted uranium. UF_6 was converted to UF_4 in a process that used perchloroethylene as a reductant.[15] UF_4 was then reduced to uranium metal. In that process, a semi-continuous fluid bed reactor was used to convert UF_6 to UF_4 by feeding UF_6 gas, CO_2, and vaporized perchloroethylene into the fluid bed unit at 550° F. The UF_4 was then reduced to uranium derby metal in an induction-heated reactor using magnesium as the reductant. The reduction unit was also used to oxidize some large depleted uranium buttons from Hanford to U_3O_8.

By May 1965, the primary operations at Cushing were directed toward the recovery of high enriched uranium from metal reduction slag. In this process, slag batches were dissolved in nitric acid, the resulting solution filtered, and the uranyl nitrate solution solvent extracted. The uranium was then stripped back into the aqueous phase and concentrated. The waste stream, raffinate, was collected and sampled prior to discharge to a waste pond. At that time also, a high enriched UO_2 processing line

15 AEC Inspection Report dated 1/23/64

was being readied for startup on new fuel powder orders. The initial jobs would involve preparation of ceramic UO_2.

Thorium processing, conducted in Building 31, was begun in December, 1964. The thorium process used as feed material either thorium nitrate tetrahydrate ($Th(NO_3)_4 \cdot 4H_2O$) or recycled scrap of high thorium content. The feed material was dissolved in water or nitric acid. The feed solution was then contacted with oxalic acid solution to precipitate thorium oxalate, which was then aged in a barrel. The slurry was then centrifuged for separation of oxalate cake. The oxalate cake was dried, and the dry thorium oxalate was reduced to thorium oxide in a rotating kiln. Process steam and ammonia were fed into the kiln to convert the dry thorium oxalate to thorium oxide[16] The thorium oxide, plus calcium metal and calcium chloride, a catalyst, were heated in a pressure vessel to reduce the thorium oxide to metal sponge.

Two processes were used for producing thorium pellets from metal sponge. After mixing thorium oxide with calcium metal and calcium chloride and reducing the thorium to metal sponge, in one process[17] the metal sponge was leached with water to remove the soluble unreacted calcium and calcium chloride. The thorium metal, in a liquid slurry, was then vacuum dried. In another process[18] slag residue was leached from the sponge with nitric acid. All of the final process steps commencing with drying were done in an argon atmosphere in closed equipment. The wash solutions were transferred to large storage tanks for sampling prior to disposal to Skull Creek. The thorium metal was vacuum dried under argon atmosphere. In both processes, the dried powdered thorium was pressed into pellets.

2.2.5 Waste Disposal Practices

Solid source or special nuclear materials are not believed to have been disposed of at the Cushing site during processing. In the Building 30 uranium scrap recovery process, the solvent process generated a raffinate in which the uranium concentration was about 0.05 g/l ($< 1.7 \cdot 10^{-5}$ $\mu Ci/cc$). Reports that the raffinate was discharged into Skull Creek,[19] and was discharged into a waste pond[20] are in disagreement. KMC believes they were discharged into the creek.

The UF_6 to UF_4 conversion generated no liquid or solid waste. An AEC inspection report[21] stated, "The unique aspect of the conversion [i.e., UF_6 to UF_4] is that no waste material is generated. The reaction can be carried out in a vapor phase fluid bed reactor or in conventional liquid phase reaction equipment."

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16 AEC Inspection Report dated 9/21/65

17 AEC report dated 7/9/65 of investigation of a fire and rapid oxidation involving thorium processing at the Cushing facility.

18 AEC Inspection Report dated 9/21/65

19 AEC Inspection Report dated 1/23/64.

20 AEC Part 70 Inspection Report dated 5/26/65.

21 AEC Inspection Report dated 1/23/64.

In the thorium process, the filtrate extracted from oxalate slurry was neutralized with lime before being disposed of in the refinery sludge pond (Pit 4) when the thorium content was less than 27 mg/l. Slag wash solution from the breakout step in the thorium reduction process was pumped to holding tanks and, after sampling, discharged into Skull Creek.[22] The thorium liquid wastes thus disposed of began with the processing of thorium in late December, 1964.

A survey by Oak Ridge Associated Universities (ORAU) indicated evidence of routine discharges of wash water onto a hill in the NE corner of the property and disposal of low-level decommissioning wastes in the trash dump in the NW and in the area in the SE corner of the tank farm property north of Deep Rock Road, *i.e.*, an area south of Pit 4 and north of Deep Rock Road.[23]

A 1984 an EPA contractor's reconnaissance inspection of the Cushing site indicated that thorium oxalate filters from thorium processing had been deposited in a refinery waste sludge pit (Pit 4).[24] At that time, Pit 4 also contained part of a structure, concrete chunks and slabs, that emitted radiation that "cannot be attributable to buried materials alone." The concrete members were thought to have been part of a floor or dock or the base for one or more vertical storage tank(s).[25]

2.3 Facility History of Licensed Material

2.3.1 Radionuclides

Uranium and thorium processing operations were conducted at the Cushing site between late 1962 and mid-1966.

Uranium. The uranium received at Cushing was a highly refined form, either UF_6 or metal, having only a very small fraction of its radioactivity in the form of long-lived decay products. Only the radioisotopes of uranium: U^{238}, U^{235}, and U^{234}, and a short-lived nuclide, Th^{231}, would have arrived at Cushing in significant quantity. By now Th^{234}, Pa^{234m}, and Pa^{234} will have grown into radioactive equilibrium with U^{238} but not the daughters of U^{234}. Thus, the uranium series radionuclides of primary radiological interest are U^{238}, U^{234}, Th^{230}, and Ra^{226}. U^{235} in the actinium series is also of interest.

Since the purity of the uranium received at Cushing was high, there was very little Th^{230} or Ra^{226} in it, any Th^{230} and Ra^{226} would have tended to remain together in waste, and Th^{230} would have to exceed Ra^{226} by more than an order of magnitude in order to produce significantly more Ra^{226} during the next millennium. Thus, if auxiliary measurements demonstrate that Th^{230} is not significantly more abundant in soil than is Ra^{226}, routine measurement and control of Ra^{226} will adequately assure that Th^{230} is also controlled. Moreover, a current finding of significant Ra^{226} would be indicative of NORM.

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22 H.W. Crocker, NRC:III, *Part 70 Inspection*, Sept. 21, 1965.

23 ORAU Scoping Study dated 10/27/89

24 *Filters* seems to have been an erroneous reference to filtrate.

25 Memorandum from Ecology and Environment, Inc., to Keith Bradley, EPA Region VI, dated 10/28/86

SNM-695 authorized Kerr-McGee to possess up to 1000 kg of U^{235} at any one time in Building 30. A January, 1964, AEC inspection report indicated that the highest enrichment processed at the plant was 25% U^{235} and that the largest order theretofore was 300 kg of UO_2 at 4.5% enrichment. During an AEC inspection in January, 1965, Kerr-McGee's SNM inventory was 155 kg of U^{235}, of which approximately 90% was enriched to ≥ 90 wt% U^{235}.[26] Although uranium with a wide range of U^{235} enrichment values were received, most environmental samples have exhibited relatively low enrichment.

Thorium. The thorium processing, in Building 31, used as feed material either thorium nitrate tetrahydrate ($Th(NO_3)_4 \cdot 4H_2O$) or recycled scrap of high thorium content. The thorium nitrate tetrahydrate was a refined form which had been separated from its decay products before receipt at Cushing. Since it has been about 28 years since thorium processing ended at Cushing, the thorium series radionuclides will have grown within about 0.95 of secular equilibrium with the Th^{232}.

2.3.2 Locations Where Radioactive Material Was Processed, Handled, or Stored

The Nuclear Products Department of Kerr-McGee's Cushing facility consisted of approximately 15,000 square feet under roof and was divided into three adjacent areas.[27] The largest of the these areas was Building 30, a brick building of approximately 10,000 square feet, including the second floor. The others were buildings A6 and 31.[28]

Building 30 was devoted to processing uranium in all available enrichments above natural. Ceramic-grade UO_2, uranium carbide, and uranium metal were produced from enriched UF_6 in Building 30. Enriched uranium contained in metal reduction residues was recovered by dissolution in nitric acid and extracted from the aqueous uranium solution by contacting it with a solvent extraction solution of tributylphosphate (TBP) and amsco, a kerosene-type diluent, followed by stripping the uranium from the TPB extractant. At one time the building was also used for storage of natural and depleted uranium compounds and for storage of U^{235}.

A second processing area, Building A6, was immediately accessible from Building 30 through a large portal. Ordinarily, only natural and depleted uranium were processed in this building, but on at least one occasion, a number of large metal reductions of 3.7 percent enriched uranium were performed there.[29] An earlier report[30] indicated that Building A6 was devoted to producing depleted uranium from UF_6 by reducing UF_6 to UF_4 and then to metal. The reduction unit was also used to oxidize some large depleted uranium buttons from Hanford to U_3O_8.

All thorium processing operations occurred in Building 31, formerly the Materials Storage Facility. There, thorium-nitrate-tetrahydrate was converted to pure thorium oxide, which was reduced

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26 P.S. Sandel, NRC:IV, *Compliance Inspection Report*, Feb. 16, 1965.

27 AEC Inspection Report dated 9/2/64

28 Kerr-McGee, *Plot Plan (Process Areas)*, dwg. A-NPD-78, May 1, 1964.

29 AEC Inspection Report dated 9/2/64

30 AEC Inspection Report dated 1/23/64

to a metal powder and pressed into compacts. The thorium processes are described in detail in §2.2.4, *Processes Performed*.

2.3.3 Locations of Spills and Releases

Records pertaining to the Cushing facilities' nuclear materials processing activities provide information about three incidents, two of which resulted in non-routine releases. Routine discharges of waste products is covered in §2.2.5, *Waste Disposal Practices*. Both non-routine releases were due to explosions occurring in Building 31 from the processing of thorium. The second occurrence led Kerr-McGee to abandon that process. Uranium processing had already been moved to Kerr-McGee's Cimarron facility at the time of the latter accident.

An incident that occurred on February 13, 1965, was said not to result in the release of radioactive material. In that incident, a fire and explosion occurred within a metal drying tube during thorium processing. Reportedly, there was no sign of rupture of the sealed drying tube or leakage of thorium oxide from it, and all air samples following the incident were well below MPC.[31]

The first serious accident occurred on June 23, 1965, when a fire and explosion involving 120 lb of natural thorium metal propelled a filter-dryer out a garage-type door and across Skull Creek, coming to rest near an oil storage tank in the refinery approximately 200 yards from its origin. Thorium was deposited on the outside wall of the building (Building 31) where the container had exited. Contamination readings on that wall ran as high as 180,000 dpm/100 cm^2. No other contamination along the path of the filter-dryer was detected.[32] Calculations indicated that the maximum quantity of activity available for release was 6 millicuries of natural thorium from the 120 lb of thorium powder that were in the filter-dryer before the incident.

The second consequential accident occurred on February 7, 1966, during a process in which thorium scrap material was being dissolved (reclaimed) with nitric acid. The process generated hydrogen gas, which was ordinarily carried away through a stack. However, Kerr-McGee representatives theorized that a heavy fog in the area caused the hydrogen gas to back up in the building. The high concentration of hydrogen gas then exploded, possibly due to a spark from an electrical motor. The building's metal roof was badly damaged, one corner of the building was blown out, and a small section of an interior wall was knocked down. The explosion destroyed most of the equipment in the area. There was, reportedly, minimal spread of contamination within the plant. A survey of the area of the explosion found maximum alpha contamination of 5000 dpm/4 sq in. Minor contamination (2000 dpm/4 sq in) was spread to connecting refinery and maintenance rooms." An AEC compliance report[33] stated that the "spread of thorium contamination outside of the process building was insignificant." Surveys outside Building 31 showed a maximum smear of 300 dpm/4 sq in

[31] AEC Internal memo dated 4/14/65

[32] Memorandum from Ecology and Environment, Inc., to Keith Bradley, EPA Region VI, dated 10/28/86.

[33] AEC Compliance Report dated 3/7/66.

immediately south of the building. Kerr-McGee terminated its thorium operations following this incident.

2.4 Previous Decommissioning Activities

After operations were terminated in February, 1966, the licensed processing site was cleaned-up to then existing standards. Kerr-McGee surveyed the processing site for radioactivity, found it to meet then applicable AEC release criteria, and applied to the AEC for license termination on June 9, 1966. The AEC advised Kerr-McGee that any residual contamination at the licensed site was insignificant and presented no hazard to health and safety. The two licenses under which operations were conducted were terminated on July 25, 1966.[34]

In 1972, surveys were performed and cleanup conducted of the northeast corner of the Cushing site, the Old Globe Property Dump (thought to be the trash dump), and around portions of the former processing buildings. The contaminated soil and trash was placed in Pit 4, and covered with about 4 feet of clean soil.[35]

Between 1979 and 1982, additional decontamination and stabilization activities were performed on Building 30, the building access road, (*i.e.*, the road connecting Building 30 and Deep Rock Road), Skull Creek, and the NW, NE, and SE sections of the Kerr-McGee tank farm area. Contaminated soil and other wastes that exceeded a radiation reading of 50 μR/hr were sent to the Cimarron facility for further processing. Soil measuring 30 to 50 μR/hr was placed in trenches on the NE corner of the tank farm and covered with 4 feet of clean soil. Soil measuring less than 30 μR/hr was left in place or deep plowed. Approximately 20 acres of land in the NE corner were plowed and terraced to distribute residual contamination and to prevent surface runoff.[36]

In October 1989, a survey by the Oak Ridge Associated Universities confirmed the presence of general low-level radioactive material in the northeast corner of the site and around and in Pit 4. The survey also detected residual low-level radioactive material in previously identified areas inside and outside the former process building and in the vicinity of the former tank berms. ORAU reported that, "The relative direct gamma levels in these areas suggest that the concentrations of radionuclides may exceed the current NRC guideline values for property being released for unrestricted use."[37]

In a consent order with the State of Oklahoma that went into effect in May, 1990, Kerr-McGee agreed to remove contamination in and around the old process buildings to Option 1 criteria specified in the NRC's Branch Technical Position (BTP). Kerr-McGee was also to actively pursue a thorough characterization survey of the entire original site, including Skull Creek and other drainage pathways, sufficient to define exposure rates, surface contamination levels, and licensed material concentrations in soil. Within one year of the agreement, Kerr-McGee was to conduct a radiation survey of the refinery

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34 Moore, Morgan, Kerr-McGee Refining Corporation, letter to Scott Thompson, Oklahoma State Dept. Health, October 24, 1990.

35 ORAU, Scoping Study, Oct. 27, 1989.

36 *loc. cit.*

37 ORAU, Scoping Study, Oct. 27, 1989.

site and submit the results in a written report which details the radiological impacts of the contamination.

Kerr-McGee immediately began to implement the consent order after it went into effect. The radiological characterization survey[38] was performed in 1990 and has helped guide the remedial action. Contaminated soil was stockpiled, analyzed for both chemical and radiological contaminants, and shipped to the Chem-Nuclear waste disposal site in Barnwell, South Carolina. Floor sweepings, light fixtures, pipes, electrical conduit, drainlines and fiberglass insulation that failed to meet NRC criteria for unrestricted release were also drummed and shipped to the disposal site. The concrete floors in the process buildings were cleaned using a steel shot blasting machine to remove the top layer of the floor. Waste material generated in this process was also drummed and shipped to the disposal site, along with paint material from the east wall of Building A6 that was removed with the steel shot blasting machine. High pressure steam was used to wash down the ceiling and support beams in the uranium process area. A 500-gallon septic tank that was found to be contaminated was removed. Contaminated soils were also removed from the Skull Creek stream bed and stockpiled. Concurrent with the effort to reduce radiological contaminants, Kerr-McGee worked to clean up and remediate the refinery site.

2.4.1 Building 30

Upstairs. A characterization survey including direct and smear measurements was begun in 1989. Decontamination done during 1990 included these activities:

- removed ventilation ductwork, loose piping, and loose material on the floor;
- removed asbestos from piping and loose asbestos from the floor and packaged it for shipment to a disposal facility offsite;
- removed contaminated floor tile and packaged it for shipment offsite to a disposal facility;
- surveyed sheetrock on a 2 x 2 m grid. removed that meeting release limits, and buried it onsite. packaged contaminated sheetrock for shipment to a disposal facility;
- removed electrical conduit, light fixtures, floor drains, and all remaining material; surveyed those materials to sort for release or packaged it for shipment offsite to a disposal facility;
- washed-down the area with high pressure steam;
- used a steel shot blasting machine to clean the floor;
- washed down the walls and floor again;
- performed a complete radiation survey of the walls, ceiling, beams, posts, and floor; and
- cleaned contaminated spots to less than the release limit.

Downstairs. During 1990, asbestos was removed and packaged for shipment to an offsite disposal facility. Piping, pipe hangers, brackets, and stubs of angle iron were surveyed. That which could not be released was drummed for shipment to an offsite disposal facility. The concrete floor was cleaned with a steel shot blasting machine. Light fixtures were removed and temporary lighting was installed.

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38 Kerr-McGee, *Cushing Site - Radiological Characterization*, May, 1991

In early 1991, the entire downstairs area was scanned and contaminated areas were marked. Those areas, including floor, ceiling, posts, angle iron, and beams were vac-u-blasted. Later, the walls, posts, angle iron and ceiling were steam cleaned.

In 1992, downstairs walls and ceiling were gridded at 2 x 2 m and surveyed by direct and smear measurements. Any contaminated spot was cleaned and surveyed again to achieve unrestricted release limits.

Remaining contamination exists primarily in areas inaccessible for decontamination until building demolition takes place.

West Dock. During alpha and gamma surveys of the west dock in 1992, several areas of contamination were found along the edge by the building and across the seam at the south end of the dock. A needle gun chipper was used to remove the top layer of contaminated concrete before the dock was broken up into slabs and hauled into building A6 for final survey and more cleaning. The broken slabs were surveyed on top and bottom, numbered, and the survey results documented. The clean slabs are stacked at the south end of Building A6 and the contaminated ones are in a different pile for future disposition.

Reinforcing bar and angle iron were surveyed for final release before shipment to a scrap metal dealer.

East Dock. During 1992, the dock along the east side of Building 30 was scanned for radioactive contamination. All elevated areas identified by scanning were cleaned to below release limits. A follow-up survey was performed by marking the dock into a 2 meter grid (top, side, and bottom) and doing complete alpha and gamma surveys except behind the lip of the dock that is against the building.

Some of the contaminated dirt under the east dock has been removed; some dirt remains to be removed.

Basement. During 1991, a roadway into the basement was excavated. Using a portable instrument with a shielded, 3-inch NaI detector to guide the work, the basement floor and piping were cleaned. Contaminated brick were removed and put into 55-gallon drums. Contaminated pipe was removed, drummed, and shipped offsite for burial at a licensed facility. A final survey remains to be done.

2.4.2 Pad of Building 31

Where Building 31 stood, concrete from the floor pad was surveyed; concrete with releasable contamination was hauled to an area in blocks 121 and 122 or put in a ditch along the railroad right-of way in blocks 125, 133, and 140.

2.4.3 SNM Storage Building

After gamma-scanning the floor in 1991, contamination was removed from the concrete floor with a steel shot blasting machine. Contaminated areas of the walls, ceiling, support posts, and angle iron were scanned and cleaned.

During 1993, another scan of the floor, walls (inside and out), ceiling (underneath and on top), support posts, channel iron, and angle iron was done. There are still some contaminated areas on the floor and walls that remain to be cleaned to the unrestricted release limit.

2.4.4 Building A6

A portion of this building was not used for processing. The wall between it and Building A6 was removed before the current decommissioning effort. The combined room has been used to survey, sort, and package contaminated materials.

After a scan of the floor was done in 1990, a vac-u-blasting machine was used to remove the contamination. In 1991 the north, east and west walls including the tool and storage rooms were surveyed inside and out. After samples of the paint were determined to be contaminated, a vac-u-blast machine was used to remove the contaminated paint.

There was a metal sump approximately 18 inches in diameter x 3 feet deep in Building A6 about 4 feet south of the tool room. Contaminated concrete under the lip of the tank and the dirt in the hole were removed. A portable survey instrument with a shielded 3" NaI crystal detector and the lab gamma spectrum analyzer (MCA) were used to verify that all the contaminated material had been removed to below BTP option 2 concentration. The sump tank was cleaned, surveyed, and released as scrap metal. To ensure safety, the hole was filled with clean dirt and capped with concrete.

No further cleaning or surveying has been done in Building A6 because KMC is using it for packaging drums of waste material and dirt for shipment to a off-site radiation burial facility. The dock section in front of Building A6 has not been surveyed.

2.4.5 Land Around Process Building

Yard East of Buildings 30 and A6. During 1990, the yard east of the process buildings was surveyed; contaminated soil was excavated and sorted using a portable instrument having a shielded 3-inch NaI detector and by sample analysis using gamma spectrometry to establish sort points. Excavated soil was placed into different piles based on NRC BTP criteria.

Dirt from piles of option 2 and above was moved into building A6, then put into 55 gallon drums to be shipped to a radioactive waste disposal site. The pile of option 1 dirt was hauled up to the tank berm in blocks 113, 114, 121 and 122. The brick and rock was washed and was scanned with the 3-inch shielded detector. Clean brick was buried on-site. Contaminated brick was placed into 55 gallon drums and was shipped to an off-site burial facility. Further decommissioning remains to be done.

Septic Tank and Line. The septic tank serving the process laboratory and shower room was excavated in 1991. The lines and tank were broken into pieces small enough to be drummed and shipped to a burial facility offsite. The pit was cleaned to option 1 level and back-filled.

2.4.5.1 Ditches Adjacent to the Process Building.

There were 3 ditches between the process buildings and Skull Creek. Two of them remain from excavation of pipe from the building. One was the route of a 16-inch pipe which drained effluent from Building 31 into Skull Creek. This pipe has been removed and the ditch remains open. The third is a concrete-lined drainage ditch reaching from the southwest end of Building 31 to Skull Creek. At one time before Skull Creek was cleaned, the concrete lined ditch was used to clean brick; at that time a sandbag filter was used to prevent particulate from reaching the creek. The ditches between the process building and Skull Creek could be contaminated by uranium and/or thorium. To prevent contamination from reaching the creek, a terrace to intercept any drainage was graded along the creek bank.

2.4.6 Block 125

During the characterization survey in 1990, an area with an exposure rate of 36 μR/hr was observed in block 125. Guided by a survey instrument having a shielded, 3-inch NaI detector and the results from the in-house sample counter, the contaminated soil was excavated until the shielded, 3-inch detector readings were at background levels. The affected area of block 125 was then gridded on a 2 meter by 2 meter grid, sampled, and those samples analyzed by gamma spectrometry after its cleanup. The instrument with a shielded, 3-inch NaI detector was used to do a complete scan of the area for release. The sample results showed that the remediated area was at background levels.

The soil excavated from block 125 was transported to the yard beside Building 30 for sorting. Soil containing option 2 was placed into 55 gallon drums and shipped to a burial facility for radioactive waste. Soil containing BTP option 1 or less radioactivity was put in the tank berm in Blocks 113, 114, 121 and 122.

2.4.7 Blocks 133 and 140

Blocks 133 and 140 contained areas that exhibited elevated exposure rates (15 to 19 μR/hr) during the characterization survey. These areas were revisited with a micro-R survey instrument and an instrument with a shielded, 3-inch NaI detector. Soil sample analyses demonstrated that the soil is at background radioactivity concentration and the elevated exposure rate is produced by furnace refractory brick which had been deposited there.

2.4.8 Skull Creek

The upstream, and thus unaffected part of Skull Creek is southwest of the nuclear materials process buildings. That part of the channel was rerouted during September through December, 1991 to mitigate surface water impact from hydrocarbon pit 5. Before excavation, gamma exposure rate surveys were performed on a 10 meter interval along the old channel.

During the site characterization survey, exposure rate readings were taken at 10 meter intervals along the creek downstream of the process building discharge points. Six readings, three on each bank, were taken at edge of water, one meter from the waters edge, and three meters from the waters edge, and recorded. Between these readings, a gamma scan was performed. After all these readings were taken, samples were taken where the elevated readings had been observed and were analyzed.

Before any material was removed, a survey of the creek bottom sediment was performed with a portable instrument having a 2" x 2" NaI crystal detector encased inside a 3" PVC pipe to identify elevated gamma levels in the creek sediment. The entire creek bottom from Block 109 through Block 104 was scanned.

The survey identified spots of elevated gamma activity in the bottom of Skull Creek. A gross removal of the contaminated soil was performed from the creek and its banks, with the soil being sorted into 3 piles using the survey instrument having a 3" x 1/2" NaI detector and with KMC's gamma spectrometer to verify the sort points. These piles of dirt are stored south of Building 31. Soil in the affected area was removed until only background levels remained.

After the gross removal of dirt in the affected area was done, the original grid was re-established at 5 meter intervals with survey readings recorded at waters edge, 1 meter and 5 meters on each bank using a lead shielded, 3" x 1/2" NaI detector and a μR survey instrument. Locations of elevated readings were sampled at the surface and 1 foot deep and were analyzed in KMC's gamma spectrometer to verify results.

KMC found two contaminated areas in Block 102 & 103. Soil there was removed, then the area was scanned to verify that background level was achieved. Those areas were then gridded and again surveyed. Soil samples were taken and counted to confirm that background levels were reached. There may still be some cleaning to do uphill from this point in block 102.

Between the railroad bridge and the site boundary downstream, only 3 spots contaminated above option 1 concentration were found. After remediation, perfomed in a similar manner, the creek was surveyed again. As a result of these actions, the section of Skull Creek from the process building to the property boundary is free of radioactive contamination above BTP Option 1 and is typically at background.

Historical, aerial photographs show that part of Skull Creek in blocks 103 and 104 between the railroad bridge and the site boundary was rerouted. The abandoned channel was backfilled.

2.4.9 Pits 1, 2, 3, and 5.

Material in Pits 1 through 5 consists of a mixture of clay, hydrocarbon, ans sulfuric acid from an acid-clay process used in refining lube stocks. These five sludge pits existed when Kerr-McGee acquired the refinery. Acid sludge in the five pits onsite consist of high molecular weight hydrocarbons, diatomaceous earth, and sulfuric acid. The materials are tar-like in nature. Four of the five pits (1,2,3, and 5) were full and were not used by Kerr-McGee. Pits 1, 2, 3, and 5 were sampled and analyzed for radionuclides in 1986.[39] Analyses of samples from those pits confirm that they are not contaminated by licensed radioactive material above background.

2.4.10 Pit 4

Thorium contaminated waste was previously disposed of in the northwestern corner of the Pit 4. Later, it was covered with a soil cap. In 1990, radioactive contamination in Pit 4 was characterized by removal and analysis of core samples.

Soil northwest of Pit 4 was sampled in areas that displayed elevated gamma radiation in the characterization survey. The samples were analyzed in the lab by MCA to determine which radionuclide series was dominant. Depending on whether it was uranium or thorium, a field instrument count rate was derived to sort soil into piles based on BTP Option 2 and 4. Field survey was performed with a 3-inch NaI detector + count rate instrument. For confirmation, soil samples were taken from the piles and analyzed on the lab MCA. Soil that was contaminated in excess of BTP Option 2 radioactivity concentration was excavated and shipped to an off-site disposal facility in 1992.

2.4.11 Trash Dump

Believed to have been called the trash burn pit and the old Globe property dump, the trash dump in the northwest berm was used to dispose trash and debris from nuclear operations. It contains significant concentrations of enriched uranium, natural uranium, and natural thorium as well as some refinery waste. Some excavation was done in 1992 to remove non-oily, option 4 material.

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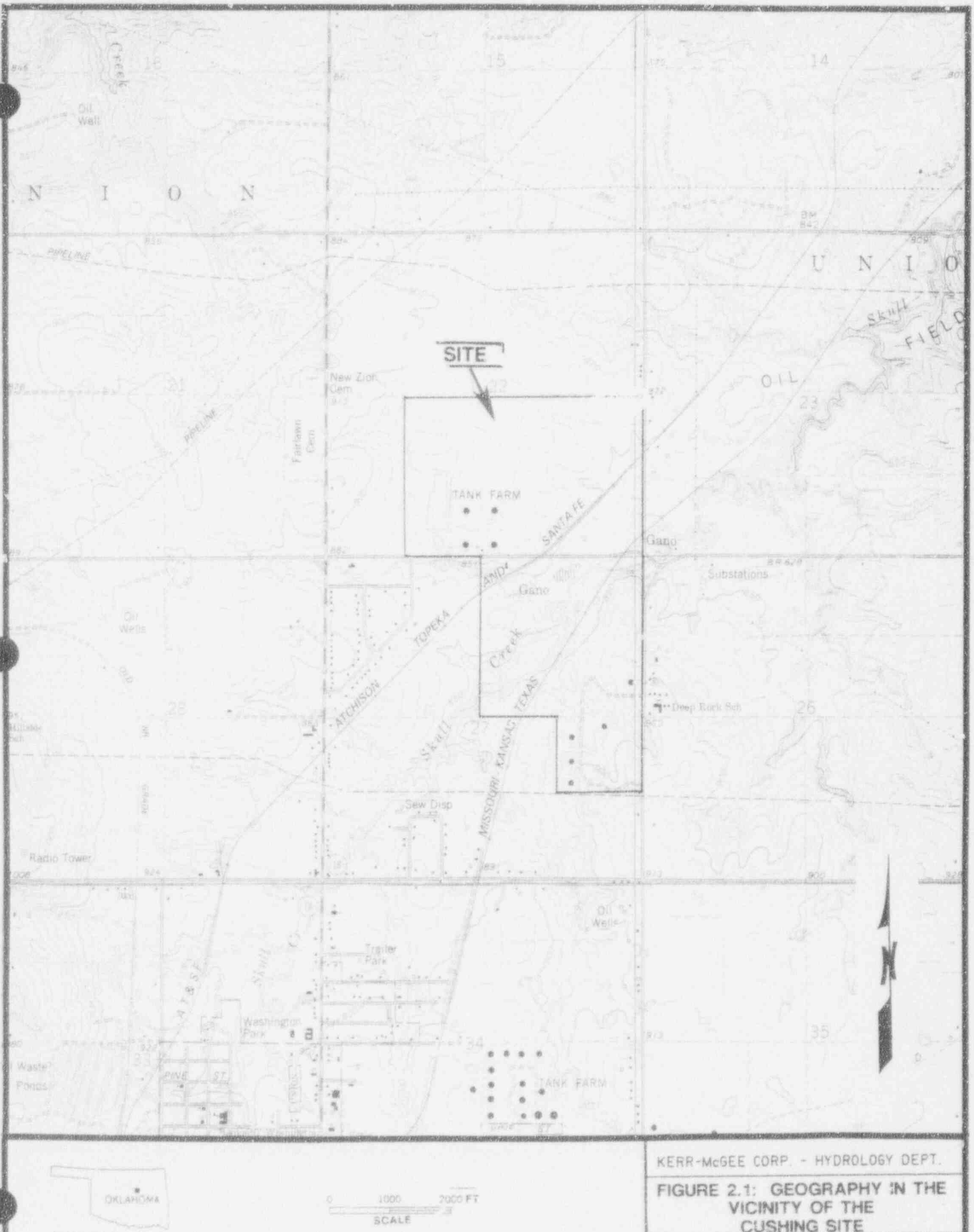
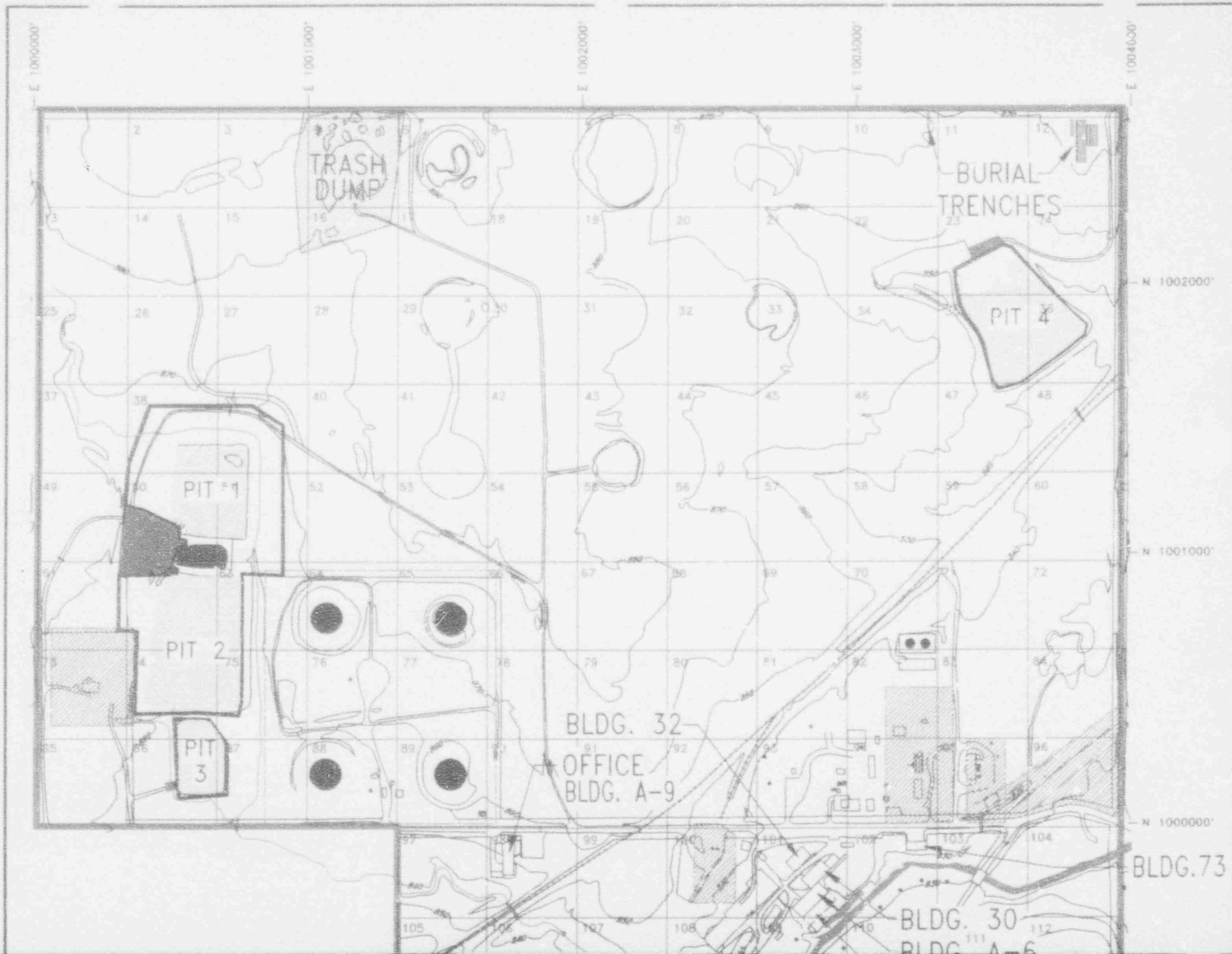
[39] Moore, 1990.



KERR-McGEE CORP. - HYDROLOGY DEPT.

FIGURE 2.1: GEOGRAPHY IN THE VICINITY OF THE CUSHING SITE

MAP DATE: 2/94


E 1000000'
E 1001000'
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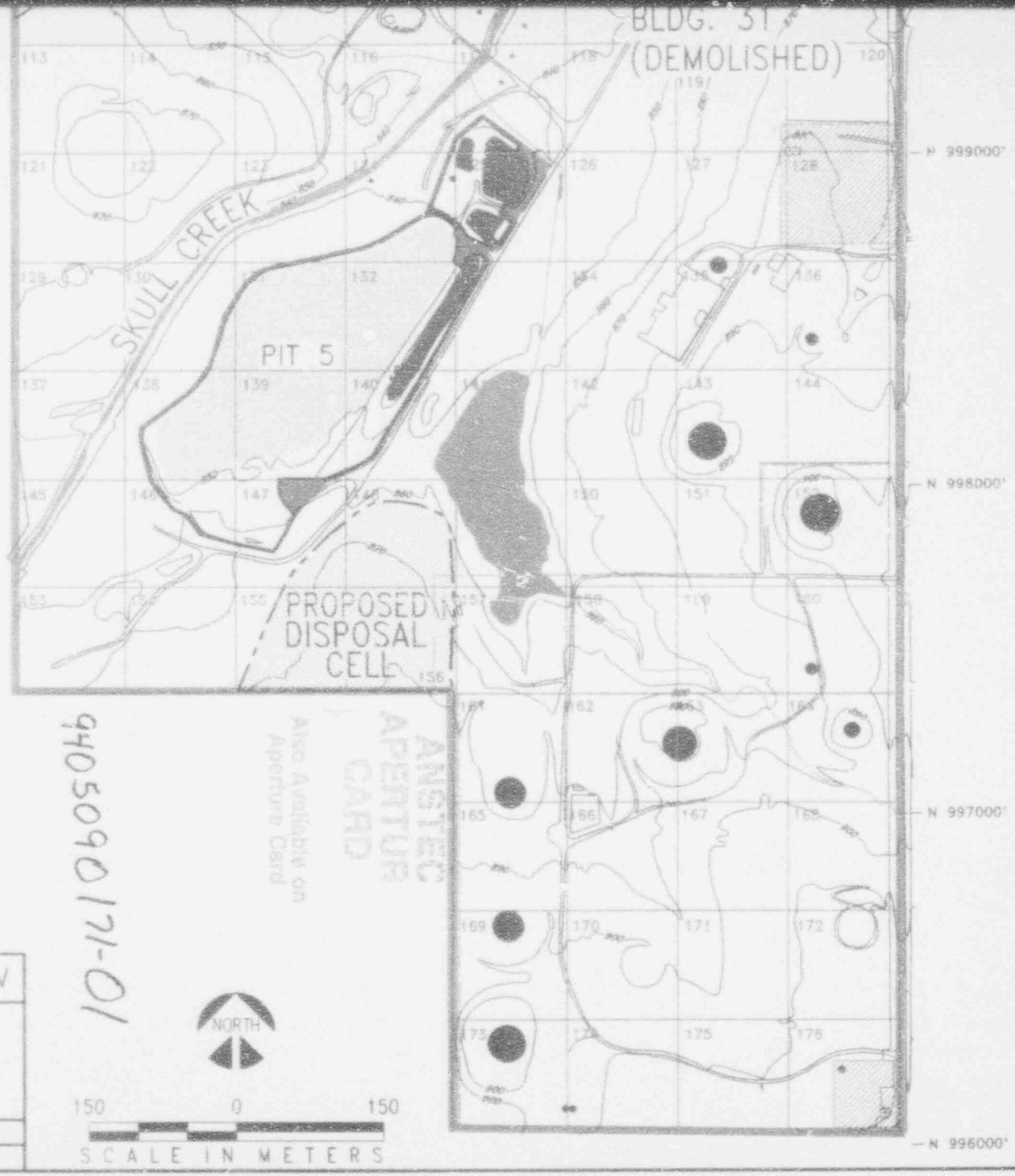
N 1000000'
TRASH DUMP
BURIAL TRENCHES
PIT 4
PIT 1
PIT 2
PIT 3
BLDG. 32
OFFICE BLDG. A-9
BLDG.73
BLDG. 30



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LEGEND

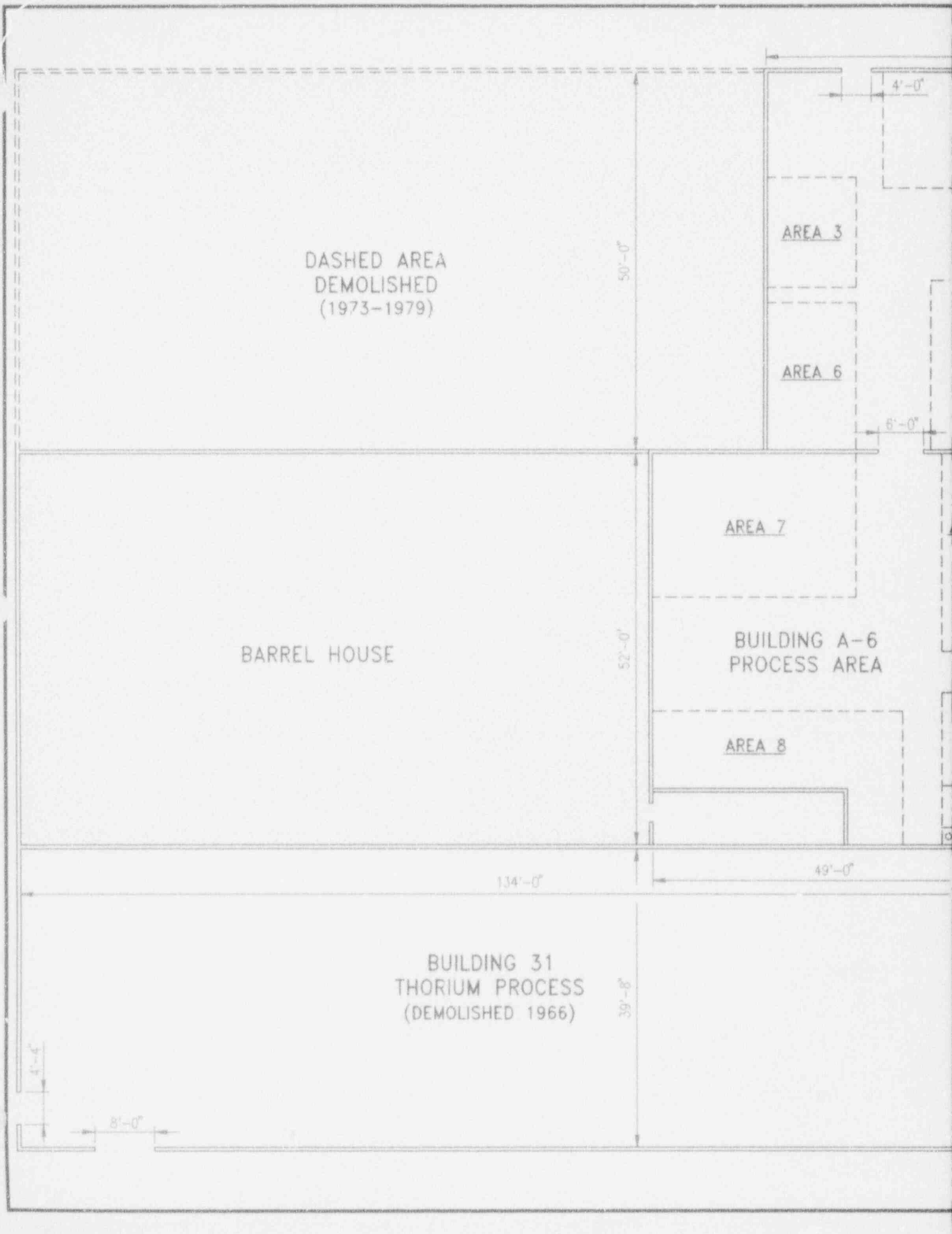
- EXCLUSION ZONE
- CONTAMINATION REDUCTION ZONE
- ACID SLUDGE PIT
- ACIDIC STORMWATER COLLECTION AND TREATMENT AREAS
- PROPERTY NOT OWNED BY KERR-McGEE
- PETROLEUM STORAGE TANKS

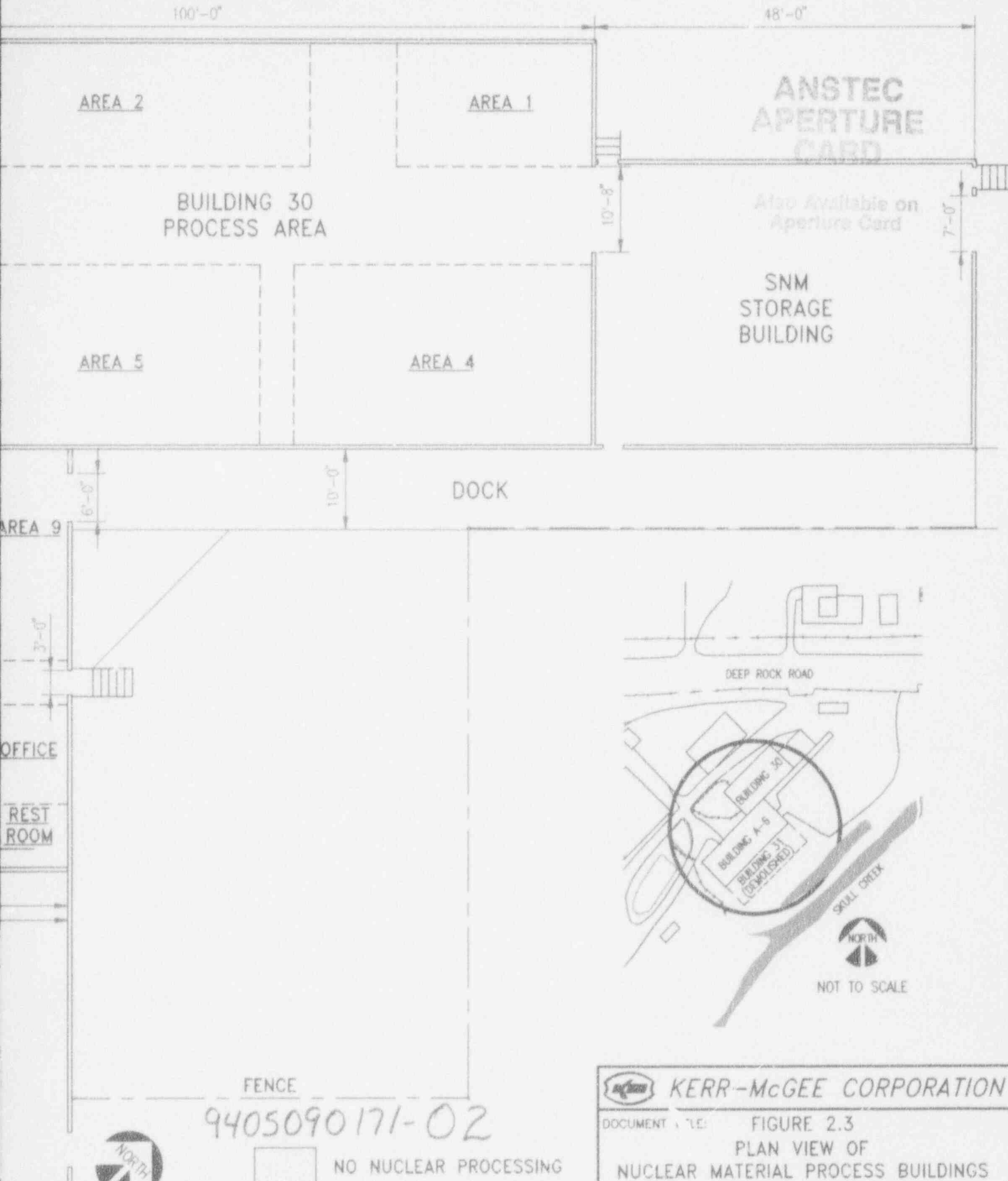
KERR-McGEE CORPORATION

DOCUMENT TITLE: FIGURE 2.2

MAIN FEATURES OF
THE CUSHING SITE

PREPARED BY: JO	DWN BY: JE
DRAWING NO. JEFF_01	DATE: 4/21/94


4'-0"
AREA 3
DASHED AREA
DEMOLISHED
(1973-1979)
50'-0"
AREA 6
6'-0"
AREA 7
BUILDING A-6
PROCESS AREA
BARREL HOUSE
52'-0"
AREA 8
134'-0"
49'-0"
BUILDING 31
THORIUM PROCESS
(DEMOLISHED 1966)
39'-8"
4'-4"
8'-0"



9405090171-02

NO NUCLEAR PROCESSING

SCALE: 1/16" = 1'-0"

KERR-McGEE CORPORATION

DOCUMENT TITLE: FIGURE 2.3
PLAN VIEW OF
NUCLEAR MATERIAL PROCESS BUILDINGS
(AS OF 5/1/64)

PREPARED BY: JL	DWN BY: JE
DRAWING NO. JEFF_03	DATE: 4/21/94

3. DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

3.1 DECOMMISSIONING OBJECTIVE

The decommissioning objective is to clean up the very low level radioactivity remaining from processing licensed material on the Cushing site to existing radiological criteria for unrestricted use in order to obtain termination of license SNM-1999. Kerr-McGee Corporation (KMC) intends to perform the decommissioning activities in a controlled manner, in accordance with applicable laws and regulations to protect the health and safety of workers, other people onsite, members of the public, and the environment.

3.2 RADIOLOGICAL CRITERIA FOR DECOMMISSIONING

The NRC has stated its intention to continue to accept existing NRC guidance, criteria, and practices[1] to determine whether a site has been sufficiently decontaminated so that it may be released for unrestricted use, pursuant to, or consistent with, the decommissioning rules in 10 CFR 70.38. These cleanup criteria may be applied on a site-specific basis with emphasis on residual contamination levels that are ALARA.

KMC plans to separate soil and debris contaminated with licensed radioactive material into three categories. Soil and debris containing radionuclides between maximum acceptable concentrations in BTP Options 1 and 2 will be put into an engineered cell onsite for permanent disposition in accordance with site specific application of BTP Option 2. A preliminary exposure pathways analysis demonstrates that a radionuclide concentration more than enumerated in BTP Option 2 may be safely put into an engineered cell onsite. KMC may request NRC approval to put soil and debris having radionuclide concentration in excess of the BTP 2 Option into the cell. Soil and debris containing more than approved for onsite disposition will be shipped to an authorized recipient offsite for disposal. Soil and debris satisfying BTP Option 1 may be left in place or used to fill excavations.

Equipment and buildings remaining intact and left in place will meet NRC's Guidelines for Decontamination of Facilities and Equipment Prior to Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Materials.

The criteria KMC proposes to judge completion of decommissioning are based on the existing guidance, applied to the Cushing site, and are presented here. All criteria apply only to licensed radioactive material; it does not apply to naturally occurring radioactive material (NORM).

3.2.1 Licensed Radionuclides Present

Uranium. The uranium received at Cushing was UF_6, a highly refined form of uranium having only a very small fraction of its radioactivity in the form of long-lived decay products. A wide range of

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1 Selin, Ivan, *SDMP Sites: The View From NRC*, speech at SDMP Workshop, Rockville, Maryland, Nov. 19, 1992

uranium-235 enrichment values were reported to have been received, but residual uranium enrichment is typically about 12 % U^{235} or less.

Uranium series radionuclides of primary radiolcgical interest are U^{238}, U^{234}, Th^{230}, and Ra^{226}. U^{235} in the actinium series is also of interest. Cushing received refined uranium compounds: UF_6, etc. Only the radioisotopes of uranium: U^{238}, U^{235}, and U^{234}, and a short-lived nuclide, Th^{231}, would have arrived at Cushing in significant quantity. By now Th^{234}, Pa^{234m}, and Pa^{234} will have grown into radioactive equilibrium with U^{238} but not the daughters of U^{234}.

Since the purity of the uranium received at Cushing was high, 1) there was little Th^{230} or Ra^{226} in it, 2) any Th^{230} and Ra^{226} would have tended to remain together in waste, and 3) Th^{230} would have to exceed Ra^{226} by more than an order of magnitude in order to produce significantly more Ra^{226} during the next millennium. Thus, if auxiliary measurements demonstrate that Th^{230} is not significantly more abundant in soil than is Ra^{226}, routine measurement and control of Ra^{226} will adequately assure that Th^{230} is also controlled.

Thorium. Although natural thorium was received in purified form, it has been long enough since cessation of operations that thorium progeny are presumed to have grown practically to secular equilibrium with the parent Th^{232}.

3.2.2 Criteria for Land and Buildings

KMC plans to clean up buildings it intends to keep and land onsite to NRC criteria for unrestricted release stated in this section. Existing radiological criteria for unrestricted release of decommissioned facilities on which cleanup of land and buildings is planned follow.[2,3,4]

3.2.3 Surface

The maximum radioactive contamination on surfaces of buildings and equipment on the Cushing site which may be released without restriction is stated in Table 3.1. The volumetric limit in §3.2.6 may be used for bulk rubble such as chunks of concrete or brick. These surface contamination criteria are based on *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material*, Policy and Guidance Directive FC 83-23.[5]

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2 Austin, John H., Chief, Decommissioning and Regulatory Issues Branch, USNRC. Site Decommissioning Management Plan Workshop. Rockville, MD. Nov. 19, 1992.

3 USNRC:NMSS, "Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites," in *NMSS Licensee Newsletter*, NUREG/BR-0117, no. 92-2, June 1992.

4 USNRC:NMSS:Decom. and Reg. Issues Br., *Branch Technical Position On Site Characterization For Decommissioning Sites*, draft, July 1992.

5 Cunningham, R.E., USNRC:Div Ind & Med Nuc Saf, *Termination of Byproduct, Source, and Special Nuclear Material Licenses*, Policy And Guidance Directive FC 83-23, Nov. 4, 1983, rev. August 1987.

Table 3.1. Acceptable Surface Contamination Levels

Nuclides[a]	Average[b,d] (dpm/100 cm^2)	Maximum[c,d] (dpm/100 cm^2)	Removable[b,d] (dpm/100 cm^2)
uranium	5,000	15,000	1,000
thorium, nat.	1,000	3,000	200

[a] Including associated decay products.
[b] Average contamination may be averaged over as much as 1 m^2. If the area of an object is less than 1 m^2, average contamination over the object.
[c] Maximum contamination level applies to an area $\leq$ 100 cm^2.
[d] dpm/100 cm^2 may be measured by either alpha or beta-gamma sensing instrument.
[e] Where both U and Th occur, the sum-of-fractions $\leq$ 1 formula may be employed.

Uranium and thorium were received in refined form without significant decay products. While thorium progeny will have grown near to radioactive equilibrium, neither uranium nor thorium progeny is expected to exceed its parent's concentration. Thus, the limits tabulated are appropriate for uranium, thorium, and their associated decay products. In the event mixed uranium and thorium are present, the sum-of-fractions $\leq$ 1 formula may be used to derive an appropriate limit based on these values.

3.2.4 Exposure Rate

Thorium and uranium concentrations remaining in land and buildings shall be sufficiently low so that the gamma exposure rate at one meter above the surface does not exceed 10 μR/hr above background at one meter above the ground or building surface.[6] In the event the exposure rate above ground exceeds 10 μR/hr above background while radioactivity concentration in soil does not exceed the BTP Option 1 concentration limit, KMC may plow the soil to increase self-shielding rather than excavate.

The average and maximum radiation levels associated with surface contamination in a building resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 mg/cm^2 total absorber.

3.2.5 ALARA

Residual radioactivity concentration shall be As Low As Is Reasonably Achievable. Decommissioning activities will be conducted to minimize increase of contaminated ground surface to ALARA.

6 USNRC, Branch Technical Position, *Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations*, 46 FR 52601, October 23, 1981.

3.2.6 Volumetric

Options 1 and 2 from the USNRC Branch Technical Position, *Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations*, provide for unrestricted release of land containing acceptably low concentration of uranium or thorium series radionuclides and are stated hereafter.

Option 1. A volumetric concentration of thorium and or uranium above background not exceeding those specified in Table 3.2 qualify material for unrestricted release with no requirement for burial.

Table 3.2. BTP Option 1 Radioactivity Concentration Limit

Kind of Material	Concentration (pCi/gm)[a]
Thorium ($Th^{232}+Th^{228}$) if all daughters are present	10.
Depleted Uranium	35
Enriched Uranium	30

[a] above background

Material is in the Option 1 category when the combined radionuclide concentration, in pCi/g, less background, is ≤ 1 using the following equation.

$$\frac{[U238]}{35} + \frac{[U235] + [U234]}{30} + \frac{[Th232] + [Th228]}{10} \leq 1$$

Concentration limits for thorium and natural uranium wastes containing fewer daughters than at secular equilibrium may be calculated on a case-by-case basis using the isotopic data that are applicable.

3.2.7 Application of Radioactivity Limits to Measurement Area

3.2.7.1 Average Radioactivity

- Stated radioactivity limits are for average values, above background, applicable to *affected* areas:
  - 100 m^2 area for soil radioactivity,
  - 100 m^2 area for exposure rate on open land,
  - 100 m^2 area for paved surface radioactivity,
  - 10 m^2 area for indoor exposure rate, and
  - 1 m^2 for surface radioactivity on a building interior or exterior.
- Stated radioactivity concentration limits for ground water are for average values, above background, applicable to the samples taken at a location. The average radioactivity above background, measured within the specified area, will be compared with the stated limit. In the event a limit is exceeded, additional cleanup is required.

3.2.7.2 Area-weighted Radioactivity

- The average radioactivity concentration in soil must be $< (100 \div A)^{1/2}$ times the stated limit where A = area of elevated radioactivity in m^2 and is $< 100\ m^2$.

- Surface radioactivity on a building interior or exterior that is between 1 and 3 times the stated limit is acceptable provided the area-weighted average radioactivity within a 1 m^2 area containing the elevated activity is within the stated limit.

- Surface radioactivity on a paved surface out-of-doors that is between 1 and 3 times the stated limit is acceptable provided area-weighted average radioactivity within a 100 m^2 area containing the elevated activity is within the stated limit.

The area-weighted radioactivity, above background, within the specified area is compared with the stated limit. In the event a limit is exceeded, additional cleanup within the area exceeding the limit is required.

3.2.7.3 Maximum Radioactivity

- The maximum radioactivity in soil at any location may not exceed 3 times the stated limit above background.

- The maximum exposure rate at any location indoors or out-of-doors may not exceed 2 times the stated limit above background.

- The maximum radioactivity on an interior or exterior building surface, when averaged over 100 cm^2, may not exceed 3 times the stated limit above background.

Radioactivity measurements, above background, will be individually compared with the stated limit. In the event a maximum radioactivity specification is exceeded, additional cleanup within the area exceeding the limit is indicated.

3.2.7.4 Survey Unit

- After average values satisfy stated radioactivity limits, the data set for each survey unit will be tested to determine whether it provides 95% confidence that the true mean activity in the unit meets the stated limit.
- A survey unit is a group of contiguous grids or regions with the same classification of contamination potential and a similar history of use.
- A maximum survey unit area is not specified for land.
- A maximum survey unit area for an interior or exterior building surface area or a paved surface out-of-doors is 100 m^2.

Each survey unit for which measurements demonstrate the stated limit is met with 95% confidence will be acceptable and no further cleanup or survey is required. However, if the mean of measurements is less than the stated limit but the 95% confidence test is inconclusive, *i.e.*, avg. activity

< limit < (avg. activity + $t_{95} \cdot \sigma \div (n-1)$), either additional cleanup followed by measurements or additional measurements may be conducted to enable the 95% confidence test to be met.

3.2.8 Onsite Disposal Cell Criteria

NRC BTP Option 2 provides for disposal of certain low concentrations of thorium and uranium when buried under prescribed conditions with no subsequent land use restrictions and no continuing NRC licensing of the material. KMC plans to design a cell that will stabilize candidate materials in place and will inhibit transport of contained material away from the site. Land and buildings or portions thereof found to be impractical to decontaminate to BTP Option 1 criteria or to surface contamination criteria limits in Table 3.1 but which meet criteria for disposition in the engineered cell onsite may be dismantled and disposed in it.

The average concentration of radioactive material that may be buried under BTP Option 2 is:

Table 3.3 BTP Option 2 Radioactive Concentration Limit

Kind of Material	Concentration (pCi/gm)
Thorium (Th^{232} + Th^{228}) if all daughters are present	50
Depleted Uranium	
soluble	100
insoluble	300
Enriched Uranium	
soluble	100
insoluble	250

Natural uranium containing Ra^{226} is not included under BTP Option 2 because of possible Rn^{222} releases and resultant higher than acceptable exposure of individuals in private residences if houses were built over buried material. Licensed uranium received at Cushing was in purified form, not containing Th^{230} or Ra^{226}, and thus qualifies for BTP Option 2.

KMC plans to evaluate topographical, geological, and hydrological characteristics of the site. It plans to design a cell that will stabilize materials in place, that will inhibit transport of disposed material away from the site, and minimize likelihood of intrusion. KMC plans to derive and propose specifications for design and construction of the cell. At a minimum, burial depth will be at least 4 feet below the surface. In the event site specific analysis demonstrates that radionuclide concentrations greater than listed in Table 3.3 are unlikely to cause more radiation dose than the basis of BTP Option 2, KMC may propose the alternative concentration to the NRC for approval. In that event, the alternative concentration limit would apply in lieu of the BTP Option 2 limit everywhere herein.

3.2.8.1 Potable Water

KMC will estimate radionuclide concentration in water originating from the cell in which contaminated soil may be placed that a potentially exposed member of the public may drink from a nearby well. Then it plans to judge acceptability of the design of the cell by comparing the prijected concentration in well water that might be withdrawn against the following maximum contaminant concentration (MCC).

Table 3.4. Criteria for Radioactivity in Water

Contaminant	MCC[a]
Radium-226 + Radium-228	5 pCi/l
Gross alpha[b]	15 pCi/l

[a] MCC = maximum contaminant concentration.
[b] including Ra^{226} but excluding radon and uranium

The decommissioning criterion for radioactivity concentration in water potentially affected by leachate from the cell is intended to meet the tabulated maximum contaminant levels for radionuclides in community and non-transient, non-community water systems in the Environmental Protection Agency's (EPA) *Interim Primary Drinking Water Regulations*, 40 CFR Part 141[7] Other provisions of 40 CFR 141 do not apply to radioactive cleanup of the Cushing site.

3.2.9 Offsite Disposal Criterion

In the event decontamination removes material in excess of criteria for onsite disposition, KMC plans to ship it to an authorized recipient for disposal offsite.

3.3 Cleanup Candidates

Low-level uranium and thorium contamination remains on the Cushing refinery site as the result of uranium and thorium processing while radium contamination exists from naturally occurring radioactive materials, *i.e.*, NORM, such as pipe scale from crude oil production activities in this area. Areas displaying elevated gamma radiation include Pit 4, several tank berms, segments of Skull Creek, the maintenance building sump, a pipe storage yard, and several small spots of contaminated soil. Some process residues are buried in several trenches onsite. The status of various areas on the Cushing site as measured during the characterization survey[8] and from employee knowledge of the site is summarized hereafter.

7 USEPA, *National Interim Primary Drinking Water Regulations*, EPA-570/9-76-003; and 41 FR 38404; July 9, 1978.

8 Kerr-McGee, *Cushing Site-Radiological Characterization*, May 4, 1991.

3.3.1 Pit 4.

Pit 4, in the northeast part of the site contains heavy hydrocarbons from a lubricating oil manufacturing operation and wax. The hydrocarbons are primarily high molecular weight asphaltenes, and contain a significant percentage of sulfuric acid (typically 15 to 25 percent). Thorium contaminated waste was previously disposed in the northwestern corner of the pit; later, the pit was covered with a soil cap. In 1990, the pit was extensively cored, sampled, and the extent of radioactive contamination was delineated. An estimated 1,900 cubic yards of acidic hydrocarbon sludge in Pit 4 is contaminated with thorium. Soil northwest of Pit 4 that was contaminated in excess of BTP Option 2 radioactivity concentration was removed and shipped offsite for disposal in 1992. According to the 1991 characterization survey, samples collected from 10 randomly located borings showed no radioactivity above background. Measured uranium and thorium concentrations range up to 7 and 34 pCi/g respectively, in biased sampling in the northwest part of Pit 4 where elevated gamma radiation exists. Thorium contamination in the northwest part of Pit 4 is a candidate for removal.

3.3.2 Refinery Tank Berms.

In several tank berms exhibiting elevated gamma radiation, thorium contamination was found to be within one foot of ground surface. Some tank berms contain tar-like residue and natural thorium in concentrations typically ranging from 10 to 30 pCi/g. The thorium-bearing residue within affected berms is subject to further characterization and cleanup.

3.3.3 Trash Dump.

Also known as the trash burn pit and the old Globe property dump, the trash dump was used to dispose trash and debris both from refinery and nuclear operations. It contains significant concentrations of enriched uranium, natural uranium, and natural thorium as well as some refinery waste. Some excavation was done in 1992 to remove non-oily, BTP Option 4 material. Remaining materials within the berm surrounding the trash dump are subject to further cleanup.

3.3.4 Burial Trenches.

During historic cleanup activities, solid radwaste having elevated radioactivity concentration was shipped to the Cimarron site. During cleanup activities in 1979 through 1982, contaminated soil, sand, concrete, and waste presenting a radiation exposure rate between 30 and 50 μR/hr was buried in trenches on the Cushing site, while material with higher concentrations was shipped to licensed disposal sites. The burial trenches were excavated as deep as 12 to 14 feet and 6 to 7 feet wide.

Gamma radiation observed on the ground above the trenches averaged only about 2.5 μR/hr above background or less. Of 83 core samples taken within the trenches and analyzed by KMC, only ten were in excess of NRC BTP Option 1 average concentration limit of 10 pCi Th_{nat} /g. In only one sample did thorium exceed 3 times the limit. Uranium did not exceed 30 pCi U/g, the Option 1 limit for uranium in any sample. The activity concentration in all of KMC's characterization measurements related to the trenches was less than the BTP Option 2 average concentration limit[9] KMC intends to characterize these burial trenches more closely.

3.3.5 Skull Creek.

The upstream, and thus unaffected part of Skull Creek is southwest of the process building. That part of the channel was rerouted during September through December, 1991 to aid in remediating hydrocarbon pit 5. Gamma exposure rate was surveyed on a 10 m interval along the old channel.

At the time of the 1991 characterization report, the creek bottom and banks downstream of the process building were reported to be contaminated with uranium and thorium from process operations. In the creek bottom, contamination was in sediments between about 6 and 12 inches deep. In the banks, contaminated soil mixed with building rubble was identified. After the 1991 survey, Skull Creek was excavated from the entry of the upstream ditch at the process building downstream to the railroad bridge until radioactivity was indistinguishable from background. Between the railroad bridge and the site boundary downstream, only 3 spots contaminated above BTP Option 1 concentration were found. Dirt removed from the creek was sorted into 3 piles, now stored south of Building 31.

Part of Skull Creek in blocks 103 and 104 between the railroad bridge and the site boundary was rerouted. The abandoned part was filled. Where it estimates the creek was, KMC plans to drill and sample the abandoned, filled section of creek bed on a 10 m interval.

KMC also plans to sample the Skull Creek bed beyond the property boundary along the creek centerline to the low water crossing about 200 m downstream of the site boundary.

3.3.6 Process Buildings.

In former process buildings A6 and 30, some areas, particularly those that conot be accessed until building demolition, remain contaminated in excess of current NRC guidance for unrestricted release. Uranium and thorium are localized in their separate processing areas, with cross-contamination limited to areas where analytical laboratory and change rooms were formerly located.[10]

A portion of Building A6 was not used for processing. The wall between it and the process area was removed before the current decommissioning effort. The combined room has been used to survey, sort, and package contaminated materials.

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9 Kerr-McGee, *Cushing Site-Radiological Characterization,* Table 3, May 4, 1991.

10 Kerr-McGee, 1991, p.54.

3.3.7 Land Areas.

3.3.7.1 Land Adjacent the Process Building.

Yard. Radioactive contamination around the process building is localized. An area next to the loading dock is contaminated to about 4 feet deep. A small amount of radioactive material has been identified under the process building.[11] These spots are subject to cleanup.

Ditches. There are 3 ditches between the process buildings and Skull Creek. Two of them remain from excavation of drain pipes from the buildings. The third is a concrete-lined ditch. Before Skull Creek was cleaned, the concrete-lined ditch was used to collect wash water while cleaning brick; at that time a sandbag filter was used to prevent particulates from reaching the creek. The resulting ditches between the process building and Skull Creek may be contaminated by uranium and or thorium. To prevent any contamination from reaching the creek, a terrace was graded along the creek bank to collect any drainage from the ditches.

The septic tank serving the process laboratory and shower room was excavated; the pit was cleaned to BTP Option 1 level and backfilled.

3.3.7.2 Soil and Rubble.

A pile of earth in blocks 101, 108, and 109 was excavated from Skull Creek downstream of the process building.

Where Building 31 stood, concrete from the floor pad was surveyed; concrete with releasable contamination was hauled to an area in blocks 121 and 122 or put in a ditch along the railroad right-of-way. The railroad right-of-way is located in blocks 125, 133, and 140.

Thorium process building rubble may have been put in a *wash* near the boundary between blocks 102 and 103.

3.3.7.3 Spots North of Deep Rock Road.

Some localized spots of contamination were found by gamma surveys during the characterization survey in 1991. Most of them are thought to have resulted from surface drainage or from spillage while waste or raffinate was being hauled to the trash dump or to pit 4.

3.3.7.4 Piles of BTP Option 1 Material.

Blocks 113, 114, 121, and 122 contain piles of soil and concrete with licensed radioactive material not exceeding BTP Option 1. The accumulated material originated in the thorium building pad and in land in block 125.

11 Kerr-McGee, 1991, p.54.

3.3.8 NORM.

Radium contamination in a sump near Building 32 close to the nuclear materials processing building and in the adjacent pipe storage yard is considered to be NORM associated with cleaning oil field equipment.

Several small areas in the refinery process area which present more than 15 μR/hr gamma exposure contain fire brick, which, in turn, contain naturally occurring uranium series radionuclides unrelated to processing operations on site.

Firebrick in several spots in blocks 103, 132, 133, and 140 contain NORM. Spots in blocks 82 and 93 contain pipe scale contaminated with NORM.

3.3.9 Estimated Volume

Volumes of contaminated material onsite have been estimated.[12] In Table 3.5, the estimated volume of all contaminated soil in the burial trenches and the volumes exceeding BTP Option 1 concentrations in other areas are tabulated.

Burial trench characterization data average 5.6 pCi Th/g and 7 pCi U/g. In combination, they average 0.8 of the BTP Option 1 limit.[13] The volume in the burial trenches is estimated to be 1800 yd^3.

Site-wide contamination consists of contaminated soil and sludge, primarily north of Deep Rock Road, excluding the trash pit area, Pit 4, and the burial trenches. Most of the BTP Option 2 and 4 contamination identified as *site-wide* is thorium. Of 169 *site-wide* samples, only 4 indicated a higher Option level based on uranium than on thorium.

Only thorium has been observed above BTP Option 1 concentration in samples from Pit 4. It averages about 20 pCi Th/g in about 1900 yd^3 total volume of thorium-contaminated material.

The trash pit, located near the northern property boundary, contains the most heterogeneous waste and variable thorium and uranium contamination on the site. While the estimates are uncertain, about 400 yd^3 of material in BTP Option 4 concentration and about 600 yd^3 of material in BTP Option 2 concentration are estimated to be in the trash pit.

Other than in Pit 4 and the burial trenches, about 5100 yd^3 of BTP Option 2 material and 550 yd^3 of BTP Option 4 material remain onsite.

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12 Kerr-McGee, NRC License Application, Cushing, OK Refinery Site, rev. 1, attach. 1, Sept. 1992.

13 Kerr-McGee, *Cushing Site Radiological Characterization*, Table 3, 1991.

Table 3.5 Estimated Volume of Contaminated Soil and Debris

Location	Material Volume (yd^3)	Avg. Thorium Concentration (pCi/g)	Avg. Uranium Concentration (pCi/g)
Pit 4	1900.	20.	low
Trash Pit	400.	60.	160.
	600.	20.	60.
Site Wide	150.	60.	low
	2050.	30.	low
	2500.	7.	low
Burial Trenches	1800.	6.	7.

3.3.10 Summary.

Most of the contamination is in discrete locations north of Deep Rock Road or in or near the processing buildings. Uranium and thorium contamination is primarily in shallow soils; their concentrations are typically less than 50 pCi/g thorium and 100 pCi/g uranium.

3.4 DECOMMISSIONING ACTIVITIES AND TASKS

3.4.1 Pit 4.

Thorium contaminated waste was previously placed in the northwestern corner of Pit 4; the pit was later covered with a soil cap. Pit 4 was extensively cored and sampled in 1990 to delineate the extent of radioactive contamination. An estimated 1,900 cubic yards of acidic hydrocarbon sludge in Pit 4 is contaminated with thorium. Samples from 10 boreholes located randomly showed no radioactivity above background. Biased sampling detected uranium and thorium concentrations ranging up to 7 and 34 pCi/g respectively.[14]

Soil northwest of Pit 4 that was contaminated in excess of BTP Option 2 radioactivity concentration was removed in 1992.

14 Kerr-McGee, 1991, Table 4.

The sulfuric acid contained in the acidic hydrocarbon sludges requires neutralization prior to excavation. Materials handling studies performed on the other four acidic hydrocarbon sludge pits shows that, when excavated without prior neutralization, sulfur dioxide is emitted in quantities sufficient to exceed National Ambient Air Quality Standards at the property line. In addition, the sludge is very corrosive to equipment if not neutralized first. These acidic hydrocarbon sludges will be treated and disposed of in accordance with a remediation plan approved the the Oklahoma Department of Environmental Quality (ODEQ). As a result, KMC plans the following actions to remediate Pit 4.

1. A grid that is referenced to the sitewide grid will be established on the surface of the pit.
2. Material in the pit will be sampled for acidity. Kerr-McGee is performing treatability studies to determine the preferred method for efficiently and economically neutralizing and excavating the acidic, oily wastes. The same method used to neutralize other acid hydrocarbon pits will be used to neutralize Pit 4.
3. Acid sludges in the pit will be neutralized to a pH of 9 ± 2 standard units by adding basic reagents and mixing in about a 0.3 to 1 m layer. During neutralization activities, the sludge will be handled in accordance with requirements governing both hazardous and radioactive waste. KMC believes the mixing process will produce homogeneity with depth in each layer.
4. Neutralized material in each treated layer will be sampled and analyzed for radioactivity or measured *in-situ* on a 3.5 x 3.5 m grid depicted in Figure 3.1. The radioactivity measurement methods are generically described in §3.4.9.
5. The measurement will determine whether residue in each 3.5 m x 3.5 m x treatment depth element in the interval is BTP Option 1, 2, or > Option 2.
6. Material having radionuclide concentration greater than BTP Option 1 will be excavated and sorted according to the radioactivity concentration measurement representing each 3.5 x 3.5 m x treatment depth grid element.
7. Material removed that contains BTP Option 1 radioactivity concentration will be disposed of in an ODEQ-approved disposal cell in the northwest corner of the site, located in blocks 1, 2, 3, 13, 14, and 15. Such material is designated as *Other Industrial Waste* (OIW) by the ODEQ.
8. Material containing > BTP Option 1 radioactivity concentration will be transported to and stored in one of the designated storage areas surrounded by a berm.
9. When approved, waste containing BTP Option 2 and up to the maximum concentration demonstrated to meet cell criteria will be placed in an engineered cell onsite.
10. Waste exceeding BTP Option 2 radionuclide concentration or the maximum concentration demonstrated to meet cell criteria will be transported to and stored in one of the designated storage areas surrounded by a berm pending disposal offsite at a permitted disposal facility.
11. After all waste has been removed, KMC plans to verify by sampling and analysis or by *in-situ* measurement that the residual radioactivity concentration in Pit 4 does not exceed BTP Option 1. To do that, measurements will be made on a 5 x 5 m grid at the surface and 1 m deep where waste was removed.
12. After all treated waste has been removed from the pit, KMC will partially backfill it with earth that is not contaminated in excess of BTP option 1 radioactivity concentration.
13. KMC will notify the NRC prior to placing uncontaminated soil in Pit 4 in the event that an NRC confirmatory survey of the pit is desired.

14. KMC will afford the NRC an opportunity to perform a confirmatory survey of treated material placed in the OIW cell before KMC covers it.

3.4.2 Refinery Tank Berms.

During refinery operations, there were about 23 large oil storage tanks on the part of the Cushing site north of Deep Rock Road. Four of them, in blocks 64, 65, 88, and 89 remain in use. Each of the tanks was surrounded by an earthen berm, intended to confine oil spilled from the encircled tank.

There is a tar-like layer in the floor of the berms in block 7, in blocks 17 and 29, and in blocks 41 and 53 that is radioactively contaminated. *Affected* areas within refinery tank berms will be cleaned to BTP Option 1.

KMC intends to follow the general plan described in §3.4.9 to survey, sort, and excavate contaminated soil and debris from contaminated berm areas.

1. Material removed that contains BTP Option 1 radioactivity concentration will either be left in place or may be stored temporarily in a pile near the tank berm. This material may eventually be used as fill dirt to help contour the site or be handled as *Other Industrial Waste*.
2. Material having radioactivity concentration greater than BTP Option 1 will be excavated and sorted as generally described in §3.4.9.3, Excavation and Sorting, according to the radioactivity concentration measurement representing each 3.5 x 3.5 x 0.3 m grid element.
3. Dirt and debris containing greater than BTP Option 1 radioactivity concentration will be transported to and stored the designated storage area surrounded by a berm, pending disposition.
4. When approved, waste containing BTP Option 2 and up to the maximum concentration demonstrated to meet cell criteria will be placed in an engineered cell onsite. In the interim, KMC plans to store it in a designated storage area surrounded by a berm.
5. Material exceeding BTP Option 2 radioanuclide concentration and the maximum concentration demonstrated to meet cell criteria will eventually be packaged and transported offsite for disposal at a permitted disposal facility.
6. After material containing > BTP Option 1 radioactivity has been removed from the berm area, KMC plans to verify by sampling and analysis or by *in-situ* measurement that the residual radioactivity concentration in ground surrounded by the berm and in the berm does not exceed BTP Option 1. To do that, measurements will be made on a 5 x 5 m grid at the surface and at 1 m deep where contaminated soil and debris was removed
7. KMC will notify the NRC prior to putting uncontaminated soil in the former tank berm, including the surrounding berm, in the event that the NRC wants to do a confirmatory survey.
8. After residues have been removed from the area surrounded by the tank berm, KMC intends to bulldoze the earthen berm toward the interior and grade it to gently sloping topography.
9. The reclaimed ground will be revegetated.

It is impractical to attempt to screen, crush, and or sample metal scrap and tar-like substance in the area surrounded by the tank berms. Such material, if radioactively contaminated above a screening level designed to be less than the BTP Option 1 limit, will be excavated, stored in a designated area, and eventually put into the engineered cell as is.

3.4.3 Trash Dump, (NW Berm)

Also known as the trash burn pit and the old Globe property dump, the trash dump is located in block 4. It was used to dispose trash and debris from nuclear operations. It contains significant concentrations of enriched uranium, natural uranium, and natural thorium as well as some refinery waste on the ground surrounded by the berm. Some excavation was done in 1992 to remove non-oily, BTP Option 4 material. Remaining materials within the berm surrounding the trash dump are subject to further cleanup.

KMC intends to follow the general plan described in §3.4.9 to survey, sort, and excavate contaminated soil and debris from the interior and any contamination in the berm.

1. Material removed that contains BTP Option 1 radioactivity concentration will either be left in place or may be stored temporarily in a pile near the trash dump. This material may eventually be used as fill dirt to help contour the site or be handled as *Other Industrial Waste*.
2. Material having radioactivity concentration greater than BTP Option 1 will be excavated and sorted as generally described in §3.4.9.3, Excavation and Sorting, according to the radioactivity concentration measurement representing each 3.5 x 3.5 x 0.3 m grid element.
3. Dirt and debris containing greater than BTP Option 1 radioactivity concentration will be transported to and stored the designated storage area surrounded by a berm, pending disposition.
4. When approved, waste containing BTP Option 2 and up to the maximum concentration demonstrated to meet cell criteria will be placed in an engineered cell onsite. In the interim, KMC plans to store it in a designated storage area surrounded by a berm.
5. Material exceeding BTP Option 2 radioactivity concentration and the maximum concentration demonstrated to meet cell criteria will eventually be packaged and transported offsite for disposal at a permitted disposal facility.
6. After material containing > BTP Option 1 radioactivity has been removed from the trash dump, KMC plans to verify by sampling and analysis or by *in-situ* measurement that the residual radioactivity concentration in ground surrounded by the berm and in the berm does not exceed BTP Option 1. To do that, measurements will be made on a 5 x 5 m grid at the surface and at 1 m deep where contaminated soil and debris was removed.
7. KMC will notify the NRC prior to putting uncontaminated soil in the former trash dump area in the event that the NRC wants to do a confirmatory survey.
8. After residues have been removed from the trash dump area, KMC intends to bulldoze any remaining earthen berm toward the interior and grade it to gently sloping topography.
9. The reclaimed ground will be revegetated.

There is enough metal scrap and tar-like substance in the trash dump that it is impractical to attempt to screen, crush, and or sample it. Such material, if radioactively contaminated above a screening level designed to be less than the BTP Option 1 limit, will be excavated, stored in a designated area, and eventually put into the engineered cell as is.

3.4.4 Burial Trenches.

The burial trenches and their contents are described in §3.3.4 and in the 1991 characterization report.[15]

Activities Planned. KMC plans to do additional boring and coring to better define the lateral boundaries and depth of contamination in the trenches. At a minimum, borings will be done at 5 m intervals along the estimated centerline of each trench and at 1 m on each side of the centerline, or if it is narrower, within the trench. Samples from the trenches will be analyzed for radionuclides.

Results will be compared with NRC BTP Option 1 and 2 radionuclide concentration guidelines.

1. If BTP Option 1 is met, KMC will leave material in the ground.
2. If the results are between BTP Option 1 and 2 limits, KMC will perform exposure pathway analyses to determine whether radiation dose criterion would be met and disposition in place would be the preferred alternative.
3. If measurements exceed the derived maximum concentration corresponding to the radiation dose criterion, KMC will excavate material locally that exceeds the derived concentration guideline, survey and sort it by activity concentration, and put that material into the engineered cell or ship it offsite to an authorized disposal facility.
4. In the event some contamination in the trenches exceeds the BTP Option 1 limit but is demonstrated to justify disposition in place, KMC will submit the justification for NRC review and approval. If some excavation were required, it would be done as described in §3.4.9.3.

In the event some excavation from the vicinity of the burial trenches were required, soil meeting unrestricted release guidelines, *i.e.*, BTP Option 1 concentration guidelines, would be put into the cavity to cover residual soil at least 4 feet deep, compacted to restore the ground to grade, and seeded to establish a vegetative cover.

If excavation of contamination from trenches were necessary, health, safety, and environmental protection provisions described in Chapter 5 herein would be practiced while excavating and handling the material.

3.4.5 Skull Creek.

Part of Skull Creek in blocks 103 and 104 between the railroad bridge and the site boundary was rerouted. The abandoned part was filled. KMC plans to drill and sample the abandoned, filled section of creek bed on a 10 m interval. In the event contaminated sediment is confirmed in the Creek bed, additional sampling will be done in the vicinity to determine its extent.

If KMC finds no contamination > BTP Option 1 in the ditches between the process buildings and Skull Creek, it will not be surveyed again downstream to the site boundary. If contamination is

[15] *Ibid.*

found, then KMC will survey the terrace along the creek bank. If contamination is found there, then KMC will survey Skull Creek downstream.

Part of Skull Creek in blocks 103 and 104 between the railroad bridge and the site boundary was rerouted. The abandoned part was filled. KMC plans to drill and sample the abandoned, filled section of creek bed on a 10 m interval. KMC also plans to sample the bed of Skull Creek beyond the property boundary at 10 meter intervals along the creek centerline to the low water crossing about 200 m downstream of the site boundary.

If contaminated soil or sediment in the Creek bed is measured, additional survey in the vicinity will be done to determine its extent. In the event soil and or sediment is excavated from Skull Creek, KMC would plan to do it during a time of low flow. KMC would seek permission from the Oklahoma Department of Environmental Quality (ODEQ) to dam the creek temporarily and to pump water around the affected area during excavation.

KMC intends to follow the general plan described in §3.4.9 to survey, sort, and excavate contaminated soil and debris from contaminated creek bed areas.

1. Material removed that contains BTP Option 1 radioactivity concentration will either be left in place or may be stored temporarily in a pile near the creek. This material may eventually be used as fill dirt to help contour the site or be handled as *Other Industrial Waste*.
2. Material having radioactivity concentration greater than BTP Option 1 will be excavated and sorted as generally described in §3.4.9.3, Excavation and Sorting, according to the radioactivity concentration measurement representing each 3.5 x 3.5 x 0.3 m grid element.
3. Dirt and debris containing greater than BTP Option 1 radioactivity concentration will be transported to and stored the designated storage area surrounded by a berm, pending disposition.
4. When approved, waste containing BTP Option 2 and up to the maximum concentration demonstrated to meet cell criteria will be placed in an engineered cell onsite. In the interim, KMC plans to store it in a designated storage area surrounded by a berm.
5. Material exceeding BTP Option 2 radionuclide concentration and the maximum concentration demonstrated to meet cell criteria will eventually be packaged and transported offsite for disposal at a permitted disposal facility.
6. After material containing > BTP Option 1 radioactivity has been removed from the creek bed, KMC would verify by sampling and analysis or by *in-situ* measurement that the residual radioactivity concentration in ground surrounded by the berm and in the berm does not exceed BTP Option 1. To do that, measurements will be made on a 5 x 5 m grid at the surface and at 1 m deep where the material had been removed.

3.4.6 Other Land Areas.

Historical information and the site characterization survey have identified discrete areas, or spots, of land which may need cleanup or final survey.

3.4.6.1 Areas Known to be Contaminated

Some discrete areas, or spots, of land where contamination has been identified are:

- an area beside the loading dock of Building A6 or 30;
- An area under the east dock of Building 30;
- ground under Building 30; (after the building floor is dismantled); and
- a number of spots north of Deep Rock Road, most notably in blocks 9, 19, and 20 that are contaminated near ground surface.

3.4.6.2 Potentially Contaminated Areas

Other areas that have been cleaned (most have been surveyed) or that KMC plans to investigate for possible contamination are:

- area where Building 31 was located;
- the spot where the septic tank serving Building 30 was located;
- the basement under Building 30 (after Building 30 is dismantled);
- sediment removed from Skull Creek and now piled southwest of Building 31 in blocks 108 and 109;
- debris in a *wash* in block 102
- an area in block 72 where contaminated doors and clothing resulting from the 1966 thorium processing incident may have been disposed of);
- the area in the northeast corner of the property where thorium process waste water had been discharged; and
- an area northwest of Pit 4 where BTP Option 2 and greater contamination was removed during 1992.

3.4.6.3 Cleanup Survey and Plan

Generally the bounds of an area will be determined by the 1991 characterization survey, by a new exposure rate survey of the area, by personal knowledge, and/or by logical physical boundaries.

These areas will be surveyed and, if necessary, contamination removed in the following actions.

1. KMC intends to follow the general plan described in §3.4.9 to survey, sort, and excavate contaminated soil and debris from land areas which are the object of this section.
2. Material removed that contains BTP Option 1 radioactivity concentration will either be left in place or may be stored temporarily in a pile near the excavation site. This material may eventually be used as fill dirt to help contour the site or be handled as *Other Industrial Waste*.
3. Material having radioactivity concentration greater than BTP Option 1 will be excavated and sorted as generally described in §3.4.9.3, Excavation and Sorting, according to the radioactivity concentration measurement representing each 3.5 x 3.5 x 0.3 m grid element.
4. Dirt and debris containing greater than BTP Option 1 radioactivity concentration will be transported to and stored the designated storage area surrounded by a berm, pending disposition.
5. When approved, waste containing BTP Option 2 and up to the maximum concentration demonstrated to meet cell criteria will be placed in an engineered cell onsite. In the interim, KMC plans to store it in a designated storage area surrounded by a berm.

6. Material exceeding BTP Option 2 radioactivity concentration and the maximum concentration demonstrated to meet cell criteria will eventually be packaged and transported offsite for disposal at a permitted disposal facility.
7. After material containing > BTP Option 1 radioactivity has been removed from the berm area, KMC plans to verify by sampling and analysis or by *in-situ* measurement that the residual radioactivity concentration in ground surrounded by the berm and in the berm does not exceed BTP Option 1. To do that, measurements will be made on a 5 x 5 m grid at the surface and at 1 m deep where material was removed.
8. KMC will notify the NRC prior to putting uncontaminated soil in the former tank berm, including the surrounding berm, in the event that the NRC wants to do a confirmatory survey.
9. After residues have been removed from the area surrounded by the tank berm, KMC intends to bulldoze the earthen berm toward the interior and grade it to gently sloping topography.
10. The reclaimed ground will be revegetated.

It is impractical to attempt to screen, crush, and or sample metal scrap and tar-like substance. Such material, if radioactively contaminated above a screening level designed to be less than the BTP Option 1 limit, will be excavated, stored in a designated area, and eventually put into the engineered cell as is.

3.4.6.4 Buried Rubble

Where buried rubble contaminated by licensed material above the BTP Option 1 level for unrestricted release is suspected to be, KMC plans to survey and, if necessary remove the contaminated rubble and soil in accordance with the plan in §3.4.6.3. This includes rubble from Building 31 not yet surveyed and excludes what has already been surveyed.

Contaminated rubble, including brick and concrete from process buildings and or equipment previously dismantled may be crushed to reduce its volume and to allow its radioactivity to be measured representatively. In that circumstance, the crushed rubble would be sampled and analyzed for its radioactivity concentration. Some contaminated rubble containing metal and or tar-like substance cannot be screened, crushed, or sampled. It will be put into the engineered cell as is.

3.4.7 NORM

Naturally occurring radioactive material (NORM) in a higher concentration than ordinarily occurring in soil has been observed onsite. Radium contamination in a sump near the maintenance building in the adjacent pipe storage yard northwest of the process buildings is thought to be NORM associated with cleaning oil field equipment. Spots blocks 103, 125, 126, 133, and 140 along the railroad right-of-way contain fire brick. In other instances, such fire brick has displayed elevated NORM. Other spots in blocks 82 and 93 contain pipe scale, with which NORM concentration is often associated.

Concentrations of NORM material will be collected and handled in accordance with the requirements of the ODEQ and the Oklahoma Corporation Commission.

3.4.8 Process Buildings.

3.4.8.1 Conditions

Of the original nuclear materials process buildings, uranium process Building 30, the SNM Storage Building, and Building A6 remain. Figure 2.3 shows the arrangement of these buildings in plan view as they were in 1964. Since then, part of Building 30, the thorium process building, and Building 31, was dismantled and a wall separating Building A6 and the Barrel House was removed. The combined Building A6 and Barrel House have been used to sort and package contaminated soil and debris for shipment offsite.

In 1966, the process buildings were cleaned to then existing standards for unrestricted release. During 1989 through 1992, these buildings were decontaminated again and the Building 31 floor was removed. Some hard-to-access spots remain to be decontaminated to the current standard for unrestricted release. After their service to package contaminated material for shipment offsite to a disposal facility, Building A6 will need to be decontaminated.

SNM Storage Building. There are still some contaminated areas on the floor and walls of the chemical storage room that remain to be cleaned to unrestricted release limits.

3.4.8.2 Plan

KMC expects to clean and dismantle Building 30 and the SNM Storage Building. Whether Building A6 will be dismantled has not been decided. Specifics of a plan to decontaminate and decommissioning these process buildings will be submitted to the NRC at a later date.

3.4.9 Measurement and Sorting

3.4.9.1 Scoping Survey Before Excavation

A radioactivity survey may be performed if useful or needed for a particular area before excavation for one or more of the following reasons.

a. Estimate the approximate radioactivity concentration range.
b. Identify bounds of contamination.
c. Delineate where to excavate.
d. Confirm relationships between important radionuclides and surrogate radionuclides and or to establish whether uranium predominates, thorium predominates, or there is a mixture of uranium and thorium.

1. Where a location is designated as *affected*, KMC plans to establish a 10 x 10 m grid referenced to the 100 x 100 m site grid. This grid will be marked with stakes or surveyor flags.
2. Exposure rate will be measured at each 10 m grid node.
3. If the exposure rate is at background level, then soil sampling will not be performed. But if the exposure rate exceeds background with 95% confidence, (approximately background + 3σ), KMC plans to further delineate the affected area by sampling and analysis or *in-situ* measurement.

Portable survey instruments (Micro-R or similar type) or a more sensitive radiation detection instrument equipped with a lead shielded 3" x ½" NaI instrument may then be used to help define the areal extent of near surface contamination. This area would be marked with stakes or surveyor flags. Soil or debris samples are collected and analyzed with the computer-based, multi-channel gamma analyzer to determine the radionuclides present. If subsurface radioactive contamination is expected, sampling with +depth enables the volume of soil or debris and concentration within that volume to be approximately determined. The soil or debris may be excavated at that time or the location recorded and the area left for excavation at a future time.

3.4.9.2 Measurement for Excavating and Sorting

KMC plans to measure radioactivity concentration in the soil or debris to help guide excavation and to categorize it for interim storage in anticipation of eventual disposition. Alternative means of measuring for this purpose need to be prepared for varying circumstances. Thus, excavated soil may be measured *in-situ* in the field or may be sampled and analyzed in a laboratory. The following procedure for measuring and sorting includes these alternatives.

1. Near ground surface on a 10 x 10 m grid, KMC plans to take a sample for analysis **or** measure *in-situ*.
2. In the event an area is confirmed by a scoping survey or the survey on a 10 x 10 m grid to be affected
    a. the grid will be increased to a 5 x 5 m grid, and
    b. KMC plans to take a sample for analysis **or** measure *in-situ* on the grid.
        1) if potential contamination is most likely to be surficial, *e.g.*, on undisturbed terrain, sample or measure *in-situ* within 0 to 15 cm of ground surface.
        2) if potential contamination was deposited subsurface, *e.g.*, in a pit or buried, sample or measure *in-situ* at each depth in increments of 0.5 m on the grid.
3. Where ≥ BTP Option 1 radioactivity concentration is detected,
    a. increase the grid to ≤ 3.5 x 3.5 m spacing, and
    b. at each depth in increments of ≤ 0.5 m on the grid, take a sample for analysis or measure *in-situ*.

A grid of 5 x 5 m and 1 m interval with depth is recommended for a final survey[16]. The proposed 3.5 x 3.5 x 0.5 m grid for excavating and sorting will be approximately 6 m^3, which is 0.25 of the volume represented by recommended spacing for a final survey of a previously affected area. This is a reasonably small volume, considering the large total volume of material to be moved and the size of equipment needed to excavate it.

Contaminated rubble, including brick and concrete from processing buildings and/or equipment previously dismantled may be crushed to reduce its volume and to allow its radioactivity to be measured representatively. In that circumstance, the crushed material would be sampled and analyzed for radioactivity concentration.

16 Berger, pp. 4.16 & 4.19.

Some rubble or solids containing metal or asphaltic material cannot be crushed. Such material, if radioactively contaminated, will be put into the engineered cell as is.

Measurement In Laboratory. To measure radioactivity concentration in a laboratory, a soil sample will be sent to the laboratory for multi-channel gamma spectrum analysis (MCA).

a. When uranium is predominant, the soil sample, collected as specified, will be analyzed by MCA or other radionuclide analysis.
b. When both uranium and thorium are present in competitive concentrations, the soil, or soil sample collected as specified, will be analyzed by MCA or ot. radionuclide analysis.
c. When thorium is predominant, it may be measured either by NaI detector + single-channel gamma spectrum analysis (SCA), by NaI + MCA, or by similar instrument.
   (1) When measuring thorium with an NaI detector + SCA, Ac^{228} concentration may be measured as a surrogate for thorium series radionuclides.
   (2) Alternatively thorium series radionuclides may be measured with an NaI detector + MCA.

Measurement *In-situ*. In the event soil or debris is measured in the field, it may be done by either putting the detector at measured intervals in an augered hole in the ground, in an excavated pile, or in a vessel of the material. The instrument will have been calibrated by immersing its detector in three or more vessels of soil containing independently determined concentrations of uranium and thorium to simulate measurement conditions.

3.4.9.3 Excavation and Sorting

Measurement, described in §3.4.9.1 and §3.4.9.2, will indicate which category each 3.5 x 3.5 x 0.5 m element or lot belongs in. Alternatives are:

a. Return to land or store for return to land (radioactivity concentration in BTP Option 1 range);
b. Store for disposition in engineered cell on-site (may have one or more concentration ranges and storage piles in this category to accommodate a future regulatory decision);
c. Store for shipment off-site to burial.

After radioactivity concentration is measured, material whose concentration is > BTP Option 1 will be excavated. Designated material will be excavated as closely as practical to the bounds represented by the radioactivity measurement, typically 3.5 x 3.5 x 0.5 m, considering the motorized excavator being used. A portable instrument will be used to guide the excavation process until the detector indicates concentrations below BTP Option 2 levels.

As determined by the measurement before excavation, excavated soil or debris will be sorted into one of three categories by putting each increment removed, *e.g.*, a 3.5 x 3.5 x 0.5 m element represented by a radioactivity measurement, into a specified pile or into a carrier destined for a specified storage area.

The category for storage of soil or debris containing both thorium and uranium will be determined by calculating the sum of fractions of the maximum permissible concentration (ΣFMPC). The ΣFMPC is determined by dividing the activity of each radionuclide by the maximum permissible concentration within an option, and then summing the ratios. If the sum of the ratios is less than one, the material lies within that option. For example, a soil containing 8 pCi/g thorium above natural background, plus 20 pCi/g enriched uranium above natural background would be 1.5 times the maximum permissible concentration (MPC) for BTP Option 1 material.

An assessment will be made concerning whether or not the excavated area must be immediately back-filled because of safety, location or other considerations. If prompt back-filling is not mandated, the area may be cordoned off and posted. If the area must be back-filled promptly, the excavation site will be mapped on a three-dimensional basis to enable soil samples to be taken later from below the excavated area, if necessary.

3.4.9.4 NORM Material

Some material exhibiting enhanced concentrations of radium-226 has been identified. This material is associated with previous activities involving oil field equipment and firebrick material, and is therefore NORM in origin. NORM material will be collected and handled in accordance with the requirements of the ODEQ and the Oklahoma Corporation Commission.

3.4.10 Stockpiling and On-site Storage

The interim storage area for radioactively contaminated materials, depicted in Figures 3.2 and 3.3, will consist of a three foot high earthen berm surrounding the storage area. A portion of the berm will be sloped gently to provide vehicular access to the storage area. A fence will be constructed around the berm to restrict access. A gate will be installed in the fence for access, and will be locked when not being used. The fence will be posted with signs reading, "CAUTION, RADIOACTIVE MATERIALS". Thermoluminescent dosimeters (TLD) will be posted on the fence surrounding the storage area to monitor exposure rate. TLD will be sent to the laboratory for analysis on a quarterly basis.

During sorting and stockpiling activities, wind dispersal of the soils placed in the storage areas will be controlled either by wetting or by covering with plastic sheeting. Once sorting and stockpiling of all contaminated materials on site has been completed, a vegetative cover will be established to minimize airborne dispersion of soil particles. The storage area will provide storage for the radioactive material placed therein until the site decommissioning plan stipulating final disposition of the material is approved. In the future, KMC intends to use a portion of unaffected area 1 in the NW corner of the site for disposition of soil meeting BTP Option 1 concentration.

3.4.11 Ability of Storage Areas to Resist Erosion

During stockpiling activities, wind dispersal of the materials placed in the storage areas will be controlled by wetting or by covering the material with plastic if air sampling were to indicate a need.

Once stockpiling of all contaminated materials on-site is complete, a vegetative cover will be established to minimize airborne dispersion of the soil.

The radioactive material storage area will consist of an earthen berm 400 feet in diameter or larger. The earthen berm will be constructed in accordance with Figures 3.2 and 3.3. The berm will consist of native soils currently contained in existing dikes or from within the diked area. It will have exterior slopes not exceeding 3:1 (approximately 19%), and will be constructed so that the lowest point on the peak of the berm will extend a minimum of three feet above the highest point on the floor of the storage area.

An access road will be constructed on the floor of the storage area. The access roads will consist of compacted soil covered with approximately three inches of crushed rock. The elevation of the road on the berm will be maintained so that it does not become the low point in the berm.

The 25-year, 24-hour rainfall event is approximately seven inches in this area. The storage area will be able to contain this quantity of water, plus more than 6,000 cubic yards of material, without exceeding the elevation of the berms.

A surface water collection sump will be constructed in the topographically lowest point of the storage area. The sump will serve as a basin from which to discharge surface water that collects in the storage area, assuming such surface water meets effluent criteria established in 10 CFR 20.1302(b)(2). The intake for the discharge will be set above the bottom of the basin to minimize the discharge of sediment.

After construction, a vegetative cover will be established on the berms. The vegetative cover will consist of warm weather grasses, such as Bermuda grass, that require little water, tolerate heat and sunlight, and develop extensive root systems. The vegetative cover will serve as an erosion inhibitor. If the berm is constructed in the fall, the initial vegetative cover will consist of winter wheat, rye or other quick-germinating grass, which will be supplanted with a warm weather grass in the spring.

After the vegetative cover has germinated, a fence will be established on the perimeter of the berm. It will consist of three-strand, barbed wire with a locking gate to provide vehicular access to the storage area. The fence will be posted with signs reading, "Caution: Radioactive Materials" in accordance with 10 CFR 20.1902.

3.5 Engineered Cell for On-site Disposal

Kerr-McGee intends to bury material meeting NRC BTP Option 2 requirements in an engineered cell on-site. A site has tentatively been identified on the southern boundary of the property. A preliminary geologic investigation has been conducted on the site, and a conceptual design for an engineered cell has been developed. A preliminary analysis of the conceptual design and the site hydrology has been performed in order to judge the feasibility of such an engineered cell. KMC intends to submit a formal design for the engineered cell and a demonstration of safety in a 10 CFR 20.2002 application at a later date. A preliminary exposure pathways analysis demonstrates that a radionuclide concentration more than enumerated in BTP Option 2 may be safely put into an engineered cell onsite, KMC may request NRC approval to put soil and debris having radionuclide concentration in excess of the BTP 2 Option into the cell. In that event, the alternative concentration limit would apply everywhere herein in lieu of the BTP Option 2 limit.

3.5.1 Performance Objectives

The proposed cell design is being formulated to meet the following performance objectives:

- to protect the general population from releases of radioactivity so dose does not exceed 100 mrem/yr total effective dose equivalent (TEDE) when institutional provisions are obeyed,
- isolate disposed material to minimize the potential for waste constituents to migrate from the disposal cell into the environment,
- to achieve long term stability of the site without ongoing maintenance,
- to minimize potential for intrusion into unit.
- to control radiation dose below the dose criterion for at least 200 years and, to the extent reasonably achievable, for 1000 years.

3.5.2 Site Description

3.5.2.1 Location

The location of the site for the proposed engineered cell is shown on Figures 2.2 and 3.4. The site is located on the Cushing property on the tip of a small ridge of land extending from the southern property boundary. It is located immediately to the southwest of the site of a planned industrial waste disposal cell whose location is also indicated in Figure 3.4.

The Cushing property is located approximately two miles north of the town of Cushing. The property is remote from any large population center. The area immediately surrounding the property is sparsely populated and rural in nature. No significant development or population growth is anticipated in the area.

Both developed and undeveloped land border the Cushing property. Undeveloped areas bordering the property are used primarily for agricultural purposes. Specific agricultural activities include growing grain, managing the land as pasture, and raising livestock. Developed land surrounding the property is zoned industrial and residential. Some residences are located adjacent the property. Deep Rock School is located east of the property boundary.

3.5.2.2 Topographic Setting

The Cushing facility lies in a geographic transitional zone between the Central Redbed Plains and the Northern Limestone Cuesta Plains.[17] Surface topographic relief on the property is approximately 100 feet, ranging between 820 and 920 feet above mean sea level (MSL). The property

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[17] D'Lugosz, J.J., R.G. McClaflin, and M.V. Marcher, 1986. *Geohydrology of the Vamoosa-Ada Aquifer East-Central Oklahoma*. Oklahoma Geological Survey. Circular 87.

is bisected by Skull Creek which runs in a northeasterly direction across the center of the property. The lowest point of the property occurs along Skull Creek near the eastern property boundary. The highest points on the property occur near its southeastern and northwestern corners.

The planned site of the engineered cell is located on the northernmost tip of a ridge of land extending from off-property and nearby property areas to the southeast as indicated in Figure 2.2. The elevation of the planned disposal site is between 870 and 880 feet MSL. On the eastern, northern, and western edges of the ridge, the relief drops twenty or more feet into well-developed drainage features.

3.5.2.3 Geologic Setting

The geology of Payne County is characterized by a thick sequence of sedimentary rock ranging in thickness from approximately 3,500 feet in eastern Payne County to approximately 7,500 feet in the western portion of the county. The county is immediately underlain by approximately 2,200 feet of late Pennsylvanian- and Permian-age rock. The Cushing facility lies in a geographic transitional zone between the Central Redbed Plains and the Northern Limestone Cuesta Plains. The Central Redbed Plains are primarily composed of alternating sequences of mudstone and shales with thin sandstone and limestone lenses.[18] In the adjacent Limestone Cuesta Plains, resistant limestones form steep escarpments that distinguish the topography from the rolling plains of the Central Redbed Plains.

The geology and hydrogeology of the Cushing property have undergone extensive characterization. As early as 1985, 38 monitoring wells had been installed on the property. Fifteen additional wells were installed by 1991. During a characterization study for the industrial waste disposal cell located on the hill immediately to the northeast of the site of the proposed engineered cell, an additional seven wells at three locations were installed in 1993. In addition to the borings associated with the installation of the above wells, numerous other borings have been completed throughout the Cushing property. Four borings were completed in 1994 at the site identified for the proposed engineered cell.

As a result of these extensive investigations, a thorough understanding of the geology and hydrogeology of the Cushing property has been developed. The investigations completed by early 1993 and an analysis of the facility hydrogeology are documented.[19] The site specific investigation of the nearby industrial waste disposal cell is also documented.[20] The borings completed at the site of the proposed engineered cell are documented within this Decommissioning Plan.

The investigations conducted on site have indicated that soils beneath the facility property are primarily residual, derived from weathering of the underlying bedrock originally deposited as mudstone and shale with occasional lenses of sandstone. Soil encountered during drilling includes sandy and silty

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18 Shelton et. al., 1985. Geologic Map of Payne County, Oklahoma.

19 Burns & McDonnel Waste Consultants, 1993. *Phase I Remedial Investigation Report*; Kerr- McGee Cushing Refinery Site, Cushing, Oklahoma.

20 Lower, Steven R., 1993. *Other Industrial Waste Disposal Cell Site Characterization*, Kerr-McGee Cushing Refinery Site, Cushing Oklahoma. Report prepared by Kerr-McGee Hydrology Department, December, 1993.

clays, organic silts, and clayey silts. Minor amounts of alluvium are also present in portions of Skull Creek and its tributaries.

Site soils are underlain by bedrock of the Pennsylvanian-age Vanoss Group. Core samples of the bedrock underlying the facility property have been collected from borings ranging in depth from a few feet to 254 feet. Unweathered Vanoss Group strata have generally been found to occur at a depth of 10 feet or less. Shallow bedrock is dominated by thick beds of reddish-brown mudstone with some interbeds of siltstone, sandstone, and limestone. Some shale also occurs beneath the facility property, with an increasing proportion of shale within the formations found in the southern portion of the property. Some sandstones occur as lenticular bodies within the mudstone and shale of the Vanoss Group. These sandstones typically contain varying amounts of silt and clay and are generally of limited lateral extent. They have been found in lenses ranging in thickness from less than 0.5 feet to 12 feet. Carbonate rocks, predominately limestones, are also common locally throughout the Vanoss Group. These limestones consist primarily of thin, discontinuous stringers with thicknesses ranging from 0.5 to 3 feet.

The Vanoss Group is underlain by the sandstones of the Ada Group and the sandstones and shales of the Vamoosa Formation. The Oklahoma Geological Survey collectively refers to the Ada Group and the Vamoosa Formation as the Vamoosa-Ada Aquifer hydrologic unit. The Vamoosa-Ada Aquifer unit consists of a complex sequence of fine- to very fine-grained sand stones, siltstones, shales, and conglomerates. The maximum thickness of individual sandstone units is generally about 80 feet. The sandstones representing the Vamoosa-Ada Aquifer typically occur at depths of about 175 feet in the Cushing Area. The top of the Ada Group has been located at an elevation of 720 feet MSL in a boring (CC-6) in the northwest portion of the Cushing facility. The uppermost sandstone unit encountered in this boring was found to be 66 feet in thickness. A second boring (CMW-32.2) in the southeast part of the facility and approximately one-half mile up dip geologically from boring CC-6 has located the top of the Ada Group at an elevation of 729 feet MSL.

3.5.2.4 Hydrogeologic Setting

Three separate water-bearing zones have been identified below the Cushing Property. These are the shallow unconsolidated deposits, the Vanoss Group, and the Vamoosa-Ada Aquifer. Ground water is frequently found in the shallow unconsolidated materials consisting of alluvium along stream channels, soils, and shallow weathered bedrock. These deposits are thin and too limited in extent to yield significant amounts of water. Recharge to this shallow zone is primarily a result of direct infiltration of precipitation and overland flow. Water levels in this zone generally conform to the topography and appear to be controlled by the bedrock surface and/or surface drainage features.

The principal water bearing units of the Vanoss Group are interbedded sandstone and limestone layers found in these deposits. Ground-water levels in nested monitoring wells located throughout the property have been observed over a number of years. While vertical gradients are spatially variable, downward vertical gradients are generally observed, particularly when wells screened in deeper strata are considered. Monitoring wells screened in the deep strata below 800 feet MSL generally exhibit significantly lower water levels ranging between 810 and 825 feet msl. However, water levels observed in the nested wells screened in soil and the uppermost Vanoss bedrock strata are frequently similar. Considerable variability is also observed in the horizontal head relationships, with horizontal gradients strongly influenced by topography, particularly at the shallower depths.

Recharge to the Vanoss group is thought to occur by direct infiltration of precipitation and overland flow on the outcrop areas.[21] At the Cushing property, ground water collecting in the unconsolidated overburden and moving laterally to areas of lower relief infiltrates slowly into the bedrock. However, infiltration is undoubtedly restricted by the low permeability materials generally encountered at bedrock surface or at shallow depths. Greater amounts of infiltration occur through areas of exposed sandstone or limestone interbeds or in areas of heavily weathered bedrock.

At depth, ground-water flow patterns are most likely controlled by the more permeable deposits, such as sandstone and limestone lenses. Due to their horizontal orientation, these more permeable deposits tend to direct ground-water flow horizontally, toward points of discharge. These points of local discharge may be areas of outcropping where ground water rejoins flow in the shallow overburden or may be points of direct discharge into local drainage features, including Skull Creek. The piezometric surface at any depth is strongly influenced by the elevation of these more permeable deposits and their points of discharge. Skull Creek most likely controls water levels in the deeper strata that have been monitored on site. As noted above, ground-water levels observed in wells screened in the deeper strata generally range between 810 and 825 feet MSL. These levels correspond to the elevation of Skull Creek in its downstream reaches where the creek approaches the eastern property boundary.

The impact of the more permeable sandstone and limestone deposits on the hydraulics of the shallow ground-water flow regime depends on the spacing between these deposit and the overall permeability of the material in which they are embedded. These higher permeability deposits can be thought of as drains that have the potential of creating strong downward vertical gradients into them. However, these gradients may not be particularly pronounced in areas where strong permeability contrasts are not present. Such weak vertical gradients have been observed in the northern portion of the property where a significant amount of sandstone is frequently encountered in shallow bedrock.

However, in areas where the more permeable lenses are overlaid by materials of significantly lower permeability, such as tight mudstone, strong downward vertical gradients may be induced. The effect of the strong downward drainage may be sufficient to induce near unit gradients and may result in unsaturated conditions locally. Unsaturated conditions are most likely to be encountered in association with permeability contrasts. Slight reductions in permeability may perch infiltrating ground water, resulting in the formation of unsaturated zones beneath these perching layers in layers of increased permeability.

Hydrogeologic conditions that have induced strong vertical gradients in shallow bedrock have been identified on the hill immediately to the northeast of the area identified for the proposed engineered cell. This site has been extensively investigated for purposes of constructing an engineered

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[21] D'lugosz et al. 1986.

cell for the disposal of industrial wastes and has been approved for such use by the State of Oklahoma. The nearby industrial waste site is underlain by a thick sequence of mudstone that contains limited sandstone. However, a large sandstone unit is encountered at a depth of approximately 40 feet. While monitoring wells have not been completed in the shallow mudstone, monitoring wells have been completed in this first major sandstone unit. Water levels observed in this sandstone unit extend only slightly above the top of these units, indicating a strong vertical gradient between the sandstone unit and any water perched on top of bedrock in the overlying unconsolidated material. Flexible wall permeability tests have been conducted on core samples of mudstone and sandstones taken from this site. Permeability values for the mudstone ranged from 1.2×10^{-8} cm/sec to 3.1×10^{-7} cm/sec. Permeability values for the two sandstone samples tested were 1.6×10^{-7} and 1.8×10^{-6} cm/sec. Fracturing of the mudstone is also unlikely to provide any significant secondary permeability due to the self-healing characteristics of this material.

Beneath the Cushing facility, ground water in the Vamoosa-Ada aquifer is separated from ground water in the shallow Vanoss formation by the deeper units of the Vanoss Group. Data from on-site borings indicate that these deposits are also dominated by thick mudstone and shale beds of low permeability which act as an aquitard. Ground water in the Vamoosa-Ada is confined by these overlying, low permeability strata. Ground-water gradients in the Vamoosa- Ada aquifer, itself, have not been established beneath the Cushing property. However, the flow direction in the aquifer is generally in the westward direction, from areas of recharge to points of discharge. Water level measurements in the monitoring well screened on the facility property in the Vamoosa-Ada indicate that the piezometric surface in the aquifer is at an elevation of approximately 790 feet MSL. Thus, a downward gradient from the Vanoss Group strata into the Vamoosa-Ada exists beneath the facility.

Hydraulic properties of the Vamoosa-Ada aquifer are controlled by the lateral and vertical distribution of its sandstone and shale units and the physical characteristics of these rocks. Published transmissivity values for the Vamoosa-Ada Aquifer range from 70 ft^2 /day to 290 ft^2 /day, with an overall decrease in transmissible from the south to north throughout the region. This decrease corresponds to the decreasing saturated thickness of sandstone from south to north. Hydraulic conductivity values have been reported to range between 7.1×10^{-4} cm/s and 1.4×10^{-3} cm/s, and the aggregate thickness of the water bearing sandstone of the Vamoosa-Ada aquifer has been reported to range from a minimum of 100 feet to a maximum of 550 feet.[22] Analysis of data from a twenty-four hour pumping test conducted in a well screened in the uppermost 75 feet of the Vamoosa-Ada aquifer on site yielded a hydraulic conductivity value of 1.0×10^{-5} cm/s.

Recharge to the Vamoosa-Ada Aquifer is thought to occur primarily from infiltration of direct precipitation and overland flow on the outcrop areas of these deposits.[23] Recent analysis of tritium levels in water samples taken on site indicate that the ground water of the Vamoosa Aquifer is much older than surface waters.[24] These data appear to indicate that the Vamoosa-Ada aquifer beneath the Cushing property is in poor hydraulic communication with overlying strata and supports the conclusion

22 D'lugosz et al. 1986.

23 D'lugosz et al. 1986.

24 Burns and McDonnel, 1993.

that recharge to the Vamoosa-Ada aquifer occurs primarily by infiltration of precipitation and overland flow on outcrop areas. Outcropping of the Vamoosa-Ada Aquifer begins about 2.5 miles east of the site and continue eastward.

3.5.2.5 Regional and Local Ground-Water Use

Within north central Oklahoma, wells provide water for many rural homes, municipal use in small communities, and use in small industries. Within the region, the most favorable areas for ground water development are in the unconsolidated, alluvial deposits along the floodplains and terraces of the major rivers and their tributaries. According to the Geologic Map of Payne County, Oklahoma,[25] the nearest usable alluvial aquifer is approximately 1½ mile from the Cushing property.

The uppermost water-bearing bedrock formations in the area are comprised of the thin sandstone and limestone interbeds within the low permeability mudstone of the Vanoss group. However, due to their limited extent, these sandstone and limestone beds are of marginal use in providing water supplies. The water-bearing sandstones of the deeper Vamoosa-Ada Aquifer are generally developed for municipal, domestic and stock use in the region. According to the Oklahoma Water Resources Board,[26] three wells have been completed within water-bearing sandstones of the Vanoss Group and/or the Vamoosa-Ada Aquifer within a 2-mile radius of the Cushing property. According to the well reports, water from these wells is used to meet domestic and municipal needs. However, the current status of these wells, whether active, abandoned, or plugged, is not known. Due to the limited permeability and thickness of the individual sandstones of the Vanoss, wells completed in the Vanoss formation require the penetration of a number of sandstones and may even tap shallow sandstone units of the Vamoosa Ada Aquifer before obtaining an adequate supply. Local water utility companies indicate that all residences within one mile of the Cushing property are served by public water supplies.

3.5.2.6 Site Geology and Hydrogeology

Four borings have recently been completed in the area identified for the proposed engineered cell. The location of each of these borings is shown on Figure 3.4. These borings range in depth from 103.5 feet to 155 feet. Boring B-148 (E-70, S-60) was continuously cored, and the remainder of the borings were geologically logged using the cuttings brought to the surface during mud rotary drilling. All borings were geophysically logged using gamma, spontaneous potential, and resistivity tools. Correlations between the cored boring and the geophysical logs from all borings provide a good definition of the bedrock materials beneath the site of the proposed engineered cell. The geologic and geophysical logs are contained in Appendix A.

The boring data from the site of the proposed engineered cell indicate that the site conforms well with the geology observed throughout the rest of the site, particularly with that observed at the nearby industrial waste disposal site. Bedrock was found at a depth of between 5 and 10 feet. The

25 Shelton et al., 1985.

26 Gary Glover, 1991. Oklahoma Water Resources Board.

bedrock sequence is dominated by shale and mudstone with only limited amounts of sandstone encountered. Boring data from directly beneath the planned disposal site (boring B-156, E-20, S-20) indicate that no sandstones lenses are present directly beneath the site above a depth of 99 feet (approximate elevation of 778 ft. MSL.); although a one and one-half foot layer of limestone was encountered at a depth of 13 feet, and a second, one-foot layer of limestone was encountered at a depth of 84 feet. The sandstone encountered at 99 feet marks the beginning of a sequence of interbedded sandstones that grade into a 20 foot thickness of sandstone that begins at a depth of 110 feet (approximate elevation of 767 ft MSL). Mudstone with only limited stringers of limestone was encountered beneath this sandstone in the remainder of the boring which extended to a depth of 155 feet.

Some thin lenses of sandstone were encountered at shallower depths in the borings located on the periphery of the proposed site, particularly along the southern border of the property. In boring B-155, E-30, S-90 a ten-foot thickness of sandstone was encountered at a depth between 10 and 20 feet (approximate elevation of 851 - 861 ft., MSL.). However, no other significant sandstones were encountered over the remainder of the 105 foot boring. Similarly, in boring B-156, E-80, S-90, a shallow, seven-foot thick sandstone lens was encountered at a depth of 15 feet (approximate elevation of 863 ft. MSL.). An additional sandstone lens was encountered between the depths of 54 and 66 1/2 feet. In the shallow ravine located immediately northeast of the proposed site, data from boring B-148, E-70, S-60 indicated only thin sandstone stringers at depths of 50 and 58 feet (approximate elevations of 816 ft. and 808 ft MSL), before encountering a 20 foot section of sandstone at an approximate elevation of 781 feet MSL. This 20 foot section of sandstone is likely the lateral extension of the sandstone sequence first encountered at the same elevation directly beneath the site for the proposed engineered cell.

Thus, the planned site for the proposed engineered cell is underlain by a massive mudstone sequence with potentially a few shallow, thin sandstone or limestone lenses of only limited lateral extent. The first significant sandstone sequence with any apparent lateral continuity is found at a depth of 99 feet (approximate elevation of 778 ft MSL).

While monitoring wells have not been installed at the site to verify hydraulic conditions, it is anticipated that the hydrology of the site conforms closely with that identified for the nearby industrial waste cell. While perched ground water may be present in the shallow unconsolidated deposits directly overlying bedrock, infiltration into bedrock is undoubtedly restricted by the low permeability mudstone that dominates shallow bedrock. The permeability of this mudstone is low and selected layers of this material likely exhibits vertical permeabilities as low as 10^{-8} cm/sec, as found at the nearby industrial waste disposal site. Any water infiltrating into bedrock will tend to migrate vertically downward toward any thin interbeds of sandstone and limestone that are present. Flow may be directed laterally for limited distances in these discontinuous lenses. Unsaturated conditions may exist locally, and perched layers of ground water may form at permeability contrasts. Ground water may also be directed laterally along these perched zones, if present. However, the dominant control on lateral and vertical flow will be exerted by the more significant sandstone layer encountered at approximately 778 feet MSL. Strong downward vertical gradients are likely toward this layer. The piezometric surface in this sandstone should be in the 810 to 820 feet MSL, and ground water reaching this layer will be directed toward Skull Creek, with eventual discharge into some downstream point along the creek. Little, if any, ground water infiltrating from the surface will ever reach the Vamoosa-Ada Aquifer.

The hydrogeology of the site identified for the proposed engineered cell appears to be favorable for the development of an engineered cell. The low permeability mudstone bedrock will provide an excellent natural liner that will minimize the migration of moisture from the cell. Engineered controls can be implemented to minimize infiltration into the cell. The disposed material will be placed approximately 75 feet above the first potential point of ground water use and will be separated from that potential point of use by a thick sequence of low-permeability mudstone. The top of the principal aquifer in the area is 135 feet below the bottom of the cell and is separated by a thick sequence of low-permeability bedrock. Recharge to the principal aquifer by infiltration at the ground surface is minimal, if at all. Thus, the hydrogeology of the site appears suitable for developing an engineered cell that is capable of effectively isolating buried materials from ground water and minimizing any potential migration of radionuclides to points of potential ground-water use. Additional hydrogeologic investigations will be conducted as necessary to demonstrate the isolation of buried material from ground water and to determine the potential for the migration of radionuclide from the cell.

3.5.2.7 Surface Water Hydrology

Much of Payne County, including the Cushing property, lies in the drainage basin of the Cimarron River. The Cimarron River, located approximately 4 miles north of the Cushing facility, flows east-northeast in this area of Oklahoma. The region is well drained with a dendritic drainage pattern that shows an overall southeasterly trend north of the Cimarron River and a northerly to northeasterly trend south of the river. Runoff from the property flows into Skull Creek via several small, unnamed tributaries. Skull Creek flows in a northeasterly direction and eventually discharges into the Cimarron River. Gauging data is not available for Skull Creek in the vicinity of the Cushing property, but Skull Creek is a perennial stream that carries significant quantities of runoff during storm events. Skull Creek is used for agricultural, municipal, industrial, recreational and aesthetic purposes.[27]

The site identified for the proposed engineered cell is located on the northern most tip of a ridge of land extending from off-property and nearby property area to the southeast. The site is well drained and free of areas of flooding or frequent ponding. Drainage of surface water onto the site from uphill areas should be minimal due to this topographic position. Runoff from the site should be down the eastern, northern and western slopes of this ridge. With a maximum grade of approximately 7/100, these slopes are gentle and should present no significant hazard due to potential erosion. Runoff down the western and northern slopes will be toward Skull Creek which lies approximately 1000 feet from the site. At the present a pit containing refinery waste lies immediately to the north of the site; but the materials contained in this pit are to be removed, and the area regraded with drainage toward Skull Creek. Runoff from the eastern slope should be toward a tributary of Skull Creek and an impoundment constructed on that tributary. The impoundment can be removed should it prove necessary.

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[27] Oklahoma Water Resources Board, 1982.

3.5.3 Cell Design

A preliminary conceptual design has been developed for the proposed engineered cell. It has been developed to demonstrate the feasibility of constructing a cell that can provide long-term isolation of buried materials without requiring continuing active maintenance after site closure. A detailed design will be developed. The final design will clearly demonstrate that these long-term goals will be met.

3.5.3.1 Basic Conceptual Design

An engineered cell with a potential capacity of as much as 7,500 cubic meters is currently planned. The areal dimensions of the cell would be 50 x 50 meters, and the placement of as much a three meters of disposed material is now planned.

Below ground burial will be implemented. Material will be buried at least four feet below the ground surface to meet Option 2 criteria. However, to accommodate the inadvertent construction of a basement or other shallow excavation, burial of soil and rubble at a depth no less than 10 feet is currently planned. Based on an approximate ground surface elevation of 875 feet MSL, disposed material would be buried between the 855 and 865 feet MSL. Excavation of overlying unconsolidated soil and between 10 and 15 feet of mudstone will be required. At 855 feet MSL, the bottom of the cell would be approximately 75 feet above the top of the first significant sandstone lens (see section 3.5.2.6).

The top of the radioactive material deposit is assumed to be 3.05 m (10 ft) beneath the surface. A low-permeability (10^{-8} cm/s) clay-soil cover 1.22 m (4 ft) thick is assumed to be located immediately above the disposed soil and rubble. The top of the cover would be 1.83 m (6 ft) beneath the surface. If any Ra^{226}-bearing NORM is put into the cell, it is assumed that it will be placed in the lower third of the disposal cell to gain maximum benefit of overlying materials in attenuating the emanation of radon-222.

3.5.3.2 Infiltration Controls

The disposed material will be placed directly on top of and within the excavated bedrock. A low permeability barrier will be placed immediately above the buried material, and a french drain will be constructed around the periphery of the cell. These features are included in the preliminary design of the cell to minimize any potential contact of percolating or standing water with the buried materials after closure of the cell and to isolate the buried material from the ground-water regime.

With permeabilities approaching 10^{-8} cm/sec, the mudstone bedrock will serve as an ideal natural liner and will minimize any potential migration of moisture from the cell. The barrier placed immediately on top of the buried material will have a permeability of no greater than 10^{-8} cm/sec. However, the barrier material will also be at least as impermeable as the underlying bedrock. This is to ensure that the buried material remains unsaturated. Based on current estimates of the bedrock permeability, a permeability of 10^{-8} cm/sec should prove adequate for this purpose. Should subsequent measurements indicate a lower bedrock permeability, the barrier design will be modified accordingly. It is anticipated that this low-permeability barrier will be a compacted, natural clay, but the inclusion of synthetic materials will be considered, as necessary, to enhance the long-term performance and reliability of the barrier. The low-permeability barrier will be placed below basement level so that a potential intrusion scenario would not impact the integrity of the barrier. A thickness of four feet is now being considered for this barrier.

A french drain will be installed around the periphery of the cell to intercept any water potentially migrating horizontally into or above the closed cell. As discussed in §3.5.2.6, ground water may be perched, either permanently or temporarily after precipitation events, in the unconsolidated deposits overlying the bedrock surface. It is anticipated that the low-permeability barrier installed immediately above the buried material will be placed largely below the soil bedrock interface and will consequently isolate the buried material from any perched water present. However, to further isolate the cell from any such potential flow and to prevent the build up of any hydraulic head over the low-permeability barrier, a french drain will be installed to prevent any perched water present from flowing into the cell area. A sand layer may also be installed directly over the low permeability barrier and drained into the french drain as an added measure to ensure that water does not inadvertently collect over the low-permeability barrier.

The french drain will also be extended the full depth of the cell to ensure that any ground water percolating into the bedrock will not drain laterally into the cell. The drain has been included primarily to intercept any potential flow from sandstone or limestone stringers that may exist within the mudstone bedrock. The french drain will also serve to intercept any moisture that may be able to migrate laterally through mudstone into the cell. The drain will be constructed so as to drain by gravity to a point of lower elevation, most likely into the tributary stream located immediately to the northeast of the site. It will also be design and constructed to require no ongoing maintenance to function effectively.

3.5.3.3 Cover Design

A cover will also be placed at ground surface over the area excavated for the cell. While not the primary infiltration barrier, the cover will be designed to minimize the infiltration of rainfall. Analysis of cover designs for the nearby industrial waste cell indicated that it is feasible to construct a cover that will limit infiltration to less than 0.1 in/yr. The cover will be constructed to conform with the general contour of the natural land surface except as necessary to facilitate drainage of precipitation off the cover and to prevent the flow of runoff onto the cover. Upon completion of the cover, surface features will be contoured so as to direct surface water drainage away from the cell in a manner that will not cause erosion or that will require ongoing active maintenance. A full, self-sustaining vegetative cover or a rock cover will be established.

As part of the final design of the cell, an analysis of the stability of the site will be performed to demonstrate the long term stability of the site. This long-term stability demonstration will be based upon analyses of natural active processes such as erosion, mass wasting, slope failure, settlement of wastes and backfilled, infiltration through covers over disposal areas and adjacent soils, and surface drainage. A preliminary inspection of site topography and surface drainage indicates that the characteristics of the site are favorable toward promoting the long-term stability of the closed cell (see §3.5.2.1 and §3.5.2.7).

3.5.3.4 Institutional Controls

The institutional controls that will be implemented (e.g., markers, deed restrictions) are yet to be determined.

3.5.4 Operational Procedures

Plans establishing operational procedures will be developed before excavating the cell. These plans will include procedures to be implemented during the movement of material to the site of the engineered cell and during placement of that material in the cell. The proposed location of the engineered cell, in block 56, is an *unaffected* area of the site; as such, construction of the cell may proceed without radiation protection until placement of radioactively contaminated material begins.

Procedures will be implemented to ensure adequate control of liquids in the cell and buried material while the cell remains open. Similarly, procedures will be implemented to ensure that buried material will be adequately compacted so as to minimize future consolidation and settlement and to ensure the future stability of the low-permeability barrier place over the material. In the event that NORM materials are placed in the cell, procedures will be necessary to ensure that these materials are placed below an adequate thickness of materials containing only naturally occurring radium-226.

A construction quality control plan will be required to ensure that the low-permeability barrier, french drain, cover, and other design features are properly constructed. A summary description of the construction quality control plan is provided in section 4.2. The health and safety plan that will be followed is presented in Chapter 5.0.

3.5.5 Environmental Radioactivity Pathways Analysis

3.5.5.1 Introduction

The primary purpose of this pathway analysis is to develop a preliminary estimate of the maximum acceptable concentrations of thorium, uranium, and radium nuclides in materials that might be placed in the disposal cell, taking into account radiation doses that might result from those nuclides and their radioactive progeny. The secondary purpose is to establish minimum acceptable cover thicknesses for materials containing thorium-232 and for NORM, *i.e.*, radium-226, respectively.

The pathway analysis process consists of three steps: 1) development of exposure scenarios based on anticipated site conditions and uses; 2) use of a mathematical model with simplified representations of site physical conditions and potentially exposed populations to calculate future exposures and radiation doses as a function of time and as a function of concentration of nuclides in the waste material for the specified scenarios; and 3) computation of maximum acceptable waste concentrations based on maximum acceptable dose and the calculated relationship between dose and waste concentration. The following sections describe the potential exposure scenarios and pathways evaluated, the results, and the conclusions. The analyses are described more fully in Appendix B.

Within the context of NRC regulation of decommissioning, pathway analysis includes the estimation of radiation doses that might be received by a typical member of a small group of people from use of the site as far as 1,000 years into the future. Thus, this analysis considers not only the current conditions at the site, but projected conditions as well. The analysis evaluates potential uses of the site and potential migration of radioactive materials through the environment over time, taking account of both natural processes and human activities that could be expected to alter the patterns or rates of contaminant movement.

Oil production activity has left a small amount of NORM elevated in Ra^{226} on-site. Since the volume is minor relative to the soil and debris contaminated with licensed material, the most reasonable disposition would seem to be to place the NORM in the lower part of the engineered cell. To evaluate this alternative, exposure pathway analyses included $Ra.^{226}$

3.5.5.2 Potential Exposure Pathways

Depending on potential uses of land and groundwater resources, people might conceivably be exposed to radioactive materials in the cell on the Cushing site in a number of ways. Use of the land in the near future is most likely to be similar to the present industrial use. However, over the 1,000-year period of interest, redevelopment for farming and/or residential use may occur, increasing potential for exposure to buried soil and rubble. Withdrawal of groundwater for domestic purposes or for irrigation is considered unlikely before reaching the deeper sandstone strata separated by intervening mudstone of low permeability. Excavations into the soil above the waste material or construction of a well through the waste material would be unexpected intrusions because of the proposed depth of the clean cover atop the buried soil and debris.

Considering conceivable land and water uses, exposure to residual radioactive material in soils on the site could possibly occur through one or more of three terrestrial pathways, depending on the location of soils containing residual radioactive material with respect to the ground surface. If residual radioactive material were contained in soil near the ground surface, exposure could occur by irradiation directly from radioactive material in the soil, from inhalation of dust containing residual radioactive material suspended 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. In the cases involving groundwater use, 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.

A number of site-specific exposure scenarios have been developed to identify the hypothetical receptor likely to receive the maximum dose. These scenarios allow for varying levels of disturbance of the contaminated materials by human action, so that the potential impact of isolation by administrative action can be examined. Each scenario consists of a set of exposure pathways and particular site conditions that might occur for a particular hypothetical receptor engaged in activities that cause him to be exposed to radioactive materials either in place or in transport, due either to his actions or to natural processes. Two *base case* scenarios have been developed to represent the most probable use. In addition, two scenarios have been developed for purposes of sensitivity analysis. These are considered scenarios of intrusion, and are considered to be much less likely than the base case scenario. These scenarios are:

- Base Cases:
  - Farm product consumer (**FPC**):
    Land above waste is used only for agricultural purposes. No residence or activity resulting in excavation or well construction through the waste is assumed. The land above the disposal cell is assumed to provide the exposed person either his entire diet or as much of it as can be produced from the limited land area.
  - Farm worker (**FW**):
    An agricultural worker works for 2,000 hr/yr on the land above the disposal cell, where he is assumed to be exposed to airborne dust, radon progeny, and direct radiation.

- Sensitivity Analysis Cases:
  - Resident farmer, house with basement (**RFB**):
    A farm family is assumed to reside in a house built on the land over the waste and to grow agricultural products on the land for their own consumption. The house is assumed to have a basement, the floor of which is 6 ft below the surface and 4 ft above the waste. The family is assumed to consume water from a well drilled at the edge of the waste cell and screened in the uppermost sandstone layer beneath the engineered cell. This case is considered to be an unexpected intrusion scenario.
  - Resident farmer, house with no basement (**RFS**):
    A farm family is assumed to reside in a house built on the land over the waste and grows agricultural products on the land for their own consumption. The house has no basement, but is built on a slab at the surface. The family is assumed to consume water from a well drilled at the edge of the waste cell and screened in the uppermost sandstone layer beneath the engineered cell. This case is considered to be an unexpected intrusion scenario.

The exposure pathways assumed to be associated with each exposure scenarios are identified in Table 3.6 and described in Appendix B.

3.5.5.3 Results and Conclusions

Analyses. Preliminary exposure pathway analyses for radioactive material put in the engineered cell are described in Appendix B.

Results, Exposure Scenarios. Results of RESRAD runs for the four exposure scenarios identified above are summarized in Table 3.7. Listings of input and output files for one RESRAD run in each of the four scenarios evaluated are provided in Appendix B. To aid in reproducing results, Appendix B also contains an explanation of how input data from other runs in a given sequence differ from the run for which listings are provided.

As expected, maximum doses from the farm product consumer (FPC) scenario were calculated to be zero. This is because the assumed depth of material in the cell is too deep to permit uptake in plant material over the entire 1,000-year period of interest and because radioactive material does not migrate deep enough in the 1,000 year period of interest to affect groundwater assumed to be used for irrigation. Thus, no exposure pathway is complete in the FPC scenario.

Calculated maximum doses for the farm worker (FW) scenario exceed zero because the radon progeny inhalation and external dose pathways are assumed to be complete for the farm worker. However, doses remain very low in the FW scenario because the cover material assumed to be located between the disposed soil and rubble and the receptor effectively attenuates or prevents radiation exposure.

Calculated maximum doses for scenarios involving intrusion are substantially higher than doses calculated for base case scenarios. For the resident farmer with a house on a surface slab (RFS), dose remains below 1 x 10^{-6} mrem/y per pCi nuclide/g soil except for U^{234} and Ra^{226}. The maximum calculated dose for U^{234} is slightly less than 1 x 10^{-6} mrem/y per pCi nuclide/g soil. The maximum calculated dose for Ra^{226} distributed only in the bottom third of the cell is 0.033 mrem/y per pCi nuclide/g soil. Even if Ra^{226} were distributed uniformly throughout the entire depth of the cell, the maximum calculated dose would be approximately 0.30 mrem/y per pCi nuclide/g soil. The radon progeny inhalation pathway would be the main contributor to dose from U^{234} and Ra^{226}. Food pathways and groundwater pathways contribute nothing to dose because they remain incomplete for this scenario.

For the resident farmer with a house with basement (RFB), dose remains below 2 x 10^{-6} mrem/y per pCi nuclide/g soil for U^{235} and U^{238}. The maximum calculated doses for Th^{232} and U^{234} are 3.0 x 10^{-4} and 1.8 x 10^{-3} mrem/y per pCi nuclide/g soil, respectively. The maximum calculated dose for Ra^{226} distributed only in the bottom third of the cell is 0.12 mrem/y per pCi nuclide/g soil. (The maximum calculated dose for Ra^{226} distributed uniformly throughout the entire depth of the cell would be approximately 1.1 mrem/y per pCi nuclide/g soil.) The direct exposure pathway is the major contributor to dose for Th^{232}. The radon progeny inhalation pathway is the major contributor to dose for U^{234} and Ra^{226}. Food pathways and groundwater pathways contribute nothing to dose because they remain incomplete for this scenario.

Results, Sensitivity Analyses. RESRAD runs examining the effect of soil cover attenuation on irradiation by Th^{232} and its progeny are summarized in Figure 3.5. The calculated dose by external irradiation from Th^{232} and its progeny, 3 to 10 mrem/y per pCi Th^{232} /g soil with no shielding cover, would be reduced by a factor of 40 to 100 by each meter of soil shielding between the radioactive material and the receptor. The variability in these estimates results from differences in calculational models. Listings of input and output files for the first run in this sequence are provided in Appendix B. Other runs differed only in the cover thickness and or dose model selected.

Results presented in Figure 3.5 are based on assumption of occupancy 0.5 of the time to accommodate potential exposure to both irradiation and radon. These results are probably slightly low for a scenario that includes a house on a surface slab and somewhat high for a scenario that includes a house with a basement. The results in Figure 3.5 apply strictly only to the case of a house on a surface slab but can be fit to cases with basements above the contaminated zone by scaling the results to an adjusted *occupancy* factor. The most appropriate values for the *occupancy* factor would be about 0.6 for the surface slab case and about 0.35 for the basement case.

Results of RESRAD runs examining the effect of soil cover attenuation on the inhalation dose from radon progeny are illustrated in Figure 3.6. The calculated inhalation dose from radon-222 progeny depends on the diffusion coefficient for the concrete slab that serves as either the basement floor or, if no basement is present, the foundation of the house. Assuming a reasonably tight slab having a diffusion coefficient of 2×10^{-8} m^2/s, the dose would be about 5 mrem/y per pCi Ra^{226} /g soil for no attenuating soil cover between the floor and the radioactive material. The dose would be reduced by about a factor of 3 by each meter of attenuating soil between the radioactive material and the receptor. Listings of input and output files for the first run in this sequence are provided in Appendix B. Other runs differed only in the cover thickness and/or radon diffusion coefficient for the concrete slab floor.

Results of the calculation of nuclide migration distances and times in infiltrating water as a function of K_d are presented graphically in Figure 3.7. Given reasonable expectations for the long-term, low permeability of the cell cover (10^{-8} cm/s) and a reasonably low estimate of radionuclide retardation in the mudstone materials beneath the cell, equivalent to a K_d greater than about 10 ml/g, radionuclides in the cell would be isolated from the uppermost groundwater aquifer for tens of thousands of years. Isolation for at least 1,000 years can be expected even if sorption on mudstone materials is only minimal, *e.g.*, K_d greater than 1 ml/g, provided the cover remains tight. However, even if the permeability of the cover and the underlying mudstone is assumed to be higher by a factor of 10 (increased from 10^{-8} to 10^{-7} cm/s), which would effectively move the migration time curve in Figure 3.7 down by a decade and the migration distance curve up by a decade, isolation for 1,000 years can be expected, provided that a minimal K_d in the mudstone layer of about 4 ml/g is assumed.

Conclusions. Results of the calculation of the maximum contaminant concentration in material which may be placed in the engineered cell without exceeding candidate acceptance criteria are also included in Table 3.7. The results indicate that the isolation capabilities of the disposal cell would be sufficient to contain materials with concentrations far above NRC Branch Technical Position Option 1 and Option 2 limits. Even if acceptance criteria were chosen to protect against low doses in the event of unanticipated intrusion, material with nuclide concentrations higher than 10,000 pCi/g could be accommodated for all nuclides except Ra^{226} for the scenarios examined. For Ra^{226} and the most restrictive combination of exposure scenario and acceptance criteria, the limiting concentration would be slightly greater than 800 pCi/g. The key features determining this result are the site's capacity for disposal sufficiently deep to make intrusion into the material unlikely, even if intrusive excavation of a residential basement were to occur on the site, and the long travel time to the uppermost aquifer beneath the cell, which prevents contamination of the aquifer within the 1,000-year period of interest.

Although at present, KMC is proposing to dispose of soil and debris meeting BTP Option 2 concentration criterion, environmental radioactivity pathways analyses indicate an engineered disposal cell on the Cushing site would be capable of isolating radionuclides in all the contaminated site materials requiring remediation. An engineered cell onsite designed as described herein would effectively isolate the material in such a way that radiation doses to members of the public over a 1,000-year period of interest would not exceed appropriately chosen criteria.

3.6 Radioactive Waste Management

The site decommissioning activities involve relocating residual radioactive contamination, assessing the nature and extent of the contamination, and removing as necessary, contaminated material for disposition.

Decontamination Materials. KMC plans to dispose of decontamination materials in the following ways:

a. Solids will be surveyed; any exceeding unrestricted release limits will be buried onsite in the engineered cell or packaged and shipped offsite for disposal.
b. Contaminated liquids will be absorbed into contaminated soil in a storage pile.
c. Equipment will be decontaminated or disposed in the engineered cell onsite.

Liquids. Contaminated liquids are not discharged from indoor activities. The only contaminated liquids generated indoors are a small amount of acid washings from steel beam decontamination activities. When surface contamination is removed by washing with nitric acid, contaminated wipes are neutralized and stored in bags. Discharge of contaminated liquids is prevented by decontamination procedures.

Contaminated water may be generated outdoors during precipitation events. Due to the low solubility of the contamination on site, it is unlikely that precipitation can solubility and mobilize contaminants in solution. Surface water may collect within the cavity of an area being excavated; runoff will be contained within berms surrounding designated storage areas as described in §3.4.10. Samples of accumulated surface water will be obtained and analyzed for contamination prior to release to the environment. No discharges above the limits prescribed in 10 CFR Part 20.1302 will be allowed.

3.7 Offsite Disposal

Remaining BTP Option 4 material will be removed, packaged, and shipped to a licensed radioactive waste disposal site. Should existing disposal sites become inaccessible to Kerr-McGee, the material will be stored on site in accordance with applicable regulations until a licensed low level radioactive waste disposal facility becomes accessible.

Solids. The solid materials are acceptable for land disposal and will be handled in accordance with 10 CFR Part 61 provisions for Class A waste not assured of meeting provisions of Part 61.56(b). The waste does not contain any nuclides listed in Tables 1 or 2 of 10 CFR 61.55 and is therefore Class A waste according to 10 CFR 61.55(a)(6).

Packaging. Material to be shipped offsite will be:

- classified per 10 CFR Part 61;

- verified or made to meet waste form requirements of Part 61;
- packaged to meet DOT requirements for transportation as specified in 10 CFR Part 71.
- A shipping manifest is prepared.

3.8 Schedule

A estimated schedule to decommission the Cushing site is presented in Table 3.8. It is recognized that approval of all government agencies having jurisdiction over elements of an activity is required before that activity may commence.

3.9 Report

Details regarding completion of decommissioning actions will be documented in a Site Decommissioning Report.

TABLE 3.6 EXPOSURE PATHWAYS BY SCENARIO

SCENARIO	EXPOSURE PATHWAYS												
	WATER INDEPENDENT							WATER DEPENDENT					
	GROUND	DUST	RADON	PLANT	MEAT	MILK	SOIL	WATER	FISH	RADON	PLANT	MEAT	MILK
1 FPC				X	X	X					X	X	X
2 FW	X	X	X				X						
3 RFS	X	X	X	X	X	X	X	X		X	X	X	X
4 RFB	X	X	X	X	X	X	X	X		X	X	X	X

1 FPC--Food Product Consumer

2 FW--Farm Worker

3 RFS--Resident Farmer, House on Surface Slab

4 RFB--Resident Farmer, House with Basement

TABLE 3.7

CALCULATED MAXIMUM CONCENTRATIONS OF NUCLIDES

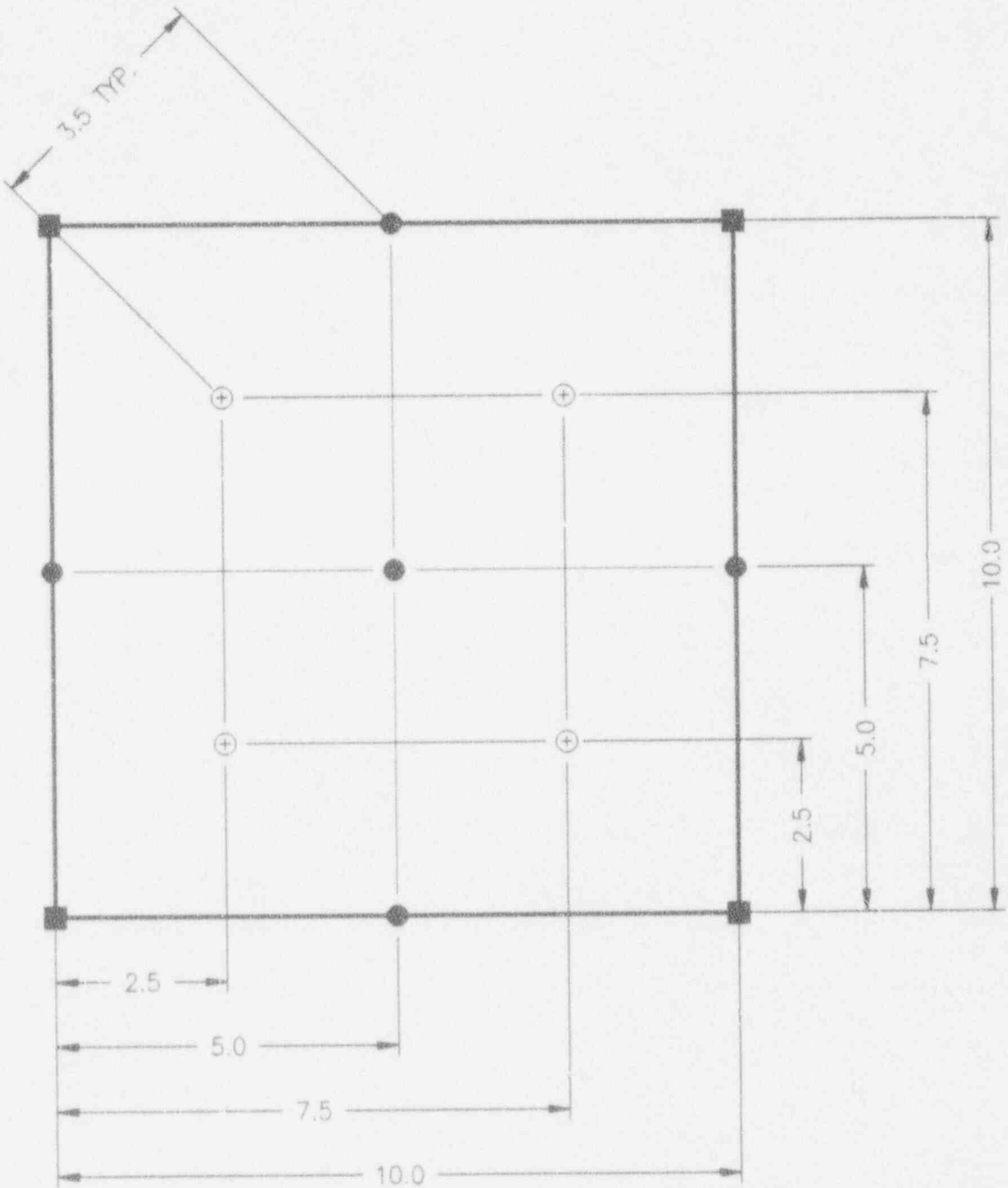
Scenario	Nuclide	Maximum Dose	------- Calculated Maximum Concentration, pCi/g -----		
			1994 10CFR20 Rad Prot Std	Pre-1994 10CFR20 Rad Prot Std	Natural Background Radiation
		mrem-g/y-pCi	100 mrem/y	500 mrem/y	300 mrem/y
Base Case Scenarios					
FPC	Th-232	0.00E+00	>10000	>10000	>10000
	U-234	0.00E+00	>10000	>10000	>10000
	U-235	0.00E+00	>10000	>10000	>10000
	U-238	0.00E+00	>10000	>10000	>10000
	U-depl	0.00E+00	>10000	>10000	>10000
	U-nat	0.00E+00	>10000	>10000	>10000
	LEU	0.00E+00	>10000	>10000	>10000
	HEU	0.00E+00	>10000	>10000	>10000
	Ra-226	0.00E+00	>10000	>10000	>10000
FW	Th-232	2.60E-07	>10000	>10000	>10000
	U-234	1.60E-07	>10000	>10000	>10000
	U-235	1.80E-14	>10000	>10000	>10000
	U-238	1.60E-10	>10000	>10000	>10000
	U-depl	1.10E-08	>10000	>10000	>10000
	U-nat	7.82E-08	>10000	>10000	>10000
	LEU	1.27E-07	>10000	>10000	>10000
	HEU	1.55E-07	>10000	>10000	>10000
	Ra-226	6.70E-06	>10000	>10000	>10000
Intrusion Scenarios					
RFS	Th-232	6.90E-07	>10000	>10000	>10000
	U-234	7.90E-04	>10000	>10000	>10000
	U-235	4.80E-14	>10000	>10000	>10000
	U-238	7.80E-07	>10000	>10000	>10000
	U-depl	5.44E-05	>10000	>10000	>10000
	U-nat	3.86E-04	>10000	>10000	>10000
	LEU	6.28E-04	>10000	>10000	>10000
	HEU	7.65E-04	>10000	>10000	>10000
	Ra-226	3.30E-02	3030	>10000	9091
RFB	Th-232	3.00E-04	>10000	>10000	>10000
	U-234	1.80E-03	>10000	>10000	>10000
	U-235	1.80E-09	>10000	>10000	>10000
	U-238	1.80E-06	>10000	>10000	>10000
	U-depl	1.24E-04	>10000	>10000	>10000
	U-nat	8.79E-04	>10000	>10000	>10000
	LEU	1.43E-03	>10000	>10000	>10000
	HEU	1.74E-03	>10000	>10000	>10000
	Ra-226	1.20E-01	833	4167	2500

Note: Ra-226 assumed confined to bottom third of cell

Table 3.8 Cushing Site Radioactive Decommissioning Schedule

Activity	Start	Finish
Unaffected Area Survey		
Plan	in development	5/30/94
Perform Survey		
Prepare Report		
Submit to NRC		7/1/94
Characterization Surveys	2/94	4/1/95
Temporary Storage Areas		
Construct	at approval of all gov't agencies	+ 3 months
Decommission	at removal of all stored material	
Excavate, Sort, Stockpile		
Trash Dump	4/1/95 or approval of all gov't agencies, whichever is later	+ 24 months[a]
North Property	4/1/95 or approval of all gov't agencies, whichever is later	+ 24 months[a]
Skull Creek	4/1/95 or approval of all gov't agencies, whichever is later	+ 24 months[a]
Other Land Areas	4/1/95 or approval of all gov't agencies, whichever is later	+ 24 months[a]
Pit 4		
Treat, Sort, Stockpile	8 to 12 months after approval of all gov't agencies	
ORISE Confirmatory Survey		
Process Buildings		
Develop Plan		7/1/95
Decontaminate and/or Demolish	at approval of all gov't agencies	+ 12 months
Engineered Disposal Cell		
Design	in development	5/1/95
Construct	at approval	+ 6 months
Fill	completion of construction	+ 6 months
ORISE Confirmatory Survey		
Closure		
Final Survey		
Perform Survey	at closure of engineed cell	+ 12 months
ORISE Confirmatory Survey		

[a] 24 months schedule includes **all** areas, not each one



LEGEND

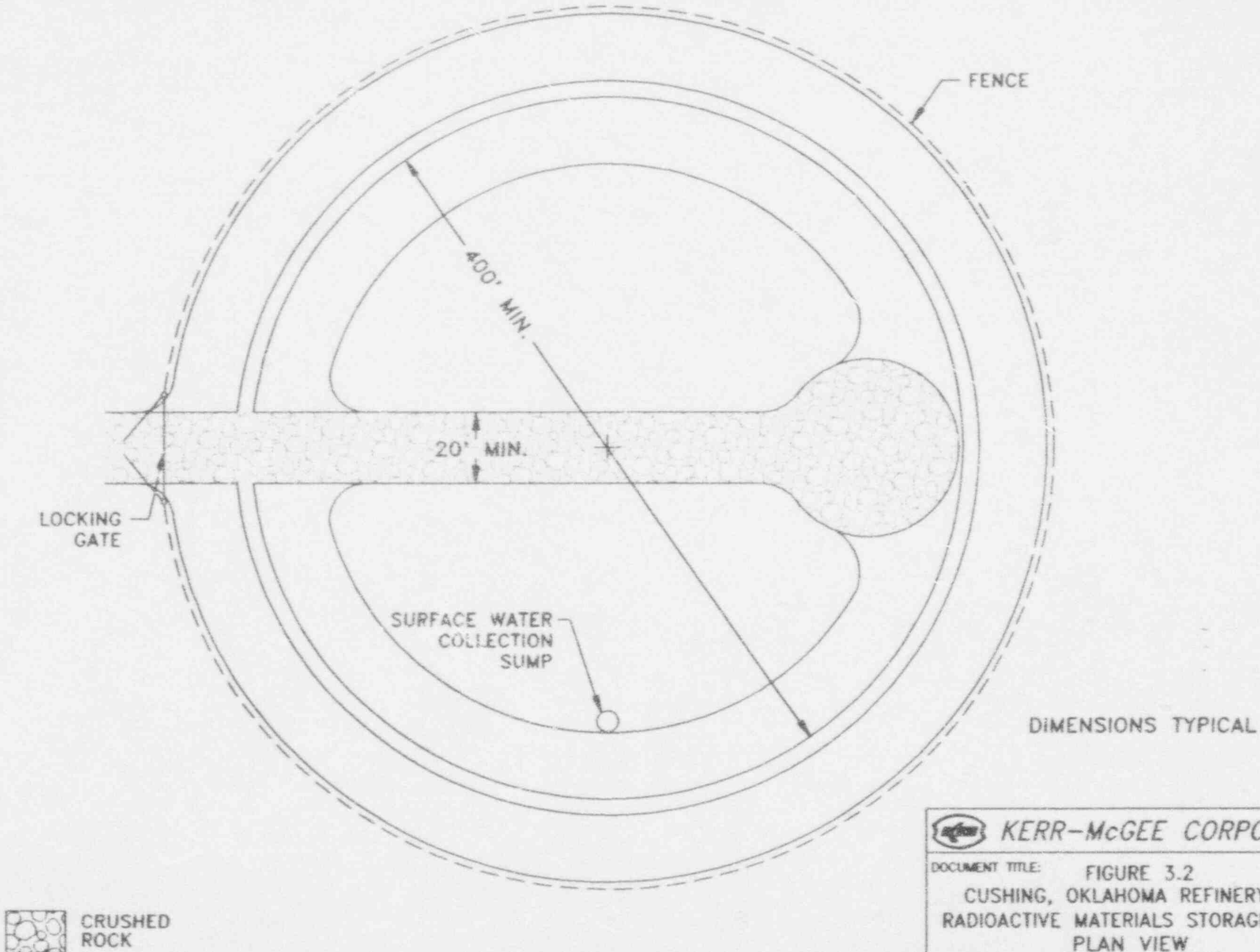
Symbol	Grid
■	10 METER GRID
● ■	5 METER GRID
⊕ ● ■	3.5 METER GRID

KERR-McGEE CORPORATION

DOCUMENT TITLE:

FIGURE 3.1 SOIL MEASUREMENT GRID

PREPARED BY: JL	DWN BY: JE
DRAWING NO. JEFF_04	DATE: 4/4/94

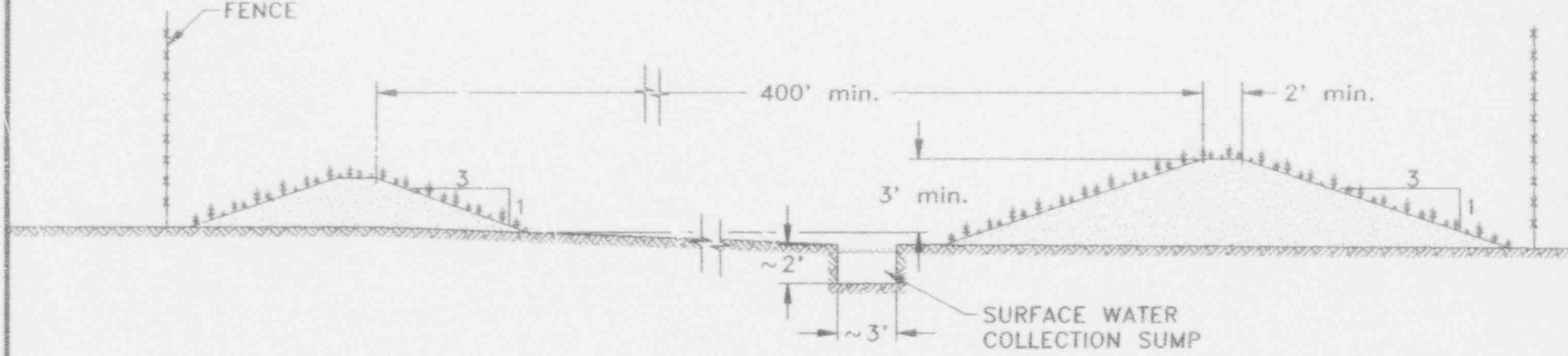


NO SCALE INTENDED

KERR–McGEE CORPORATION

DOCUMENT TITLE: FIGURE 3.2
CUSHING, OKLAHOMA REFINERY SITE
RADIOACTIVE MATERIALS STORAGE AREA
PLAN VIEW

PREPARED BY: JL	DWN BY: JE
DRAWING NO. STOR_PLN	DATE: 4/20/94



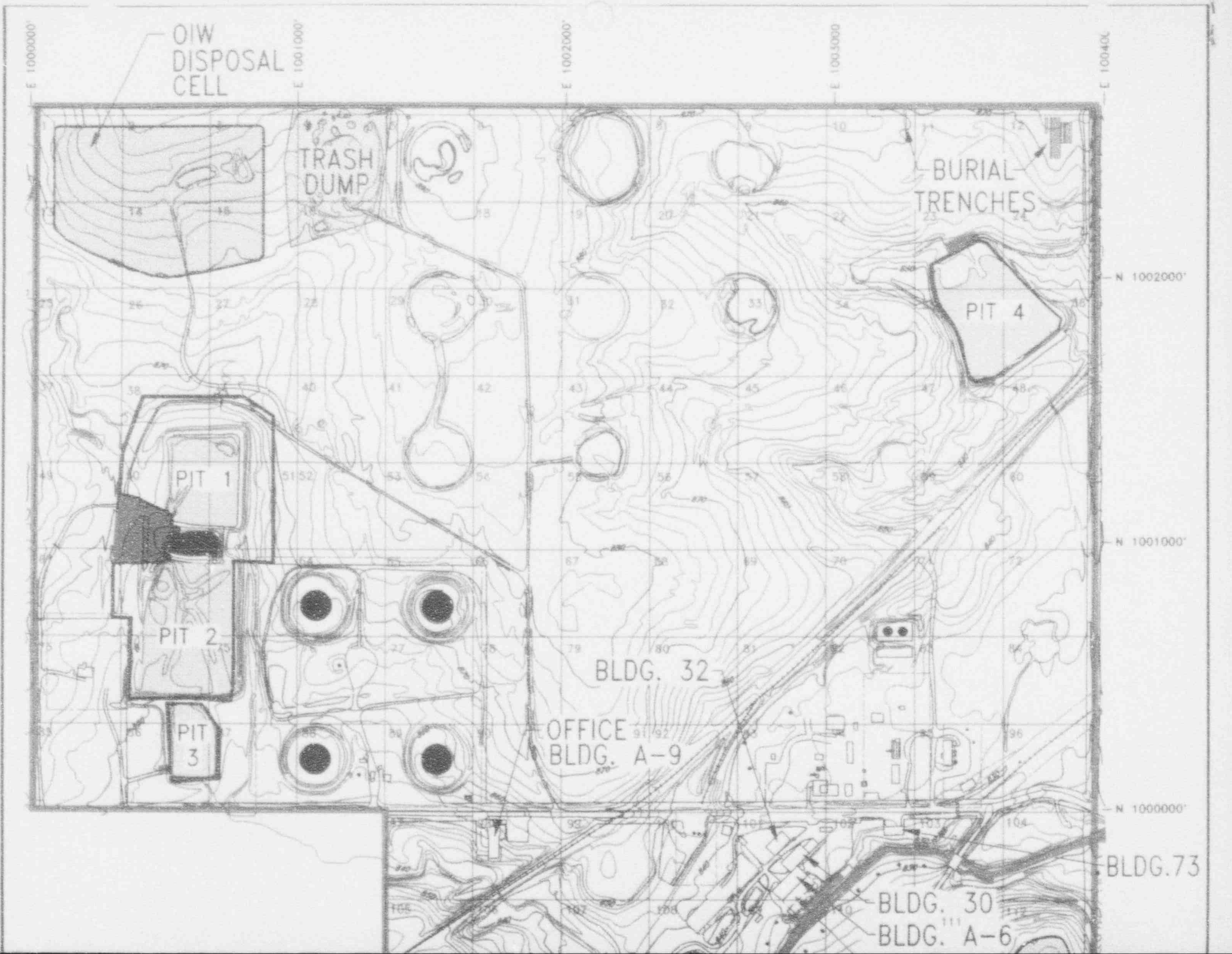
NATIVE SOIL

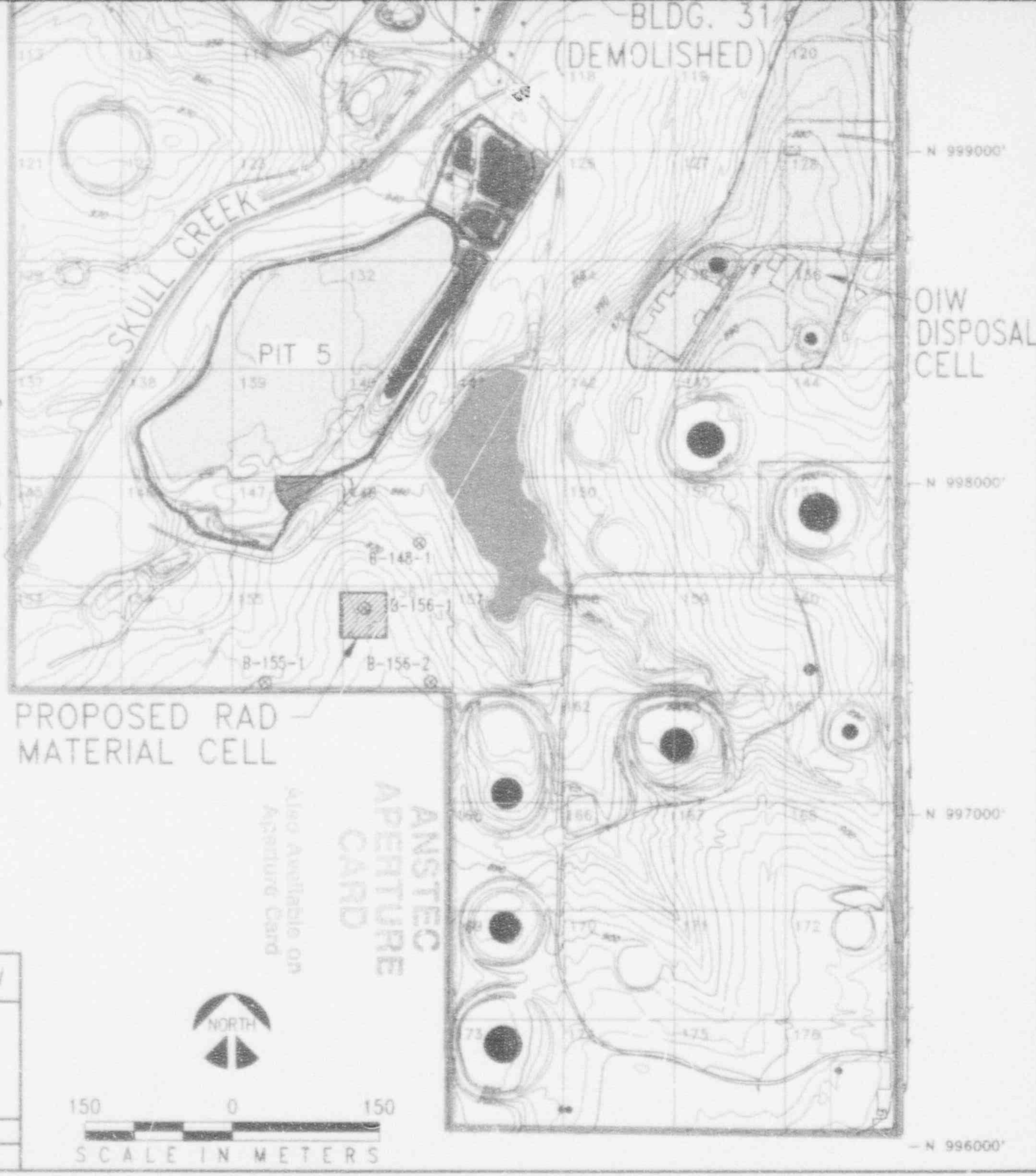
EXISTING TANK DIKE "FLOOR" (SOIL)

DIMENSIONS TYPICAL

NO SCALE INTENDED

KERR-McGEE CORPORATION	
DOCUMENT TITLE: FIGURE 3.3 CUSHING, OKLAHOMA REFINERY SITE RADIOACTIVE MATERIALS STORAGE AREA CROSS SECTION	
PREPARED BY: JL	DWN BY: JE
DRAWING NO: STOR_ELV	DATE: 4/20/94


E 1000000'
E 1001000'
E 1002000'
E 1003000'
E 1004000'
N 1002000'
N 1001000'
N 1000000'
OIW DISPOSAL CELL
TRASH DUMP
BURIAL TRENCHES
PIT 4
PIT 1
PIT 2
PIT 3
BLDG. 32
OFFICE BLDG. A-9
BLDG.73
BLDG. 30
BLDG. A-6



9405090171-03

LEGEND

- EXCLUSION ZONE
- CONTAMINATION REDUCTION ZONE
- ACID SLUDGE PIT
- ACIDIC STORMWATER COLLECTION AND TREATMENT AREAS
- PETROLEUM STORAGE TANKS

KERR-McGEE CORPORATION

DOCUMENT TITLE: FIGURE 3.4

LOCATION OF ENGINEERED CELLS
AND RELATED BORINGS

PREPARED BY: JL	DWN BY: JE
DRAWING NO: JEFF_L2	DATE: 4/21/94

FIGURE 3.5
EXTERNAL DOSE VS. SOIL COVER THICKNESS
1 pCi Th-232/g

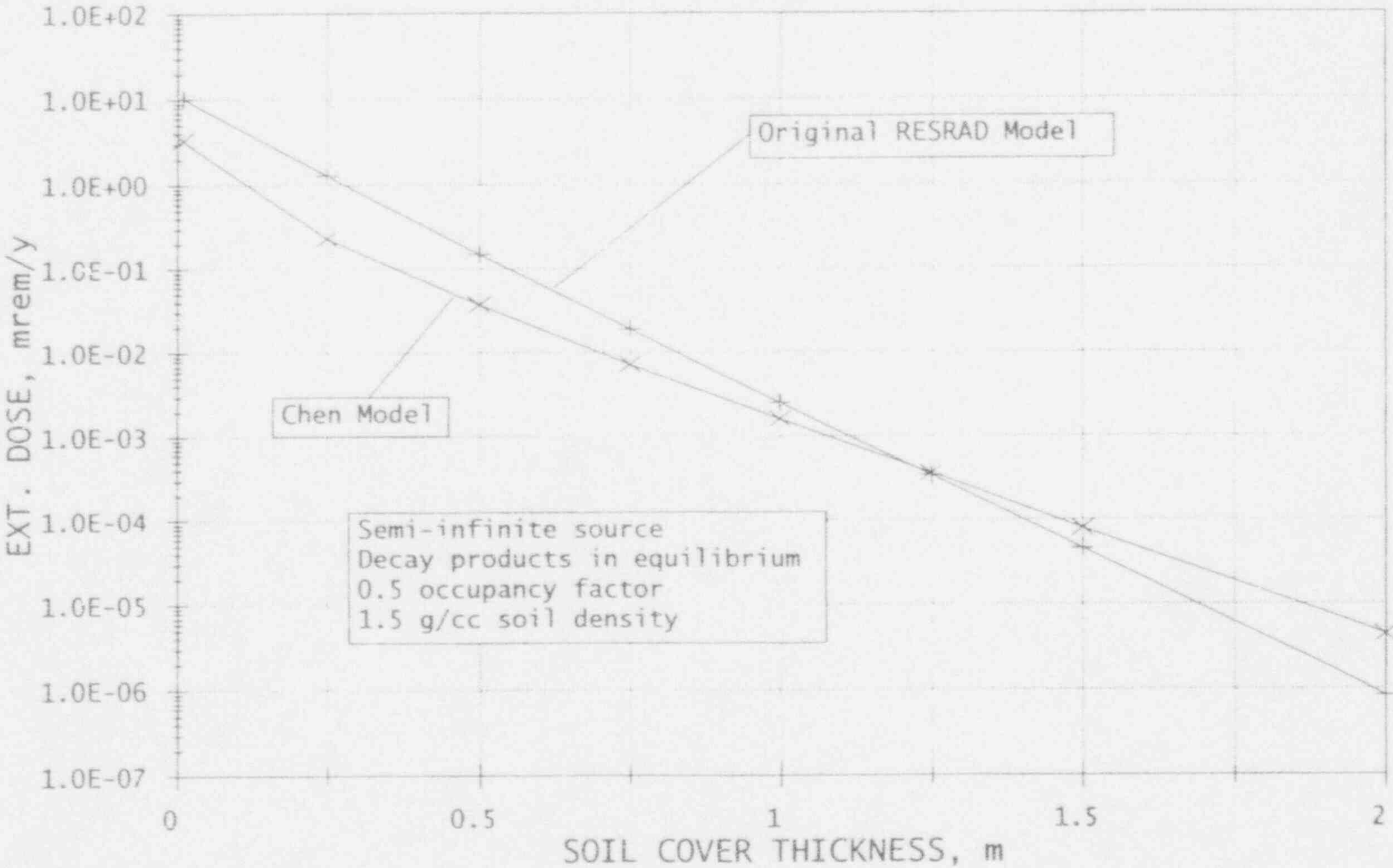


FIGURE 3.6

RADON DOSE VS. SOIL COVER THICKNESS

1 pCi Ra-226/g

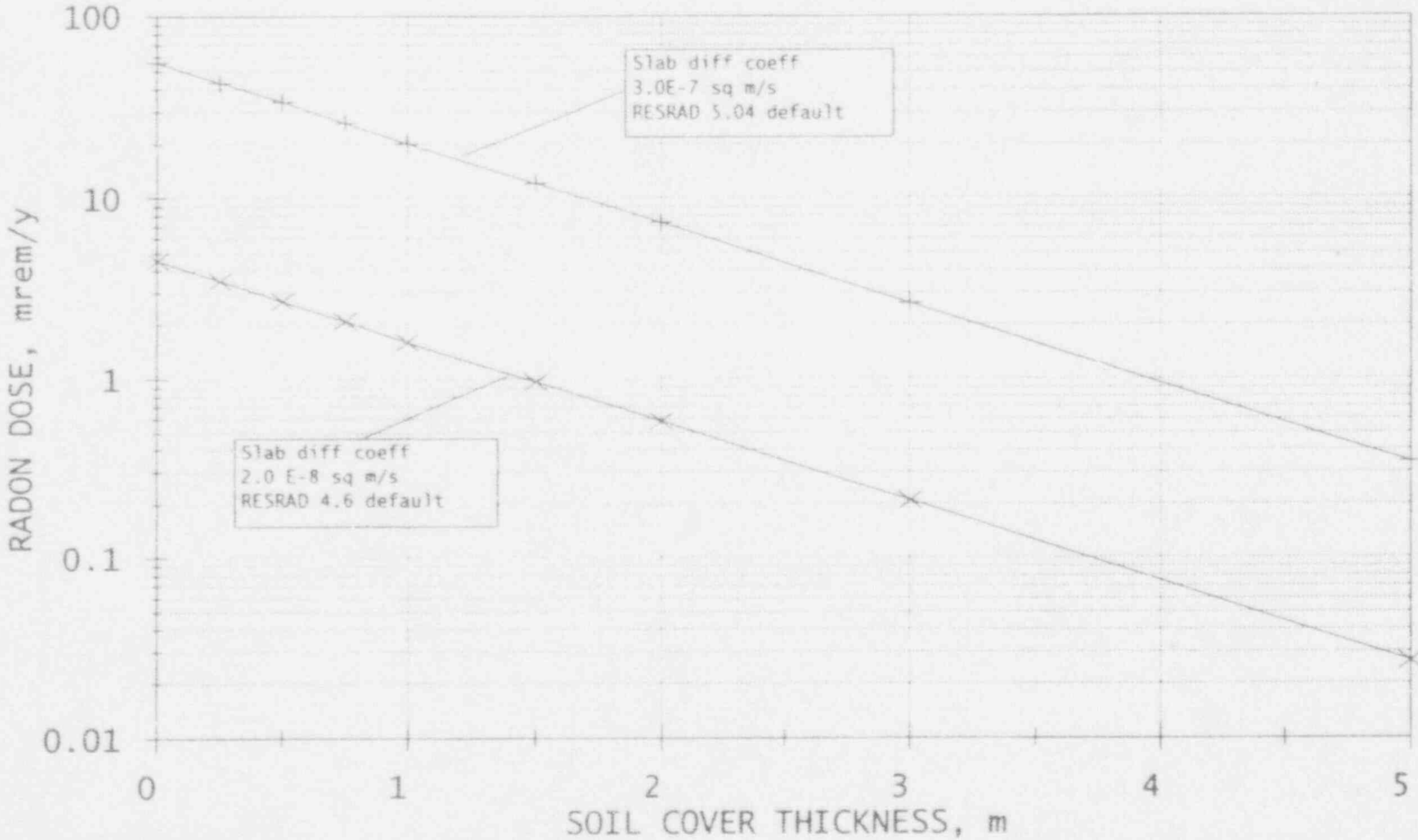
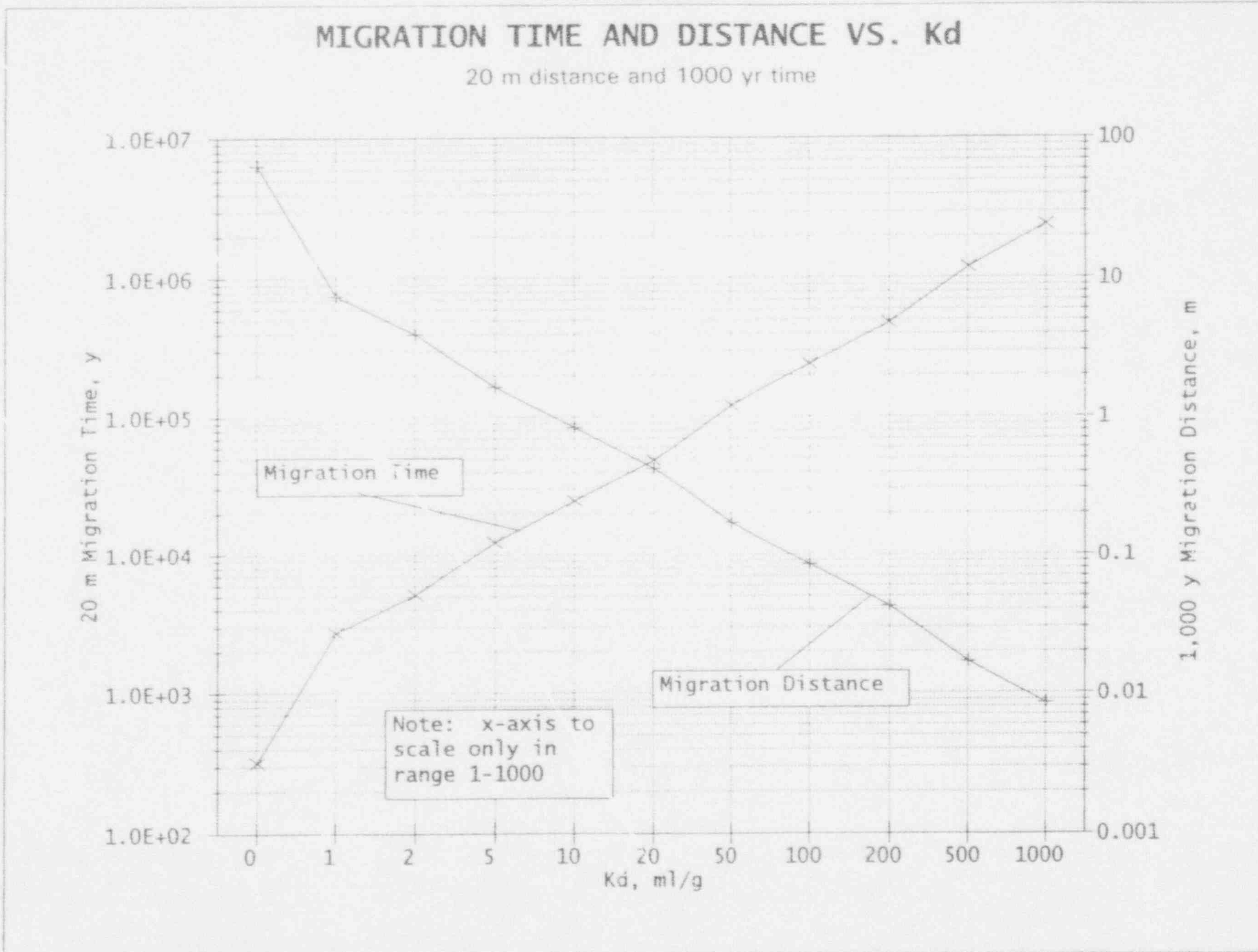


FIGURE 3.7



MIGRATION TIME AND DISTANCE VS. Kd
20 m distance and 1000 yr time
20 m Migration Time, y
1,000 y Migration Distance, m
1.0E+07
1.0E+06
1.0E+05
1.0E+04
1.0E+03
1.0E+02
100
10
1
0.1
0.01
0.001
0
1
2
5
10
20
50
100
200
500
1000
Kd, ml/g
Migration Time
Migration Distance
Note: x-axis to scale only in range 1-1000

4. ORGANIZATION AND ADMINISTRATION

4.1 ORGANIZATION

4.1.1 Licensee Organization

Kerr-McGee Corporation is an integrated natural resource company engaged in oil and gas exploration and production; petroleum refining, distribution, and marketing; inorganic chemical processing and manufacturing; wood preserving; and coal mining. Former operations included uranium mining, milling and conversion, thorium processing, soda products, and nuclear fuel fabrication. While the Corporation is no longer engaged in uranium and thorium production and processing, decommissioning activities are being performed at locations still under license by the Nuclear Regulatory Commission or an agreement state. The company maintains the organization, qualified staff, formal policies and procedures, and other administrative and training programs needed to perform the final decontamination activities at the Cushing site in accordance with regulations and accepted industry practices.

An organizational chart for the Cushing site, Figure 4.1, displays the operations line organization as well as relationships with other units of the company that are directly involved with the Cushing site cleanup. Key personnel responsible for the Cushing site decommissioning and other positions and incumbents in Kerr-McGee who are directly involved and the qualifications of key personnel are summarized in Appendix C.

4.1.1.1 Corporate Management Responsibilities

Management is committed to providing the resources necessary to complete the remediation work involving licensed material at the Cushing refinery site in compliance with applicable health-based industrial hygiene methods, the Consent Order executed between Kerr-McGee and the Oklahoma State Department of Health, NRC regulations, the specific terms of license SNM-1999 and to maintaining radiation exposures as low as reasonably achievable (ALARA).

4.1.1.2 Operations Management Responsibilities

Operations management is responsible for performing site decommissioning activities in accordance with approved standards and procedures. Operations management directs daily work activities and the handling, transfer, storage, and disposal of radioactive materials. These procedures are intended to maintain exposure levels to employees and the public as low as reasonably achievable.

4.1.1.3 Employee Responsibilities

Employees are responsible for understanding and complying with the rules and regulations for avoiding internal and external exposure to radiation in accordance with the instruction and training they receive. The employees will guard against damage to personnel protective equipment and will immediately report all malfunctioning equipment to the responsible person. Failure to comply with rules and procedures is cause for appropriate disciplinary action which may include dismissal.

4.1.2 Radiation Safety Organization.

Kerr-McGee maintains a radiation safety program, described in chapter 5. Its implementing procedures are reviewed and approved by at least the Radiation Safety Officer and either the Vice President of Environment Operations or the Vice President of Environment and Health Management.

4.1.2.1 Radiation Safety Officer (RSO) Responsibilities

The Radiation Safety Officer, in conjunction with his staff, reviews procedures to assure that exposure limits are not exceeded and monitors activities to assure that exposures are maintained at levels as low as reasonably achievable. The RSO maintains programs to monitor, recognize, evaluate, and control radiation exposures. Training is conducted at least annually under the direct supervision of the RSO to ensure that employees know and understand applicable radiation safety procedures.

4.1.3 Contractor Assistance

KMC intends to decommission the Cushing site mostly by using KMC employees under KMC supervision and management. As tasks or work packages are defined, a preference for contracting some elements of the work may be realized. In the event contracted personnel work onsite, each shall be trained in health and safety to the extent prescribed by KMC's Cushing Radiation Safety Officer and at least as specified herein. All contractors working on the Cushing site shall be subject to KMC supervision.

4.2 Quality Assurance Program

The quality assurance (QA) emphasis at the Cushing site emphasizes quality control and assessment. The main objective of quality control (QC) is to help ensure reproducible measurements or execution of intended actions. The main aim of quality assessment is to evaluate performance and determine whether desired quality is achieved. Quality assurance depends on the competence of the staff, good practices, procedures for specific actions, audits and reviews, documentation, and training. During the Cushing decommissioning project, the quality of radiation and radioactivity measurements and design and construction of the engineered cell will receive particular emphasis.

4.2.1 Administration

QA/QC responsibilities will be handled by the Quality Assurance Coordinator. As QA officer, he will coordinate all QA interface requirements during the survey process. A QA administrative procedure will be developed from the QA plan. Quality controls are ordinarily integrated into calibration or survey procedures. Any changes or alterations to these procedures will be handled in the same manner as changes to survey procedures.

4.2.2 Radiation and Radioactivity Measurement

KMC's quality assurance program for measuring radiation and radioactivity addresses the following areas.

- Procedures
- Quality Control in Sampling
- Quality Control During Sample Handling
- Reference Standards
- Calibration
- Operability Checks
- Instrument Maintenance
- Laboratory Analytical Quality Control
- Data Processing
- Records
- Audits
- Training

Regulatory Guide 4.15.[1] was consulted during the development of the QA plan for measurements.

4.2.3 Engineered Cell

The construction quality control plan will include procedures and record keeping requirements to verify that sufficient inspections and tests are performed on a continuing basis and that the work conforms to the drawings and specifications. These requirements will enable certification of the performance of the engineered cell, in accordance with standards of quality of materials, workmanship, construction, finish and functional performance. The plan will also detail personnel qualifications and responsibilities, appropriate facilities, instruments, and testing devices necessary for quality control performance.

4.2.4 Audits

A Kerr-McGee Corporation Regulatory Compliance Auditor audits procedures and records at least annually to assess the effectiveness of the radiation protection program and to verify compliance with the program. Audit results shall be documented and reviewed by corporate management, operations management, and the RSO. Operations management is responsible to respond to the corporate audit, taking follow-up action and providing evidence of such action where indicated.

4.3 Procedures and Procedures Control System

4.3.1 Objectives

The site radiation safety program guides all activities required for the remediation and release of the former uranium and thorium processing building and residual areas of soil contamination. The

1 USNRC, *Quality Assurance for Radiological Monitoring Programs - Effluent Streams and the Environment*, Regulatory Guide 4.15, 1979.

radiation safety program documents exposures and verifies that workers and the public do not receive exposures above the limits stipulated in NRC *Standards for Protection Against Radiation,* 10 CFR Part 20. In addition, radiation exposures to employees and the public are maintained as low as reasonably achievable (ALARA).

4.3.2 Primary Program Tasks

Primary tasks under the radiation safety program include:

1. Providing training in radiation safety on a routine basis for all personnel who work in or frequent restricted areas.
2. Preparing special work permits governing the safe performance of decommissioning activities.
3. Performing instrument calibration and training technicians in the proper use of instruments.
4. Monitoring the performance of decommissioning activities to assure that operating procedures maintain exposure levels as low as reasonably achievable.
5. Performing environmental sampling to ensure that the public and environment are not exposed to radiation above the limits specified in 10 CFR 20.1301 and 20.1302.
6. Performing air sampling to ensure that airborne contamination is maintained below levels specified in 10 CFR 20.1201 and 20.1202.
7. Performing personnel monitoring to ensure that exposure to radiation workers does not exceed levels specified in 10 CFR 20.1201.
8. Ensuring that material and equipment that leaves radioactive materials areas is releasable for unrestricted use in accordance with applicable NRC regulations.
9. Developing release survey plans that will ensure that the release of facilities and/or property is in compliance with NRC regulations.
10. Ensuring that licensed material is properly inventoried and that disposal documentation is in accordance with applicable regulations.
11. Notifying management of, investigating, and recommending corrective action for, accidents, injuries, and/or incidents of exposure.

4.3.3 Written Procedures

Work in radioactive materials areas or restricted areas, or work with licensed material not in a radioactive material or restricted area, is to be done in accordance with an approved radiation safety procedure or a Special Work Permit (SWP). To maintain control that is adaptable and specific to varied locations and circumstances onsite, the procedure on procedures provides for an SWP to complement other control activities related to site remediation and radiation protection.

Either a written procedure or a special work permit is required and must be completed before beginning work whenever a safety hazard is suspected to exist or could be created. Each Special Work Permit specifies industrial and radiation safety measures to be used when a particular task is done. Supervisory staff generate SWPs. Before work begins, each SWP is approved by the radiation safety officer the health and safety officer, and the site coordinator.

Employees assigned to an SWP-related activity review the SWP and follow the indicated precautions to perform the task safely. All personnel responsible for either the preparation of the SWP or the performance of the task are required to sign it, indicating awareness of the safety precautions associated with that task. SWPs are posted at the work location. When a task covered by an SWP has been completed, the SWP form is signed and dated by the supervisor, and is then filed in the office. A completed SWP is evidence that a task was completed in accordance with the precautionary provisions stipulated in the SWP. A typical copy of the Special Work Permit form is included in this plan as Figure 4.2.

4.3.4 Emergency Procedures

Fire and ambulance service is available from the City of Cushing. Fire, police, and other emergency personnel have been provided on site briefings concerning hazards found at the site. A roster containing the telephone numbers of key management and emergency contact personnel is posted on site to enable prompt notification of proper individuals and organizations. The list is included as Appendix D.

4.4 Training

Appropriate training about radiation hazards and the control of radiation exposure will be required and provided for workers at the site and for visitors who enter designated radioactive materials areas.

4.4.1 Training Objectives and Topics

4.4.1.1 Two-to-three-hour Indoctrination

A brief 2-to-3-hour indoctrination program will be given to new employees and contractors whose site activities are related to radioactive material and who will be under supervision of a trained radiation worker.

4.4.1.2 Eight-hour Training

All employees and contract personnel will attend an 8-hour health and safety indoctrination session prior to working independently with radioactive materials. This health and safety indoctrination will be documented and include, as a minimum, the following topics:

Radioactivity and the types of radioactive contamination encountered at the site,
Radiation and contamination control procedures used at the site,
Film badge issuance and use of film badges,
Bioassay sample schedule and collection procedure,
Personnel and area air sampling programs,
Respirator issuance, fit testing, and the proper use of respirators,
Use of special work permits,
Protective clothing requirements, including safety glasses, shoes, etc.,
Use of alpha survey instruments,

Survey requirements for movement of equipment and material,
Emergency signals and how to respond appropriately,
Admitting, escorting, and supervising visitors,
First aid techniques, and
How to report injuries and incidents.

4.4.1.3 Topics Specified in 10 CFR Part 19.12

Both the 2-to-3 hour and the 8-hour health and safety indoctrinations for people working in or frequenting any portion of a restricted area include information on, instruction in, or advice about:

- Storage, transfer, or use of radioactive materials or of radiation within the restricted area;
- Health protection problems associated with exposure to such radioactive materials or radiation;
- Precautions or procedures to minimize exposure;
- Purposes and functions of protective devices employed;
- The applicable provisions of NRC regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials occurring such areas and instruction to observe those provisions to the extent within the worker's control;
- Responsibility to report promptly to the licensee any condition which may lead to or cause a violation of NRC regulations and licenses or unnecessary exposure to radiation or to radioactive material;
- Appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and
- Awareness of radiation exposure reports which workers may request pursuant to 10 CFR Part 19.13.

The extent of these instructions will be commensurate with potential radiological health protection problems in the restricted area.

4.4.1.4 Annual Training

Annual refresher training is given to all employees and contract personnel whose work requires handling of radioactive materials. Annual training includes, as a minimum, the following topics:

Basic nuclear physics,
Methods of radiation detection,
Biological effects of radiation,
Exposure measuring techniques,
First aid and injury reporting,
Contaminated injuries,
Restricted area control,
General radiation safety,
Control of visitor and employee exposure,
Existing procedures,
Film badges and other dosimeters,
Bioassay sampling,

- Unrestricted release of material and equipment,
- Shipping and receiving of radioactive material,
- Liquid waste release,
- Contamination control,
- Decontamination techniques,
- Protective clothing,
- Use of respirators,
- Survey instrument use, and
- Emergency procedures.

4.4.2 Duration and Frequency of Training

New employee indoctrination will be performed one time before the new employee or contractor is allowed to work independently in radioactive materials areas or with radioactive materials. This training requires approximately 8 hours to complete. Annual refresher training occurs once per year; it requires approximately 16 to 24 hours. Special radiation safety training programs will be scheduled on an *as needed* basis.

Special training sessions will be scheduled by the RSO when required as a result of changes in radioactivity levels or materials handling procedures.

4.4.3 Testing and Comprehension

A written examination will be administered at the end of each formal training session to document each employee's attendance and understanding of the training material covered. The written exams will be reviewed at the end of the training course and correct answers to all questions will be discussed.

4.4.4 Recording Participation

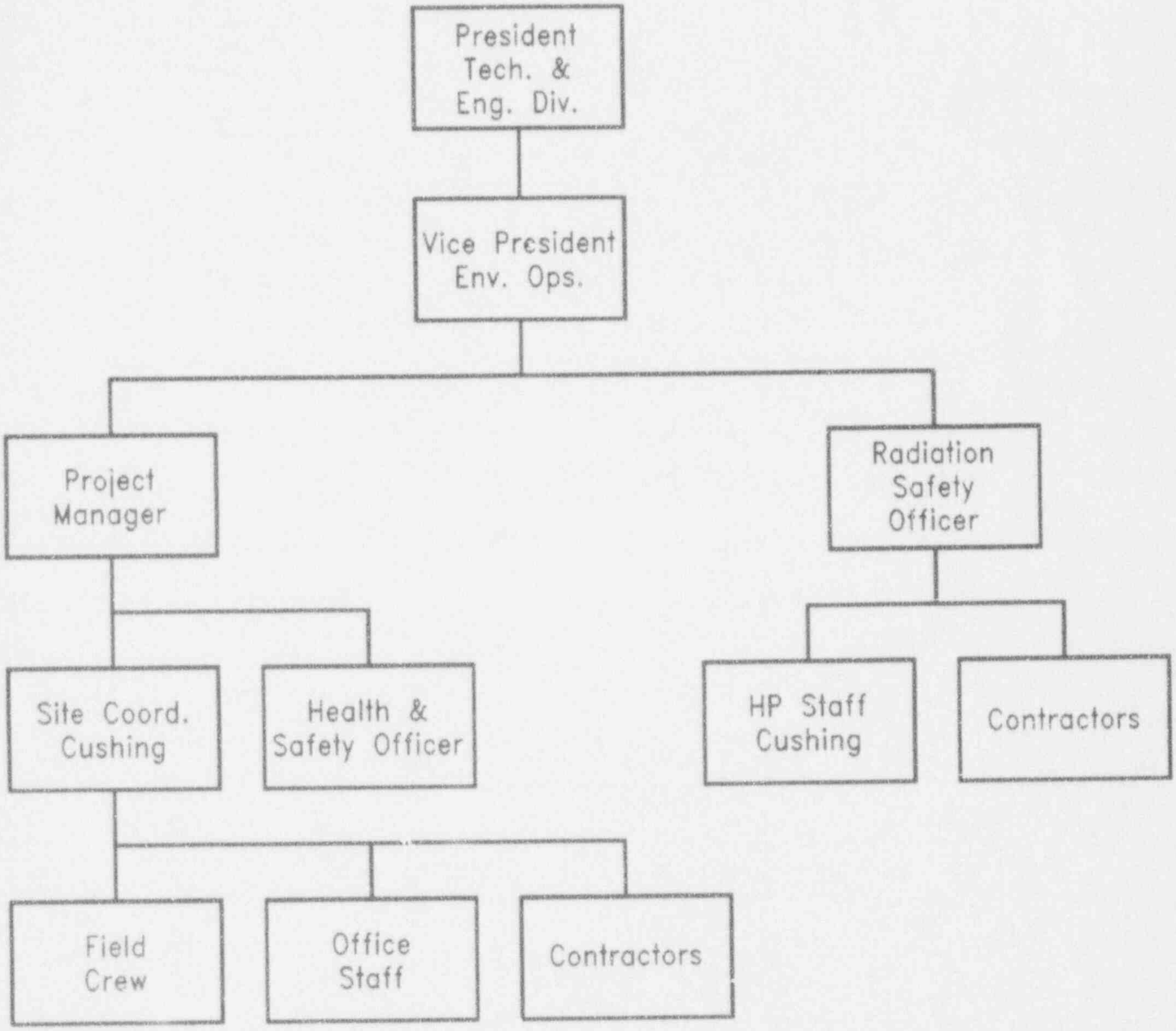
Examination records and attendance rosters will be kept on file for at least two years.

4.4.5 Qualified Safety Training Personnel

Training will be provided by the RSO or his designated alternate.

4.5 CHANGES

If it were impractical to implement a specific element of the decommissioning plan as described or if an improvement is realized, KMC may change an element of decommissioning activities described in §3.4 provided criteria in §3.2 are not changed, organization and administration in §4, the health and safety program in §5, or the final survey plan in §6 provided each change conforms to regulations and license conditions and would not be expected to result in any significant increase in radiation exposure to workers or in any significant increase in impact on the environment. Such change must be approved by the RSO and either the Vice President, Environment Operations, or the Vice President, Environment & Health Management.



KERR–McGEE CORPORATION

DOCUMENT TITLE: FIGURE 4.1
CUSHING REFINERY SITE
DECOMMISSIONING PLAN
ORGANIZATIONAL CHART

PREPARED BY: JL	DWN BY: JE
DRAWING NO. ORG_CHT	DATE: 4/20/94

Figure 4.2 Special Work Permit Form

KERR McGEE CORP. CUSHING, OKLA.

SPECIAL WORK PERMIT #447

Effective Date: 01/24/94-0730 hrs; Expiration Date: 12/29/94-1545 hrs

JOB DESCRIPTION: OFF-SITE BACKGROUND SURVEYS & SAMPLE COLLECTION

INDUSTRIAL SAFETY

POTENTIAL HAZARD	TYPES OF ACCIDENTS	RECOMMENDED SAFEGUARDS
A. Mechanical, Physical	Struck by equipment	Use caution while working around equipment.
	Lifting/straining	Use proper lifting techniques.
	Trip/Slip hazards	Be aware of holes, trenches, uneven ground.
B. Environmental	Poison Ivy/other allergen-producing plants.	Use caution, avoid contact
	Insect bites, stings.	Avoid contact.
C. Chemical	Minimal, not anticipated.	N/A

Industrial Safety Equipment Required:

X Safety glasses (ANSI Z87 approved)
X Safety shoes (rubber/neoprene boots)
__ Hard hat
X Normal Level D Work Uniform
X Leather, or cotton gloves

RADIOLOGICAL SAFETY

H.P. Tech. Required:	Personnel Monitoring:	Radiological Survey Requirements:
X Job Start	__ Film Badge	__ Job Start
__ Full Time	__ Lapel Air Sampler	__ Full Time
X Intermittently		__ Intermittently
__ End of Job		__ End of Job

HP TECH. Special Instructions:

1. Verify survey & sampling locations are off-site.
2. Survey for unrestricted release any equipment to be taken offsite, if it is currently stored in a Restricted Area or Radioactive Materials Area, or was used in affected areas on-site and not yet surveyed.
3. If licensee radioactive material is found off-site: <u>Stop Work</u>, and notify the RSO and the Site Coordinator immediately.
4. H.P. Tech shall assist in the background surveys and sampling. The RSO or the H.P. Tech may remove this requirement once the work has begun, and the crew no longer requires the Technician's assistance.

KERR McGEE CORP. CUSHING, OKLA.

SPECIAL WORK PERMIT #447

Effective Date: 01/24/94-0730 hrs; Expiration Date: 12/29/94-1545 hrs

WORK PLAN

1. Verify that work location is off-site.

2. Check in with HP Tech. prior to job start.

3. Background Determinations:
   - Perform three determinations at each location, using a 5 meter triangle.
   - For each sample take a Micro-R/hr reading at ground surface, and at one meter above surface.
   - For each sample take an integrated unshielded NaI detector reading of at least 1/10 minute at ground surface and at one meter above ground surface. Use Ludlum Model 2221, Serial # 102029. Other instruments may only be used with the approval of the RSO/SC.
   - Take a surface soil sample, 0-15cm (0-6"), of approximately one liter. Either hand operated or motorized equipment may be used.
   - At the RSO/SC discretion, samples may be mixed for a composite analysis.
   - Label each sample with the appropriate information; ie. date, time, location, etc.

4. Health Physics Technician may impose requirements more restrictive than those specified in this SWP. Workers shall follow those requirements.

SPECIAL INSTRUCTIONS

1. No smoking, No chewing, No eating or drinking.

2. Chain Of Custody is required for any samples leaving the site.

KERR McGEE CORP. CUSHING, OKLA.

SPECIAL WORK PERMIT #447

Effective Date: 01/24/94-0730 hrs; Expiration Date: 12/29/94-1545 hrs

Signatures of all people involved in Job

	Approval Signature	Date Signed
Site Coordinator	[signature]	1-24-94
Radiation Safety Officer	T M Moore	01/21/94
Health and Safety Officer	Ellen C Cheatham	21 January, 1994
Individuals working under this SWP (Print Name)	Signature	Date Signed
Crew Supervisor	William J. Rhodes	1-24-94
HP Tech.	Irving Powell	1-24-94
	Mickey Hicks	1-24-94

Work Completed and SWP Terminated Date: _______ Time: _______

Site Coordinator: ________________

5. METHODS TO PROTECT HEALTH AND SAFETY

5.1 HEALTH PHYSICS PROGRAM

Radiation safety measures are employed to protect workers and the general public against exposure to radiation levels exceeding permissible limits and to assure any exposures are maintained as low as reasonably achievable. The radiation safety program includes various monitoring and control measures appropriate for the kind and range of radioactive material concentration present on the Cushing site. The site characterization report confirms that the two previous campaigns to clean up the site and sequester most of the residual material have left relatively low radioactivity concentration. This proposed health physics program is intended to be appropriate for the low radioactivity concentration on the site.

5.1.1 Personnel Monitoring Devices

Film badges are used to monitor the external gamma radiation exposure of employees. The badges are furnished and processed by a supplier certified under The National Voluntary Laboratory Accreditation Program (NVLAP) as required under 10 CFR Part 20.1501(c). Anyone entering a radioactive materials area is required to wear a film badge. Assigned workers wear film badges at all times while on site. Records of exposure are kept on file.

5.1.2 Bioassays

The licensed material remaining at the site has been exposed to the effects of the weather for many years. The remaining radioactivity is therefore chemically fixed within various matrices and is insoluble.[1] Kerr-McGee considers the licensed material remaining on site as contamination to have a *Y* lung solubility classification.

Employees' internal exposure to airborne radioactive material is monitored by an air sampling program. Compliance with the airborne intake limits is determined by measuring the total concentration of radioactivity in air and referencing the concentration to the concentration limits listed in 10 CFR Part 20, Appendix B, Table 1. Gamma spectrum analyses of soil samples indicates that some of the contaminated material at the site contains both uranium and thorium. Since the thorium limit is more restrictive than the limits for any of the uranium isotopes, thorium DAC values may be used for initial exposure control measures. If the need is indicated, further evaluation is based on a determination of the prevalence of uranium and thorium in the work area.

Urine analysis supplements the air sampling program in determining internal exposure to uranium. Urine samples are collected and analyzed from employees who routinely work with radioactive materials. Bioassay samples for internal exposure to thorium (fecal samples) are not collected on

1 Except in the acidic condition in Pit 4, which KMC plans to neutralize. But there uranium concentration is insignificant. ref. Kerr-McGee, *Cushing Facility Characterization Survey Report*, Table 5, 1991.

a routine basis. Fecal samples would be collected for thorium analysis under special circumstances, such as if air samples indicate significant (>520 DAC-hours in a quarter) exposure.

Area air samplers are located in or near excavation, packaging, or materials handling areas where the potential for airborne suspension of particulates exists. Lapel and or area samples are collected and counted on a daily basis where potential for airborne activity is significant.

If the result of any lapel or area air sample exceeds 0.5 DAC, an evaluation is performed to determine what dust suppression measures were in effc : and what additional measures should be implemented, if any. Work will not continue under the same conditions that produce air sample results confirmed to exceed 1.0 DAC. This assures that radioactive material intake will not exceed 40 DAC-hours within a work week.

An *in-vivo* lung count is performed every two years on each employee who routinely works with radioactive material. *In-vivo* lung count results are used to compare the levels of uranium and thorium deposition in the lungs with the ALI or maximum permissible lung burden.

5.1.3 Surveys and Monitoring

5.1.3.1 During Work With Licensed Radioactive Materials

Health physics activities supporting site decontamination activity include definition of areas of radioactive contamination and monitoring of ambient conditions. Where monitoring results recommend or dust is visible in a radioactive material area, engineered controls, protective clothing, respiratory protection, and personnel monitoring will be specified in an SWP. As a minimum, where licensed radioactive materials are being handled, airborne contamination is monitored using personal lapel samplers, area air sampling, or a combination of both. Air samples are counted on a daily basis. Records of exposure are maintained on file. Employees survey hands and feet with an alpha counter before exiting radioactive materials areas.

5.1.3.2 Storage Areas

Designated storage areas are monitored for external gamma exposure rates with thermoluminescent dosimeters (TLD) placed on the fence or wall that encloses the storage area. Alpha radiation readings for surfaces within indoor storage areas are taken directly with appropriate instrumentation. Surface wipes are collected for determination of removable alpha radioactivity.

Health physics activities performed while crews work in storage areas include monitoring of ambient conditions. Where indicated by monitoring results or observation of airborne particulates, protective clothing, respiratory protection, and personnel monitoring may be specified. As a minimum, airborne contamination is monitored using personal lapel samplers, area sampling, or a combination of both. Air samples are, at a minimum, counted for alpha radiation.

5.1.3.3 Air Sampling Program

Airborne radioactive materials may be encountered during excavation of contaminated material, its transfer, and packaging for shipment. Airborne particulates may be generated indoors when removing contaminated concrete from building floors, and when packaging contaminated soils. Airborne particulates may be generated outdoors during excavation activities and transfer of radioactive materials to storage or packaging areas.

Air sampling is performed at locations where the potential for airborne contamination exists, *e.g.*, during excavation of contaminated soil. Air samples are analyzed daily. Results are evaluated to determine whether specific limits are exceeded. If a concentration is confirmed to exceed 1.0 DAC, corrective action will be taken, such as wetting soil to reduce dusting.

In addition, environmental air samplers monitor the release of airborne contaminants to unrestricted areas to enable KMC to test whether the level stipulated in 10 CFR Part 20.1302 (old Part 20.106) may be exceeded.

If there was 1 mg dust/m^3 air, the radionuclide concentration in airborne particles < 10 μm in diameter could be as much as 1000 pCi/g dust or soil without exceeding the DAC for the natural thorium series. Most sample measurements at the Cushing site have observed less than 100 pCi/g soil, which would produce less than 0.1 of the DAC limit. Moreover, it is reasonable to expect that 1 mg/m^3 airborne dust would be noticeable in view of the realizations that 1) the observed upper limit of airborne soil mass loading of particulate less than 10 μm in diameter is about 0.7 mg/m^3, 2) the observed upper limit of particles larger than 10 μm in air is about 230 mg/m^3, 3) 5 mg/m^3 respirable fraction and 15 mg/m^3 total dust are the maxima of inert or nuisance dust allowed by OSHA, and 4) a dust loading of 110 mg/m^3 is barely tolerable for breathing.[2] Therefore, as long as the total uranium and thorium series concentrations in soil are below about 100 pCi/g, excavation and handling the dirt is unlikely to produce as much as 0.1 DAC in airborne dust or cause as much as 0.1 ALI to a person exposed 40 hours/week by inhalation while working. In that circumstance, neither continuous air sampling is lapel or breathing zone air sampling is proposed by Regulatory Guide 8.25.[3]

5.1.3.4 Effluent and Environmental Monitoring

Effluent and environmental monitoring is addressed in three aspects: environmental monitoring, monitoring of intentional releases, and monitoring of unintentional releases.

Environmental monitoring consists of collecting air, surface water and groundwater, soil, and vegetation samples from unrestricted areas to determine the concentration of licensed materials in these media.

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2 Stewart, 1967, quoted in D. Randerson, ed., Atmospheric Science and Power Production, DOE/TIC 27601, p. 542, 1984.

3 NRC, *Air Sampling in the Workplace*, Reg. Guide 8.25, rev.1, June 1992.

Airborne radioactive contaminants released to unrestricted areas are monitored by three high volume air samplers. Soil and vegetation samples are collected at eight locations on an annual basis to determine the concentration of licensed material in the soil and flora. Groundwater samples are obtained from five groundwater monitoring wells. Upstream and downstream surface water samples are collected at the property line to monitor the concentration of licensed material in surface waters. Surface water and groundwater samples are analyzed on an annual basis for gross alpha and beta activity. Analyses for uranium and thorium concentration will be performed for samples that have gross alpha activity exceeding 15 pCi/liter.

The only intentional release anticipated would be discharge of surface water from an excavation or from Skull Creek. In such event, effluent sampling would be performed and the discharge would be controlled.

Should an unintentional release occur, appropriate measures will be taken to monitor the release of radioactive materials to the environment. These measures may include, but are not limited to: placement of area air sampler(s) downwind from the release, installation of lapel air samplers on all personnel working in the area, and sampling of soil and surface water releases to evaluate the radioactive material concentrations in the effluent.

5.1.4 Radiation Detection Instruments and Calibration

Portable alpha and gamma radiation monitoring instruments are used to determine site radiation exposure and activity levels. These instruments are calibrated at the Cimarron Corporation's Cimarron Facility on a quarterly basis in accordance with manufacturer's recommendations. Performance of all instruments is checked daily with a radiation source of known activity or at two locations where radiation intensity is reproducible. If an instrument reading varies by more than 10%, the instrument calibration is checked, except a micro-R meter may vary by as much as 2 μR/hr on lower scales. Logs are kept on file as a record of instrument calibration.

Multi-channel gamma spectrum analyzers (MCA) are available in the counting lab to determine the concentrations of licensed material in soil and environmental samples. Each uses a lead shielded, sodium iodide crystal, well-type detector and a multi-channel gamma spectrum analyzers. Gamma energies and nuclide concentrations are calibrated using standards having known gamma-ray energies and radionuclide concentrations.

Table 5.1 presents a list of radiation monitoring instruments, the type of radiation detected, and the minimum detectable activity of each. Table 5.2 presents a list of personal, environmental, and area monitoring equipment and the type of media sampled or monitored by the equipment.

5.1.5 Airborne Radioactive Material

Measures will be taken to control airborne suspension of radioactive material during decontamination activities in order to maintain employee and public exposure as low as reasonably achievable.

Primary emphasis is on engineered control, then secondary emphasis is on personal protective equipment and clothing.

Dust suppression measures will be considered when there is visible dust and on the basis of radioactivity measurements as well. Dust suppression measures usually consist of water spray on the loose particulate material until suspension of particulate matter has visually subsided. Dust control measures may vary for each activity depending on the nature of the work.

5.1.5.2 Demolition of Structures

When contamination cannot be removed from structures in place or is shown to be in soils under structures, complete demolition may be necessary. Generally the contamination is fixed and limited to surface areas in such ways that suspension of radioactive materials would not be expected. However, areas are wetted down paying particular attention to seams or other areas where dust would be generated. After demolition, some of the rubble may be separated and contamination removed using the methods discussed in chapter 3 herein.

5.1.5.3 Excavation

Excavation of contaminated soils, building rubble, and sludges is accomplished with typical earthmoving equipment. Ambient soil moisture normally precludes dusting. However, each operation is evaluated for dust control applications that may involve use of water sprays, foams, wetting agents, dust suppressors or a combination thereof. Excavations will be limited to minimize normal drying of soils during the excavation process.

5.1.6 Equipment

Equipment used to excavate and move radioactive material will be stored within the confines of the restricted area unless it becomes necessary to remove the equipment to perform work in other areas or for service. Before equipment is removed from a restricted area, appropriate decontamination and survey activities will be performed. Material or equipment will be released for unrestricted use upon meeting the release criteria presented in §3.2 herein.

5.1.7 Administrative Control

KMC will establish procedures to govern transport of radioactively contaminated, bulk material in *unaffected* areas and to prevent significant contamination of any *unaffected* area by licensed material from an *affected* area.

5.2 Ensuring Occupational and Public Exposures Are ALARA

KMC protects employees, the public, and the environment by maintaining radiation exposures and releases of radioactive material to the environment as low as reasonably achievable (ALARA). ALARA emphasis is an integral part of KMC's radiation protection program. It is everyone's responsibility, requiring involvement and cooperation of all personnel.

Kerr-McGee's health physics and environmental programs are designed to promote practices that keep occupational and public exposure to licensed material ALARA. They provide integral emphasis of ALARA exposure and effluents in:

- job planning, procedures, and SWP
- contamination surveys
- radiation dosimetry and air sampling
- environmental monitoring
- selection of protective equipment
- training in radiological and industrial safety and in emergency response
- records management, and
- health and safety program audits.

The principal means to ensure that exposures and releases will be ALARA during decommissioning are through planning activities that involve radioactive material. Each procedure is reviewed to assure that appropriated measures are included to maintain radiation exposures and releases ALARA. Each job safety analysis done to prepare an SWP takes ALARA considerations into account.

Accurate and dependable surveillance of radioactivity on surfaces, in air, in personnel, and in effluents are essential to maintaining ALARA radiation exposure and radioactive effluent. Cleanup and restoration activities are monitored to identify deficiency in engineered or administrative control which might increase potential exposure of workers or members of the public. Monitoring both the work and site environments help KMC staff to recognize such deficiency and initiate timely correction.

Administrative controls facilitate the setting of ALARA goals, job planning, monitoring, and reviews; evaluation and control of releases of radioactive material; assessment of ALARA emphasis; and any corrective actions found to be needed to make exposures and effluents ALARA.

5.3 Radiation Protection of Contractor Personnel

In the event a contractor works on decommissioning in an area where licensed radioactive material is handled or is being cleaned up, Kerr-McGee radiation protection policies, health physics program, training, and administration described herein would apply to contract personnel.

TABLE 5.1

RADIATION MONITORING INSTRUMENTS

INSTRUMENT TYPE	NUMBER AVAILABLE	RADIATION DETECTED	SCALE RANGE	MDA
Micro-R Meter	2	Gamma	1 - 5,000 μR/hr	2 μR/hr
Ion Chamber	1	Gamma	0.1 - 300 mR/hr	0.2 mR/hr
3" x 1/2"NaI Scintillator	2	Gamma	0 to 500,000 cpm	500 cpm
435 cm^2 Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	30 dpm/100 cm^2
100 cm^2 Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	150 dpm/100 cm^2
60 cm^2 Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	300 dpm/100 cm^2
60 cm^2 Count Rate Meter	3	Alpha	0 - 500,000 cpm	350 dpm/100 cm^2
60 cm^2 Personnel Room Monitor	1	Alpha	0 - 50,000 cpm	350 dpm/100 cm^2
2" Slide Drawer Counter	1	Alpha	0 - 500,000 cpm	1 dpm
Pressurized Ion Chamber	1	Gamma	0 - 100 mR/hr	~ 3μR/hr Δ0.5 μR/hr @ 10 min count
Computer-Based Auto Sample Counter Tennelec LB5100W	1	Alpha-Beta	0 - 99,999,999 cpm	1 dpm
Computer-Based Multichannel Analyzer- NaI Well Counter	1	Gamma Spectrum		Being evaluated

TABLE 5.2

PERSONAL, ENVIRONMENTAL, AND AREA MONITORING EQUIPMENT

EQUIPMENT	MEDIA SAMPLED OR MONITORED	NUMBER AVAILABLE	CAPACITY OR RANGE
Personal Lapel Pumps w/2" Filter Heads	Air	5	0 - 4.5 LPM
Powered Area Monitors-Health Physics	Air	3	0 - 3 CFM
Powered Area Monitors - Environmental	Air	3	0 - 5 CFM
Personal Film Badges	Gamma Radiation	As Required	MDA = 10mRem
Thermoluminescent Dosimeters	Gamma Radiation	As Required	MDA = ~0.8 mRem/week

6. FINAL RADIOACTIVITY SURVEY PLAN

6.1 Background Information

Kerr-McGee Corporation used part of its Cushing oil refinery site during 1962 through 1966 to process natural thorium and natural, depleted, and enriched uranium under two AEC licenses, SNM-695 and SMB-664. The site was released and the licenses terminated in 1966. As a result of subsequently determined contamination on the site, a new license, SNM-1999, was issued by the NRC in 1993 for decommissioning the site for unrestricted use. Additional discussion of background information may be found in Chapter 1, *Introductory Information*, and Chapter 2, *Site Information*, of this Site Decommissioning Plan.

6.2 Site Information

6.2.1 Site Description

The Cushing site is located in Payne County, Oklahoma, 2.5 miles NE of the City of Cushing, midway between Tulsa and Oklahoma City. Figure 2.1 shows the region of the Cushing site. The terrain of the region is rolling, oil-producing, pasture land. Skull Creek runs through the site before joining the Cimarron River 4 miles ENE at an elevation of 760 feet above mean sea level (MSL). The mean elevation of the site is 840 ft MSL. More information about the site is contained in Chapter 2, *Site Information*.

6.2.2 Site Conditions at Time of Final Survey

The Cushing site will have been decontaminated and decommissioned to levels that satisfy current NRC guidelines,[1] and it will be ready for the final survey described herein. Four areas comprising approximately 200 acres of unaffected area land of the total 440 acre site will have been previously surveyed and met the current NRC criteria for release for unrestricted use. However, some portions of the unaffected area land will have been subsequently used for disposition of soil from affected areas. Figure 6.1 shows the location of the designated unaffected areas and other features relevant to decommissioning on the site.

As part of the decommissioning activities, contaminated structural surfaces of remaining buildings will have been cleaned by scrubbing, shot blasting, chipping, and the use of chemical agents. Buildings no longer desired for use will have been demolished. Buildings 32, A6, A9 (Office Building), and 73 will be retained until no longer needed by KMC.

Disposition of contaminated soil, including that from the trash dump, trenches, the neutralized Pit 4, refinery tank berms, areas surrounding process buildings, other land areas, and the bed and banks of Skull Creek, will have been made according to the criteria described in Section 3, *Description of Planned Decommissioning Activities*. Some soil will have been left in place or moved (BTP Option 1

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1 *Guidelines* refers to survey objectives in §6.3.1.

the previous unaffected areas, and some will have been shipped offsite for burial at a licensed disposal site (Option 4 material).

6.3 Final Radioactivity Survey Overview

6.3.1 Survey Objectives

The purpose of the final radioactivity survey is to demonstrate that the radiological conditions at the KMC Cushing site satisfy survey objectives in §6.3.1, and that the site can therefore be released for unrestricted future use without radiological controls and the license terminated. The specific objectives of the survey are to show that:

A. Surface Activity Inside Buildings and Structures
   1. Average surface contamination levels for each survey unit are within the acceptable levels specified in Table 3.1, Acceptable Surface Contamination Levels.
   2. Small areas of residual activity, *i.e.*, discrete spots, do not exceed three times the average value. The discrete spot limit applies to areas up to 100 cm^2. The average activity level within a 1 m^2 area containing a discrete spot must be within the surface activity criteria in §3.2.
   3. Reasonable efforts have been made to clean up removable activity, and removable activity within each survey unit is within the acceptable levels specified in Table 3.1.
   4. Exposure rates in occupiable locations are less than 10 μR/hr above background. Exposure rate levels are measured at 1 m from floor/lower wall surfaces and are averaged over surface areas, not to exceed a maximum of 100 m^2. Maximum exposure rates at any location may not exceed 20 μR/hr above background.

B. Volumetric Activity of Soil, Water, and Building Materials
   1. Average radionuclide concentrations in soil are within the acceptable levels specified in Table 3.2, Option 1 Radioactivity Concentration Levels, and Table 3.3, Option 2 Radioactivity Concentration Levels. Concentrations may be averaged over a 100 m^2 grid area.
   2. Reasonable efforts have been made to identify and remove discrete spots that may exceed the average criterion in Table 3.1 by greater than a factor of $(100/A)^{1/2}$, where A is the area (in m^2) of the discrete spot.
   3. Exposure rates do not exceed 10 μR/hr above background at 1 m above the surface. Exposure rates may be averaged over a 100 m^2 grid area. Maximum exposure rates over any discrete area of greater than 100 m^2 may not exceed 20 μR/hr.
   4. Average radionuclide concentrations above background in Skull Creek water are within the acceptable levels specified in Table 3.4, Criteria for Radioactivity in Water. If alpha activity < 15 pCi/l above background, analysis for named radionuclides is not required.

These conditions will be demonstrated at a 95% confidence level for each survey unit as a whole.

The survey results may also be used to determine the inventory of radionuclides in the engineered cell that will remain on-site following release of the site for unrestricted use and termination of the license.

6.3.2 Identity of Contaminants

Based on the knowledge of site operations and the results of a preliminary assessment, a characterization survey, and other measurements, the significant radiological contaminants have been determined to be natural thorium and isotopes of uranium. The uranium is comprised of depleted, natural, and enriched forms, resulting in an average enrichment above the naturally occurring level. Although uranium with a wide range of U235 enrichment values were received, most environmental samples have exhibited relatively low enrichments. In addition, there is some radium resulting from crude oil production activities on the site. Section 2.2, *Site Information*, and Section 3.2, *Radiological Criteria for Decommissioning*, contain additional information about the origin and composition of the radiological contaminants on the site.

On the basis of the determined combination of radiological contaminants, the criteria for on-site disposition of the contaminants are those shown in Tables 3.1 through 3.3.

In addition to the radioactive contaminants, the site contains soil areas with acidic hydrocarbon sludge, oils, and greases. These materials as well as NORM materials will be addressed in accordance with requirements of the State of Oklahoma and the U.S. Environmental Protection Agency.

6.4 Organization and Administration

6.4.1 Organization and Responsibilities

The overall organization and responsibilities for decommissioning are described in Chapter 4, *Organization and Administration*. The final radioactivity survey will be performed by a team within the organization composed primarily of qualified personnel at the Cushing site, Cimarron Corporation, and KMC headquarters in Oklahoma City. Some contractor assistance may be required for certain, not now identified, services or tasks. The team organization for the survey is shown in Figure 4.1, Organization Chart for the Cushing Site, and it includes any potential contractor assistance.

The team will operate under the general direction of the Site Coordinator. The Site Coordinator will have the authority to make appropriate changes to the survey plan (subject to the established QA/QC program) as deemed necessary as the survey progresses.

Field measurements of radiological parameters and sample collection will be under the direction of the Radiation Safety Officer. He will also oversee the activities of any field contractor assistance.

Laboratory activities for in-house analyses will be under the direction of the Radiation Safety Officer. He will also oversee the activities of any laboratory contractor assistance.

Quality assurance (QA) responsibilities will be handled by the Quality Assurance Coordinator. As QA officer, he will coordinate all interface requirements during the survey process. Quality controls are ordinarily integrated into calibration or survey procedures. Any changes or alterations to these procedures will be handled in the same manner as changes to survey procedures. The QA program for radiation and radioactivity measurement is outlined in §4.2.

The Waste Management Department will provide expertise on spectrometry instrumentation and sample analysis. Other KMC personnel will provide expertise, advice, and audits as described in Chapter 4, *Organization and Administration*, of the decommissioning plan.

6.4.2 Training

Kerr-McGee Corporation provides continuing training for its Decontamination Project personnel and others who may be exposed to radioactive materials. Training varies according to the potential exposure and nature of employees' job duties. In addition to the training specified in Section 4.4, *Training*, special training will be provided on equipment, special techniques, and practices relative to the survey activities for those employees who will be involved in taking radiation measurements and radioactive samples, and in performing laboratory analyses. All members of the final radioactivity survey team will attend an in-house training session at which radiation protection, survey procedures, and quality assurance activities will be reviewed.

6.4.3 General Survey Plan

The survey plan consists of systematic processes and procedures found to be acceptable by industry standards and the NRC. Activities have been defined and tasks within those activities described. Table 6.1, Overview of Final Radiation Survey Activities and Tasks, provides a breakdown of activities and tasks that currently comprise the final radioactivity survey plan. The tasks will be assigned to the appropriate team members as required.

Subsequent sections provide information on conduct of these tasks.

6.4.4 Tentative Schedule

The first three of the major activities in the final radioactivity survey depicted in Table 6.1 have been completed. The remaining activities will be scheduled to begin within 60 days after NRC approval for capping the engineered cell. A milestone chart showing the time line for performing the remaining major activities of the final radioactivity survey is shown in Figure 6.2, Milestone Chart for Final Radioactivity Survey Activities.

6.5 Survey Plan Methods

6.5.1 General

Due to the nature of operations conducted at the Cushing site, buildings and land areas considered potentially contaminated will be surveyed. The location, type, and density of samples taken at the site will be based on the potential for residual radioactivity. This potential is based on a review of site history and the results of a preliminary assessment and a characterization survey. The bases for classification of land areas as affected and unaffected are described in Section 6.5.3.1, Area Classification. To the extent that locations of measurements or sampling in support of characterization, remedial action control, or other previous surveys have not been disturbed since those earlier surveys, and the radiological status would therefore be unchanged, data from those surveys may also be used as part of or in support of the final radioactivity survey.

Throughout this chapter, the survey activities are generally described in the future tense. However, it should be understood that some activities and parts of other activities, particularly those involving the earlier surveys mentioned above, have already been completed, and the tense remains future.

6.5.2 Instrumentation

Table 6.2, Instrumentation for Final Radioactivity Survey, lists the instrumentation planned for use in the final radioactivity survey, along with applications, typical parameters, and detection sensitivities for the instrumentation.

The minimum detectable activity (MDA) of an instrument is an *a priori* estimate of detection sensitivity. The basic equation for estimating instrument MDA is:

$$MDA = \frac{2.71 + 3.29 \cdot \sqrt{B \cdot (1/t_b + 1/t_s)}}{E \cdot A}$$

where

MDA = minimum detectable radioactivity
B = background or blank count rate (ct/min)
t_b = background count time (min)
t_s = sample or source count time (min)
E = overall detection efficiency
A = volume, mass, or area of sample measured

When $t_b = t_s$, this equation is equivalent to applications of this relationship to several practical radioactivity survey modes presented in NUREG/CR-5849, §5.2.

Sensitivities for surface contamination surveys by alpha or beta-gamma instruments are based on movement of the detector over the surface at about 1 detector width per second and the use of audible indicators to sense changes in instrument count rates. Calibration of field instruments will be maintained in accordance with established KMC procedures. Calibration will be appropriate for the radiation energies expected to be present at the site. Operational and background checks will be performed as specified by KMC procedures.

The objective MDA for instruments used to perform final survey measurements is to achieve 25% or less of the stated, average limit.

6.5.3 Survey Plan

6.5.3.1 Area Classification

For purposes of establishing the sampling and measurement frequency and pattern, the site has been divided into affected and unaffected areas. The bases for these classifications are:

Affected Areas: Areas (including buildings) that are likely to have radioactive material contamination based on plant operating history or known radioactive material contamination based on preliminary or characterization radiological surveys. This includes areas where radioactive materials were used and stored, where records indicate spills or other unusual occurrences that could have resulted in contamination, and where radioactive materials were buried. Areas immediately surrounding or adjacent locations where radioactive materials were used, stored, spilled, or buried are included in this classification because of the potential for inadvertent spread of contamination.

Unaffected Areas: All areas not classified as affected. These areas are not expected to have radioactive material contamination, based on a knowledge of site history and previous survey information.

Table 6.3, Potentially Affected Areas, lists the various site areas, including buildings, that are known to be in the affected area classification. Affected areas containing the most significant concentrations of licensed material are also shown in a scale drawing of the site, Figure 2.2, Main Features of the Cushing Site.

6.5.3.2 Reference Grids

A grid has been established for the purpose of referencing locations for measurements and sampling. The grid intervals will be based on the classification categories described in 6.5.3.1, Area Classification, and other factors described below.

All building floor and lower wall (up to 2 m) surfaces in an affected area will be gridded at 1 m intervals. Upper walls and ceiling surfaces will also be gridded at 2 m intervals. Building surfaces in unaffected areas or those upper surfaces in affected areas that have not been contaminated will not be gridded; measurements of these surfaces will be referenced to other grid systems or to prominent building features.

Both affected and unaffected outside areas will be gridded at 10 m intervals. The grid system is identical to the one used during the characterization survey and remedial action activities. Where necessary, the previous grid system will be reestablished, expanded, subdivided, or otherwise modified to meet specific topographic conditions and survey requirements.

The site will be divided into survey units having common history or contamination potential or that are naturally distinguishable from other site areas. These survey units will be sized to assure a minimum of 30 measurement locations each for outside areas, as well as for building floors and lower walls and for other building horizontal and vertical surfaces.

Survey units in unaffected areas identified by scans, direct measurements, or sampling as exceeding appropriate limits will be reclassified as affected areas and will be gridded and resurveyed accordingly. If a single, discrete spot in an unaffected area survey unit exceeds a guideline, the reclassified affected area surrounding the spot will be 100 m^2 for open land, 10 m^2 for indoor exposure rate, and 1 m^2 for contamination on building surfaces.

6.5.3.3 Surface Scans

Scanning of surfaces to identify locations of residual surface and near-surface contamination will be performed according to the following protocol:

- *Affected Area* Surfaces - 100% of surface
- Upper Surfaces in *affected* areas (§6.5.3.2) - scans in immediate vicinity of measurement
- *Unaffected Area* Surfaces - 10% of surface (none in upper building surfaces)

Building interior surfaces will be scanned for alpha and/or beta-gamma radiations, depending on the expected contaminants. Building exterior and paved surfaces will be scanned for beta-gamma radiations. Soil surfaces will be scanned for gamma radiation only.

Instrumentation for scanning is listed in Table 6.2. The instruments having the greatest detection sensitivity will be used for scanning as physical surface conditions and measurement locations permit.

Scanning speeds will be approximately 1 detector width per second for alpha and beta detection instruments, and 0.5 m per second for gamma detection instruments. Audible indicators (headphones or speakers) will be used to identify locations having levels of direct radiation about 2 times higher than ambient. All scanning results will be noted on standard field record forms, locations of higher than ambient radiation will be identified for subsequent investigation.

6.5.3.4 Surface Contamination Measurements

Direct Measurements. Direct measurements of alpha and beta-gamma surface contamination will be performed at selected locations using instrumentation described in Table 6.2. The instruments having the greatest detection sensitivity will be used for surface contamination measurements as physical surface conditions and measurement locations permit. For instruments so equipped and calibrated, measurements will be conducted by integrating counts over the time period used to estimate the MDA. When a ratemeter type of instrument is used, the count averaging time should be about twice the time constant of the instrument.

Because scanning is capable of detecting uranium and thorium contamination at <25% of the guideline values, direct surface contamination measurements will be systematically performed only at 2 m intervals on building floors and lower walls in affected areas, and at the same intervals on upper surfaces that may have contamination >25% of the guideline values, as determined by scanning.

On building upper surfaces in affected areas that are not suspected of contamination, measurements will be performed at a minimum of 30 locations in each survey unit of vertical and horizontal surfaces. These locations will include surfaces where radioactive material would likely settle and sufficient additional locations to provide measurement coverage at an average of at least 1 measurement location per 20 m^2 of surface area.

On building surfaces in unaffected areas, a minimum of 30 random measurements or an average of at least 1 measurement location per 50 m^2 of surface area, whichever is greater, will be performed for each survey unit. These locations will include all building surfaces.

Removable Contamination Measurements. Smears to detect removable surface contamination will be collected at locations in buildings where direct measurements are performed.

6.5.3.5 Exposure Rate Measurements

Gamma radiation exposure rates will be measured at 1 m above ground and floor surfaces, using a pressurized ion chamber instrument, or a gamma scintillation instrument or micro-R meter calibrated against the pressurized ion chamber instrument. Measurements will be uniformly spaced according to the following protocol:

Building Interiors
- Affected Areas: 1 measurement per 4 m^2
- Unaffected Areas: 1 measurement per 200 m^2

Outside Areas
- Affected Areas: 4 measurements per 100 m^2
- Unaffected Areas: 4 measurements per block (100,000 m^2) or 30 measurements at randomly selected locations, whichever is greater

6.5.3.6 Soil/Sediment/Water Sampling

Surface. Samples of surface soil (0-15 cm) will be systematically collected from 4 points midway between the center and the block corners for each 10 m x 10 m grid (or equivalent protocols) in affected areas. At least 30 samples will be obtained from random locations in each survey unit of unaffected areas. Samples will be collected at 10 m intervals along the drains from the former process buildings to Skull Creek and from any natural surface drainage pathways from affected areas to Skull Creek. At each surface sampling location, contact gamma radiation levels before and after sampling will be monitored to verify that subsurface contamination is not present.

Samples of sediment will be collected about 0 to 15 cm deep at the outfalls of existing or previous drains to Skull Creek and at 10 m intervals along Skull Creek, beginning 25 m upstream of the outfall most upstream and ending at the site boundary. For each outfall and 10 m interval, samples will be collected on the centerline and about 2 m to one side of the centerline of Skull Creek. In addition, samples will be collected from the center of the former route of Skull Creek between the former process buildings and the site boundary, as well as downstream of the site boundary to the low water crossing several hundred meters downstream, at 10 m intervals.

Subsurface. Subsurface investigations will be performed at the location of Pit 4, the trash dump, dismantled Building 30, and the former trenches in the NE portion of the site. Subsurface samples will be obtained using the split barrel method. Sampling will be at the top (0-15 cm) and at 1 m below the surface at each location. Ten uniformly spaced sampling locations will be selected around the perimeter of Pit 4 and the trenches to confirm the absence of subsurface migration. Borings will extend about one meter below the depth of excavation.

Samples will be collected and analyzed on a gamma spectrum analyzer or measurements made *in-situ*. If results are above a cleanup limit, subsurface samples will be obtained to define the area and magnitude of residual contamination.

Water. A series of 10 or more pairs of 1 liter water samples will be collected from Skull Creek at its entrance and exit from the site. Each sample will be analyzed for gross alpha activity. If the alpha activity concentration in the downstream sample exceeds that in the upstream sample by more than 15 pCi/l, the pair of samples will be analyzed for Ra^{226}, Ra^{228}, uranium, Th^{232}, and Th^{228}.

Soil Placement in Engineered Cell. Samples will be collected from each element of soil as part of the process of excavating, sorting, and moving the soil to a storage area for subsequent emplacement in the engineered cell. (See also Section 3.4.8, *Measurement and Sorting*). these samples will be archived for possible future analysis.

6.5.3.7 Special Measurements and Samples

Building Interiors. Other than surveys of walls, floors, and ceilings, survey measurements of building interiors are not expected to be necessary because most fixtures have already been removed.

Building Exteriors. Measurements of direct and removable contamination will be performed on the exterior and interior surfaces of any remaining air exhaust equipment and at representative locations on roof drains in affected areas. Samples of roofing material will be obtained where direct measurements indicate possible entrained contamination.

Outside Areas. Cores and soil sampling will be performed on paved outside surfaces where scans or direct measurements indicate possible contamination beneath the paving. The number and location of these cores will be determined based on the findings as the survey progresses.

6.5.4 Background Level Determinations

Background radiation exposure rates will be determined for building interiors by taking a minimum of 10 measurements at locations without a history of use with radioactive materials. Background radiation exposure rates and concentrations of uranium and thorium in soil will be determined for outdoor areas by taking a minimum of 10 measurements and samples at appropriate locations on-site or within a 0.5 to 10 km radius of the site. Radiation exposure rate measurements will be performed as described in Section 6.5.3.5, Exposure Rate Measurements. Results of background radiation exposure rates and concentrations of uranium and thorium in soil will be evaluated to assure that the averages determined are representative of the true averages. If the upper 95% confidence level bound on the background average is greater than 10% of the guideline value, the background data will be tested to assure that the average represents the true mean to within ±20% at the 95% confidence level. If necessary, additional measurements or sampling will be performed to satisfy the criteria. The total number of background measurements needed to satisfy the objective will be calculated by:

$$n_b = [(t_{95.5\%,df} \cdot s_x) \div (0.2 \cdot x_b)]^2$$

where
n_b = number of background measurements required
x_b = mean of initial background measurements
s_x = standard deviation of initial background measurements
$t_{95\%,df}$ = t statistic for 95% confidence at df=n-1 degrees of freedom, where n is the number of initial background data points

Table 6.4 contains a list of values for the $t_{95\%}$ statistic at various degrees of freedom.[2] Subtracting the number of data points already collected (n) from the total calculated number (n_b) will determine the number of additional measurements or samples that will be required to demonstrate the desired confidence of the data. If this calculation indicates that additional background data are needed, they will be collected uniformly over the area, using the same sampling or measurement protocol as that used for the original sampling or measurement. The average background will then be recalculated using all data points.

6.5.5 Sample Analysis

Smears and swabs collected for removable contamination will be analyzed for gross alpha and gross beta activity. Soil, sediment, roofing material, and other large volume samples will be analyzed for thorium and U^{235} and U^{238} by gamma spectrometry; total uranium will be calculated on the basis of previously determined average specific activity ratios for the site (See Section 2.4.1, *Radionuclides*). Samples of paint, residues, and other samples of small volume will be analyzed for uranium and thorium by wet chemistry and alpha spectrometry.

Laboratory chain-of-custody procedures will be observed for all samples analyzed.

6.6 DATA INTERPRETATION

Measurement data will be converted to units of dpm/100 cm² (surface contamination), μR/hr (radiation exposure rates), and pCi/g (soil concentrations) for comparison with guidelines. Net measurements, i.e., after subtraction of background, will be used for the comparisons. Individual measurements and soil concentrations will be compared with discrete-spot criteria. Weighted average values for surface contamination, radiation exposure rates, and soil concentrations will be determined using the following equation:

$$x_w = (1/n_s) \Sigma x_i \cdot [1 - \Sigma A_k] + \Sigma y_k \cdot A_k$$

---

2 NUREG/CR-5849, Table B-1.

where x_w = weighted mean including elevated area(s)

x_i = systematic and random measurements at point i

n_s = number of systematic and random measurements

y_k = elevated area activity in area k

A_k = fraction of 1 m^2 occupied by elevated area k

n_k = number of elevated areas

Average values for surface contamination, radiation exposure rates, and soil concentrations, as specified in Section 6.3.1, Survey Objectives, will be determined using the following equation:

$$x = (1/n_s) \Sigma x_i$$

The averages will be tested to determine whether the data for each survey unit provide a 95% confidence that the true mean levels meet the guidelines. The data will be tested using the following equation:

$$u_\alpha = x + t_{1-\alpha,df} \cdot s_x \div \sqrt{n}$$

where $t_{1-\alpha,df}$ = 95% confidence level obtained from Table 6.3; df is n-1; α is the false probability (the probability that u_α is less than the guideline value if the true mean activity level is equal to the guideline level)

x = calculated mean

s_x = standard deviation

n = number of individual points used to determine x and s_x

The value of u_α will be compared to the guideline value. If u_α is less than the guideline value, the data being tested meet the guideline at a 95% confidence level.

In the event additional remediation and/or further sampling and measurement is performed where guidelines are not met or cannot be demonstrated to the specified level of confidence, computations and comparisons will be repeated as necessary.

Average levels may be used to estimate the inventory of uranium and thorium emplaced in the on-site engineered cell.

6.7 Report

A report describing the findings of the final radioactivity survey will be prepared and submitted to the NRC. Report format and content will generally follow the recommendations contained in NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Termination*. Data will be summarized in tables and figures. Measurement and sampling locations will be shown on scale drawings.

All field and analytical data, including procedures and instrument calibration certificates used in the survey, will be archived by Kerr-McGee Corporation until such time as the NRC agrees that they may be disposed or until the license is terminated.

Table 6.1 Overview Of Final Radioactivity Survey Activities And Tasks

Activities	Tasks
Evaluate contamination potential	1. Review operating history with respect to facility use, spills, releases, etc. 2. Review radioactivity data from scoping and characterization surveys. 3. Identify radionuclides of concern and determine guidelines 4. Classify areas as to *affected* and *unaffected*
Establish grid reference system	1. Install grids 2. Prepare facility survey maps
Determine background levels	1. Measure indoor exposure rates and ambient beta-gamma radiation levels 2. Measure outdoor exposure rates 3. Collect and analyze background soil samples. 4. Measure background radionuclide concentration in soil.
Perform direct measurements	1. Conduct surface scans 2. Determine frequency and locations of measurements to meet criteria 3. Conduct building surface activity measurements 4. Measure exposure rates
Collect samples	1. Determine frequency and locations of sampling to meet criteria 2. Collect systematic and special samples
Analyze samples	1. Count smears and swabs. Analyze soil, residue, liquid, and other samples for uranium and thorium activity
Interpret data	1. Convert data to standard units 2. Calculate average levels 3. Compare data with criteria 4. Compute inventory of residual radioactivity in disposal cell
Prepare report	1. Construct data tables and figures 2. Prepare text 3. Submit report to NRC.

TABLE 6.2

RADIATION MONITORING INSTRUMENTS

INSTRUMENT TYPE	NUMBER AVAILABLE	RADIATION DETECTED	SCALE RANGE	MDA
Micro-R Meter	2	Gamma	1 - 5,000 μR/hr	2 μR/hr
Ion Chamber	1	Gamma	0.1 - 300 mR/hr	0.2 mR/hr
3" x 1/2"NaI Scintillator	2	Gamma	0 to 500,000 cpm	500 cpm
435 cm² Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	30 dpm/100 cm²
100 cm² Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	150 dpm/100 cm²
60 cm² Gas Flow Digital Scaler	1	Alpha-Beta, Gamma	0 - 500,000 cpm	300 dpm/100 cm²
60 cm² Count Rate Meter	3	Alpha	0 - 500,000 cpm	350 dpm/100 cm²
60 cm² Personnel Room Monitor	1	Alpha	0 - 50,000 cpm	350 dpm/100 cm²
2" Slide Drawer Counter	1	Alpha	0 - 500,000 cpm	1 dpm
Pressurized Ion Chamber	1	Gamma	0 - 100 mR/hr	~ 3μR/hr Δ0.5 μR/hr @ 10 min count
Computer-Based Auto Sample Counter Tennelec LB5100W	1	Alpha-Beta	0 - 99,999,999 cpm	1 dpm
Computer-Based Multichannel Analyzer- NaI Well Counter	1	Gamma Spectrum		Being evaluated

Table 6.3 T-test Factors for Comparing a Survey Data Set and Its Limit

Degrees of Freedom	$t_{.95}$	Degrees of Freedom	$t_{.95}$
1	6.314	19	1.729
2	2.920	20	1.725
3	2.353	21	1.721
4	2 132	22	1.717
5	2 [illegible]15	23	1.714
6	[illegible].943	24	1.711
7	1.895	25	1.708
8	1.860	26	1.706
9	1.833	27	1.703
10	1.812	28	1.701
11	1.796	29	1.699
12	1.782	30	1.697
13	1.771	40	1.684
14	1.761	60	1.671
15	1.753	120	1.658
16	1.746	400	1.649
17	1.740	∞	1.645
18	1.734		

Degrees of freedom is the number of items of data minus 1. For values of degrees of freedom not in the table, interpolate between values listed.

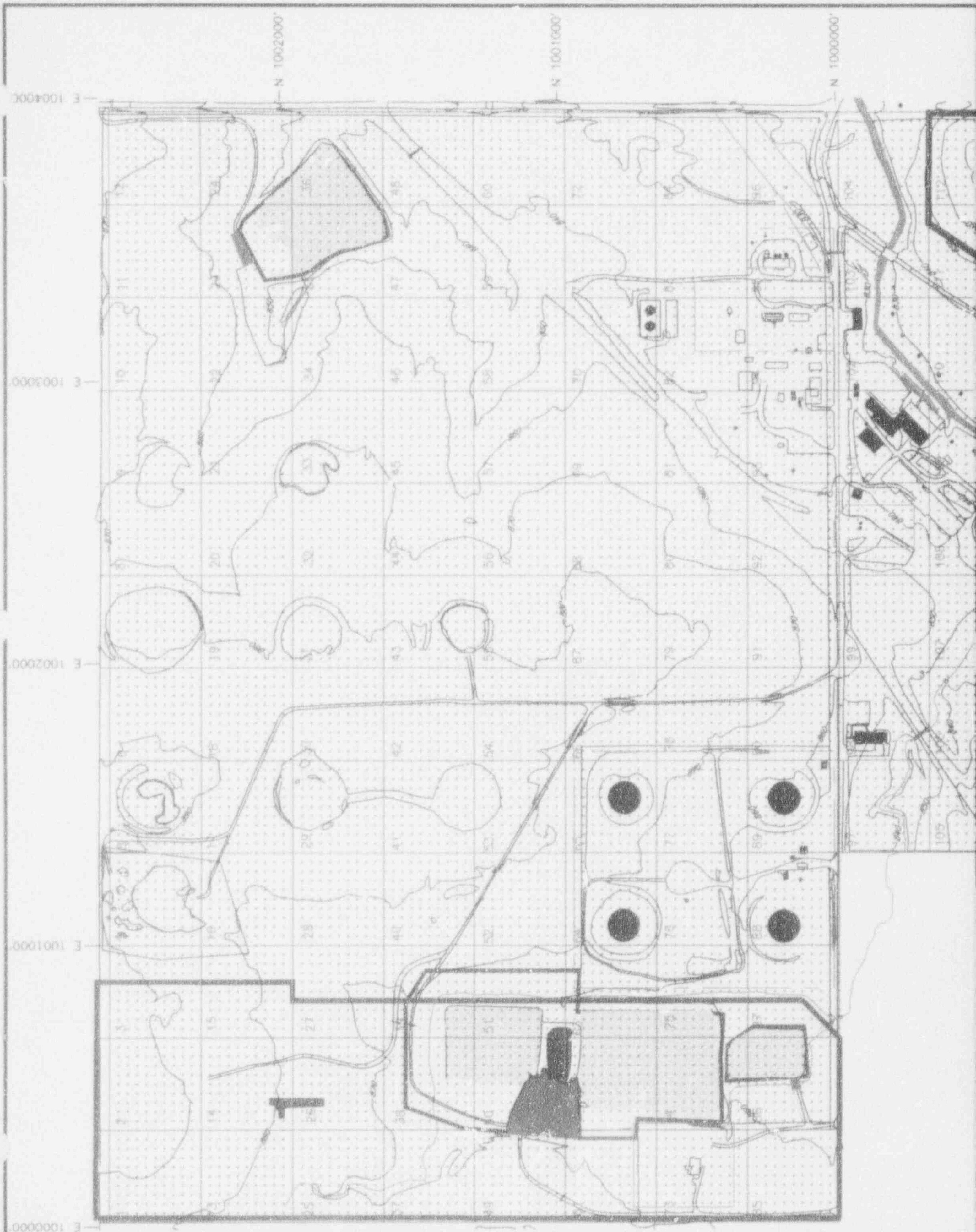
Table 6.4 Potentially Affected Areas

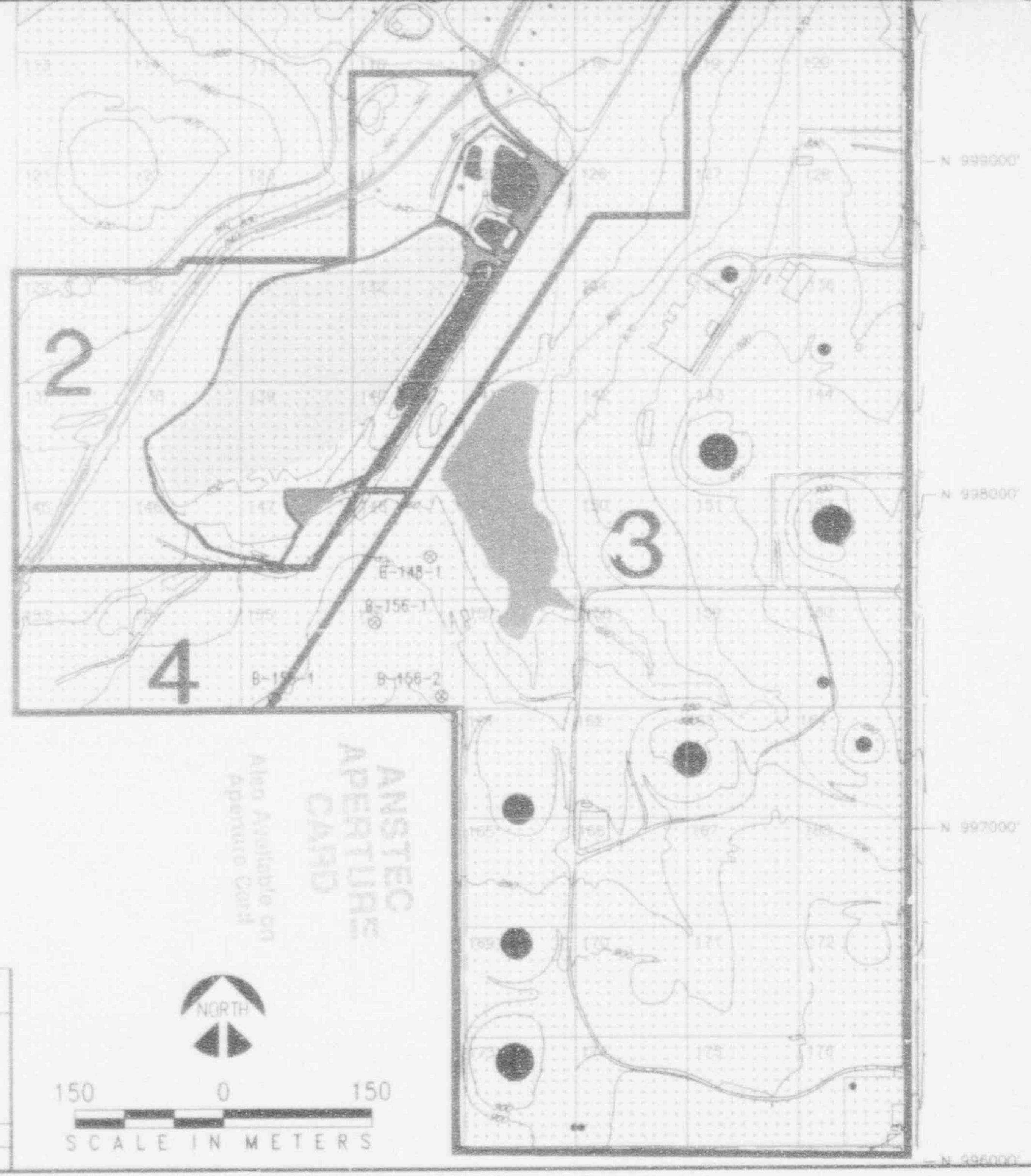
Licensed Material

NW part of Pit 4
Land area adjacent NW side of Pit 4
Refinery tank berms in blocks 7, 29, and 41
Trash dump in block 4
Burial trenches in blocks 10 and 12
Skull Creek downstream of process building to site boundary
Abandoned section of Skull Creek in blocks 103 and 104
Former process buildings A6 and 30 and the Barrel House
Area of former process building 31
Three ditches between process buildings and Skull Creek
Spot of land adjacent the loading dock
Soil and rubble in blocks 121 and 122
Soil and rubble in blocks 113, 114, 121, and 122
Pile of earth in blocks 108 and 109
Rubble in *wash* in block 102
Several spots north of Deep Rock Road
Ditch along the railroad right-of-way in blocks 126 and 133

Naturally Occurring Radioactive Material

Sump adjacent SW end of maintenance building
Pipe storage yard near SW end of maintenance building
Firebrick in several spots in blocks 103, 133, 140, and along the railroad right-of-way


N 1002000'
N 1001000'
N 1000000'
E 1004000'
E 1003000'
E 1002000'
E 1001000'
E 1000000'



9405090171-04

LEGEND

UNAFFECTED AREAS

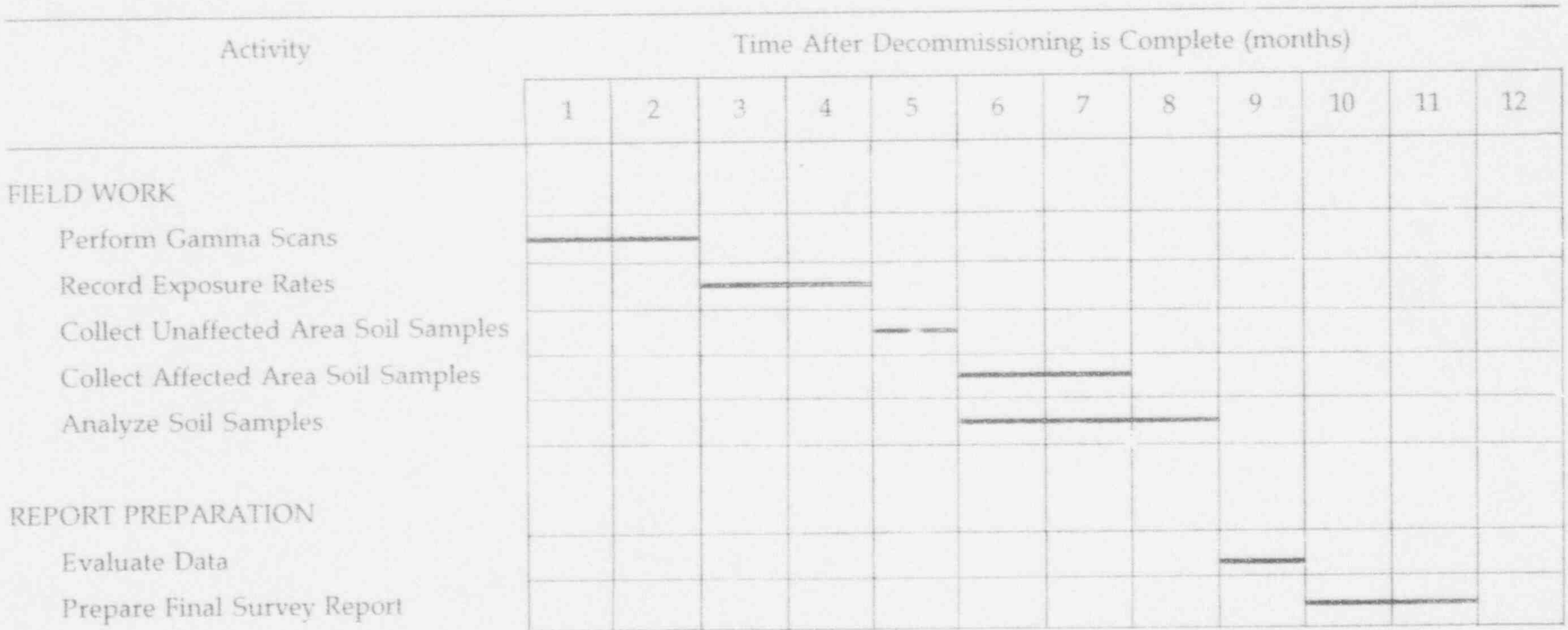
KERR–McGEE CORPORATION

DOCUMENT TITLE:

FIGURE 6.1
CUSHING FACILITY MAP
UNAFFECTED AREAS

PREPARED BY: JL | DWN BY: JE
DRAWING NO.: UNAFF_11 | DATE: 4/21/94

Figure 6.2. Cushing Final Survey Plan Implementation Schedule



Appendix A

Geophysical and Geological Logs

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF OVERSIZE PAGES FILMED ON APERTURE CARDS 4

9405090171-05-08

APERTURE CARD/HARD COPY AVAILABLE FROM

RECORDS AND REPORTS MANAGEMENT BRANCH

SOIL BORING LOG KM-5655-A

B-148-1

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM - TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E-70 S-60 B-148

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
	CLAY, BROWN TO RED BROWN HARD					1		2	2'	SHELBY TUBE
	CLAY RED BROWN, GREEN MOTTLING, HARD					2		4	2'	SHELBY TUBE
						3		4.5	.5"	SHELBY TUBE
5	SANDSTONE, LIGHT BROWN TO TAN		Ss			4		6'		SAMPLES FROM RETURN
	SANDSTONE, LIGHT BROWN BLACK SPECKS, IRON SPECKS		Ss			5		10	3.3'	CORE
10	CLAY, SHALY, SILTY, SANDY INTERBEDDED, LIGHT GREENISH GRAY, BROWN, FISSILE					6		15	4.6'	"
15	SHALE, GRAY, TO DARK GRAY FOSSILS		Sh			7		20	5.0'	"
20	SHALE DARK GRAY		Sh							
	SHALE, DARK GRAY, HIGHLY FOSSILIFEROUS, LARGE PELECPODS		Sh			8		25	5.0'	" EQUIVALENT TO ZONE BY CREEK
25	CLAY, SHALY, RED BROWN LIGHT GRAY MOTTLING									
	CLAY, SHALY, GRAY					9		30	5.0'	"
30	CLAY, SHALY, DARK GRAY									
	CLAY, SHALY, DARK RED GREEN MOTTLING					10		35	3.9'	"
35	SAME AS ABOVE					11		40	5.0'	"
40										

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

SPLIT BARREL; AUGER; ROCK CORE; THIN WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC (PEAT); SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT

DATE DRILLED: 1-20-94
PAGE: 1 of 3
DRILLING METHOD: MUD ROTARY / CORE
DRILLED BY: WINNEK
LOGGED BY: R KRAKOWSKI
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

B-148-1

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION	BORING NUMBER
	KM - TECHNOLOGY	CUSHING, OK	E·70 S·60 B-148

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)
	CLAY/SHALY RED BROWN GREEN MOTTLING (MUDSTONE)		Sh		
45	CLAY/SHALY, SILTY, SANDY RED BROWN, GREEN BROWN ALTERNATING LAYERS		Sh		
	SILTSTONE, RED GREEN MOTTLING		Sh		
50	SANDSTONE, BROWN, CORSE		Ss		
	CLAY/SHALY SILTY, SANDY RED BROWN GREEN BROWN BROWN ALTERNATING LAYERS VARVED		Sh		
55	(MUDSTONE)				
	SANSTONE, TAN, MED TO COURSE GLAUCANITIC		Ss		
60	SHALE LIMESTONE CLASTS PHOSPHORITIC		Ls		
	SHALY CLAY, SILTY, SANDY RED BROWN, GREEN BROWN, BROWN ALTERNATING LAYERS VARVED		Sh		
65	MUDSTONE, RED BROWN GREEN MOTTLING		Sh		
	MUDSTONE, GRAY GREEN, BROWN MOTTLING		Sh		
70	CLAY/SHALE, SILTY, SANDY, RED BROWN, GREEN BROWN VARVED		Sh		
	SHALE, FOSSILIFEROUS, GREEN BROWN		Sh		
	MUDSTONE, GREEN, GRAY, RED BROWN, HARD		Sh		
75	SAME AS ABOVE		Sh		
80					

SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
12		45'	4.6	CORE
13		50'	5.0	"
14		55'	4.7	"
15		60'	4.5	"
16		65'	3.3	"
17		70'	4.2	"
18		75'	5.0	"
19		80'	4.8	"

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL; AUGER; ROCK CORE; THIN-WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC PEAT; SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT

DATE DRILLED	1-19-94
PAGE	2 of 3
DRILLING METHOD	MUD ROTARY/CORE
DRILLED BY	WINNEK
LOGGED BY	R. KRAKOWSKI
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	

B-148-1

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY: KM-TECHNOLOGY

LOCATION: CUSHING, OK

BORING NUMBER: E-70 S-60 B-148

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
80	MUDSTONE, GREEN GRAY, RED BROWN, HARD	Sh			20			5.0	CORE
	MUDSTONE GRAY BLACK	Sh					85'		
85	SANDSTONE, GREENISH TAN	Ss			21			5.0	"
	SILTSTONE, RED BROWN GREEN MOTTLING	Sh					90'		
90	SANDSTONE, GREENISH TAN SAME	Ss			22		95'	5.0	"
95	SANDSTONE TAN	Ss			23			5.0	"
	SANDSTONE/SHALY, TAN	Sh					100'		
100	SANDSTONE, TAN	Ss			24		103.5	3.5	"
	TO 103.5								

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

SPLIT-BARREL | AUGER | ROCK CORE | THIN WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY, DEBRIS FILL, SILT, HIGHLY ORGANIC (PEAT), SAND, SANDY CLAY, GRAVEL, CLAYEY SAND, SILTY CLAY, CLAYEY SILT

DATE DRILLED: 1-20-93

PAGE: 3 of 3

DRILLING METHOD: MUD ROTARY / CORE

DRILLED BY: WINNEK

LOGGED BY: R. KRAKOWSKI

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

B-155-1

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KM- TECHNOLOGY	LOCATION CUSHING, OK	BORING NUMBER E-30, S-90 B-155

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
0–4.5	CLAY, TAN TO LIGHT BROWN		CL			1		2'	1.4'	SHELBY
5	CLAY, GRAY		CL							
10	LIMESTONE		Ls			2				SAMPLED & LOGGED FROM RETURNS
	SANSTONE TAN		Ss							
15	SANDSTONE		Ss							
20	SHALE DARK GRAY		Sh							
25	(MUDSTONE)									SAMPLED & LOGGED FROM RETURNS
30	SHALE DARK GRAY		Sh			3				
35	SHALE, RED (MUDSTONE		Sh							
40										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL — AUGER — ROCK CORE — THIN WALLED TUBE — CONTINUOUS SAMPLER — NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY — DEBRIS FILL — SILT — HIGHLY ORGANIC PEAT — SAND — SANDY CLAY — GRAVEL — CLAYEY SAND — SILTY CLAY — CLAYEY SILT

DATE DRILLED: 1-13-94

DRILLING METHOD: MUD ROTARY

DRILLED BY: WINNEK

LOGGED BY: R. KRAKOWSKI

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

B-155-1

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM-TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E-30 S-90 B-155

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
45	RED SHALE (MUDSTONE)		Sh			4		40'		SAMPLED & LOGGED FROM RETURNS
50										
55	RED SHALE (MUDSTONE)		Sh							
60								60'		
	LIMESTONE GRAY		Ls							
65	SHALE, RED SAND STRINGERS		Sh			5				SAMPLED & LOGGED FROM RETURNS
70										
	LIMESTONE		LS							
75	SHALE RED, SOME GRAY MOTTLING (MUDSTONE)		Sh							
80										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL · AUGER · ROCK CORE · THIN WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY · DEBRIS FILL · SILT · HIGHLY ORGANIC (PEAT) · SAND · SANDY CLAY · GRAVEL · CLAYEY SAND · SILTY CLAY · CLAYEY SILT

DATE DRILLED: 1-13-94
PAGE 2 of 3
DRILLING METHOD: MUD ROTARY
DRILLED BY: WINNEK
LOGGED BY: R. KRAKOWSKI
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM - TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E-30 S-90 B-155

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
80	SHALE, GRAY (MUDSTONE)	Sh							
	LIMESTONE	LS							
85	SHALE GRAY (MUDSTONE)	Sh			6				SAMPLED & LOGGED FROM RETURNS
90									
95	SHALE GRAY (MUDSTONE)	Sh							
100	SANDSTONE TAN	Ss							
105	TD 105'						105'		

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL; AUGER; ROCK CORE; THIN-WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC PEAT; SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT

DATE DRILLED	1-13-94
PAGE	3 of 3
DRILLING METHOD	MUD ROTARY
DRILLED BY	WINNEK
LOGGED BY	R. KRAKOWSKI
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

B-156-1

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM-TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E-20, S.20 B-156

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	TYPE	DEPTH	REC	REMARKS OR FIELD OBSERVATIONS
	CLAY, DARK RED BROWN, HARD		CL			1		2	1.2	SHELBY TUBE
	SILTSTONE, TAN, RED BROWN					2		3.5	1.5	SHELBY TUBE
	CLAY, SILTY, SANDY, RED BROWN TAN MOTTLING		CL			3		4.0	.2	SHELBY TUBE
5	SAND, SILTY, TAN, SOFT		SM							SHEEN ON WATER
	SHALE, BROWN (MUD STONE		Sh							PID 1.6 FROM TANK ON WATER
10	SAME AS ABOVE					4				PVC CASING
	LIMESTONE, GRAY, HARD		Ls							6" PVC CASING SET AT 20'
15	SHALE, GRAY (MUDSTONE)		Sh					20		SAMPLES LOGGED FROM RETURN
20										
25	SHALE, GRAY (MUDSTONE)		Sh			5				SAMPLES LOGGED FROM RETURN
30										
35	SHALE, GRAY		Sh					40		
40										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL; AUGER; ROCK CORE; THIN WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC (PEAT); SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT

DATE DRILLED: 1-12-94
PAGE 1 of 4
DRILLING METHOD: MUD ROTARY
DRILLED BY: WINNEK ENVIRONMENTAL
LOGGED BY: R. KRAKOWSKI
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

B-156-1

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM-TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E-20, S-20 B-156

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
40–55	SHALE - RED BROWN (MUD STONE)		Sh							SAMPLED LOGGED FROM RETURNS
	SHALE - RED BROWN		Sh			6				
55–60	SHALE - RED TO GRAY (MUDSTONE)		Sh							
60–65	SHALE - LIGHT BROWN (MUDSTONE)		Sh							
65–70	SHALE - RED (MUDSTONE)		Sh							SAMPLED LOGGED FROM RETURNS
70–80	SHALE - RED TO GRAY (MUDSTONE)		Sh			7				

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL; AUGER; ROCK CORE; THIN-WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC (PEAT); SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT

DATE DRILLED: 1-12-94
PAGE: 2 of 4
DRILLING METHOD: MUD ROTARY
DRILLED BY: WINNEK ENVIRONMENTAL
LOGGED BY: R. KRAKOWSKI
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM - TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E-20 S-20 B-156

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
80	SHALE, GRAY (MUDSTONE)		Sh						80'	
	LIMESTONE, GRAY		Ls							
85	SHALE, GRAY (MUDSTONE)		Sh			8				SAMPLES LOGGED FROM RETURNS
90	SHALE, GRAY - RED BROWN (MUDSTONE)		Sh							
95	SHALE, GRAY - RED BROWN SOME SANDSTONE, GRAY TAN, SILTY		Sh						100'	
100	SANDSTONE, SILTY BROWN TO LIGHT BROWN		Ss							
	SHALE, GRAY, RED BROWN		Sh							SAMPLES LOGGED FROM RETURNS
105	SANDSTONE, SILTY, BROWN TO LIGHT BROWN		Ss							
	SHALE, GRAY, RED BROWN SOME SANDSTONE		Sh			9				
110	SANDSTONE, LIGHT TAN SILTY		Ss							
115	SAME AS ABOVE		Ss							
120										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL; AUGER; ROCK CORE; THIN WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND: CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC PEAT; SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT

DATE DRILLED: 1-12-94
PAGE: 3 of 4
DRILLING METHOD: MUD ROTARY
DRILLED BY: WINNEK
LOGGED BY: R. KRAKOWSKI
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

B-156-1

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM· TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E-20 S-20 B-156

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
120	SANDSTONE, LIGHT TAN	Ss			10		120		SAMPLES LOGGED FROM RETURNS
125		Ss							
130	SANSTONE, BROWN, HARD LIMESTONE, SHALE, CHERTY LINE	Ls Sh Ss							
	SHALE, GRAY (MUDSTONE)	Sh							
135	LIMESTONE, GRAY	Ls							
140	SHALE GRAY (MUDSTONE)	Sh					140		
145	SHALE TAN (MUDSTONE SHALE GREEN SHALE GRAY (MUDSTONE	Sh			11				SAMPLES LOGGED FROM RETURNS
150	SHALE GRAY	Sh							
155	CHERTY LIMESTONE, GRAY SHALE	Ls					155		

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL; AUGER; ROCK CORE; THIN-WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC (PEAT); SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT

DATE DRILLED: 1-12-94

PAGE: 4 of 4

DRILLING METHOD: MUD ROTARY

DRILLED BY: WINNEK

LOGGED BY: R KRAKOWSKI

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

B-156-2

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM-TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E-80 S-90 B-156

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
0–4	TAN CLAY & SANDSTONE MIX	CL			1, 2			SHELBY TUBES
5	CLAY, RED BROWN SOME SANDSTONE MIX	CL			3			
	CLAY, RED BROWN TO TAN	CL						
10	MUDSTONE/SILTSTONE TAN TO BROWN	Sh						SAMPLED & LOGGED FROM RETURNS
	CLAY, TAN, BROWN, GREEN MOTTLING	CL						
15	SANDSTONE, TAN TO LIGHT BROWN	Ss					20	
20	SAME							
25	SHALE GRAY (MUDSTONE)	Sh			4			SAMPLED & LOGGED FROM RETURNS
30	SHALE GRAY (MUDSTONE)	Sh						
35–40	SAME AS ABOVE						40	

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL; AUGER; ROCK CORE; THIN-WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY; SILT; SAND; GRAVEL; SILTY CLAY; CLAYEY SILT; DEBRIS FILL; HIGHLY ORGANIC (PEAT); SANDY CLAY; CLAYEY SAND

DATE DRILLED: 1-19-94

PAGE: 1 of 3

DRILLING METHOD: MUD ROTARY

DRILLED BY: WINNEK

LOGGED BY: R. KRAKOWSKI

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: KM-TECHNOLOGY	LOCATION: CUSHING, OK	BORING NUMBER: E 80 S 90 B-156

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
40	SHALE RED (MUDSTONE)		Sh							
45	SHALE RED (MUDSTONE)		Sh			5				SAMPLED FROM RETURNS
50										
55	SANDSTONE, TAN		Ss							
	SANDSTONE & RED SHALE INTERBEDED		Ss					60'		
60			Ss							
	SANDSTONE, BROWN TO RED BROWN HARD		Ss							
65	SANDSTONE TAN-GREEN, SOFT INTERBEDED CLAY, RED		Ss							
	CLAY/SHALE (MUDSTONE) RED BROWN		Sh							SAMPLED FROM RETURNS
70	SHALE RED BROWN, GREEN MOTTLING (MUDSTONE)		Sh			6				
	SHALE GRAY/GREEN LIMESTONE STREAKS		Sh							
75	SHALE, RED BROWN (MUDSTONE)		Sh							
	SHALE, GRAY		Sh							
80	SHALE, BLACK		Sh					80'		

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL; AUGER; ROCK CORE; THIN WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND: CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC (PEAT); SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT

DATE DRILLED: 1-14-94
PAGE: 2 of 3
DRILLING METHOD: MUD ROTARY
DRILLED BY: WINNEK
LOGGED BY: R. KRAKOWSKI
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KM · TECHNOLOGY	LOCATION CUSHING, OK	BORING NUMBER E-80 S-90 B-156

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
85	SHALE, BROWN SAND & LIME STREAKS		Sh Ls Sh					85		
90	SHALE, BLACK, HARD LIME AND SAND STREAKS		Sh Ls Sh							SAMPLED & LOGGED FROM RETURNS
95	SHALE, BROWN, SILTY, SANDY STREAKS		Sh			7				
100	SHALE, BROWN, SILTY SANDY, STREAKS		Sh							
105	SHALE, GRAY		Sh					105		

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO Identifies Sample by Number
TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY · DEBRIS FILL · SILT · HIGHLY ORGANIC PEAT · SAND · SANDY CLAY · GRAVEL · CLAYEY SAND · SILTY CLAY · CLAYEY SILT

DATE DRILLED: 1-14-94
PAGE: 3 of 3
DRILLING METHOD: MUD ROTARY
DRILLED BY: WINNEK
LOGGED BY: R KRAKOWSKI
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

Appendix B

Environmental Radioactivity Pathway Analysis

APPENDIX B
ENVIRONMENTAL RADIOACTIVITY PATHWAY ANALYSIS

Introduction

The planned site cleanup involves placement of materials containing concentrations of radioactive material exceeding the BTP Option 1 limit in an engineered disposal cell onsite. The cell is intended to minimize migration in groundwater, minimize intrusion potential, minimize migration of radon gas to the surface, and maintain long-term stability (assumed for this analysis) to the extent practical. Cell contents will include various material forms including soils, rubble, asphaltic materials, and miscellaneous materials that can be considered to be soils. These materials may contain enriched or depleted uranium, refined natural thorium, and naturally-occurring radioactive material (NORM) containing radium. Cell contents may also include radioactive decay products of these nuclides that can be expected to grow in over during the time period of interest. Cell design and performance can limit, and, in some instances, practically eliminate, radiation exposure to members of the public from radioactive materials placed in the cell.

The primary purpose of this pathway analysis is to develop a preliminary estimate of the maximum acceptable concentrations of thorium, uranium, and radium nuclides in materials that might be placed in the disposal cell, taking into account radiation doses that might result from those nuclides and their radioactive progeny. The secondary purpose is to establish minimum acceptable cover thicknesses for materials containing aged natural thorium and radium-226, respectively.

Within the context of NRC regulation of decommissioning, pathway analysis includes the estimation of radiation doses that might be received by a typical member of a small group of people from use of the site as far as 1,000 years into the future. Thus, this analysis considers not only the current conditions at the site, but projected conditions as well. The analysis evaluates potential uses of the site and potential migration of radioactive materials through the environment over time, taking account of both natural processes and human activities that could be expected to alter the patterns or rates of contaminant movement.

Disposal Cell Design Key Assumptions

Disposal cell location and design specifications assumed for planning purposes are discussed in §3.5. The dimensions of disposed soil and rubble in the cell are assumed to be 50 m x 50 m x 3 m deep. The top of the radioactive material deposit is assumed to be 3.05 m (10 ft) beneath the surface. A low-permeability (10^{-8} cm/s) clay-soil cover 1.22 m (4 ft) thick is assumed to be located immediately above the waste. The top of the cover would be 1.83 m (6 ft) beneath the surface. If any Ra^{226} -bearing NORM is put into the cell, it is assumed that it will be placed in the lower third of the disposal cell to gain maximum benefit of overlying materials in attenuating the emanation of radon-222.

ASSESSMENT METHODOLOGY

The pathway analysis process consists of three-steps: 1) development of exposure scenarios based on anticipated site conditions and uses; 2) use of a mathematical model with simplified representations of site physical conditions and potentially exposed populations to calculate future exposures and radiation doses as a function of time and as a function of concentration of nuclides in the waste material for the specified scenarios; and 3) computation of maximum acceptable waste concentrations based on maximum acceptable dose and the calculated relationship between dose and waste concentration.

This section describes the mathematical model used to compute the relationship between doses and concentrations of nuclides in waste materials, important site-specific input data, and the computer code run sequence developed to accomplish the assessment.

Mathematical Model Selection

Potential future radiation doses are computed from estimates of potential radioactive material intake rates and radiation exposure rates. The computation of contaminant concentrations in media and radiation doses associated with exposure to those media is complex, and is usually performed using computer codes designed for the purpose. RESRAD code version 5.04[1] was selected as suitable for evaluation of all pathways in this case. This code was developed by the U.S. Department of Energy for deriving residual radioactive material guidelines for its sites. The RESRAD code computes radiation doses from internal exposure via inhalation and or ingestion using dose factors developed from current methodology, specifically those in Federal Guidance Report 11[2]. In conformance with this guidance, the term *dose*, as it is used in this report, means *committed effective dose equivalent* (CEDE) in reference to doses from internal exposure, *deep dose* in reference to external exposure, and *total effective dose equivalent* (TEDE) in reference to combined internal and external exposure. Doses totaled over all applicable exposure pathways are computed as a function of time after license termination over a period up to 1,000 years for each potentially important receptor. The peak value for each receptor is retained.

Environmental Exposure Pathways

People could conceivably receive radiation doses through either internal or external exposure. In external exposure, the body absorbs radiation emitted by radioactive material outside the body. For example, radioactive materials deposited on the ground surface can irradiate a person standing on the contaminated ground if the radiation emitted is sufficiently penetrating to reach internal body tissues. In internal exposure, the body absorbs radiation emitted by radioactive material that has been inhaled in air, or ingested in food or water. In general, the level of the radiation dose received decreases as the

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1 Yu, C., *et.al., Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0*, ANL/EA/RP-8133, September 1993.

2 Eckerman, K., *et. al., Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*. Fed Guidance Rpt No. 11. EPA-520/1-88-20, Sept. 1988.

quantity of radioactive material available for exposure decreases, but the exact relationships are sometimes complex. External radiation exposure can be mitigated by dilution of the source material, by increasing the distance between the receptor and the source, by limiting exposure time, and by shielding, i.e., the placement of radiation-absorbing material between the receptor and the source. Internal exposure can be best mitigated by isolation or dilution of the source material to minimize inhalation or ingestion of radioactive material.

General Pathways. A comprehensive set of possible general exposure pathways for consideration in dose assessment was developed based on the nuclides of interest, the anticipated distribution of the nuclides on the site, potential uses of the site, and potential environmental migration pathways. This compilation is:

1. Ground
   - Direct radiation from gamma-emitting nuclides in soil
2. Dust
   - Suspension of surface particulate material--air--inhalation
3. Radon (water independent)
   - Release of radon gas from radioactive material in near-surface soils--ingrowth of airborne particulate radon daughter products--inhalation
4. Plant (water independent)
   - Suspension 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)
   - Suspension 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
8. Fish
   - Release of materials in soil to water flowing through the site--runoff to surface water--uptake in aquatic life--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

A suitable subset of this list can be taken as a complete list of exposure pathways for any particular exposure scenario.

Scenarios for Engineered Cell. Depending on potential uses of land and groundwater resources, people might conceivably be exposed to radioactive materials in the cell on the Cushing site in a number of ways. The site is a 440-acre industrial site in a rural setting. Use of the land in the near future is most likely to be similar to the present industrial use. However, over the 1,000-year period of interest, redevelopment for farming and residential use may occur, increasing potential for exposure to disposed soil and rubble. Use of groundwater for domestic purposes or for irrigation is considered feasible, but unlikely pathway because of the very long time to migrate to the uppermost aquifer beneath the cell. Excavation into the soil above the disposed material or construction of a well through it would be considered an intrusion.

Considering conceivable land and water uses, exposure to residual radioactive material in soils on the site could possibly occur through one or more of three terrestrial pathways, depending on the location of soils containing residual radioactive material with respect to the ground surface. If residual radioactive material were contained in soil near the ground surface, exposure could occur by irradiation directly from radioactive material in the soil, from inhalation of dust containing residual radioactive material suspended 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. In the cases involving groundwater use, 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.

A number of site-specific exposure scenarios have been developed to identify the hypothetical receptor likely to receive the maximum dose. These scenarios allow for varying levels of disturbance of the contaminated materials by human action, so that the potential impact of isolation by administrative action can be examined. Each scenario consists of a set of exposure pathways and particular site conditions that might occur for a particular hypothetical receptor engaged in activities that cause him to be exposed to radioactive materials either in place or in transport, due either to his actions or to natural processes. Two *base case* scenarios have been developed to represent the most probable use. In addition, two scenarios have been developed for purposes of sensitivity analysis. These are considered scenarios of intrusion and much less likely to occur than the base case scenario.

These scenarios are:

- Base Cases:

  - Farm product consumer (**FPC**):
    Land above waste is used only for agricultural purposes. No residence or activity resulting in excavation or well construction through the waste is permitted. The land above the disposal cell is assumed to provide the exposed person either his entire diet or as much of it as can be produced from the limited land area.

  - Farm worker (**FW**):
    An agricultural worker works for 2,000 hr/yr on the land above the disposal cell, where he is assumed to be exposed to airborne dust, radon progeny, and direct radiation.

- Sensitivity Analysis Cases:

  - Resident farmer, house with basement (**RFB**):
    A farm family is assumed to reside in a house built on the land over the waste and to grow agricultural products on the land for their own consumption. The house is assumed to have a basement, the floor of which is 6 ft below the surface and 4 ft above the waste. The family is assumed to consume water from a well drilled at the edge of the waste cell and screened in the uppermost sandstone layer beneath the engineered cell. This case is considered to be an intrusion scenario.

  - Resident farmer, house with no basement (**RFS**):
    A farm family is assumed to reside in a house built on the land over the waste and grows agricultural products on the land for their own consumption. The house has no basement, but is built on a slab at the surface. The family is assumed to consume water from a well drilled at the edge of the waste cell and screened in the uppermost sandstone layer beneath the engineered cell. This case is considered to be an intrusion scenario.

The exposure pathways assumed to be associated with each exposure scenarios are identified in Table 3.6.

<u>Evaluation of Irradiation Through Soil Cover</u>

Results presented in Figure 3.5 are based on assumption of occupancy 0.5 of the time. These results are probably slightly low for a scenario that includes a house on a surface slab and somewhat high for a scenario that includes a house with a basement. The occupancy factor is the sum of the indoor and outdoor occupation time fractions, typically considered to be 0.25 and 0.5 respectively, each weighted by a factor representing dose reduction due to structural materials. This factor is considered to be 1.0 for outdoor exposure and, typically, 0.7 for indoor exposure, leading to a default occupancy factor of about 0.6 in RESRAD. For a scenario involving a basement, the floor of which is below the surface but above the contaminated material, the cover thickness and occupancy factor must be specified carefully. Specifying the distance between the surface and the top of the contaminated zone as the cover thickness with use of the default occupancy factor will cause underestimation of external dose and radon progeny inhalation dose by overestimating attenuation of the indoor dose. Specifying the distance between the basement floor and the top of the contaminated zone as the cover thickness with use of the default occupancy factor will cause overestimation of external dose and radon progeny inhalation dose by underestimating the attenuation of the outdoor dose. The best compromise is the use of the distance between the basement floor and the top of the contaminated zone as the cover thickness and occupancy factors designed to correct the overestimate of outdoor dose. As a consequence, the results in Figure 3.5 apply strictly only to the case of a house on a surface slab but can be fit to cases with basements above the contaminated zone by scaling the results to an adjusted occupancy factor. The most appropriate values for the occupancy factor would be about 0.6 for the surface slab case and about 0.35 for the basement case.

Evaluation of Groundwater Migration Pathways

The concentration of radionuclides in ground water was computed using RESRAD's mass balance option. The low rate of infiltration through the cover makes use of this approach conservative without being unduly restrictive in this case. This option is based on the assumption that the entire release of radionuclides reaching ground water in a particular year will be withdrawn by a well located on site. If the volume of leachate reaching the water table in a particular year is less than the volume of water withdrawn by the well during that year, the ratio of the volume of leachate to the volume of ground water withdrawn from the well is used as a dilution factor. If the volume of leachate is greater than or equal to the volume of water withdrawn from the well, no dilution is assumed. RESRAD's default assumption for the volume of water withdrawn annually from an on-site well is 250 m^3 /yr. This is roughly equivalent to 180 g/d, which is a conservative estimate for average family use given total domestic water requirements.

Application of this method requires an estimate for the amount of water infiltrating through the buried material. An estimate of the infiltrating volume of water was obtained by assuming a unit gradient across the low-permeability barrier placed immediately above the buried material. Assuming a saturated hydraulic conductivity of 10^{-8} cm/sec, the annual infiltration rate through this barrier is 3.15 x 10^{-3} m (0.124 in). Based on a surface area of 2500 m^2 , the total infiltration through the barrier is 7.88 m^3/y. Using RESRAD's default well withdrawal rate, a dilution factor of 0.032 is obtained. RESRAD computes infiltration through buried material by applying runoff and evapotranspiration coefficients to the infiltration and irrigation rates. To obtain the infiltration rate, the precipitation and irrigation rates and the runoff and evapotranspiration coefficients entered into RESRAD were manipulated to produce an infiltration rate of 3.15 x 10^{-3} m. For runs assuming no irrigation, the precipitation rate was set to 1 m/y, the irrigation rate was set to 0 m/y, and the runoff and evapotranspiration coefficients were set to 0.99685 and 0, respectively. F[illegible]ns assuming irrigation, the precipitation rate was set to 0.8 m/y, the irrigation rate was set to 0.[illegible] and the runoff and evapotranspiration coefficients were set to 0 and 0.99685, respectively.

Concentrations of radionuclides in the leachate leaving the burial cell at any point in time are computed by RESRAD using distribution coefficients (K_d) and concentrations of radionuclides in the buried material at that time. RESRAD's default K_d were used for the buried material.

The first significant sandstone lens below the cell was treated as the water table aquifer in the ground-water pathway analysis. The thick mudstone deposits between the bottom of the cell and the first significant sandstone layer were treated as an unsaturated zone in the RESRAD model. However, the saturated hydraulic conductivity of this material was specified to be 3.15 x 10^{-3} m/y (10^{-8} cm/s), effectively saturating the material based on the infiltration rate established above. While data identifying the total and effective porosity of the mudstone are not available, conservative values of 0.2 and 0.05 were used for total and effective porosity, respectively. These values were chosen so as to minimize the retardation coefficient and maximize the interstitial velocity of ground water in the mudstone, within reasonable limits. A thickness of 20 m was conservatively assumed for this zone.

The identification of an appropriate value for the K_d for each radionuclide in the mudstone is preliminary. The mudstone is composed, in large part, of fine grained particles, including a high percentage of clay particles, and could exhibit a high degree of adsorption. However, the consolidation and limited cementation that this material has undergone can reduce the ability of the material to adsorb radionuclides. Consequently, a range of K_d values was assumed to evaluate the effect of this parameter on the dose received from the ground water pathway. These values ranged from 0 ml/g, indicating no partitioning of radionuclides to the solid phase, to as high as 60,000 ml/g, and included default RESRAD values. Since the mass balance option for computing dilution factors in ground water does not depend on the parameters specified for the aquifer, default RESRAD values were assumed for the water table aquifer.

To repeat, the first significant sandstone lens below the cell was treated as the water table aquifer in the groundwater pathway analysis. Leachate flow from the cell into RESRAD's default well withdrawal rate resulted in an estimated dilution factor of 0.032. Analysis of radionuclide migration times from the cell to the top of the first extensive sandstone layer indicated that, with minimal K_d, arrival times would easily exceed 1000 years. While the potential impact on the water dependent pathways was included by specifying that all irrigation water as well as potable water be obtained from an intruding on-site well. RESRAD analyses predict no impact on water-dependent pathways due to the long radionuclide travel times to the sandstone unit.

When considering the prospect of radionuclide migration to surface water, the eventual discharge of any leachate reaching the first extensive sandstone layer to Skull Creek is a conceivable pathway. While not necessarily the shortest route to the creek, the migration time via this sandstone lens would likely be the least given the steep vertical gradient expected above the layer and the apparently extensive nature of the sandstone. Earlier arrival or radionuclides at Skull Creek via a shallower ground-water pathway does not seem plausible because of the low horizontal gradients and the low permeability of the mudstone deposits between the bottom of the cell and the sandstone layer.

A dilution factor for leachate from the cell transported by groundwater into Skull Creek can similarly be estimated as the ratio of the flow of leachate out of the cell to the average flow of the creek.

Assuming a minimal average flow in Skull Creek of 1.0 gpm, the estimated dilution factor would be 0.004. Even if groundwater-to-surface water pathways were complete, dilution in Skull Creek would be much greater and radionuclide migration times would be longer than into well water. Thus an exposure scenario involving water drawn from Skull Creek would, if anything, estimate even less potential for dose than water drawn from a nearby well. As a result analysis using RESRAD does not seem necessary and has not been included.

RESRAD Case Sequence

Two RESRAD cases were computed for each of the four scenarios examined. In the first of the cases, the material assumed to be deposited in the cell contained 1 pCi/g each of Th^{232}, U^{238}, U^{235}, U^{234}, and Ra^{226}, and the material was assumed to be distributed uniformly over the entire 3 m depth of the cell. These cases are summarized in Appendix B as:

Table KMCFPC1	Farm Product Consumer Base Case
Table KMCFW1	Farm Worker Base Case
Table KMCRFB1	Resident Farmer, House With Basement
Table KMCRFS1	Resident Farmer, House Without Basement

In the second run of each of these cases, the material assumed to be deposited in the cell contained 1 pCi Ra^{226}/g, and the material was assumed to be distributed uniformly over the bottom third (1 m) of the depth of the cell.

Several sensitivity analyses were performed. Two sequences of RESRAD runs were executed to examine the sensitivity of doses from certain nuclides and pathways to the thickness of soil cover between the top of the contaminated material and the receptor above. The first sequence examined the effect of cover thickness on external dose from Th^{232} and progeny. The first run in the sensitivity analysis, at 0.01 meter soil cover, is summarized in Appendix B as Table KMCSH1A for the model using irradiation-to-dose conversion factors by Kocher and Sjoreen and as Table KMCSH2A for the model using factors by Chen. The second sensitivity analysis examined the dose from inhalation of radon-222 progeny as a function of soil cover thickness. The first run in the analysis, assuming no soil cover, is summarized in Table KMCSH3A. Another parametric analysis examined the effect of K_d in the zone between the bottom of the cell and the top of the uppermost aquifer on the time required to migrate through the zone and on the migration distance in 1,000 years. The input data for the sequence and the computed transport times for various nuclides to migrate to the uppermost aquifer are in Table KMCSH5E.

Table KMCFPC1

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCFPC1

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCFPC1

Dose Conversion Factor (and Related) Parameter Summary

0 Menu	Parameter	Current Value	Default	Parameter Name
A-1	Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3)			
A-1	Ac-227+D , soil density = 1.0 g/cm**3	2.760E+00	2.760E+00	DCF1(1,1)
A-1	Ac-227+D , soil density = 1.8 g/cm**3	1.520E+00	1.520E+00	DCF1(1,2)
A-1				
A-1	Pa-231 , soil density = 1.0 g/cm**3	2.210E-01	2.210E-01	DCF1(2,1)
A-1	Pa-231 , soil density = 1.8 g/cm**3	1.210E-01	1.210E-01	DCF1(2,2)
A-1				
A-1	Pb-210+D , soil density = 1.0 g/cm**3	4.870E-03	4.870E-03	DCF1(3,1)
A-1	Pb-210+D , soil density = 1.8 g/cm**3	2.310E-03	2.310E-03	DCF1(3,2)
A-1				
A-1	Ra-226+D , soil density = 1.0 g/cm**3	1.550E+01	1.550E+01	DCF1(4,1)
A-1	Ra-226+D , soil density = 1.8 g/cm**3	8.560E+00	8.560E+00	DCF1(4,2)
A-1				
A-1	Ra-228+D , soil density = 1.0 g/cm**3	8.180E+00	8.180E+00	DCF1(5,1)
A-1	Ra-228+D , soil density = 1.8 g/cm**3	4.510E+00	4.510E+00	DCF1(5,2)
A-1				
A-1	Th-228+D , soil density = 1.0 g/cm**3	1.330E+01	1.330E+01	DCF1(6,1)
A-1	Th-228+D , soil density = 1.8 g/cm**3	7.360E+00	7.360E+00	DCF1(6,2)
A-1				
A-1	Th-230 , soil density = 1.0 g/cm**3	2.110E-03	2.110E-03	DCF1(7,1)
A-1	Th-230 , soil density = 1.8 g/cm**3	1.030E-03	1.030E-03	DCF1(7,2)
A-1				
A-1	Th-232 , soil density = 1.0 g/cm**3	1.350E-03	1.350E-03	DCF1(8,1)
A-1	Th-232 , soil density = 1.8 g/cm**3	6.040E-04	6.040E-04	DCF1(8,2)
A-1				
A-1	U-234 , soil density = 1.0 g/cm**3	1.580E-03	1.580E-03	DCF1(9,1)
A-1	U-234 , soil density = 1.8 g/cm**3	6.970E-04	6.970E-04	DCF1(9,2)
A-1				
A-1	U-235+D , soil density = 1.0 g/cm**3	8.940E-01	8.940E-01	DCF1(10,1)
A-1	U-235+D , soil density = 1.8 g/cm**3	4.900E-01	4.900E-01	DCF1(10,2)
A-1				
A-1	U-238+D , soil density = 1.0 g/cm**3	1.270E-01	1.270E-01	DCF1(11,1)
A-1	U-238+D , soil density = 1.8 g/cm**3	6.970E-02	6.970E-02	DCF1(11,2)
A-3	Depth factors, ground external gamma, dimensionless			
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(1,1,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(1,2,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,1)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.100E-01	9.100E-01	FD(1,1,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,2)
A-3				
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(2,1,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 1.5 m	1.000E+00	1.000E+00	FD(2,3,1)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = .15 m	9.200E-01	9.200E-01	FD(2,1,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(3,1,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,1)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.700E-01	9.700E-01	FD(3,1,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,2)
A-3				
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.300E-01	6.300E-01	FD(4,1,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.200E-01	9.200E-01	FD(4,2,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,1)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(4,1,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(4,2,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,2)
A-3				
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.800E-01	6.800E-01	FD(5,1,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(5,2,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,1)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(5,1,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(5,2,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,2)
A-3				
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.100E-01	6.100E-01	FD(6,1,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.400E-01	9.400E-01	FD(6,2,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,1)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	7.500E-01	7.500E-01	FD(6,1,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(6,2,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,2)
A-3				
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = .15 m	9.300E-01	9.300E-01	FD(7,1,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,1)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(7,1,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,2)
A-3				
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m	9.500E-01	9.500E-01	FD(8,1,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,1)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(8,1,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,2)
A-3				
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = .15 m	9.000E-01	9.000E-01	FD(9,1,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,1)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(9,1,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.700E-01	8.700E-01	FD(10,1,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,1)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(10,1,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+0.	1.000E+00	FD(10,3,2)
A-3				
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.800E-01	7.800E-01	FD(11,1,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,1)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(11,1,2)
*A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,2)
A-3	U-238+D , soil density = 1.2 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,2)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.700E+00	6.700E+00	DCF2(1)
B-1	Pa-231	1.300E+00	1.300E+00	DCF2(2)
B-1	Pb-210+D	2.100E-02	2.100E-02	DCF2(3)
B-1	Ra-226+D	7.900E-03	7.900E-03	DCF2(4)
B-1	Ra-228+D	4.500E-03	4.500E-03	DCF2(5)
B-1	Th-228+D	3.100E-01	3.100E-01	DCF2(6)
B-1	Th-230	3.200E-01	3.200E-01	DCF2(7)
B-1	Th-232	1.600E+00	1.600E+00	DCF2(8)
B-1	U-234	1.300E-01	1.300E-01	DCF2(9)
B-1	U-235+D	1.200E-01	1.200E-01	DCF2(10)
B-1	U-238+D	1.200E-01	1.200E-01	DCF2(11)
D-1	Dose conversion factors for ingestion, mrem/pCi			
D-1	Ac-227+D	1.500E-02	1.500E-02	DCF3(1)
D-1	Pa-231	1.100E-02	1.100E-02	DCF3(2)
D-1	Pb-210+D	6.700E-02	6.700E-03	DCF3(3)
D-1	Ra-226+D	1.100E-03	1.100E-03	DCF3(4)
D-1	Ra-228+D	1.200E-03	1.200E-03	DCF3(5)
D-1	Th-228+D	7.500E-04	7.500E-04	DCF3(6)
D-1	Th-230	5.300E-04	5.300E-04	DCF3(7)
D-1	Th-232	2.800E-03	2.800E-03	DCF3(8)
D-1	U-234	2.600E-04	2.600E-04	DCF3(9)
D-1	U-235+D	2.500E-04	2.500E-04	DCF3(10)
D-1	U-238+D	2.500E-04	2.500E-04	DCF3(11)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(8,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-06	3.400E-04	RTF(10,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(10,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E-01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and moll.sks	[illegible].500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Th-228+D , fish	1.00[illegible]E+02	[illegible].000E+02	BIOFAC(6,1)
D-5	Th-228+D , crustacea and mollusks	5.[illegible]00E-02	[illegible].000E+02	BIOFAC(6,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(8,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(8,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(10,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(10,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.500E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	3.000E+03	---	T(9)
R011	Times for calculations (yr)	not used	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E+00	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-232	1.000E+00	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): U-234	1.000E+00	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): U-235	1.000E+00	0.000E+00	---	S1(10)
R012	Initial principal radionuclide (pCi/g): U-238	1.000E+00	0.000E+00	---	S1(11)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(10)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(11)
R013	Cover depth (m)	3.048E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.969E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	8.000E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	0.000E+00	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	MB	ND	---	MODEL
R014	Individual's use of groundwatrr (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	2.000E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	2.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	5.000E-02	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	3.150E-01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.979E-06	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.474E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.990E-06	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.979E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	not used	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	not used	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	not used	2.500E-01	---	FOTD
R017	Shape factor, external gamma	not used	1.000E+00	---	FS1

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA				
R017	Outer annular radius (m) = √(1/π)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/π)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/π)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/π)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/π)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/π)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/π)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/π)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/π)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/π)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/π)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/π)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.125E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.125E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec)				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

Contaminated Zone Dimensions

Area:	2500.00 square meters
Thickness:	3.00 meters
Cover Depth:	3.05 meters

Initial Soil Concentrations, pCi/g

Ra-226	1.000E+00
Th-232	1.000E+00
U-234	1.000E+00
U-235	1.000E+00
U-238	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	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

0Maximum TDOSE(t): 0.000E+00 mrem/yr at t = 1.000E+03 years

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

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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 = 0.000E+00 years
Water Dependent Pathways

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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.

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

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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
Water Dependent Pathways

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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.

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

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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 = 3.000E+00 years
Water Dependent Pathways

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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.

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

0
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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+01 years
Water Dependent Pathways

0
0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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

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

0
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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 = 3.000E+01 years
Water Dependent Pathways

0
0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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

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

0
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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+02 years
Water Dependent Pathways

0
0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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

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

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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 = 3.000E+02 years
Water Dependent Pathways

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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

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

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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+03 years
Water Dependent Pathways

0
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated
DSR(j,t) (mrem/yr)/(pCi/g)

0Parent (i)	Product (j)	Branch Fraction	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	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
Ra-226	Pb-210	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
Ra-226	ΣDSR(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
0Th-232	Th-232	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
Th-232	Ra-228	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
Th-232	Th-228	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
Th-232	ΣDSR(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
0U-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
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
U-234	Ra-226	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
U-234	Pb-210	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
U-234	ΣDSR(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
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
U-235	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
U-235	Ac-227	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
U-235	ΣDSR(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
0U-238	U-238	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
U-238	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
U-238	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
U-238	Ra-226	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
U-238	Pb-210	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
U-238	ΣDSR(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

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	*9.882E+11	*9.882E+11	*9.882E+11	9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11	*9.882E+11
Th-232	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05
U-234	*6.233E+09	*6.233E+09	*6.233E+09	*6.233E+09	*6.233E+09	*6.233E+09	*6.233E+09	*6.233E+09
U-235	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06
U-238	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05

*At specific activity limit

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

0Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-226	1.000E+00	1.000E+03	0.000E+00	*9.882E+11	0.000E+00	*9.882E+11
Th-232	1.000E+00	1.000E+03	0.000E+00	*1.092E+05	0.000E+00	*1.092E+05
U-234	1.000E+00	1.000E+03	0.000E+00	*6.233E+09	0.000E+00	*6.233E+09
U-235	1.000E+00	1.000E+03	0.000E+00	*2.160E+06	0.000E+00	*2.160E+06
U-238	1.000E+00	1.000E+03	0.000E+00	*3.360E+05	0.000E+00	*3.360E+05

*At specific activity limit

Table KMCFW1

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCFW1

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCFW1

Dose Conversion Factor (and Related) Parameter Summary

0 Menu	Parameter	Current Value	Default	Parameter Name
A-1	Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3)			
A-1	Ac-227+D , soil density = 1.0 g/cm**3	2.760E+00	2.760E+00	DCF1(1,1)
A-1	Ac-227+D , soil density = 1.8 g/cm**3	1.520E+00	1.520E+00	DCF1(1,2)
A-1				
A-1	Pa-231 , soil density = 1.0 g/cm**3	2.210E-01	2.210E-01	DCF1(2,1)
A-1	Pa-231 , soil density = 1.8 g/cm**3	1.210E-01	1.210E-01	DCF1(2,2)
A-1				
A-1	Pb-210+D , soil density = 1.0 g/cm**3	4.870E-03	4.870E-03	DCF1(3,1)
A-1	Pb-210+D , soil density = 1.8 g/cm**3	2.310E-03	2.310E-03	DCF1(3,2)
A-1				
A-1	Ra-226+D , soil density = 1.0 g/cm**3	1.550E+01	1.550E+01	DCF1(4,1)
A-1	Ra-226+D , soil density = 1.8 g/cm**3	8.560E+00	8.560E+00	DCF1(4,2)
A-1				
A-1	Ra-228+D , soil density = 1.0 g/cm**3	8.180E+00	8.180E+00	DCF1(5,1)
A-1	Ra-228+D , soil density = 1.8 g/cm**3	4.510E+00	4.510E+00	DCF1(5,2)
A-1				
A-1	Th-228+D , soil density = 1.0 g/cm**3	1.330E+01	1.330E+01	DCF1(6,1)
A-1	Th-228+D , soil density = 1.8 g/cm**3	7.360E+00	7.360E+00	DCF1(6,2)
A-1				
A-1	Th-230 , soil density = 1.0 g/cm**3	2.110E-03	2.110E-03	DCF1(7,1)
A-1	Th-230 , soil density = 1.8 g/cm**3	1.030E-03	1.030E-03	DCF1(7,2)
A-1				
A-1	Th-232 , soil density = 1.0 g/cm**3	1.350E-03	1.350E-03	DCF1(8,1)
A-1	Th-232 , soil density = 1.8 g/cm**3	6.040E-04	6.040E-04	DCF1(8,2)
A-1				
A-1	U-234 , soil density = 1.0 g/cm**3	1.580E-03	1.580E-03	DCF1(9,1)
A-1	U-234 , soil density = 1.8 g/cm**3	6.970E-04	6.970E-04	DCF1(9,2)
A-1				
A-1	U-235+D , soil density = 1.0 g/cm**3	8.940E-01	8.940E-01	DCF1(10,1)
A-1	U-235+D , soil density = 1.8 g/cm**3	4.900E-01	4.900E-01	DCF1(10,2)
A-1				
A-1	U-238+D , soil density = 1.0 g/cm**3	1.270E-01	1.270E-01	DCF1(11,1)
A-1	U-238+D , soil density = 1.8 g/cm**3	6.970E-02	6.970E-02	DCF1(11,2)
A-3	Depth factors, ground external gamma, dimensionless			
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(1,1,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(1,2,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,1)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.100E-01	9.100E-01	FD(1,1,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,2)
A-3				
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(2,1,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,1)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = .15 m	9.200E-01	9.200E-01	FD(2,1,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(3,1,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,1)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.700E-01	9.700E-01	FD(3,1,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,2)
A-3				
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.300E-01	6.300E-01	FD(4,1,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.200E-01	9.200E-01	FD(4,2,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,1)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(4,1,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(4,2,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,2)
A-3				
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.800E-01	6.800E-01	FD(5,1,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(5,2,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,1)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(5,1,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(5,2,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,2)
A-3				
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.100E-01	6.100E-01	FD(6,1,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.400E-01	9.400E-01	FD(6,2,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,1)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	7.500E-01	7.500E-01	FD(6,1,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(6,2,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,2)
A-3				
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = .15 m	9.300E-01	9.300E-01	FD(7,1,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,1)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(7,1,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,2)
A-3				
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m	9.500E-01	9.500E-01	FD(8,1,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,1)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(8,1,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,2)
A-3				
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = .15 m	9.000E-01	9.000E-01	FD(9,1,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,1)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(9,1,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.700E-01	8.700E-01	FD(10,1,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,1)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(10,1,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,2)
A-3				
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.800E-01	7.800E-01	FD(11,1,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,1)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(11,1,2)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,2)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,2)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.700E+00	6.700E+00	DCF2(1)
B-1	Pa-231	1.300E+00	1.300E+00	DCF2(2)
B-1	Pb-210+D	2.100E-02	2.100E-02	DCF2(3)
B-1	Ra-226+D	7.900E-03	7.900E-03	DCF2(4)
B-1	Ra-228+D	4.500E-03	4.500E-03	DCF2(5)
B-1	Th-228+D	3.100E-01	3.100E-01	DCF2(6)
B-1	Th-230	3.200E-01	3.200E-01	DCF2(7)
B-1	Th-232	1.600E+00	1.600E+00	DCF2(8)
B-1	U-234	1.300E-01	1.300E-01	DCF2(9)
B-1	U-235+D	1.200E-01	1.200E-01	DCF2(10)
B-1	U-238+D	1.200E-01	1.200E-01	DCF2(11)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.500E-02	1.500E-02	DCF3(1)
D-1	Pa-231	1.100E-02	1.100E-02	DCF3(2)
D-1	Pb-210+D	6.700E-03	6.700E-03	DCF3(3)
D-1	Ra-226+D	1.100E-03	1.100E-03	DCF3(4)
D-1	Ra-228+D	1.200E-03	1.200E-03	DCF3(5)
D-1	Th-228+D	7.500E-04	7.500E-04	DCF3(6)
D-1	Th-230	5.300E-04	5.300E-04	DCF3(7)
D-1	Th-232	2.800E-03	2.800E-03	DCF3(8)
D-1	U-234	2.600E-04	2.600E-04	DCF3(9)
D-1	U-235+D	2.500E-04	2.500E-04	DCF3(10)
D-1	U-238+D	2.500E-04	2.500E-04	DCF3(11)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(8,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(10,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(10,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)
D-5				

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Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(8,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(8,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(10,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(10,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)

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Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.500E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	3.000E+03	---	T(9)
R011	Times for calculations (yr)	not used	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E+00	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-232	1.000E+00	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): U-234	1.000E+00	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): U-235	1.000E+00	0.000E+00	---	S1(10)
R012	Initial principal radionuclide (pCi/g): U-238	1.000E+00	0.000E+00	---	S1(11)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(10)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(11)
R013	Cover depth (m)	3.048E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.969E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	8.000E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	0.000E+00	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	6.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	MB	ND	---	MODEL
R014	Individual's use of groundwater (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	2.000E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	2.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	5.000E-02	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	3.150E-03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.979E-06	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.474E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.990E-06	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.979E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-03	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.300E-01	2.500E-01	---	FOTD
R017	Shape factor, external gamma	1.000E+00	1.000E+00	---	FS1

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Outer annular radius (m) = √(1/π)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/π)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/π)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/π)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/π)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/π)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/π)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/π)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/π)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/π)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/π)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/π)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.000E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.125E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.125E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	4.000E-01	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	5.000E-02	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	2.000E-06	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	not used	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	1.500E-01	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

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Summary : KM CUSH-KMCFW1 FULL CELL DEPTH File: KMCFW1.DAT

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2500.00 square meters	Ra-226	1.000E+00
Thickness:	3.00 meters	Th-232	1.000E+00
Cover Depth:	3.05 meters	U-234	1.000E+00
		U-235	1.000E+00
		U-238	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.405E-05	3.407E-05	3.411E-05	3.425E-05	3.465E-05	3.609E-05	4.057E-05	6.129E-05
M(t):	1.135E-06	1.136E-06	1.137E-06	1.142E-06	1.155E-06	1.203E-06	1.352E-06	2.043E-06

0Maximum TDOSE(t): 6.129E-05 mrem/yr at t = 1.000E+03 years

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Summary : KM CUSH-KMCFW1 FULL CELL DEPTH File: KMCFW1.DAT

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

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.
Ra-226	4.928E-13	0.0000	0.000E+00	0.0000	3.405E-05	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	4.630E-28	0.0000	0.000E+00	0.0000	0.000E+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	1.471E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.928E-13	0.0000	0.000E+00	0.0000	3.405E-05	1.0000	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

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.405E-05	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	4.630E-28	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	1.471E-18	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	3.405E-05	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : KM CUSH-KMCFW1 FULL CELL DEPTH File: KMCFW1.DAT

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.
Ra-226	4.974E-13	0.0000	0.000E+00	0.0000	3.407E-05	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.675E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	9.702E-22	0.0000	0.000E+00	0.0000	6.646E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.384E-24	0.0000	0.000E+00	0.0000	0.000E+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	1.489E-18	0.0000	0.000E+00	0.0000	6.924E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.173E-12	0.0000	0.000E+00	0.0000	3.407E-05	1.0000	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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.407E-05	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.675E-12	0.0000
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	6.646E-14	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	1.384E-24	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	1.558E-18	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	3.407E-05	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : KM CUSH-KMCFW1 FULL CELL DEPTH File: KMCFW1.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
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.
Ra-226	5.068E-13	0.0000	0.000E+00	0.0000	3.411E-05	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.133E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	8.901E-21	0.0000	0.000E+00	0.0000	5.991E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	7.082E-26	0.0000	0.000E+00	0.0000	0.000E+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	1.526E-18	0.0000	0.000E+00	0.0000	1.702E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.184E-11	0.0000	0.000E+00	0.0000	3.411E-05	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.411E-05	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.133E-11	0.0000
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	5.951E-13	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	7.082E-24	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	3.228E-18	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	3.411E-05	1.0000

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+01 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.
Ra-226	5.408E-13	0.0000	0.000E+00	0.0000	3.425E-05	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	5.438E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	1.057E-19	0.0000	0.000E+00	0.0000	6.698E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	5.880E-23	0.0000	0.000E+00	0.0000	0.000E+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	1.663E-18	0.0000	0.000E+00	0.0000	6.319E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	5.492E-11	0.0000	0.000E+00	0.0000	3.425E-05	1.0000	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

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.425E-05	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.438E-11	0.0000
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	6.698E-22	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	5.880E-23	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	6.485E-17	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	3.425E-05	1.0000

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+01 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.
Ra-226	6.511E-13	0.0000	0.000E+00	0.0000	3.465E-05	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.085E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	1.152E-18	0.0000	0.000E+00	0.0000	6.133E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	5.112E-22	0.0000	0.000E+00	0.0000	0.000E+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	2.128E-18	0.0000	0.000E+00	0.0000	1.737E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.092E-10	0.0000	0.000E+00	0.0000	3.465E-05	1.0000	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

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.465E-05	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.085E-10	0.0000
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	6.133E-11	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	5.112E-22	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	1.739E-15	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	3.465E-05	1.0000

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+02 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.
Ra-226	1.247E-12	0.0000	0.000E+00	0.0000	3.609E-05	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.976E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	2.502E-17	0.0000	0.000E+00	0.0000	7.242E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	8.177E-21	0.0000	0.000E+00	0.0000	0.000E+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	5.038E-18	0.0000	0.000E+00	0.0000	6.854E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.989E-10	0.0000	0.000E+00	0.0000	3.609E-05	1.0000	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+02 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.609E-05	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.976E-10	0.0000
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	7.242E-10	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	8.177E-21	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	6.854E-14	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	3.609E-05	1.0000

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

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.
Ra-226	7.982E-12	0.0000	0.000E+00	0.0000	4.056E-05	0.9998	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	9.736E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	1.527E-15	0.0000	0.000E+00	0.0000	7.760E-09	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	4.480E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	5.947E-17	0.0000	0.000E+00	0.0000	2.219E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	9.816E-10	0.0000	0.000E+00	0.0000	4.056E-05	1.0000	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

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.056E-05	0.9998
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.736E-10	0.0000
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	7.760E-09	0.0002
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	4.480E-19	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	2.219E-12	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	4.057E-05	1.0000

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+03 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.
Ra-226	5.298E-09	0.0001	0.000E+00	0.0000	6.087E-05	0.9931	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.591E-07	0.0042	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	1.383E-11	0.0000	0.000E+00	0.0000	1.589E-07	0.0026	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.827E-14	0.0000	0.000E+00	0.0000	0.000E+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	3.393E-13	0.0000	0.000E+00	0.0000	1.550E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.644E-07	0.0043	0.000E+00	0.0000	6.103E-05	0.9957	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+03 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.087E-05	0.9932
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.591E-07	0.0042
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	1.589E-07	0.0026
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	1.827E-14	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	1.554E-10	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	6.129E-05	1.0000

0*Sum of all water independent and dependent pathways.

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

0Parent (i)	Product (j)	Branch Fraction	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
			DSR(j,t) (mrem/yr)/(pCi/g)							
Ra-226	Ra-226	1.000E+00	3.405E-05	3.407E-05	3.411E-05	3.425E-05	3.465E-05	3.609E-05	4.056E-05	6.087E-05
Ra-226	Pb-210	1.000E+00	0.000E+00	1.673E-29	5.048E-29	1.719E-28	5.603E-28	3.112E-27	1.173E-25	3.264E-20
Ra-226	ΣDSR(j)		3.405E-05	3.407E-05	3.411E-05	3.425E-05	3.465E-05	3.609E-05	4.056E-05	6.087E-05
0Th-232	Th-232	1.000E+00	2.276E-39	2.337E-39	2.465E-39	2.967E-39	5.042E-39	3.225E-38	6.475E-36	7.423E-28
Th-232	Ra-228	1.000E+00	0.000E+00	5.391E-15	1.471E-14	3.650E-14	6.233E-14	1.316E-13	1.030E-12	1.380E-09
Th-232	Th-228	1.000E+00	0.000E+00	1.570E-12	1.132E-11	5.434E-11	1.085E-10	1.975E-10	9.726E-10	2.577E-07
Th-232	ΣDSR(j)		2.276E-39	1.675E-.2	1.133E-11	5.438E-11	1.085E-10	1.976E-10	9.736E-10	2.591E-07
0U-234	U-234	1.000E+00	3.457E-33	3.533E-33	3.691E-33	4.302E-33	6.662E-33	3.080E-32	2.446E-30	1.091E-23
U-234	Th-230	1.000E+00	0.000E+00	3.229E-41	1.017E-40	4.016E-40	1.957E-39	3.563E-38	1.367E-35	1.077E-27
U-234	Ra-226	1.000E+00	0.000E+00	6.646E-14	5.991E-13	6.698E-12	6.133E-11	7.242E-10	7.760E-09	1.589E-07
U-234	Pb-210	1.000E+00	0.000E+00	1.096E-38	3.023E-37	1.207E-35	4.071E-34	3.589E-32	1.796E-29	7.912E-23
U-234	ΣDSR(j)		3.457E-33	6.646E-14	5.991E-13	6.698E-12	6.133E-11	7.242E-10	7.760E-09	1.589E-07
0U-235	U-235	1.000E+00	4.630E-28	4.724E-28	4.918E-28	5.662E-28	8.468E-28	3.465E-27	1.940E-25	2.549E-19
U-235	Pa-231	1.000E+00	0.000E+00	9.113E-25	2.809E-24	1.030E-23	4.060E-23	3.517E-22	1.615E-20	7.553E-16
U-235	Ac-227	1.000E+00	0.000E+00	4.721E-25	4.272E-24	4.850E-23	4.706E-22	7.825E-21	4.319E-19	1.751E-14
U-235	ΣDSR(j)		4.630E-28	1.384E-24	7.082E-24	5.880E-23	5.112E-22	8.177E-21	4.480E-19	1.827E-14
U-238	U-238	1.000E+00	1.471E-18	1.489E-18	1.526E-18	1.663E-18	2.128E-18	5.036E-18	5.904E-17	3.258E-13
U-238	U-234	1.000E+00	0.000E+00	9.996E-39	3..33E-38	1.217E-37	5.655E-37	8.715E-36	2.077E-33	3.091E-26
U-238	Th-230	1.000E+00	0.000E+00	0.000E+00	0.000E+00	5.603E-45	8.268E-44	5.040E-42	5.799E-39	1.522E-30
U-238	Ra-226	1.000E+00	0.000E+00	6.924E-20	1.702E-18	6.319E-17	1.737E-15	6.854E-14	2.219E-12	1.551E-10
U-238	Pb-210	1.000E+00	0.000E+00	0.000E+00	5.269E-43	8.660E-41	9.016E-39	2.847E-36	4.694E-33	7.478E-26
U-238	ΣDSR(j)		1.471E-18	1.558E-18	3.228E-18	6.485E-17	1.739E-15	6.854E-14	2.219E-12	1.554E-10

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter. CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j)
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	8.810E+05	8.805E+05	8.795E+05	8.759E+05	8.658E+05	8.313E+05	7.397E+05	4.928E+05
Th-232	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05
U-234	*6.233E+09	*6.233E+09	*6.233E+09	*6.233E+09	*6.233E+09	*6.233E+09	3.866E+09	1.888E+08
U-235	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06
U-238	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05

*At specific activity limit

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

0Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-226	1.000E+00	1.000E+03	6.087E-05	4.928E+05	6.087E-05	4.928E+05
Th-232	1.000E+00	1.000E+03	2.591E-07	*1.092E+05	2.591E-07	*1.092E+05
U-234	1.000E+00	1.000E+03	1.589E-07	1.888E+08	1.589E-07	1.888E+08
U-235	1.000E+00	1.000E+03	1.827E-14	*2.160E+06	1.827E-14	*2.160E+06
U-238	1.000E+00	1.000E+03	1.554E-10	*3.360E+05	1.554E-10	*3.360E+05

*At specific activity limit

Table KMCRFB1

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCRFB1

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCFRB1

Dose Conversion Factor (and Related) Parameter Summary

0 Menu	Parameter	Current Value	Default	Parameter Name
A-1	Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3):			
A-1	Ac-227+D , soil density = 1.0 g/cm**3	2.760E+00	2.760E+00	DCF1(1,1)
A-1	Ac-227+D , soil density = 1.8 g/cm**3	1.520E+00	1.520E+00	DCF1(1,2)
A-1				
A-1	Pa-231 , soil density = 1.0 g/cm**3	2.210E-01	2.210E-01	DCF1(2,1)
A-1	Pa-231 , soil density = 1.8 g/cm**3	1.210E-01	1.210E-01	DCF1(2,2)
A-1				
A-1	Pb-210+D , soil density = 1.0 g/cm**3	4.870E-03	4.870E-03	DCF1(3,1)
A-1	Pb-210+D , soil density = 1.8 g/cm**3	2.310E-03	2.310E-03	DCF1(3,2)
A-1				
A-1	Ra-226+D , soil density = 1.0 g/cm**3	1.550E+01	1.550E+01	DCF1(4,1)
A-1	Ra-226+D , soil density = 1.8 g/cm**3	8.560E+00	8.560E+00	DCF1(4,2)
A-1				
A-1	Ra-228+D , soil density = 1.0 g/cm**3	8.180E+00	8.180E+00	DCF1(5,1)
A-1	Ra-228+D , soil density = 1.8 g/cm**3	4.510E+00	4.510E+00	DCF1(5,2)
A-1				
A-1	Th-228+D , soil density = 1.0 g/cm**3	1.330E+01	1.330E+01	DCF1(6,1)
A-1	Th-228+D , soil density = 1.8 g/cm**3	7.360E+00	7.360E+00	DCF1(6,2)
A-1				
A-1	Th-230 , soil density = 1.0 g/cm**3	2.110E-03	2.110E-03	DCF1(7,1)
A-1	Th-230 , soil density = 1.8 g/cm**3	1.030E-03	1.030E-03	DCF1(7,2)
A-1				
A-1	Th-232 , soil density = 1.0 g/cm**3	1.350E-03	1.350E-03	DCF1(8,1)
A-1	Th-232 , soil density = 1.8 g/cm**3	6.040E-04	6.040E-04	DCF1(8,2)
A-1				
A-1	U-234 , soil density = 1.0 g/cm**3	1.580E-03	1.580E-03	DCF1(9,1)
A-1	U-234 , soil density = 1.8 g/cm**3	6.970E-04	6.970E-04	DCF1(9,2)
A-1				
A-1	U-235+D , soil density = 1.0 g/cm**3	8.940E-01	8.940E-01	DCF1(10,1)
A-1	U-235+D , soil density = 1.8 g/cm**3	4.900E-01	4.900E-01	DCF1(10,2)
A-1				
A-1	U-238+D , soil density = 1.0 g/cm**3	1.270E-01	1.270E-01	DCF1(11,1)
A-1	U-238+D , soil density = 1.8 g/cm**3	6.970E-02	6.970E-02	DCF1(11,2)
A-3	Depth factors, ground external gamma, dimensionless:			
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(1,1,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(1,2,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,1)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.100E-01	9.100E-01	FD(1,1,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,2)
A-3				
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(2,1,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,1)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = .15 m	9.200E-01	9.200E-01	FD(2,1,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(3,1,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,1)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.700E-01	9.700E-01	FD(3,1,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,2)
A-3				
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.300E-01	6.300E-01	FD(4,1,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.200E-01	9.200E-01	FD(4,2,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,1)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(4,1,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(4,2,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,2)
A-3				
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.800E-01	6.800E-01	FD(5,1,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(5,2,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,1)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(5,1,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(5,2,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,2)
A-3				
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.100E-01	6.100E-01	FD(6,1,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.400E-01	9.400E-01	FD(6,2,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,1)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	7.500E-01	7.500E-01	FD(6,1,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(6,2,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,2)
A-3				
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = .15 m	9.300E-01	9.300E-01	FD(7,1,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,1)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(7,1,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,2)
A-3				
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m	9.500E-01	9.500E-01	FD(8,1,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,1)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(8,1,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,2)
A-3				
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = .15 m	9.000E-01	9.000E-01	FD(9,1,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,1)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(9,1,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.700E-01	8.700E-01	FD(10,1,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,1)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(10,1,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,2)
A-3				
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.800E-01	7.800E-01	FD(11,1,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,1)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(11,1,2)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,2)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,2)
B-1	Dose conversion factors for inhalation, mrem/pCi			
B-1	Ac-227+D	6.700E+00	6.700E+00	DCF2(1)
B-1	Pa-231	1.300E+00	1.300E+00	DCF2(2)
B-1	Pb-210+D	2.100E-02	2.100E-02	DCF2(3)
B-1	Ra-226+D	7.900E-03	7.900E-03	DCF2(4)
B-1	Ra-228+D	6.500E-03	4.500E-03	DCF2(5)
B-1	Th-228+D	3.100E-01	3.100E-01	DCF2(6)
B-1	Th-230	3.200E-01	3.200E-01	DCF2(7)
B-1	Th-232	1.600E+00	1.600E+00	DCF2(8)
B-1	U-234	1.300E-01	1.300E-01	DCF2(9)
B-1	U-235+D	1.200E-01	1.200E-01	DCF2(10)
B-1	U-238+D	1.200E-01	1.200E-01	DCF2(11)
D-1	Dose conversion factors for ingestion, mrem/pCi			
D-1	Ac-227+D	1.500E-02	1.500E-02	DCF3(1)
D-1	Pa-231	1.100E-02	1.100E-02	DCF3(2)
D-1	Pb-210+D	6.700E-03	6.700E-03	DCF3(3)
D-1	Ra-226+D	1.100E-03	1.100E-03	DCF3(4)
D-1	Ra-228+D	1.200E-03	1.200E-03	DCF3(5)
D-1	Th-228+D	7.500E-04	7.500E-04	DCF3(6)
D-1	Th-230	5.300E-04	5.300E-04	DCF3(7)
D-1	Th-232	2.800E-03	2.800E-03	DCF3(8)
D-1	U-234	2.600E-04	2.600E-04	DCF3(9)
D-1	U-235+D	2.500E-04	2.500E-04	DCF3(10)
D-1	U-238+D	2.500E-04	2.500E-04	DCF3(11)
D-34	Food transfer factors			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(8,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(10,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(10,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-5	Bioaccumulation factors, fresh water, L/kg			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	DIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-228+D , crustacea and mol,usks	5.000E+02	5.000E+02	BIOFAC(6,2)
D-5				

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Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(8,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(8,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(10,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(10,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)

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Summary : KM CUSH-KMCRFB1 FULL CELL DEPTH File: KMCRFB1.DAT

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.500E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	3.000E+03	---	T(9)
R011	Times for calculations (yr)	not used	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g) Ra-226	1.000E+00	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g) Th-232	1.000E+00	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g) U-234	1.000E+00	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g) U-235	1.000E+00	0.000E+00	---	S1(10)
R012	Initial principal radionuclide (pCi/g) U-238	1.000E+00	0.000E+00	---	S1(11)
R012	Concentration in groundwater (pCi/L) Ra-226	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L) Th-232	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L) U-234	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L) U-235	not used	0.000E+00	---	W1(10)
R012	Concentration in groundwater (pCi/L) U-238	not used	0.000E+00	---	W1(11)
R013	Cover depth (m)	1.220E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.969E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	8.000E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	0.000E+00	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	MB	ND	---	MODEL
R014	Individual's use of groundwater (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	2.000E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	2.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	5.000E-02	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	3.150E-03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.979E-06	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.474E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.990E-06	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.979E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	2.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor, external gamma	1.000E+00	1.000E+00	---	FS1

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA				
R017	Outer annular radius (m) = √(1/n)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/n)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/n)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/n)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/n)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/n)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/n)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/n)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/n)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/n)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/n)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/n)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200F+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.30C+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.125E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.125E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
R021	Thickness of building foundation (m)	1.500E-01	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+0^	---	DENSFL
R021	Total porosity of the cover material	4.000E-01	4.000F '.	---	TPCV
R021	Total porosity of the building foundation	1.000E-01	1.00'..-01	---	TPFL
R021	Volumetric water content of the cover material	5.000E-02	5.'.,0E-02	---	PH2OCV
R021	Volumetric water content of the foundation	3.000E-01	.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	2.000E-06	2.000E-06	---	DIFCV
R021	in foundation material	2.000F-08	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	5.000E-01	5.000E-01	---	REXG
R021	Height of the building (room) (m)	2.500E+00	2.500E+00	---	HRM
R021	Building interior area factor	0.000E+00	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	0.000E+00	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	1.500E-01	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2500.00 square meters	Ra-226	1.000E+00
Thickness:	3.00 meters	Th-232	1.000E+00
Cover Depth:	1.22 meters	U-234	1.000E+00
		U-235	1.000E+00
		U-238	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.091E+00	1.091E+00	1.090E+00	1.087E+00	1.077E+00	1.044E+00	9.558E-01	7.027E-01
M(t):	3.637E-02	3.636E-02	3.633E-02	3.622E-02	3.590E-02	3.481E-02	3.186E-02	2.342E-02

0Maximum TDOSE(t): 1.091E+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

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
Ra-226	3.967E-05	0.0000	0.000E+00	0.0000	1.091E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.854E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	1.255E-15	0.0000	0.000E+00	0.0000	0.000E+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	6.873E-12	0.0000	0.000E+00	0.0000	0.000E+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	1.356E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.968E-05	0.0000	0.000E+00	0.0000	1.091E+00	1.0000	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

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
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.091E+00	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.834E-18	0.0000
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	1.255E-15	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	6.873E-12	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	1.356E-08	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	1.091E+00	1.0000

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
Ra-226	3.945E-05	0.0000	0.000E+00	0.0000	1.091E+00	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	6.558E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	7.820E-16	0.0000	0.000E+00	0.0000	2.127E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	6.998E-12	0.0000	0.000E+00	0.0000	0.000E+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	1.356E-08	0.0000	0.000E+00	0.0000	2.216E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.602E-05	0.0000	0.000E+00	0.0000	1.091E+00	1.0000	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
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.091E+00	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.558E-06	0.0000
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	2.127E-09	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	6.998E-12	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	1.356E-08	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	1.091E+00	1.0000

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+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	3.941E-05	0.0000	0.000E+00	0.0000	1.090E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.898E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	6.935E-13	0.0000	0.000E+00	0.0000	1.914E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	7.410E-12	0.0000	0.000E+00	0.0000	0.000E+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	1.356E-08	0.0000	0.000E+00	0.0000	5.436E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	7.841E-05	0.0001	0.000E+00	0.0000	1.090E+00	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.090E+00	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.898E-05	0.0000
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	1.914E-08	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	7.410E-12	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	1.356E-08	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	1.090E+00	1.0000

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+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	3.929E-05	0.0000	0.000E+00	0.0000	1.086E+00	0.9998	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.699E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	7.685E-12	0.0000	0.000E+00	0.0000	2.124E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.040E-11	0.0000	0.000E+00	0.0000	0.000E+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	1.356E-08	0.0000	0.000E+00	0.0000	2.004E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.092E-04	0.0002	0.000E+00	0.0000	1.086E+00	0.9998	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.085E+00	0.9998
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.699E-04	0.0002
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	2.124E-07	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	1.040E-11	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	1.356E-08	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	1.087E+00	1.0000

0*Sum of all water independent and dependent pathways.

Total Dose Contributions TD"SE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	3.895E-05	0.0000	0.000E+00	0.0000	1.077E+00	0.9997	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.869E-04	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	6.894E-11	0.0000	0.000E+00	0.0000	1.906E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	2.880E-11	0.0000	0.000E+00	0.0000	0.000E+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	1.356E-08	0.0000	0.000E+00	0.0000	5.398E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.259E-04	0.0003	0.000E+00	0.0000	1.077E+00	0.9997	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.077E+00	0.9997
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.869E-04	0.0003
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	1.906E-06	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	2.880E-11	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	1.361E-08	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	1.077E+00	1.0000

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+02 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
Ra-226	3.776E-05	0.0000	0.000E+00	0.0000	1.044E+00	0.9997	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.989E-04	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	7.577E-10	0.0000	0.000E+00	0.0000	2.095E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.408E-10	0.0000	0.000E+00	0.0000	0.000E+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	1.354E-08	0.0000	0.000E+00	0.0000	1.983E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.366E-04	0.0003	0.000E+00	0.0000	1.044E+00	0.9997	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+02 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
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.044E+00	0.9997
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.989E-04	0.0003
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	2.095E-05	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	1.408E-10	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	1.553E-08	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	1.044E+00	1.0000

0*Sum of all water independent and dependent pathways

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Summary KM CUSH-KMCRFB1 FULL CELL DEPTH File: KMCRFB1.DAT

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

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
Ra-226	3.455E-05	0.0000	0.000E+00	0.0000	9.553E-01	0.9995	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.989E-04	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	6.612E-09	0.0000	0.000E+00	0.0000	1.828E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	5.106E-10	0.0000	0.000E+00	0.0000	0.000E+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	1.351E-08	0.0000	0.000E+00	0.0000	5.227E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.334E-04	0.0003	0.000E+00	0.0000	9.555E-01	0.9997	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

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
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.554E-01	0.9995
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.989E-04	0.0003
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	1.828E-04	0.0002
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	5.106E-10	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	6.577E-08	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	9.558E-01	1.0000

0*Sum of all water independent and dependent pathways

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Summary KM CUSH-KMCRFB1 FULL CELL DEPTH File: KMCRFB1.DAT

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

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
Ra-226	2.534E-05	0.0000	0.000E+00	0.0000	7.005E-01	0.9969	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.989E-04	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	6.615E-08	0.0000	0.000E+00	0.0000	1.829E-03	0.0026	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.785E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	1.344E-08	0.0000	0.000E+00	0.0000	1.784E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.243E-04	0.0005	0.000E+00	0.0000	7.024E-01	0.9995	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+03 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
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.005E-01	0.9970
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.989E-04	0.0004
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	1.829E-03	0.0026
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	1.785E-09	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	1.798E-06	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	7.027E-01	1.0000

0*Sum of all water independent and dependent pathways

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

0Parent (i)	Product (j)	Branch Fraction	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
			DSR(j,t) (mrem/yr)/(pCi/g)							
Ra-226	Ra-226	1.000E+00	1.091E+00	1.091E+00	1.090E+00	1.086E+00	1.077E+00	1.044E+00	9.554E-01	7.005E-01
Ra-226	Pb-210	1.000E+00	0.000E+00	9.276E-15	2.697E-14	8.080E-14	1.824E-13	2.804E-13	2.692E-13	1.974E-13
Ra-226	ΣDSR(j)		1.091E+00	1.091E+00	1.090E+00	1.086E+00	1.077E+00	1.044E+00	9.554E-01	7.005E-01
0Th-232	Th-232	1.000E+00	3.854E-18	3.854E-18	3.854E-18	3.854E-18	3.854E-18	3.854E-18	3.854E-18	3.854E-18
Th-232	Ra-228	1.000E+00	0.000E+00	1.191E-06	3.182E-06	7.348E-06	1.022E-05	1.050E-05	1.050E-05	1.050E-05
Th-232	Th-228	1.000E+00	0.000E+00	5.368E-06	3.580E-05	1.626E-04	2.767E-04	2.884E-04	2.884E-04	2.884E-04
Th-232	ΣDSR(j)		3.854E-18	6.558E-06	3.898E-05	1.699E-04	2.869E-04	2.989E-04	2.989E-04	2.989E-04
0U-234	U-234	1.000E+00	1.255E-15	1.255E-15	1.255E-15	1.255E-15	1.255E-15	1.253E-15	1.244E-15	1.235E-15
U-234	Th-230	1.000E+00	0.000E+00	8.838E-22	2.651E-21	8.837E-21	2.651E-20	8.827E-20	2.641E-19	8.725E-19
U-234	Ra-226	1.000E+00	0.000E+00	2.127E-09	1.914E-08	2.124E-07	1.906E-06	2.095E-05	1.828E-04	1.829E-03
U-234	Pb-210	1.000E+00	0.000E+00	6.077E-24	1.619E-22	5.670E-21	1.325E-19	3.234E-18	4.122E-17	4.785E-16
U-234	ΣDSR(j)		1.255E-15	2.127E-09	1.914E-08	2.124E-07	1.906E-06	2.095E-05	1.828E-04	1.829E-03
0U-235	U-235	1.000E+00	6.873E-12	6.873E-12	6.873E-12	6.872E-12	6.870E-12	6.863E-12	6.844E-12	6.778E-12
U-235	Pa-231	1.000E+00	0.000E+00	9.666E-14	2.900E-13	9.664E-13	2.898E-12	9.643E-12	2.879E-11	9.433E-11
U-235	Ac-227	1.000E+00	0.000E+00	2.811E-14	2.477E-13	2.561E-12	1.903E-11	1.243E-10	4.750E-10	1.683E-09
U-235	ΣDSR(j)		6.873E-12	6.998E-12	7.410E-12	1.040E-11	2.880E-11	1.408E-10	5.106E-10	1.785E-09
0U-238	U-238	1.000E+00	1.356E-08	1.356E-08	1.356E-08	1.356E-08	1.356E-08	1.354E-08	1.351E-08	1.337E-08
U-238	U-234	1.000E+00	0.000E+00	3.552E-21	1.066E-20	3.551E-20	1.065E-19	3.546E-19	1.061E-18	3.498E-18
U-238	Th-230	1.000E+00	0.000E+00	1.250E-27	1.125E-26	1.250E-25	1.125E-24	1.249E-23	1.121E-22	1.234E-21
U-238	Ra-226	1.000E+00	0.000E+00	2.217E-15	5.436E-14	2.004E-12	5.398E-11	1.983E-09	5.227E-08	1.784E-06
U-238	Pb-210	1.000E+00	0.000E+00	0.000E+00	2.817E-28	4.070E-26	2.935E-24	2.565E-22	1.077E-20	4.523E-19
U-238	ΣDSR(j)		1.356E-08	1.356E-08	1.356E-08	1.356E-08	1.361E-08	1.553E-08	6.577E-08	1.798E-06

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j)
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	2.749E+01	2.750E+01	2.753E+01	2.761E+01	2.786E+01	2.874E+01	3.140E+01	4.282E+01
Th-232	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	1.046E+05	1.004E+05	1.004E+05	1.004E+05
U-234	*6.233E+09	*6.233E+09	1.567E+09	1.412E+08	1.574E+07	1.432E+06	1.641E+05	1.640E+04
U-235	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06
U-238	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05

*At specific activity limit

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 (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-226	1.000E+00	0.000E+00	1.091E+00	2.749E+01	1.091E+00	2.749E+01
Th-232	1.000E+00	136.8 ± 0.1	2.989E-04	1.004E+05	3.854E-18	*1.092E+05
U-234	1.000E+00	1.000E+03	1.829E-03	1.640E+04	1.255E-15	*6.233E+09
U-235	1.000E+00	1.000E+03	1.785E-09	*2.160E+06	6.873E-12	*2.160E+06
U-238	1.000E+00	1.000E+03	1.798E-06	*3.360E+05	1.356E-08	*3.360E+05

*At specific activity limit

Table KMCRFS1

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCRFS1

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCFRS1

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Summary : KM CUSH-KMCRFS1 FULL CELL DEPTH File: KMCRFS1.DAT

Dose Conversion Factor (and Related) Parameter Summary

0 Menu	Parameter	Current Value	Default	Parameter Name
A-1	Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3)			
A-1	Ac-227+D , soil density = 1.0 g/cm**3	2.760E+00	2.760E+00	DCF1(1,1)
A-1	Ac-227+D , soil density = 1.8 g/cm**3	1.520E+00	1.520E+00	DCF1(1,2)
A-1				
A-1	Pa-231 , soil density = 1.0 g/cm**3	2.210E-01	2.210E-01	DCF1(2,1)
A-1	Pa-231 , soil density = 1.8 g/cm**3	1.210E-01	1.210E-01	DCF1(2,2)
A-1				
A-1	Pb-210+D , soil density = 1.0 g/cm**3	4.870E-03	4.870E-03	DCF1(3,1)
A-1	Pb-210+D , soil density = 1.8 g/cm**3	2.310E-03	2.310E-03	DCF1(3,2)
A-1				
A-1	Ra-226+D , soil density = 1.0 g/cm**3	1.550E+01	1.550E+01	DCF1(4,1)
A-1	Ra-226+D , soil density = 1.8 g/cm**3	8.560E+00	8.560E+00	DCF1(4,2)
A-1				
A-1	Ra-228+D , soil density = 1.0 g/cm**3	8.180E+00	8.180E+00	[illegible]
A-1	Ra-228+D , soil density = 1.8 g/cm**3	4.510E+00	4.510E+00	[illegible]
A-1				
A-1	Th-228+D , soil density = 1.0 g/cm**3	1.330E+01	1.330E+01	DCF1(6,1)
A-1	Th-228+D , soil density = 1.8 g/cm**3	7.360E+00	7.360E+00	DCF1(6,2)
A-1				
A-1	Th-230 , soil density = 1.0 g/cm**3	2.110E-03	2.110E-03	DCF1(7,1)
A-1	Th-230 , soil density = 1.8 g/cm**3	1.030E-03	1.030E-03	DCF1(7,2)
A-1				
A-1	Th-232 , soil density = 1.0 g/cm**3	1.350E-03	1.350E-03	DCF1(8,1)
A-1	Th-232 , soil density = 1.8 g/cm**3	6.040E-04	6.040E-04	DCF1(8,2)
A-1				
A-1	U-234 , soil density = 1.0 g/cm**3	1.580E-03	1.580E-03	DCF1(9,1)
A-1	U-234 , soil density = 1.8 g/cm**3	6.970E-04	6.970E-04	DCF1(9,2)
A-1				
A-1	U-235+D , soil density = 1.0 g/cm**3	8.940E-01	8.940E-01	DCF1(10,1)
A-1	U-235+D , soil density = 1.8 g/cm**3	4.900E-01	4.900E-01	DCF1(10,2)
A-1				
A-1	U-238+D , soil density = 1.0 g/cm**3	1.270E-01	1.270E-01	DCF1(11,1)
A-1	U-238+D , soil density = 1.8 g/cm**3	6.970E-02	6.970E-02	DCF1(11,2)
A-3	Depth factors, ground external gamma, dimensionless			
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(1,1,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(1,2,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,1)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.100E-01	9.100E-01	FD(1,1,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,2)
A-3				
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(2,1,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,1)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = .15 m	9.200E-01	9.200E-01	FD(2,1,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,2)
A-3				

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Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(3,1,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,1)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.700E-01	9.700E-01	FD(3,1,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,2)
A-3				
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.300E-01	6.300E-01	FD(4,1,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.200E-01	9.200E-01	FD(4,2,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,1)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(4,1,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(4,2,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,2)
A-3				
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.800E-01	6.800E-01	FD(5,1,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(5,2,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,1)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(5,1,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(5,2,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,2)
A-3				
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.100E-01	6.100E-01	FD(6,1,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.400E-01	9.400E-01	FD(6,2,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,1)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	7.500E-01	7.500E-01	FD(6,1,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(6,2,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,2)
A-3				
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = .15 m	9.300E-01	9.300E-01	FD(7,1,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,1)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(7,1,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,2)
A-3				
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m	9.500E-01	9.500E-01	FD(8,1,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,1)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(8,1,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,2)
A-3				
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = .15 m	9.000E-01	9.000E-01	FD(9,1,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,1)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(9,1,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.700E-01	8.700E-01	FD(10,1,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,1)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(10,1,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,2)
A-3				
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.800E-01	7.800E-01	FD(11,1,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,1)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(11,1,2)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,2)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,2)
B-1	Dose conversion factors for inhalation, mrem/pCi			
B-1	Ac-227+D	6.700E+00	6.700E+00	DCF2(1)
B-1	Pa-231	1.300E+00	1.300E+00	DCF2(2)
B-1	Pb-210+D	2.100E-02	2.100E-02	DCF2(3)
B-1	Ra-226+D	7.900E-03	7.900E-03	DCF2(4)
B-1	Ra-228+D	4.500E-03	4.500E-03	DCF2(5)
B-1	Th-228+D	3.100E-01	3.100E-01	DCF2(6)
B-1	Th-230	3.200E-01	3.200E-01	DCF2(7)
B-1	Th-232	1.600E+00	1.600E+00	DCF2(8)
B-1	U-234	1.300E-01	1.300E-01	DCF2(9)
B-1	U-235+D	1.200E-01	1.200E-01	DCF2(10)
B-1	U-238+D	1.200E-01	1.200E-01	DCF2(11)
D-1	Dose conversion factors for ingestion, mrem/pCi			
D-1	Ac-227+D	1.500E-02	1.500E-02	DCF3(1)
D-1	Pa-231	1.100E-02	1.100E-02	DCF3(2)
D-1	Pb-210+D	6.700E-03	6.700E-03	DCF3(3)
D-1	Ra-226+D	1.100E-03	1.100E-03	DCF3(4)
D-1	Ra-228+D	1.200E-03	1.200E-03	DCF3(5)
D-1	Th-228+D	7.500E-04	7.500E-04	DCF3(6)
D-1	Th-230	5.300E-04	5.300E-04	DCF3(7)
D-1	Th-232	2.800E-03	2.800E-03	DCF3(8)
D-1	U-234	2.600E-04	2.600E-04	DCF3(9)
D-1	U-235+D	2.500E-04	2.500E-04	DCF3(10)
D-1	U-238+D	2.500E-04	2.500E-04	DCF3(11)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(8,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-34				
D-34	U-[illegible]35+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	[illegible]+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(10,2)
D-34	[illegible]+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(10,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(8,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(8,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(10,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(10,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.500E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	3.000E+03	---	T(9)
R011	Times for calculations (yr)	not used	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E+00	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-232	1.000E+00	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): U-234	1.000E+00	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): U-235	1.000E+00	0.000E+00	---	S1(10)
R012	Initial principal radionuclide (pCi/g): U-238	1.000E+00	0.000E+00	---	S1(11)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(10)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(11)
R013	Cover depth (m)	3.048E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.969E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	8.000E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	0.000E+00	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	MB	ND	---	MODEL
R014	Individual's use of groundwater (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	2.000E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	2.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	5.000E-02	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	3.150E-03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.979E-06	ALEACH(4)
R016	Solubility constant	0.000E+-0	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.474E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.396E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.990E-06	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.979E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor, external gamma	1.000E+00	1.000E+00	---	FS1

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Outer annular radius (m) = √(1/π)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/π)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/π)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/π)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/π)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/π)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/π)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/π)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/π)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/π)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/π)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/π)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.125E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.125E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
R021	Thickness of building foundation (m)	1.500E-01	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	4.000E-01	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	1.000E-01	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	5.000E-02	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	3.000E-02	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	2.000E-06	2.000E-06	---	DIFCV
R021	in foundation material	2.000E-08	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	5.000E-01	5.000E-01	---	REXG
R021	Height of the building (room) (m)	2.500E+00	2.500E+00	---	HRM
R021	Building interior area factor	0.000E+00	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	0.000E+00	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	1.500E-01	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2500.00 square meters	Ra-226	1.000E+00
Thickness:	3.00 meters	Th-232	1.000E+00
Cover Depth:	3.05 meters	U-234	1.000E+00
		U-235	1.000E+00
		U-238	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.677E-01	1.678E-01	1.680E-01	1.687E-01	1.707E-01	1.777E-01	2.000E-01	3.006E-01
M(t):	5.591E-03	5.594E-03	5.600E-03	5.623E-03	5.689E-03	5.925E-03	6.666E-03	1.002E-02

0Maximum TDOSE(t): 3.006E-01 mrem/yr at t = 1.000E+03 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0
Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.285E-12	0.0000	0.000E+00	0.0000	1.677E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	1.208E-27	0.0000	0.000E+00	0.0000	0.000E+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	3.836E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.286E-12	0.0000	0.000E+00	0.0000	1.677E-01	1.0000	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

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.677E-01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	1.208E-27	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	3.836E-18	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	1.677E-01	1.0000

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.298E-12	0.0000	0.000E+00	0.0000	1.678E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	4.370E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	2.531E-21	0.0000	0.000E+00	0.0000	3.273E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	3.610E-24	0.0000	0.000E+00	0.0000	0.000E+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	3.884E-18	0.0000	0.000E+00	0.0000	3.410E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	5.668E-12	0.0000	0.000E+00	0.0000	1.678E-01	1.0000	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-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.678E-01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.370E-12	0.0000
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	3.273E-10	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	3.610E-24	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	3.449E-16	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	1.678E-01	1.0000

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+00 years
0
Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.322E-12	0.0000	0.000E+00	0.0000	1.680E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.956E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	2.322E-20	0.0000	0.000E+00	0.0000	2.951E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.848E-23	0.0000	0.000E+00	0.0000	0.000E+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	3.981E-18	0.0000	0.000E+00	0.0000	8.381E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.088E-11	0.0000	0.000E+00	0.0000	1.680E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.680E-01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.956E-11	0.0000
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	2.951E-09	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	1.848E-23	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	8.385E-15	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	1.680E-01	1.0000

*Sum of all water independent and dependent pathways

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Summary : KM CUSH-KMCRFS1 FULL CELL DEPTH File: KMCRFS1.DAT

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

Radio-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.
Ra-226	1.411E-12	0.0000	0.000E+00	0.0000	1.687E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.419E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	2.759E-19	0.0000	0.000E+00	0.0000	3.299E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.534E-22	0.0000	0.000E+00	0.0000	0.000E+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	4.339E-18	0.0000	0.000E+00	0.0000	3.112E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.433E-10	0.0000	0.000E+00	0.0000	1.687E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.687E-01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.419E-10	0.0000
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	3.299E-08	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	1.534E-22	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	3.112E-13	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	1.687E-01	1.0000

*Sum of all water independent and dependent pathways

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Summary : KM CUSH-KMCRFS1 FULL CELL DEPTH File: KMCRFS1.DAT

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

Radio-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.
Ra-226	1.699E-12	0.0000	0.000E+00	0.0000	1.707E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.831E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	3.006E-18	0.0000	0.000E+00	0.0000	3.021E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.334E-21	0.0000	0.000E+00	0.0000	0.000E+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	5.550E-18	0.0000	0.000E+00	0.0000	8.556E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.848E-10	0.0000	0.000E+00	0.0000	1.707E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.707E-01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.831E-10	0.0000
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	3.021E-07	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	1.334E-21	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	8.556E-12	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	1.707E-01	1.0000

*Sum of all water independent and dependent pathways

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Summary : KM CUSH-KMCRFS1 FULL CELL DEPTH File: KMCRFS1.DAT

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

Radio-Nuclide	Ground 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.
Ra-226	3.253E-12	0.0000	0.000E+00	0.0000	1.777E-01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	5.155E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	6.528E-17	0.0000	0.000E+00	0.0000	3.567E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	2.133E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	1.314E-17	0.0000	0.000E+00	0.0000	3.376E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	5.188E-10	0.0000	0.000E+00	0.0000	1.777E-01	1.0000	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+02 years
Water Dependent Pathways

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.777E-01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.155E-10	0.0000
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	3.567E-06	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	2.133E-20	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	3.376E-10	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	1.777E-01	1.0000

0*Sum of all water independent and dependent pathways

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Summary : KM CUSH-KMCRFS1 FULL CELL DEPTH File: KMCRFS1.DAT

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

Radio-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.
Ra-226	2.082E-11	0.0000	0.000E+00	0.0000	1.999E-01	0.9998	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.540E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	3.984E-15	0.0000	0.000E+00	0.0000	3.826E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.169E-18	0.0000	0.000E+00	0.0000	0.000E+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	1.552E-16	0.0000	0.000E+00	0.0000	1.094E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.561E-09	0.0000	0.000E+00	0.0000	2.000E-01	1.0000	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
Water Dependent Pathways

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.999E-01	0.9998
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.540E-09	0.0000
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	3.826E-05	0.0002
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	1.169E-18	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	1.094E-08	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	2.000E-01	1.0000

0*Sum of all water independent and dependent pathways

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Summary : KM CUSH-KMCRFS1 FULL CELL DEPTH File: KMCRFS1.DAT

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

Radio-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.
Ra-226	1.382E-08	0.0000	0.000E+00	0.0000	2.999E-01	0.9974	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	6.760E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	3.608E-11	0.0000	0.000E+00	0.0000	7.829E-04	0.0026	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	4.765E-14	0.0000	0.000E+00	0.0000	0.000E+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	8.850E-13	0.0000	0.000E+00	0.0000	7.638E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	6.898E-07	0.0000	0.000E+00	0.0000	3.006E-01	1.0000	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+03 years
Water Dependent Pathways

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.999E-01	0.9974
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.760E-07	0.0000
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	7.829E-04	0.0026
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	4.765E-14	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	7.638E-07	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	3.006E-01	1.0000

0*Sum of all water independent and dependent pathways

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

0Parent (i)	Product (j)	Branch Fraction	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
			DSR(j,t) (mrem/yr)/(pCi/g)							
Ra-226	Ra-226	1.000E+00	1.677E-01	1.678E-01	1.680E-01	1.687E-01	1.707E-01	1.777E-01	1.999E-01	2.999E-01
Ra-226	Pb-210	1.000E+00	0.000E+00	4.365E-29	1.317E-28	4.485E-28	1.462E-27	8.119E-27	3.060E-25	8.514E-20
Ra-226	ΣDSR(j)		1.677E-01	1.678E-01	1.680E-01	1.687E-01	1.707E-01	1.777E-01	1.999E-01	2.999E-01
0Th-232	Th-232	1.000E+00	5.938E-39	6.098E-39	6.430E-39	7.741E-39	1.315E-38	8.414E-38	1.689E-35	1.936E-27
Th-232	Ra-228	1.000E+00	0.000E+00	1.406E-14	3.837E-14	9.522E-14	1.626E-13	3.434E-13	2.687E-12	3.60?E-09
Th-232	Th-228	1.000E+00	0.000E+00	4.356E-12	2.952E-11	1.418E-10	2.829E-10	5.152E-10	2.537E-09	?.724E-07
Th-232	ΣDSR(j)		5.938E-39	4.370E-12	2.956E-11	1.419E-10	2.831E-10	5.155E-10	2.540E-09	6.760E-07
0U-234	U-234	1.000E+00	9.017E-33	9.217E-33	9.629E-33	1.122E-32	1.738E-32	8.035E-32	6.380E-30	2.846E-23
U-234	Th-230	1.000E+00	0.000E+00	8.423E-41	2.652E-40	1.048E-39	5.106E-39	9.295E-38	3.565E-35	2.808E-27
U-234	Ra-226	1.000E+00	0.000E+00	3.273E-10	2.951E-09	3.299E-08	3.021E-07	3.567E-06	3.826E-05	7.829E-04
U-234	Pb-210	1.000E+00	0.000E+00	2.860E-38	7.886E-37	3.148E-35	1.062E-33	9.363E-32	4.686E-29	2.064E-22
U-234	ΣDSR(j)		9.017E-33	3.273E-10	2.951E-09	3.299E-08	3.021E-07	3.567E-06	3.826E-05	7.829E-04
0U-235	U-235	1.000E+00	1.208E-27	1.232E-27	1.283E-27	1.477E-27	2.209E-27	9.038E-27	5.061E-25	6.649E-19
U-235	Pa-231	1.000E+00	0.000E+00	2.377E-24	7.329E-24	2.688E-23	1.059E-22	9.174E-22	4.213E-20	1.970E-15
U-235	Ac-227	1.000E+00	0.000E+00	1.231E-24	1.115E-23	1.265E-22	1.228E-21	2.041E-20	1.127E-18	?.568E-14
U-235	ΣDSR(j)		1.208E-27	3.610E-24	1.848E-23	1.534E-22	1.334E-21	2.133E-20	1.169E-18	4.765E-14
0U-238	U-238	1.000E+00	3.836E-18	3.884E-18	3.981E-18	4.339E-18	5.550E-18	1.314E-17	1.560E-16	8.498E-13
U-238	U-234	1.000E+00	0.000E+00	2.608E-38	8.173E-38	3.175E-37	1.475E-36	2.274E-35	5.417E-33	8.063E-26
U-238	Th-230	1.000E+00	0.000E+00	0.000E+00	1.401E-45	1.541E-44	2.172E-43	1.315E-41	1.513E-38	3.971E-30
U-238	Ra-226	1.000E+00	0.000E+00	3.410E-16	8.381E-15	3.112E-13	8.556E-12	3.376E-10	1.094E-08	7.638E-07
U-238	Pb-210	1.000E+00	0.000E+00	0.000E+00	1.375E-42	2.259E-40	2.352E-38	7.427E-36	1.225E-32	1.951E-25
U-238	ΣDSR(j)		3.836E-18	3.449E-16	8.385E-15	3.112E-13	8.556E-12	3.376E-10	1.094E-08	7.638E-07

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j)
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	1.789E+02	1.788E+02	1.786E+02	1.778E+02	1.758E+02	1.688E+02	1.501E+02	1.000E+02
Th-232	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05
U-234	*6.233E+09	*6.233E+09	*6.233E+09	9.094E+08	9.931E+07	8.411E+06	7.842E+05	3.832E+04
U-235	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06
U-238	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05

*At specific activity limit

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

0Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-226	1.000E+00	1.000E+03	2.999E-01	1.000E+02	2.999E-01	1.000E+02
Th-232	1.000E+00	1.000E+03	6.760E-07	*1.092E+05	6.760E-07	*1.092E+05
U-234	1.000E+00	1.000E+03	7.829E-04	3.832E+04	7.829E-04	3.832E+04
U-235	1.000E+00	1.000E+03	4.765E-14	*2.160E+06	4.765E-14	*2.160E+06
U-238	1.000E+00	1.000E+03	7.638E-07	*3.360E+05	7.638E-07	*3.360E+05

*At specific activity limit

Table KMCSH1A

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Table KMCSH1A

Summary : KM CUSH SENS 1A, TH-232 ORIG RESRAD EXT DOSE VS COVER, 0.01 M
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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCSH1A

Dose Conversion Factor (and Related) Parameter Summary

0 Menu	Parameter	Current Value	Default	Parameter Name
A-1	Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3)			
A-1	Ra-228+D , soil density = 1.0 g/cm**3	8.180E+00	8.180E+00	DCF1(1,1)
A-1	Ra-228+D , soil density = 1.8 g/cm**3	4.510E+00	4.510E+00	DCF1(1,2)
A-1				
A-1	Th-228+D , soil density = 1.0 g/cm**3	1.330E+01	1.330E+01	DCF1(2,1)
A-1	Th-228+D , soil density = 1.8 g/cm**3	7.360E+00	7.360E+00	DCF1(2,2)
A-1				
A-1	Th-232 , soil density = 1.0 g/cm**3	1.350E-03	1.350E-03	DCF1(3,1)
A-1	Th-232 , soil density = 1.8 g/cm**3	6.040E-04	6.040E-04	DCF1(3,2)
A-1	Depth factors, ground external gamma, dimensionless			
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.800E-01	6.800E-01	FD(1,1,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(1,2,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,1)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(1,1,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,2)
A-3				
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.100E-01	6.100E-01	FD(2,1,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.400E-01	9.400E-01	FD(2,2,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,1)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	7.500E-01	7.500E-01	FD(2,1,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,2)
A-3				
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m	9.500E-01	9.500E-01	FD(3,1,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,1)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(3,1,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,2)
B-1	Dose conversion factors for inhalation, mrem/pCi			
B-1	Ra-228+D	6.500E-03	6.500E-03	DCF2(1)
B-1	Th-228+D	3.100E-01	3.100E-01	DCF2(2)
B-1	Th-232	1.600E+00	1.600E+00	DCF2(3)
D-1	Dose conversion factors for ingestion, mrem/pCi			
D-1	Ra-228+D	1.200E-03	1.200E-03	DCF3(1)
D-1	Th-228+D	7.500E-04	7.500E-04	DCF3(2)
D-1	Th-232	2.800E-03	2.800E-03	DCF3(3)
D-34	Food transfer factors			
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(2,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(3,3)
D-5	Bioaccumulation factors, fresh water, L/kg			
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(1,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(1,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(2,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(2,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(3,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(3,2)

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Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.500E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	3.000E+03	---	T(9)
R011	Times for calculations (yr)	not used	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-228	1.000E+03	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Th-228	1.000E+03	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Th-232	1.000E+03	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	1.000E-02	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E-04	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Individual's use of groundwater (m**3/yr)	not used	2.500E+02	---	UW

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	7.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	7.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	6.000E+04	7.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.889E-11	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	[illegible]	8.889E-11	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.889E-11	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	not used	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	1.000E+00	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	0.000E+00	2.500E-01	---	FOTD
R017	Shape factor, external gamma	1.000E+00	1.000E+00	---	FS1

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA				
R017	Outer annular radius (m) = $\sqrt{(1/n)}$	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = $\sqrt{(10/n)}$	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = $\sqrt{(20/n)}$	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = $\sqrt{(50/n)}$	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = $\sqrt{(100/n)}$	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = $\sqrt{(200/n)}$	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = $\sqrt{(500/n)}$	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = $\sqrt{(1000/n)}$	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = $\sqrt{(5000/n)}$	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = $\sqrt{(1.E+04/n)}$	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = $\sqrt{(1.E+05/n)}$	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = $\sqrt{(1.E+06/n)}$	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	not used	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec)				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

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Summary : KM CUSH SENS 1A, TH-232 ORIG RESRAD EXT DOSE VS COVER, 0.01 M
File   : KMCSH1A.DAT

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10000.00 square meters	Ra-228	1.000E+03
Thickness:	5.00 meters	Th-228	1.000E+03
Cover Depth:	0.01 meters	Th-232	1.000E+03

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.018E+04	1.018E+04	1.018E+04	1.018E+04	1.018E+04	1.018E+04	1.018E+04	1.018E+04
M(t):	3.393E+02	3.393E+02	3.393E+02	3.393E+02	3.393E+02	3.393E+02	3.393E+02	3.393E+02

0Maximum TDOSE(t): 1.018E+04 mrem/yr at t = 72.20 ± 0.07 years
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 = 72.20 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	2.249E+00	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	2.774E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.018E+04	0.9998	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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 = 72.20 years
0 Water Dependent Pathways
0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.249E+00	0.0002
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.774E-08	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	0.9998
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	1.0000

0*Sum of all water independent and dependent pathways

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Summary : KM CUSH SENS 1A, TH-232 ORIG RESRAD EXT DOSE VS COVER, 0.01 M
File   : KMCSH1A.DAT

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

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	3.815E+03	0.3748	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	6.363E+03	0.6251	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	4.698E-01	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.815E+03	0.3748
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.363E+03	0.6251
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.698E-01	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	1.018E+04	1.0000

0*Sum of all water independent and dependent pathways

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File   : KMCSH1A.DAT

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	5.198E+03	0.5107	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	4.429E+03	0.4351	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	5.515E+02	0.0542	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.198E+03	0.5107
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.429E+03	0.4351
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.515E+02	0.0542
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	1.0000

0*Sum of all water independent and dependent pathways

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Summary : KM CUSH SENS 1A, TH-232 ORIG RESRAD EXT DOSE VS COVER, 0.01 M
File : KMCSH1A.DAT

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

Radio-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
Ra-228	6.087E+03	0.5979	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	2.146E+03	0.2108	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.947E+03	0.1912	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.087E+03	0.5979
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.146E+03	0.2108
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.947E+03	0.1912
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	1.0000

0*Sum of all water independent and dependent pathways

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Summary : KM CUSH SENS 1A, TH-232 ORIG RESRAD EXT DOSE VS COVER, 0.01 M
File : KMCSH1A.DAT

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

Radio-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
Ra-228	3.751E+03	0.3685	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.699E+02	0.0167	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	6.258E+03	0.6148	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.751E+03	0.3685
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.699E+02	0.0167
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.258E+03	0.6148
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	1.0000

0*Sum of all water independent and dependent pathways

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File : KMCSH1A.DAT

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

Radio-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
Ra-228	3.607E+02	0.0354	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.211E-01	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	9.818E+03	0.9646	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.0.8E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.607E+02	0.0354
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.211E-01	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.818E+03	0.9646
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	1.0000

0*Sum of all water independent and dependent pathways

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Summary : KM CUSH SENS 1A, TH-232 ORIG RESRAD EXT DOSE VS COVER, 0.01 M
File : KMCSH1A.DAT

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

Radio-Nuclide	Ground 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
Ra-228	7.926E-02	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.171E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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+02 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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.926E-02	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.171E-12	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	1.0000
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	1.018E+04	1.0000

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

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
Ra-228	2.797E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.797E-12	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	1.0000
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	1.018E+04	1.0000

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+03 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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.018E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E+04	1.0000
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	1.018E+04	1.0000

0*Sum of all water independent and dependent pathways

Summary : KM CUSH SENS 1A, TH-232 ORIG RESRAD EXT DOSE VS COVER, 0.01 M
File : KMCSH1A.DAT

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

0Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	Ra-228	1.000E+00	3.815E+00	3.383E+00	2.659E+00	1.145E+00	1.032E-01	2.266E-05	7.996E-16	0.000E+00
Ra-228	Th-228	1.000E+00	0.000E+00	1.816E+00	3.427E+00	2.606E+00	2.575E-01	5.660E-05	1.997E-15	0.000E+00
Ra-228	ΣDSR(j)		3.815E+00	5.198E+00	6.087E+00	3.751E+00	3.607E-01	7.926E-05	2.797E-15	0.000E+00
0Th-228	Th-228	1.000E+00	6.363E+00	4.429E+00	2.146E+00	1.699E-01	1.211E-04	1.171E-15	0.000E+00	0.000E+00
0Th-232	Th-232	1.000E+00	4.698E-04	4.698E-04	4.698E-04	4.698E-04	4.698E-04	4.698E-04	4.698E-04	4.698E-04
Th-232	Ra-228	1.000E+00	0.000E+00	4.326E-01	1.156E+00	2.670E+00	3.712E+00	3.815E+00	3.815E+00	3.815E+00
Th-232	Th-228	1.000E+00	0.000E+00	1.184E-01	7.899E-01	3.588E+00	6.106E+00	6.363E+00	6.363E+00	6.363E+00
Th-232	ΣDSR(j)		4.698E-04	5.515E-01	1.947E+00	6.258E+00	9.818E+00	1.018E+01	1.018E+01	1.018E+01

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j)
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	7.863E+00	5.771E+00	4.929E+00	7.998E+00	8.317E+01	3.785E+05	*2.721E+14	*2.721E+14
Th-228	4.714E+00	6.773E+00	1.398E+01	1.766E+02	2.477E+05	*8.192E+14	*8.192E+14	*8.192E+14
Th-232	6.385E+04	5.440E+01	1.541E+01	4.794E+00	3.056E+00	2.947E+00	2.947E+00	2.947E+00

*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 = 72.20 ± 0.07 years

0Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-228	1.000E+03	3.164 ± 0.003	6.090E+00	4.926E+00	2.249E-03	1.334E+04
Th-228	1.000E+03	0.000E+00	6.363E+00	4.714E+00	2.774E-11	1.082E+12
Th-232	1.000E+03	168.5 ± 0.2	1.018E+01	2.947E+00	1.018E+01	2.948E+00

Table KMCSH2A

Summary : KM CUSH SENS 2A, TH-232 CHEN RESRAD EXT DOSE VS COVER, 0.01 M
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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCSH2A

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I. Mixture Sums and Single Radionuclide Guidelines

Table KMCSH2A

Dose Conversion Factor (and Related) Parameter Summary

0 Menu	Parameter	Current Value	Default	Parameter Name
A-1	Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3)			
A-1	Ra-228+D , soil density = 1.0 g/cm**3	8.180E+00	8.180E+00	DCF1(1,1)
A-1	Ra-228+D , soil density = 1.8 g/cm**3	4.510E+00	4.510E+00	DCF1(1,2)
A-1				
A-1	Th-228+D , soil density = 1.0 g/cm**3	1.330E+01	1.330E+01	DCF1(2,1)
A-1	Th-228+D , soil density = 1.8 g/cm**3	7.360E+00	7.360E+00	DCF1(2,2)
A-1				
A-1	Th-232 , soil density = 1.0 g/cm**3	1.350E-03	1.350E-03	DCF1(3,1)
A-1	Th-232 , soil density = 1.8 g/cm**3	6.040E-04	6.040E-04	DCF1(3,2)
A-3	Depth factors, ground external gamma, dimensionless			
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.800E-01	6.800E-01	FD(1,1,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(1,2,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,1)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(1,1,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,2)
A-3				
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.100E-01	6.100E-01	FD(2,1,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.400E-01	9.400E-01	FD(2,2,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,1)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	7.500E-01	7.500E-01	FD(2,1,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,2)
A-3				
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m	9.500E-01	9.500E-01	FD(3,1,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,1)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(3,1,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,2)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ra-228+D	4.500E-03	4.500E-03	DCF2(1)
B-1	Th-228+D	3.100E-01	3.100E-01	DCF2(2)
B-1	Th-232	1.600E+00	1.600E+00	DCF2(3)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ra-228+D	1.200E-03	1.200E-03	DCF3(1)
D-1	Th-228+D	7.500E-04	7.500E-04	DCF3(2)
D-1	Th-232	2.800E-03	2.800E-03	DCF3(3)
D-34	Food transfer factors:			
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(2,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(3,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(1,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(1,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(2,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(2,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(3,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(3,2)

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	*-fault	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	3.000E+03	---	T(9)
R011	Times for calculations (yr)	not used	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-228	1.000E+03	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Th-228	1.000E+03	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Th-232	1.000E+03	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	1.000E-02	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E-04	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zo~ b parameter	not used	5.300E+00	---	BSZ
R014	Water table . op rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Individual's use of groundwater (m**3/yr)	not used	2.500E+02	---	UW

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil 'pecific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hy(ulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	7.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	7.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	6.000E+04	7.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.889E-11	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.889E-11	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.889E-11	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	not used	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	1.000E+00	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	0.000E+00	2.500E-01	---	FOTD
R017	Shape factor, external gamma	-1.000E+00	1.000E+00	Negative shows SOILD used	FS1

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA				
R017	Outer annular radius (m) = √(1/n)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/n)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/n)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/n)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/n)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/n)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/n)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/n)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/n)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/n)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/n)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/n)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	not used	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area	10000.00 square meters	Ra-228	1.000E+03
Thickness	5.00 meters	Th-228	1.000E+03
Cover Depth	0.01 meters	Th-232	1.000E+03

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.352E+03	3.352E+03	3.352E+03	3.352E+03	3.352E+03	3.352E+03	3.352E+03	3.352E+03
M(t):	1.117E+02	1.117E+02	1.117E+02	1.117E+02	1.117E+02	1.117E+02	1.117E+02	1.117E+02

0Maximum TDOSE(t): 3.352E+03 mrem/yr at t = 9.275 ± 0.009 years
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 = 9.275 years
0
Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	1.337E+03	0.3987	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	7.471E+01	0.0223	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.941E+03	0.5790	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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 = 9.275 years
0
Water Dependent Pathways
0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.337E+03	0.3987
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.471E+01	0.0223
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.941E+03	0.5790
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E+03	1.0000

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 = 0.000E+00 years
0
Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	1.201E+03	0.3581	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	2.152E+03	0.6418	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	5.948E-02	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.201E+03	0.3581
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.152E+03	0.6418
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.948E-02	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	3.352E+03	1.0000

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-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	1.678E+03	0.5007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	1.498E+03	0.4468	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.762E+02	0.0526	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.678E+03	0.5007
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.498E+03	0.4468
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.762E+02	0.0526
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E+03	1.0000

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+00 years
Water Independent Pathways (Inhalation excludes radon)

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
Ra-228	1.996E+03	0.5953	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	7.256E+02	0.2165	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	6.310E+02	0.1882	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.996E+03	0.5953
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.256E+02	0.2165
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.310E+02	0.1882
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E+03	1.0000

*Sum of all water independent and dependent pathways

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

Radio-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
Ra-228	1.241E+03	0.3703	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	5.744E+01	0.0171	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.053E+03	0.6125	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.241E+03	0.3703
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.744E+01	0.0171
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.053E+03	0.6125
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E+03	1.0000

*Sum of all water independent and dependent pathways

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

Radio-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
Ra-228	1.196E+02	0.0357	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	4.095E-02	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.233E+03	0.9643	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.196E+02	0.0357
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.095E-02	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.233E+03	0.9643
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E+03	1.0000

*Sum of all water independent and dependent pathways

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

Radio-Nuclide	Ground 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
Ra-228	2.627E-02	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	3.959E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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+02 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.627E-02	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.959E-13	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E+03	1.0000
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	3.352E+03	1.0000

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
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	9.268E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.268E-13	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E+03	1.0000
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	3.352E+03	1.0000

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+03 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.352E+03	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.352E+03	1.0000
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	3.352E+03	1.0000

0*Sum of all water independent and dependent pathways

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

0Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	Ra-228	1.000E+00	1.201E+00	1.065E+00	8.368E-01	3.604E-01	3.247E-02	7.132E-06	2.516E-16	0.000E+00
Ra-228	Th-228	1.000E+00	0.000E+00	6.139E-01	1.159E+00	8.811E-01	8.708E-02	1.914E-05	6.752E-16	0.000E+00
Ra-228	ΣDSR(j)		1.201E+00	1.678E+00	1.996E+00	1.241E+00	1.196E-01	2.627E-05	9.268E-16	0.000E+00
0Th-228	Th-228	1.000E+00	2.152E+00	1.498E+00	7.256E-01	5.744E-02	4.095E-05	3.959E-16	0.000E+00	0.000E+00
0Th-232	Th-232	1.000E+00	5.948E-05	5.948E-05	5.948E-05	5.948E-05	5.948E-05	5.948E-05	5.948E-05	5.948E-05
Th-232	Ra-228	1.000E+00	0.000E+00	1.361E-01	3.638E-01	8.402E-01	1.168E+00	1.201E+00	1.201E+00	1.201E+00
Th-232	Th-228	1.000E+00	0.000E+00	4.005E-02	2.671E-01	1.213E+00	2.065E+00	2.152E+00	2.152E+00	2.152E+00
Th-232	ΣDSR(j)		5.948E-05	1.762E-01	6.310E-01	2.053E+00	3.233E+00	3.352E+00	3.352E+00	3.352E+00

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j)
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-228	2.499E+01	1.787E+01	1.503E+01	2.416E+01	2.509E+02	1.142E+06	*2.721E+14	*2.721E+14
Th-228	1.394E+01	2.003E+01	4.136E+01	5.222E+02	7.327E+05	*8.192E+14	*8.192E+14	*8.192E+14
Th-232	*1.092E+05	1.702E+02	4.754E+01	1.461E+01	9.280E+00	8.949E+00	8.949E+00	8.949E+00

*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 = 9.275 ± 0.009 years

0Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-228	1.000E+03	3.247 ± 0.003	1.998E+00	1.501E+01	1.337E+00	2.244E+01
Th-228	1.000E+03	0.000E+00	2.152E+00	1.394E+01	7.471E-02	4.016E+02
Th-232	1.000E+03	168.4 ± 0.2	3.352E+00	8.949E+00	1.941E+00	1.546E+01

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I. Mixture Sums and Single Radionuclide Guidelines

Table KMCSH3A

Dose Conversion Factor (and Related) Parameter Summary

0 Menu	Parameter	Current Value	Default	Parameter Name
A-1	Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3):			
A-1	Pb-210+D , soil density = 1.0 g/cm**3	4.870E-03	4.870E-03	DCF1(1,1)
A-1	Pb-210+D , soil density = 1.8 g/cm**3	2.310E-03	2.310E-03	DCF1(1,2)
A-1				
A-1	Ra-226+D , soil density = 1.0 g/cm**3	1.550E+01	1.550E+01	DCF1(2,1)
A-1	Ra-226+D , soil density = 1.8 g/cm**3	8.560E+00	8.560E+00	DCF1(2,2)
A-1				
A-1	Ra-228+D , soil density = 1.0 g/cm**3	8.180E+00	8.180E+00	DCF1(3,1)
A-1	Ra-228+D , soil density = 1.8 g/cm**3	4.510E+00	4.510E+00	DCF1(3,2)
A-1				
A-1	Th-228+D , soil density = 1.0 g/cm**3	1.330E+01	1.330E+01	DCF1(4,1)
A-1	Th-228+D , soil density = 1.8 g/cm**3	7.360E+00	7.360E+00	DCF1(4,2)
A-1				
A-1	Th-230 , soil density = 1.0 g/cm**3	2.110E-03	2.110E-03	DCF1(5,1)
A-1	Th-230 , soil density = 1.8 g/cm**3	1.030E-03	1.030E-03	DCF1(5,2)
A-1				
A-1	Th-232 , soil density = 1.0 g/cm**3	1.350E-03	1.350E-03	DCF1(6,1)
A-1	Th-232 , soil density = 1.8 g/cm**3	6.040E-04	6.040E-04	DCF1(6,2)
A-3	Depth factors, ground external gamma, dimensionless:			
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(1,1,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,1)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.700E-01	9.700E-01	FD(1,1,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,2)
A-3				
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.300E-01	6.300E-01	FD(2,1,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.200E-01	9.200E-01	FD(2,2,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,1)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(2,1,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,2)
A-3				
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.800E-01	6.800E-01	FD(3,1,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(3,2,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,1)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(3,1,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,2)
A-3				
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.100E-01	6.100E-01	FD(4,1,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.400E-01	9.400E-01	FD(4,2,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,1)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	7.500E-01	7.500E-01	FD(4,1,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(4,2,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = .15 m	9.300E-01	9.300E-01	FD(5,1,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(5,2,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,1)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(5,1,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(5,2,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,2)
A-3				
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m	9.500E-01	9.500E-01	FD(6,1,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(6,2,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,1)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(6,1,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(6,2,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,2)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Pb-210+D	2.100E-02	2.100E-02	DCF2(1)
B-1	Ra-226+D	7.900E-03	7.900E-03	DCF2(2)
B-1	Ra-228+D	4.500E-03	4.500E-03	DCF2(3)
B-1	Th-228+D	3.100E-01	3.100E-01	DCF2(4)
B-1	Th-230	3.200E-01	3.200E-01	DCF2(5)
B-1	Th-232	1.600E+00	1.600E+00	DCF2(6)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Pb-210+D	6.700E-03	6.700E-03	DCF3(1)
D-1	Ra-226+D	1.100E-03	1.100E-03	DCF3(2)
D-1	Ra-228+D	1.200E-03	1.200E-03	DCF3(3)
D-1	Th-228+D	7.500E-04	7.500E-04	DCF3(4)
D-1	Th-230	5.300E-04	5.300E-04	DCF3(5)
D-1	Th-232	2.800E-03	2.800E-03	DCF3(6)
D-34	Food transfer factors:			
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(1,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(1,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(1,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(2,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(3,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(4,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(4,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Pb-210+D , crustacea and mollusks	1.000F+02	1.000E+02	BIOFAC(1,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(2,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(2,2)
D-5				
D-5	Ra-22 - , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Ra-228+J , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(3,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(4,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(4,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)

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Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000F+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000F+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000F+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	3.000E+03	---	T(9)
R011	Times for calculations (yr)	not used	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E+03	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Ra-228	1.000E+03	0.000F+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Th-228	1.0007+03	0.000F+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-230	1.000E+03	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Th-232	1.000E+03	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-230	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(6)
R013	Cover depth (m)	1.000E-02	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E-03	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Individual's use of groundwater (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	6.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	1.000E+05	7.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.333E-10	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	1.000E+05	7.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.333E-10	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.889E-10	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.889E-10	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.889E-10	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Pb-2.0				
R016	Contaminated zone (cm**3/g)	1.000E+05	1.000E+02	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.333E-10	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	not used	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	0.000E+00	2.500E-01	---	FOTD
R017	Shape factor, external gamma	not used	1.000E+00	---	FS1
R017	Fractions of annular areas within AREA				
R017	Outer annular radius (m) = √(1/π)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/π)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/π)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/π)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/π)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/π)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/π)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/π)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/π)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/π)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/π)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/π)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.0.UE-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
R021	Thickness of building foundation (m)	1.500E-01	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	4.000E-01	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	1.000E-01	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	5.0?0E-02	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	3.?00E-02	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	2.000E-06	2.000E-06	---	DIFCV
R021	in foundation material	3.000E-07	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	5.000E-01	5.000E-01	---	REXG
R021	Height of the building (room) (m)	2.500E+00	2.500E+00	---	HRM
R021	Building interior area factor	0.000E+00	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	0.000E+00	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	1.500E-01	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

Contaminated Zone Dimensions

Area	10000.00 square meters
Thickness	5.00 meters
Cover Depth	0.01 meters

Initial Soil Concentrations, pCi/g

Ra-226	1.000E+03
Ra-228	1.000E+03
Th-228	1.000E+03
Th-230	1.000E+03
Th-232	1.000E+03

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years)	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t)	5.571E+04	5.571E+64	5.571E+04	5.571E+04	5.571E+04	5.571E+04	5.570E+04	5.562E+04
M(t)	1.857E+03	1.857E+03	1.85?3+03	1.857E+03	1.857E+03	1.857E+03	1.857E+03	1.854E+03

0Maximum TDOSE(t): 5.571E+04 mrem/yr at t = 2.879 ± 0.003 years
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 = 2.879 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
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	5.553E+04	0.9967	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	6.120E+01	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	4.059E+01	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	6.930E+01	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	1.340E+01	0.0002	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	5.571E+04	1.0000	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 = 2.879 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
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.553E+04	0.9967
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.120E+01	0.0011
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.059E+01	0.0007
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.930E+01	0.0012
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.340E+01	0.0002
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	5.571E+04	1.0000

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 = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	5.560E+04	0.9979	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	1.152E+02	0.0021	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	5.571E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.560E+04	0.9979
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.152E+02	0.0021
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	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	5.571E+04	1.0000

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
Water Independent Pathways (Inhalation excludes radon)

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	5.557E+04	0.9975	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	3.287E+01	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	8.018E+01	0.0014	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	2.408E+01	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	2.144E+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	5.571E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-Nuclide	Water 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.557E+04	0.9975
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.287E+01	0.0006
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.018E+01	0.0014
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.408E+01	0.0004
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.144E+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	5.571E+04	1.0000

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+00 years
Water Independent Pathways (Inhalation excludes radon)

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	5.552E+04	0.9966	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	6.204E+01	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	3.885E+01	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	7.221E+01	0.0013	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	1.430E+01	0.0003	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	5.571E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.552E+04	0.9966
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.204E+01	0.0011
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.885E+01	0.0007
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.221E+01	0.0013
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.430E+01	0.0003
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	5.571E+04	1.0000

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+01 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	5.535E+04	0.9936	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	4.717E+01	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	3.075E+00	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	2.403E+02	0.0043	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	6.495E+01	0.0012	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	5.571E+04	1.0000	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

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.535E+04	0.9936
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.717E+01	0.0008
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.075E+00	0.0001
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.403E+02	0.0043
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.495E+01	0.0012
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	5.571E+04	1.0000

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+01 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	5.488E+04	0.9850	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	4.662E+00	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	2.192E-03	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	7.178E+02	0.0129	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	1.105E+02	0.0020	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	5.571E+04	1.0000	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

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.488E+04	0.9850
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.662E+00	0.0001
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.192E-03	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.178E+02	0.0129
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.105E+02	0.0020
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	5.571E+04	1.0000

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+02 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	5.324E+04	0.9556	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	1.024E-03	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	2.119E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	2.356E+03	0.0423	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	1.152E+02	0.0021	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	5.571E+04	1.0000	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+02 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.324E+04	0.9556
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.024E-03	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.119E-14	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.356E+03	0.0423
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.152E+02	0.0021
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	5.571E+04	1.0000

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
Water Independent Pathways (Inhalation excludes radon)

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	4.882E+04	0.8765	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	3.615E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	6.766E+03	0.1215	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	1.152E+02	0.0021	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	5.570E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.882E+04	0.8765
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.615E-14	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.766E+03	0.1215
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.152E+02	0.0021
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	5.570E+04	1.0000

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+03 years
Water Independent Pathways (Inhalation excludes radon)

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	3.605E+04	0.6482	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	1.945E+04	0.3498	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	1.152E+02	0.0021	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	5.562E+04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.605E+04	0.6482
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-230	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.945E+04	0.3498
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.152E+02	0.0021
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	5.562E+04	1.0000

0*Sum of all water independent and dependent pathways.

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

0Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	1.000E+00	5.560E+01	5.557E+01	5.552E+01	5.535E+01	5.488E+01	5.324E+01	4.882E+01	3.605E+01
Ra-226	Pb-210	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
Ra-226	ΣDSR(j)		5.560E+01	5.557E+01	5.552E+01	5.535E+01	5.488E+01	5.324E+01	4.882E+01	3.605E+01
0Ra-228	Ra-228	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
Ra-228	Th-228	1.000E+00	0.000E+00	3.287E-02	6.204E-02	4.717E-02	4.662E-03	1.024E-06	3.615E-17	0.000E+00
Ra-228	ΣDSR(j)		0.000E+00	3.287E-02	6.204E-02	4.717E-02	4.662E-03	1.024E-06	3.615E-17	0.000E+00
0Th-228	Th-228	1.000E+00	1.152E-01	8.018E-02	3.885E-02	3.075E-03	2.192E-06	2.119E-17	0.000E+00	0.000E+00
0Th-230	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
Th-230	Ra-226	1.000E+00	0.000E+00	2.408E-02	7.221E-02	2.403E-01	7.178E-01	2.356E+00	6.766E+00	1.945E+01
Th-230	Pb-210	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
Th-230	ΣDSR(j)		0.000E+00	2.408E-02	7.221E-02	2.403E-01	7.178E-01	2.356E+00	6.766E+00	1.945E+01
0Th-232	Th-232	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
Th-232	Ra-228	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
Th-232	Th-228	1.000E+00	0.000E+00	2.144E-03	1.430E-02	6.495E-02	1.105E-01	1.152E-01	1.152E-01	1.152E-01
Th-232	ΣDSR(j)		0.000E+00	2.144E-03	1.430E-02	6.495E-02	1.105E-01	1.152E-01	1.152E-01	1.152E-01

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j)
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	5.396E-01	5.398E-01	5.403E-01	5.420E-01	5.467E-01	5.635E-01	6.145E-01	8.322E-01
Ra-228	*2.721E+14	9.128E+02	4.835E+02	6.360E+02	6.435E+03	2.928E+07	*2.721E+14	*2.721E+14
Th-228	2.604E+02	3.742E+02	7.723E+02	9.755E+03	1.369E+07	*8.192E+14	*8.192E+14	*8.192E+14
Th-230	*2.018E+10	1.246E+03	4.155E+02	1.248E+02	4.180E+01	1.273E+01	4.434E+00	1.542E+00
Th-232	*1.092E+05	1.399E+04	2.098E+03	4.619E+02	2.714E+02	2.604E+02	2.604E+02	2.604E+02

*At specific activity limit

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 = 2.879 ± 0.003 years

0Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-226	1.000E+03	0.000E+00	5.560E+01	5.396E-01	5.553E+01	5.403E-01
Ra-228	1.000E+03	4.558 ± 0.005	6.658E-02	4.506E+02	6.120E-02	4.902E+02
Th-228	1.000E+03	0.000E+00	1.152E-01	2.604E+02	4.059E-02	7.391E+02
Th-230	1.000E+03	1.000E+03	1.945E+01	1.542E+00	6.930E-02	4.329E+02
Th-232	1.000E+03	168.5 ± 0.2	1.152E-01	2.604E+02	1.340E-02	2.239E+03

Table KMCSH5E

Summary : KM CUSH 5E SENS, GROUNDWATER, 20 M UNSAT, KD=VARIABLE
File : KMCSH5E.DAT

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCSH5E

Summary : KM CUSH 5E SENS, GROUNDWATER, 20 M UNSAT, KD=VARIABLE
File : KMCSH5E.DAT

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Part I: Mixture Sums and Single Radionuclide Guidelines

Table KMCSH5E

Dose Conversion Factor (and Related) Parameter Summary

Menu	Parameter	Current Value	Default	Parameter Name
A-1	Ground external gamma, volume DCF's, (mrem/yr)/(pCi/cm**3)			
A-1	Ac-227+D , soil density = 1.0 g/cm**3	2.760E+00	2.760E+00	DCF1(1,1)
A-1	Ac-227+D , soil density = 1.8 g/cm**3	1.520E+00	1.520E+00	DCF1(1,2)
A-1				
A-1	Pa-231 , soil density = 1.0 g/cm**3	2.210E-01	2.210E-01	DCF1(2,1)
A-1	Pa-231 , soil density = 1.8 g/cm**3	1.210E-01	1.210E-01	DCF1(2,2)
A-1				
A-1	Pb-210+D , soil density = 1.0 g/cm**3	4.870E-03	4.870E-03	DCF1(3,1)
A-1	Pb-210+D , soil density = 1.8 g/cm**3	2.310E-03	2.310E-03	DCF1(3,2)
A-1				
A-1	Ra-226+D , soil density = 1.0 g/cm**3	1.550E+01	1.550E+01	DCF1(4,1)
A-1	Ra-226+D , soil density = 1.8 g/cm**3	8.560E+00	8.560E+00	DCF1(4,2)
A-1				
A-1	Ra-228+D , soil density = 1.0 g/cm**3	8.180E+00	8.180E+00	DCF1(5,1)
A-1	Ra-228+D , soil density = 1.8 g/cm**3	4.510E+00	4.510E+00	DCF1(5,2)
A-1				
A-1	Th-228+D , soil density = 1.0 g/cm**3	1.330E+01	1.330E+01	DCF1(6,1)
A-1	Th-228+D , soil density = 1.8 g/cm**3	7.360E+00	7.360E+00	DCF1(6,2)
A-1				
A-1	Th-230 , soil density = 1.0 g/cm**3	2.110E-03	2.110E-03	DCF1(7,1)
A-1	Th-230 , soil density = 1.8 g/cm**3	1.030E-03	1.030E-03	DCF1(7,2)
A-1				
A-1	Th-232 , soil density = 1.0 g/cm**3	1.350E-03	1.350E-03	DCF1(8,1)
A-1	Th-232 , soil density = 1.8 g/cm**3	6.040E-04	6.040E-04	DCF1(8,2)
A-1				
A-1	U-234 , soil density = 1.0 g/cm**3	1.580E-03	1.580E-03	DCF1(9,1)
A-1	U-234 , soil density = 1.8 g/cm**3	6.970E-04	6.970E-04	DCF1(9,2)
A-1				
A-1	U-235+D , soil density = 1.0 g/cm**3	8.940E-01	8.940E-01	DCF1(10,1)
A-1	U-235+D , soil density = 1.8 g/cm**3	4.900E-01	4.900E-01	DCF1(10,2)
A-1				
A-1	U-238+D , soil density = 1.0 g/cm**3	1.270E-01	1.270E-01	DCF1(11,1)
A-1	U-238+D , soil density = 1.8 g/cm**3	6.970E-02	6.970E-02	DCF1(11,2)
A-3	Depth factors, ground external gamma, dimensionless			
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(1,1,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(1,2,1)
A-3	Ac-227+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,1)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.100E-01	9.100E-01	FD(1,1,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(1,2,2)
A-3	Ac-227+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(1,3,2)
A-3				
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = .15 m	7.900E-01	7.900E-01	FD(2,1,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,1)
A-3	Pa-231 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,1)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = .15 m	9.200E-01	9.200E-01	FD(2,1,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(2,2,2)
A-3	Pa-231 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(2,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

Menu	Parameter	Current Value	Default	Parameter Name
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(3,1,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,1)
A-3	Pb-210+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,1)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = .15 m	9.700E-01	9.700E-01	FD(3,1,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(3,2,2)
A-3	Pb-210+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(3,3,2)
A-3				
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.300E-01	6.300E-01	FD(4,1,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.200E-01	9.200E-01	FD(4,2,1)
A-3	Ra-226+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,1)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(4,1,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(4,2,2)
A-3	Ra-226+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(4,3,2)
A-3				
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.800E-01	6.800E-01	FD(5,1,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.700E-01	9.700E-01	FD(5,2,1)
A-3	Ra-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,1)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.500E-01	8.500E-01	FD(5,1,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(5,2,2)
A-3	Ra-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(5,3,2)
A-3				
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = .15 m	6.100E-01	6.100E-01	FD(6,1,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	9.[illegible]00E-01	9.400E-01	FD(6,2,1)
A-3	Th-228+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,1)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = .15 m	7.500E-01	7.500E-01	FD(6,1,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(6,2,2)
A-3	Th-228+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(6,3,2)
A-3				
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = .15 m	9.300E-01	9.300E-01	FD(7,1,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,1)
A-3	Th-230 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,1)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(7,1,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(7,2,2)
A-3	Th-230 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(7,3,2)
A-3				
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = .15 m	9.500E-01	9.500E-01	FD(8,1,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,1)
A-3	Th-232 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,1)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(8,1,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(8,2,2)
A-3	Th-232 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(8,3,2)
A-3				
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = .15 m	9.000E-01	9.000E-01	FD(9,1,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,1)
A-3	U-234 , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,1)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(9,1,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(9,2,2)
A-3	U-234 , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(9,3,2)
A-3				

Dose Conversion Factor (and Related) Parameter Summary (continued)

Menu	Parameter	Current Value	Default	Parameter Name
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = .15 m	8.700E-01	8.700E-01	FD(10,1,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,1)
A-3	U-235+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,1)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = .15 m	1.000E+00	1.000E+00	FD(10,1,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(10,2,2)
A-3	U-235+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(10,3,2)
A-3				
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = .15 m	7.800E-01	7.800E-01	FD(11,1,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,1)
A-3	U-238+D , soil density = 1.0 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,1)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = .15 m	8.800E-01	8.800E-01	FD(11,1,2)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 0.5 m	1.000E+00	1.000E+00	FD(11,2,2)
A-3	U-238+D , soil density = 1.8 g/cm**3, thickness = 1.0 m	1.000E+00	1.000E+00	FD(11,3,2)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.700E+00	6.700E+00	DCF2(1)
B-1	Pa-231	1.300E+00	1.300E+00	DCF2(2)
B-1	Pb-210+D	2.100E-02	2.100E-02	DCF2(3)
B-1	Ra-226+D	7.900E-03	7.900E-03	DCF2(4)
B-1	Ra-228+D	4.500E-03	4.500E-03	DCF2(5)
B-1	Th-228+D	3.100E-01	3.100E-01	DCF2(6)
B-1	Th-230	3.200E-01	3.200E-01	DCF2(7)
B-1	Th-232	1.600E+00	1.600E+00	DCF2(8)
B-1	U-234	1.300E-01	1.300E-01	DCF2(9)
B-1	U-235+D	1.200E-01	1.200E-01	DCF2(10)
B-1	U-238+D	1.200E-01	1.200E-01	DCF2(11)
D-1	Dose conversion factors for ingestion, mrem/pCi			
D-1	Ac-227+D	1.500E-02	1.500E-02	DCF3(1)
D-1	Pa-231	1.100E-02	1.100E-02	DCF3(2)
D-1	Pb-210+D	6.700E-03	6.700E-03	DCF3(3)
D-1	Ra-226+D	1.100E-03	1.100E-03	DCF3(4)
D-1	Ra-228+D	1.200E-03	1.200E-03	DCF3(5)
D-1	Th-228+D	7.500E-04	7.500E-04	DCF3(6)
D-1	Th-230	5.300E-04	5.300E-04	DCF3(7)
D-1	Th-232	2.800E-03	2.800E-03	DCF3(8)
D-1	U-234	2.600E-04	2.600E-04	DCF3(9)
D-1	U-235+D	2.500E-04	2.500E-04	DCF3(10)
D-1	U-238+D	2.500E-04	2.500E-04	DCF3(11)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(8,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(10,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(10,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)

Dose Conversion Factor (and Related) Parameter Summary (continued)

Menu	Parameter	Current Value	Default	Parameter Name
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(8,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(8,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(10,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(10,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.500E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+[illegible]	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRLD
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	3.000E+03	---	T(9)
R011	Times for calculations (yr)	not used	1.000E+04	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E+03	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Th-232	1.000E+03	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): U-234	1.000E+03	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): U-235	1.000E+03	0.000E+00	---	S1(10)
R012	Initial principal radionuclide (pCi/g): U-238	1.000E+03	0.000E+00	---	S1(11)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(10)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(11)
R013	Cover depth (m)	3.050E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.500E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	3.150E-03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	0.000E+00	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	9.969E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	6.313E+05	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	MB	ND	---	MODEL
R014	Individual's use of groundwater (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	2.000E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	2.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	5.000E-02	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	3.150E-03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	7.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	[illegible].000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.962E-06	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+00	6.000E+04	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+00	5.000E+01	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.393E-05	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+00	5.000E+01	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.393E-05	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+01	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.393E-05	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.454E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.393E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.981E-06	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	7.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.962E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	6.000E+04	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	6.000E+06	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.167E-08	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	not used	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD

Summary : KM CUSH 5E SENS, GROUNDWATER, 20 M UNSAT, KD=VARIABLE

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Shape factor, external gamma	not used	1.000E+00	---	FS1
R017	Fractions of annular areas within AREA				
R017	Outer annular radius (m) = √(1/π)	not used	1.000E+00	---	FRACA(1)
R017	Outer annular radius (m) = √(10/π)	not used	1.000E+00	---	FRACA(2)
R017	Outer annular radius (m) = √(20/π)	not used	1.000E+00	---	FRACA(3)
R017	Outer annular radius (m) = √(50/π)	not used	1.000E+00	---	FRACA(4)
R017	Outer annular radius (m) = √(100/π)	not used	1.000E+00	---	FRACA(5)
R017	Outer annular radius (m) = √(200/π)	not used	1.000E+00	---	FRACA(6)
R017	Outer annular radius (m) = √(500/π)	not used	1.000E+00	---	FRACA(7)
R017	Outer annular radius (m) = √(1000/π)	not used	1.000E+00	---	FRACA(8)
R017	Outer annular radius (m) = √(5000/π)	not used	1.000E+00	---	FRACA(9)
R017	Outer annular radius (m) = √(1.E+04/π)	not used	1.000E+00	---	FRACA(10)
R017	Outer annular radius (m) = √(1.E+05/π)	not used	0.000E+00	---	FRACA(11)
R017	Outer annular radius (m) = √(1.E+06/π)	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.125E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.125E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
R021	Thickness of building foundation (m)	1.500E-01	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	4.000E-01	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	1.000E-01	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	5.000E-02	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	3.000E-02	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec)				
R021	in cover material	2.000E-06	2.000E-06	---	DIFCV
R021	in foundation material	1.000E-10	3.000E-07	---	DIFFL
R021	in contaminated zone soil	2.000E-06	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	5.000E-01	5.000E-01	---	REXG
R021	Height of the building (room) (m)	2.500E+00	2.500E+00	---	HRM
R021	Building interior area factor	0.000E+00	0.000E+00	code computed (time dependent)	FAI
R021	Building depth below ground surface (m)	0.000E+00	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	1.500E-01	1.500E-01	---	EMANA(2)

Summary of Pathway Selections

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

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area	2500.00 square meters	Ra-226	1.000E+03
Thickness	3.00 meters	Th-232	1.000E+03
Cover Depth	3.05 meters	U-234	1.000E+03
		U-235	1.000E+03
		U-238	1.000E+03

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years)	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t)	2.769E+01	2.768E+01	2.766E+01	2.757E+01	2.733E+01	2.649E+01	2.425E+01	2.390E+02
M(t)	9.231E-01	9.227E-01	9.219E-01	9.190E-01	9.109E-01	8.831E-01	8.083E-01	7.967E+00

Maximum TDOSE(t):   3.216E+02 mrem/yr at t =   317.6 ± 0.3 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 = 317.6 years

Water Independent Pathways (Inhalation excludes radon)

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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.406E+01	0.0772	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	5.184E-03	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	1.570E-06	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	2.406E+01	0.0772	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 317.6 years

Water Dependent Pathways

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.
Ra-226	2.207E+02	0.7083	1.347E+01	0.0432	5.240E+01	0.1681	0.000E+00	0.0000	1.704E-01	0.0005	7.963E-01	0.0026	3.116E+02	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	8.531E-09	0.0000	5.266E-10	0.0000	2.015E-09	0.0000	0.000E+00	0.0000	6.580E-12	0.0000	3.067E-11	0.0000	5.184E-03	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	3.699E-15	0.0000	2.262E-16	0.0000	8.773E-16	0.0000	0.000E+00	0.0000	2.855E-18	0.0000	1.336E-17	0.0000	1.570E-06	0.0000
Total	2.207E+02	0.7083	1.347E+01	0.0432	5.240E+01	0.1681	0.000E+00	0.0000	1.704E-01	0.0005	7.963E-01	0.0026	3.116E+02	1.0000

*Sum of all water independent and dependent pathways

Residual Radioactivity Program, Version 5.04 04/11/94 18:42 Page 13
Summary : KM CUSH SE SENS, GROUNDWATER, 20 M UNSAT, KD=VARIABLE
File : KMCSH5E.DAT

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

Water Independent Pathways (Inhalation excludes radon)

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.769E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	2.769E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.769E+01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	2.769E+01	1.0000

*Sum of all water independent and dependent pathways

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Summary : KM CUSH SE SENS, GROUNDWATER, 20 M UNSAT, KD=VARIABLE
File : KMCSH5E.DAT

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

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.768E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	5.399E-08	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	4.675E-14	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	2.768E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-Nuclide	Water 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.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.768E+01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	5.399E-08	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	4.675E-14	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	2.768E+01	1.0000

*Sum of all water independent and dependent pathways

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 317.6 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.406E+01	0.0772	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	5.184E-03	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	1.570E-06	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	2.406E+01	0.0772	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 317.6 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	2.207E+02	0.7083	1.347E+01	0.0432	5.240E+01	0.1681	0.000E+00	0.0000	1.704E-01	0.0005	7.963E-01	0.0026	3.116E+02	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	8.531E-09	0.0000	5.266E-10	0.0000	2.015E-09	0.0000	0.000E+00	0.0000	6.580E-12	0.0000	3.067E-11	0.0000	5.184E-03	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	3.699E-15	0.0000	2.262E-16	0.0000	8.773E-16	0.0000	0.000E+00	0.0000	2.855E-18	0.0000	1.334E-17	0.0000	1.570E-06	0.0000
Total	2.207E+02	0.7083	1.347E+01	0.0432	5.240E+01	0.1681	0.000E+00	0.0000	1.704E-01	0.0005	7.963E-01	0.0026	3.116E+02	1.0000

*Sum of all water independent and dependent pathways

Residual Radioactivity Program, Version 5.04   04/11/94 18:42   Page 13
Summary : KM CUSH 5E SENS, GROUNDWATER, 20 M UNSAT, KD=VARIABLE
File   KMCSH5E.DAT

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.769E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	2.769E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.769E+01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	2.769E+01	1.0000

*Sum of all water independent and dependent pathways

Residual Radioactivity Program, Version 5.04   04/11/94 18:42   Page 14
Summary : KM CUSH 5E SENS, GROUNDWATER, 20 M UNSAT, KD=VARIABLE
File   KMCSH5E.DAT

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.768E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	5.399E-08	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	4.675E-14	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	2.768E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.768E+01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	5.399E-08	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	4.675E-14	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	2.768E+01	1.0000

*Sum of all water independent and dependent pathways

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.766E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	4.858E-07	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	1.373E-12	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	2.766E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.766E+01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	4.858E-07	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	1.373E-12	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	2.766E+01	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.757E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	5.391E-06	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	5.086E-11	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	2.757E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.757E+01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	5.391E-06	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	5.086E-11	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	2.757E+01	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.733E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	4.837E-05	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	1.370E-09	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	2.733E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.733E+01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	4.837E-05	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	1.370E-09	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	2.733E+01	1.0000

*Sum of all water independent and dependent pathways

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

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.649E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	5.316E-04	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	5.031E-08	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	2.649E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.649E+01	1.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	5.316E-04	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	5.031E-08	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	2.649E+01	1.0000

*Sum of all water independent and dependent pathways

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

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	2.425E+01	0.9998	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	4.639E-03	0.0002	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	1.326E-06	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	2.425E+01	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.425E+01	0.9998
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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	4.639E-03	0.0002
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	1.326E-06	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	2.425E+01	1.0000

*Sum of all water independent and dependent pathways

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

Water Independent Pathways (Inhalation excludes radon)

Radio-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
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	1.778E+01	0.0744	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	4.642E-02	0.0002	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	4.529E-05	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	1.782E+01	0.0746	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-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
Ra-226	1.694E+02	0.7087	1.053E+01	0.0441	3.989E+01	0.1669	0.000E+00	0.0000	1.306E-01	0.0005	6.078E-01	0.0025	2.383E+02	0.9972
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	4.864E-01	0.0020	3.023E-02	0.0001	1.146E-01	0.0005	0.000E+00	0.0000	3.749E-04	0.0000	1.745E-03	0.0000	6.797E-01	0.0028
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	3.156E-04	0.0000	1.961E-05	0.0000	7.434E-05	0.0000	0.000E+00	0.0000	2.433E-07	0.0000	1.132E-06	0.0000	4.562E-04	0.0000
Total	1.699E+02	0.7107	1.056E+01	0.0442	4.001E+01	0.1674	0.000E+00	0.0000	1.310E-01	0.0005	6.095E-01	0.0026	2.390E+02	1.0000

*Sum of all water independent and dependent pathways

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

DSR(j,t) (mrem/yr)/(pCi/g)

Parent (i)	Product (j)	Branch Fraction	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	1.000E+00	2.769E-02	2.768E-02	2.766E-02	2.757E-02	2.733E-02	2.649E-02	2.425E-02	2.367E-01
Ra-226	Pb-210	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.621E-03
Ra-226	ΣDSR(j)		2.769E-02	2.768E-02	2.766E-02	2.757E-02	2.733E-02	2.649E-02	2.425E-02	2.383E-01
Th-232	Th-232	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
Th-232	Ra-228	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
Th-232	Th-228	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
Th-232	ΣDSR(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
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
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
U-234	Ra-226	1.000E+00	0.000E+00	5.399E-11	4.858E-10	5.391E-09	4.837E-08	5.316E-07	4.639E-06	6.752E-04
U-234	Pb-210	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.537E-06
U-234	ΣDSR(j)		0.000E+00	5.399E-11	4.858E-10	5.391E-09	4.837E-08	5.316E-07	4.639E-06	6.797E-04
U-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
U-235	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
U-235	Ac-227	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
U-235	ΣDSR(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
U-238	U-238	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
U-238	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
U-238	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
U-238	Ra-226	1.000E+00	0.000E+00	4.675E-17	1.373E-15	5.086E-14	1.370E-12	5.031E-11	1.326E-09	4.533E-07
U-238	Pb-210	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.897E-09
U-238	ΣDSR(j)		0.000E+00	4.675E-17	1.373E-15	5.086E-14	1.370E-12	5.031E-11	1.326E-09	4.562E-07

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j)
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	1.083E+03	1.084E+03	1.085E+03	1.088E+03	1.098E+03	1.132E+03	1.237E+03	1.259E+02
Th-232	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05	*1.092E+05
U-234	*6.233E+09	*6.233E+09	*6.233E+09	5.564E+09	6.202E+08	5.643E+07	6.467E+06	4.413E+04
U-235	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06
U-238	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05

*At specific activity limit

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 = 317.6 ± 0.3 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-226	1.000E+03	317.6 ± 0.3	3.116E-01	9.627E+01	3.116E-01	9.627E+01
Th-232	1.000E+03	1.000E+03	0.000E+00	*1.092E+05	0.000E+00	*1.092E+05
U-234	1.000E+03	1.000E+03	6.797E-04	4.413E+04	5.184E-06	5.787E+06
U-235	1.000E+03	1.000E+03	0.000E+00	*2.160E+06	0.000E+00	*2.160E+06
U-238	1.000E+03	1.000E+03	4.562E-07	*3.360E+05	1.570E-09	*3.360E+05

*At specific activity limit

Transport Time Parameters for Unsaturated Zone Stratum No. 1

Stratum thickness [h(1)]:	20.000000	m
Bulk soil material density [rhob(1)]:	1.500000	g/cm**3
Effective porosity [peuz(1)]:	0.050000	
Hydraulic conductivity [Khuz(1)]:	0.003150	m/yr
Total porosity [ptuz(1)]:	0.200000	
Soil specific b parameter [buz(1)]:	5.300000	
Saturation ratio [sruz(1)]:	1.000000	

Radio-nuclide (i)	Distribution Coefficient Kduz(i,1), cm**3/g	Retardation Factor Rduz(i,1)	Transport Time Dtuz(i,1), yr
Ac-227	2.0000E+01	1.5100E+02	4.7937E+04
Pa-231	5.0000E+01	3.7600E+02	1.1937E+05
Pb-210	1.0000E+02	7.5100E+02	2.3841E+05
Ra-226	0.0000E+00	1.0000E+00	3.1746E+02
Ra-228	2.0000E+02	1.5010E+03	4.7651E+05
Th-228	5.0000E+02	3.7510E+03	1.1908E+06
Th-230	1.0000E+03	7.5010E+03	2.3813E+06
Th-232	1.0000E+00	8.5000E+00	2.6984E+03
U-234	2.0000E+00	1.6000E+01	5.0794E+03
U-235	5.0000E+00	3.8500E+01	1.2222E+04
U-238	1.0000E+01	7.6000E+01	2.4127E+04

Appendix C

Key Personnel

APPENDIX C

KEY PERSONNEL
CUSHING SITE DECOMMISSIONING PROJECT

Roy R. Smith
Vice President, Environmental Operations, Technology & Engineering Division. (Also President, Cimarron Corporation)- Responsible for all site activities and selection of personnel for all safety and environment related positions.

Jeffrey J. Lux
Project Manager, Environmental Operations, Technology & Engineering Division- Responsible for overall project direction.

Jeffrey G. Ostmeyer
Site Coordinator, Environmental Operations, Technology & Engineering Division- Responsible for daily operations.

Terence M. Moore
Manager, Health Physics and Safety and Radiation Safety Officer. (Also, Manager Health Physics and Safety and RSO, Cimarron Facility)- Responsible for the conduct of the health physics and industrial safety program to include directing health physics technicians, conducting specified radiation safety surveillance and training and advising on radiation protection matters.

Edwin T. Still
Vice President, Kerr-McGee Corporation and Director, Environment and Health Management Division. (Also, Vice President, Cimarron Corporation)- Responsible for developing and implementing corporate policies and programs to protect the environment and the health and safety of employees and the general public to include NRC licensed facilities and for determining compliance with company policies and applicable regulations for environmental, health and safety matters.

John C. Stauter
Vice President, Environmental Services- Responsible for federal and state licenses to include NRC and agreement states, preparation of corporate radiation safety standards, and permits, liaison with regulatory agencies and for coordinating with the site manager in matters of licensing requirements.

ROY R. SMITH

Education	B. S. Mining Engineering, Michigan Technological University
	Kellogg Graduate School of Management, Advanced Executive Program, Northwestern University
Experience	More than 30 years experience in mining and earth moving operations.
	1957-1968 Responsible for planning and operations engineering of large surface mining operation.
	1968-1974 Responsible for planning and operation of open pit uranium mine.
	1974-1978 Responsible for development and operation of two large surface coal mines.
	1978-1981 Responsible for operation of two surface uranium mines.
	1981-1990 Vice President of operations for a large coal company -- two surface and one underground mines.
	1990-Present Technology and Engineering Division Vice President of Environmental Operations. Responsible for environmental operations and reclamation of orphan sites with hydrocarbon and radioactive contamination

JEFFREY J. LUX

Education	M.S., 1985, Geological Engineering, with emphasis on regulation, assessment, and remediation, University of Missouri at Rolla, Rolla, Missouri
	B. S., 1975, Geological Engineering, University of Missouri at Rolla, Rolla, Missouri
	1991, Radiation Safety Instrumentation and Compliance, Oklahoma State University
	1992, Principles of Radiation Safety, Oklahoma State University
Experience	1987-1991 Responsible for groundwater assessment and remediation, aquifer test analysis, and groundwater recovery system design. Experience with RCRA and CERCLA facility investigation and remediation programs.
	1991-Present Project manager for Environmental Operations. Responsible for cleanup operations at two orphan sites.

JEFFREY G. OSTMEYER

Education	Ph.D., 1987, Wood Chemistry, Auburn University
	M.S., 1982, Forest Products, University of Missouri- Columbia
	B.S., 1980, Forest Products, University of Missouri- Columbia
	A.A., 1979, Pre-Forestry, Colby Community College
	1992, Principles of Radiation Safety, Oklahoma State University
Experience	1988-1991 Senior Research Chemist, Kerr-McGee Corporation, Technology Division. Project leader in Applied Research, Product Development, and Chemical R&D. Technical Support to Environmental Services.
	1991-Present Site Coordinator for remediation of a closed refinery site containing both radioactive and hydrocarbon wastes.

TERENCE M. MOORE

Education	B.S. Health Physics, Radiation and Nuclear Engineering Technology, Oklahoma State University, 1980.
	National Registry of Radiation Protection Technologists (NRRPT) 1988.
	American Board of Health Physics, Part I Certification
Experience	1980 - 1991 Wolf Creek Generating Station, 1135 Mwe pressurized water nuclear reactor. Health Physics Technician, Foreman, and Radiological Engineer; responsible for various aspects of the Health Physics Program for a large nuclear power station.
	1991 - 1993 EG&G Rocky Flats, Department of Energy Weapons Production Plant. Radiological Engineer responsible for the development and implementation of various procedures for the unrestricted release of hazardous and non-hazardous wastes.
	1993 - Present Radiation Safety Officer, Kerr-McGee Cimarron Facility and Cushing Site Supervises Health and Safety staff. Functions as radiation safety officer for decommissioning the Cimarron and Cushing sites. Supervises health physics crew working on site characterization survey and decontamination activities. Responsible for manning and implementing the final release survey of the Plutonium and Uranium plants at Cimarron.

JOHN C. STAUTER

Education

Ph.D., 1970, University of Utah, Metallurgy (Chemical/Extractive)

M.S., 1967, Michigan Technological University, Metallurgical Engineering

B.S., 1966, Michigan Technological University, Metallurgical Engineering

Experience

More than ten years experience in managment and problem solving in environmental permitting and nuclear licensing programs. Responsibilities include oversight of activities related to permit requirements, ensuring compliance, and developing engineering and management solutions. Typical examples are:

1970-1974 Research Scientist, Conoco. Develop and prove processing procedures for Conoco Minerals Division (Uranium Copper, Precious Metals) and Consolidation Coal (Coal Cleaning) operations.

1974-1978 Research Group Leader, UOP Inc., Direct fundamental research into new mineral processing systems and precious metal recovery from catalysts.

1978-1981 Sr. Project Metallurgist, Kerr-McGee Technology Division- Direct long range and applied process chemistry systems recovery (uranium, titanium) and mitigation or prevention of environmental impacts.

1981-1984 Sr. Environmental Scientist. Direct regulatory and engineering oversight for facility permitting activities concerning EPA-RCRA hazardous waste. Provide technical support and regulatory interpretation for company nuclear related operations.

1984-1990 Director, Environmental Affairs and Director, Nuclear Licensing- Direct and provide corporate oversight of nuclear licensing activities and EPA air, water, and solid waste programs.

1990-Present Corporate Vice President, Environmental Services, Kerr-McGee Corporation- Direct and provide corporate oversight of nuclear licensing activities and EPA air, water, and solid waste programs.

EDWIN T. STILL

Education

DVM, 1959, University of Georgia

MS, 1964, University of Rochester

Attendee of and instructor for numerous courses concerning biological effects of ionizing radiation, risk assessment, pathways, health physics, radiation detection, instrumentation, surveys, monitoring and all facets related to radiation protection and safety.

Experience

More than 25 years in ionizing radiation field with activities ranging from bench research to field activities to program management to administration. Typical examples:

1964-1969 conducted original research on biological effects of neutrons, protons, gamma and super voltage x-rays, Department of Defense

1969-1975 planned, developed and evaluated research programs for assessing effects of ionizing radiation on humans and the environment and beneficial applications of nuclear materials, to include source, special nuclear and by-product materials, Atomic Energy Commission

1975-1979 conceived, reviewed, evaluated and initiated comprehensive research programs on radiation health effects, mechanisms of radiation injury and therapeutic measures for treating radiation injury utilizing as sources of radiation a nuclear reactor, multi-kilocurie Cobalt-60 array, variable energy electron accelerator and super voltage x-ray machines; participated in planning for and execution of decontamination of Atoll in mid-Pacific formerly used for nuclear weapons testing, Department of Defense

1979-1982 directed program to retrieve and reconstruct personnel and dosimetry data, to include external and internal dose, for specific groups involved in nuclear weapons testing and ascertain any relationships between health status and radiation exposure from the tests, Department of Defense

1982-Present responsible for developing and implementing programs for protecting the health and safety of employees and the environment to include activities involving source, special nuclear and 11(e)1 and 11(e)(2) by-product materials.

Appendix D

Emergency Contacts

EMERGENCY CONTACTS

GOVERNMENT- FEDERAL

Mr. David Fauver
Office of Nuclear Materials Safety & Safeguards
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555 (301) 504-2554

Mr. Bob Evans
U. S. Nuclear Regulatory Commission- Region IV
611 Ryan Plaza, Suite 100
Arlington, TX 76011 (817) 860-8198

GOVERNMENT- STATE

Mr. Scott Thompson
Oklahoma Department of Environmental Quality
Solid Waste Management
1000 N.E. 10th Street
Oklahoma City, OK 73152 (405) 271-7168

Mr. Gene Smith
Oklahoma Department of Environmental Quality
Consumer Protection
1000 N.E. 10th Street
Oklahoma City, OK 73152 (405) 271-5221

KERR-McGEE PERSONNEL

Smith, Roy,
Vice President, Home:(405) 348-0926
Environmental Operations Bus: (405) 270-2534

Still, Ed
Vice President,
Environmental Services & Home:(405) 348-8469
Health Management Bus: (405) 270-2934

Stauter, John
Vice President Home:(405) 341-9374

Environmental Services — Bus: (405) 270-2623

Lux, Jeff
Project Manager — Home:(405) 354-8105
Environmental Operations — Bus: (405) 270-2694

Ostmeyer, Jeff
Site Coordinator — Home:(405) 348-7446
Environmental Operations — Bus: (918) 225-7753

Terence Moore
Staff Health Physicist — Home:(405) 258 0312
Cimarron Corporation — Bus: (918) 225-7753

KERR-McGEE EMERGENCY RESPONSE PERSONNEL

Barry Brandt — Home:(405) 340-5882
Communications — Bus: (405) 270-2434

Gary Hopkins — Home:(405) 722-4006
Bus: (405) 270-2811

John F. Reichenberger — Home:(405) 720-8609
Law — Bus: (405) 270-2875

Steven D. Emerson — Home:(405) 341-0004
Safety — Bus: (405) 270-3740

Julius Hilburn — Home:(405) 755-5768
Human Resources — Bus: (405) 270-2754

John Gibbs, M.D. — Home:(405) 348-5879
Medical Services — Bus: (405) 270-5879