11/10/04

MEMORANDUM TO: George C. Pangburn, Director
Division of Nuclear Materials Safety, RI

FROM: Daniel M. Gillen, Deputy Director /RA/
Decommissioning Directorate
Division of Waste Management
and Environmental Protection
Office of Nuclear Material Safety
and Safeguards

SUBJECT: RESPONSE TO TECHNICAL ASSISTANCE REQUEST DATED JUNE 23, 2004, FOR WHITTAKER CORPORATION REQUEST FOR LICENSE AMENDMENT

I am responding to your technical assistance request (TAR) dated June 23, 2004, regarding the Whittaker Corporation's request for a license amendment. You requested that the response address the following: (1) the licensee's proposed program and actions to determine acceptability of waste blending for offsite disposal, and (2) determine the acceptability of the licensee's dose assessment analysis.

RESPONSE:

(1) The licensee's proposed program and actions to crush and blend material is consistent with the policy established in SECY-04-0035 to continue the practice of blending materials to meet waste acceptance criteria (WAC) of an offsite disposal facility if it facilitates decommissioning of sites, and is acceptable.

However, unlike the Kaiser Aluminum and Chemical Corporation's recent approval, which Whittaker used extensively to prepare their proposed actions and dose assessment, the material that is being crushed and blended is licensed material (Kaiser is remediating its site in accordance with the Site Decommissioning Management Plan, even though it is not a licensee since its license was terminated in 1971). Therefore, specific approval to ship the blended material as an unimportant quantity of source material (<0.05% by weight) in accordance with 10 CFR 40.13 to a non-licensee (Waste Control Specialists, TX or WCS), must be granted. Based on the acceptability of the dose assessment for disposal of the material at WCS (see below), it is recommended that approval be granted to Whittaker Corporation for disposal of the material at the WCS Facility, under specified conditions. Attachment 1 provides suggested conditions under which the disposal should be approved. Also, it is noted that the WCS Facility is under license for disposal of certain radioactive materials by the Bureau of Radiation Control of the Texas Department of Heath. Other requirements imposed by the Bureau may apply to the receipt and disposal of this material at the WCS Facility.

(2) The licensee's dose assessment analysis for disposal of the blended material at the WCS Facility is acceptable, as long as the specified condition in Attachment 1 concerning the total volume of waste shipped to WCS is met.

Attachment 2 is the review of the Whittaker Corporation dose assessment by the Division of Waste Management and Environmental Protection (DWMEP) staff. The review concludes that the dose analysis presented by Whittaker is acceptable. However, it notes that a few assumptions and parameters used in the analysis appear to be inconsistent with independent calculations of a more conservative nature used by staff in verifying the Whittaker calculations. Using more conservative values than Whittaker for total volume of waste requiring disposal and number of rail shipments in the calculations still results in dose values that are far less than the public dose limits in 10 CFR 20.1301. Nevertheless, a condition is recommended to ensure that the total volume of the waste (and thus, the number of shipments of waste to WCS), does not exceed the conservative values used by DMWEP staff in review of the dose analysis.

Attachments:
1. Suggested License Conditions
2. Review of Whittaker Dose Analysis

CONTACT: Derek Widmayer, NMSS/DWMEP/DCD
(301) 415-6677

Docket No.: 40-7455
License No.: SMA-1018

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DISTRIBUTION:
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ML042940681 *See previous concurrence

OFC	DWMEP*		DWMEP*		DWMEP*	
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DATE	10/25/04		11/02/04		11/10/04	

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SUGGESTED LICENSE CONDITIONS

WHITTAKER CORPORATION
MATERIAL BLENDING AND DISPOSAL AT WCS

1. The disposal of unimportant quantities of source material to the WCS Facility in Andrews County, TX, is subject to an approved Decommissioning Plan from the NRC.

2. The licensee shall obtain a composite sample from each truckload and analyze the sample prior to the truck leaving the Whittaker facility to verify that the material that will be shipped to the WCS Facility complies with the limits of acceptability.

3. The recorded results of the sampling and analysis shall be made available for NRC inspection.

4. The limits of acceptability for thorium-232 and uranium-238 is less than 0.05 percent by weight of the mixture of crushed and blended Type 1 and Type 2 material (which equates to less than 54.5 pCi/g Th-232 and less than 166.5 pCi/g U-238). The sum-of-the-fractions rule applies to the mixture so that the total source material is less than 0.05 percent of the mixture.

5. If the amount of unimportant quantities of source material that will be shipped to WCS is expected to significantly exceed the NRC calculated estimate of 7000 cubic yards, then NRC Region I should be contacted to determine if any additional environmental documentation or dose pathway analysis should be performed and documented.

Review of the Dose Assessment Analysis for Disposal of Whittaker's Unimportant Quantities at the Waste Control Specialists (WCS) Landfill Facility In Andrews, Texas

By: Boby Eid
Division of Waste Management and Environmental Protection
September 16, 2004

Introduction

Whittaker Corporation (hereafter referred to as "Whittaker," or the licensee) submitted on May 20, 2004, a request to NRC/Region I (R-I) for amendment of its source material license SMA-1018 (Docket No. 040-07455). The amendment request included two licensing actions: (1) allow for excavation, crushing, and onsite blending of slag waste materials; and (2) grant an exemption, based on dose analysis, for disposal of Whittaker's blended waste (e.g., as an unimportant quantities of source material as defined under 10 CFR 40.13) at the Waste Control Specialists (WCS) landfill facility located in Andrews, Texas. In response to the licensee's request, R-I submitted, on June 23, 2004 to the Division of Waste Management and Environmental Protection (DWMEP), a technical assistance request (TAR) for assistance in resolving two issues as follows: (1) the first issue of the TAR pertains to review of licensee's proposed actions to determine acceptability of the waste blending onsite for offsite disposal; and (2) the second issue involves conducting dose assessment reviews and analysis to determine the acceptability of the licensee's analysis for disposal of the blended waste at the WCS facility. The first issue of the TAR is being addressed by the Decommissioning Directorate staff. This report pertains to analysis and resolution of the second issue of the TAR and has been conducted by the Environmental and Performance Assessment Directorate (EPAD) staff.

In addressing the issue of the dose impact analysis associated with the disposal of unimportant quantities of source material at WCS, the licensee used a similar approach, methodology, and exposure scenarios to those used for Kaiser, Tulsa, OK (Kaiser) and Molycorp, York, PA (Molycorp) sites. In this regard, the licensee submitted, in Appendix A, a 96-page report entitled "*Dose Assessment for Disposal of Kaiser Waste Containing Less Than 0.05 WT% Source material At WCS Andrews Facility."* In addition, the licensee submitted, in Appendix B and C, copies of NRC letters to Molycorp and Kaiser respectively regarding staff acceptance of the dose assessments for disposal of unimportant quantities of source material from Molycorp and Kaiser sites at WCS. In other words, the licensee used the same dose assessment approach, methodology, and scenarios, as well as the same WCS site specific parameters, as those used for Kaiser. Nevertheless, the licensee conducted a specific exposure analysis based on its waste characteristics. The licensee used the Microshield code and Whittaker's waste models to calculate potential exposure due to waste handling and shipment (Appendix D). In addition, the licensee submitted a specific dose assessment report, prepared by SCIENTECH, which evaluates dose impacts from the disposal of the blended Whittaker's byproduct wastes at the WCS facility (Appendix E). It should be noted that the Whittaker's slag wastes (after mixing) contain unimportant quantities of source material as defined under 10 CFR 40.13, (i.e., up to 0.05% by weight of Th-232 (54.5 pCi/g) and U-238 (166.5 pCi/g)). This report presents a summary of EPAD staff review of the Whittaker's exposure and dose assessment analysis and determination of its acceptability. In conducting this review, staff reviewed the Kaiser dose analysis for the purpose of comparison only because such analysis has already been approved by the NRC staff and submitted by the licensee as the basis for accepting its amendment request.

Description of WCS Landfill Site and Facility:

The WCS site is located approximately 30 miles east of the USDOE Waste Isolation Pilot Plant facility. The city of Andrews, with a population of 10,000, is located approximately 30 miles west of WCS and the town of Eunic (population of 2,500) is located 6 miles west of WCS. The WCS facility is located on a 15, 215 acre site of which 1,338 acres are allotted for treatment, storage, and disposal of Resource Conservation and Recovery Act (RCRA) and Toxic Substance Control Act (TSCA) wastes. The currently permitted disposal area can accommodate up to 1.1 E+07 cubic yards of waste. The annual precipitation at this area is 14 inches and the average yearly evaporation rate is 63.25 inches. The WCS landfill is situated on a thick layer (about 800 to 1000 feet) of low permeability red clay. This layer represents a natural barrier to retard migration of contaminants to the subsurface aquifer. The aquifer beneath the site is about 900 feet below the surface. It is known as the Santa Rosa aquifer and is considered to be non-potable due to high contents of total dissolved solids. The nearest potable groundwater aquifer is located at least 10 miles NE of the site. The only commercial activities in the vicinity include oil well production and a gravel quarry/crushing operation.

The WCS disposal facility is a typical RCRA cell with double plastic and clay liners with a double leachate collection system. The bottom of the cell extends into the natural clay layer. Ten feet of compacted clay is placed under the sidewalls double liner from the surface down to the natural clay layer to provide an additional layer of protection from potential lateral migration near the surface. It should be noted that the WCS facility also has a license from the Texas Department of Health for radioactive waste storage and treatment. Therefore, all operations involving radioactive material are performed under an existing radiation safety program regardless of exemption status and all onsite personnel are considered radiation workers. In addition to generic RCRA cell requirements, WCS current requirements regarding design and institutional control include a minimum of 30 years for active maintenance after closure, deed restrictions which prevent disturbing the cover after closure of the facility, and a 5-meter engineered cover.

Review of Whittaker's Exposure and Dose Assessment Analysis:

3.1 Whittaker Source Material and Handling Processes:

Whittaker classified its source material into three categories designated as Type 1, 2, and 3. Type 1 material contains greater than 0.05% by weight U and Th (e.g., >166.5 pCi/g U-238; >355 pCi/g U-nat; >54.5 pCi/g Th-232; and >110 pCi/g Th-nat.; with the sum of fraction ratio used for radioniclides mixture). Both Type 2 and type 3 materials contain less than 0.05% by weight U and Th. However, Type 2 material contains U and Th isotopes with concentrations above release criteria (e.g., corresponding to an annual dose of 25 mrem/yr). Type 3 material contains U and Th isotopes of concentrations below the release criteria. Therefore, the licensee requested that Type 1 and 2 slags be allowed to be crushed and blended for offsite disposal at WCS. The purpose of the crushing and blending is to create a homogeneous mixture of Types 1 and 2 materials such that the bulk waste volume contains unimportant quantities of the source material that meet the waste acceptance criteria (WAC) for disposal at WCS. Whittaker estimated to blend 400 to 800 tons of Type 1 slag material with 8,000 to 10,000 tons of Type 2 material (SCIENTECH Document No. 82A9526, page 5). Because Type 2 material is above the decommissioning release criteria, the bulk Type 2 material is anticipated to be transported off-site for disposal at WCS along with Type 1 material. Therefore, the total waste (e.g., Type 1 and Type 2) would be in the range of 8,400 to 10,800 tons. Considering a density of two metric tons per cubic meter (e.g., $2g/cm^3$) the waste volume would be in the range of 4,200 to 5,400 m^3 or approximately 5,500 to 7100 cy. However, the licensee stated (SCIENTECH Document No. 82A9527, page 5) that "the volume of the waste that is to be sent from Whittaker site to WCS is expected to be about 1,200 tons, or about 700 cubic yards." Therefore, there appears to be an inconsistency in estimation of the waste volume. It should be noted that Whittaker used a waste volume of 700 cy for all dose exposure scenarios.

The crushed and blended slag material will be stockpiled and loaded into end-dump transport vehicles. The waste material in these vehicles will be transferred to gondola rail cars or other rail-compatible transportation containers at a rail transfer station. The total activity concentration for each waste shipment will be <2,000 pCi/g, below DOT's 49 CFR 173.403 limit for regulation under hazardous material. The maximum dose rate on contact with the shipping container will be less than 0.5 mrem/hr. Whittaker emphasized in its request that all activities for source material excavation, crushing, blending, and handling will be conducted under a site-specific health and safety plan and a radiation work permit.

3.2 Dose Analysis for Disposal of Kaiser Waste at WCS:

The licensee used Kaiser's dose impact analysis as the basis for NRC approval of Whittaker slag disposal at WCS. In this regard, the licensee presented, in Appendix A, a dose analysis report using the Kaiser source term (i.e., radionuclide concentrations (pCi/g) of Kaiser waste including 2,365 for Pb-210; 4,510 for Ra-226; 55 for Ra-228; 55 for Th-228; 192.5 for Th-230; and 55 for Th-232). The Kaiser analysis included exposure to WCS radiation workers for two types of activities. The first involves a radiation protection (RP) technician who surveys incoming railcars, and the second involves a driver who transports the waste from the rail to the facility and unload the waste. Using Kaiser's waste source and Microshield code, the exposure dose to an RP technician was calculated at 5.70E-04 mrem and the dose to an WCS truck driver was calculated at 2.96E-03 mrem. In addition, the Kaiser report included Microshield dose analysis to members of the public for a railroad transportation scenario. In this regard, the Kaiser study reported a dose of 2.20E-07 mrem for a railroad crew and a dose of 1.01 E-05 mrem for a railroad employee. Further, Kaiser reported results from RESRAD dose analysis for an offsite resident and a future onsite resident. The individual dose to each of these dose recipients was found to be essentially zero mrem. In addition to an onsite resident, the dose to an onsite inadvertent intruder, assumed to be a well digger, was evaluated. The individual dose to a well digger at the main landfill facility was found to be approximately 2.4E-03 mrem.

When using Microshield dose exposure analysis, Kaiser assumed a rectangular shape of bulk waste with a common dimension of 3 m x 16 m x 1.5 m. The dose points varied in distance from 1 m to 18 m. The input inventory of radionuclides in the code was calculated based on waste volume in a typical shipment container and using the WAC of unimportant quantity concentration for Kaiser's waste as indicated above.

In performing RESRAD dose analysis, Kaiser essentially used RESRAD code (version 6.2) default input parameters with the exception of certain parameters listed in Table 1. The input parameters listed in Table 1 were based on site-specific WCS data. Sensitivity analysis conducted by Kaiser for waste volume showed no significant dose increase for waste volumes in the range of 20,000 m^3 to 1,250,000 m^3.

Table 1: Kaiser Modified Input Parameters for RESRAD 6.2 Runs

Parameter (unit)	Kaiser Input	RESRAD Default
Cover thickness (m)	5.0	0.0
Density of cover (g/cm^3)	2.35	1.50
Cover erosion rate(m/yr)	1.83E-06	1.00E-03
Precipitation (m/yr)	0.355	1.0
Unsaturated zone thickness (m)	300	4.0
Unsaturated zone density (g/cm^3)	2.35	1.50
Unsaturated zone effective porosity	6.00E-02	2.00E-01
Unsaturated zone hydraulic conductivity (m/yr)	1.00E-03	1.00E+01
Infiltration rate m/yr	0.00028	1.0

Kaiser used a spread-sheet calculation for evaluation of dose exposure using a scenario of a potential inadvertent intruder who is assumed to intrude the landfill facility to drill a well into the Santa Rosa aquifer imploring a supply of water for domestic uses. The Kaiser dose impact analysis to an inadvertent intruder (i.e., well digger) also assumed that the intruder would build a house on or near the landfill facility. The drilling process through the landfill would exhume a mass of waste presumed to be diverted into a pit along with the drilling and cutting materials. The drilling crew is assumed to be exposed to the waste throughout the duration of the drilling process for a total of 24 hours (8 hours/d for 3 days). The potential exposure to an intruder was calculated using the following equation:

$$H_{j,k} = R_j.f_D.DF_k \qquad \text{.......} (1)$$

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

The exposure rate, R_j was calculated using the following equation:

$$R_j = GAR_{ji}.DCF_i.CF_i.SF_i \quad \text{.......................................} (2)$$

Where AR_{ji} = Activity Ratio (i for progeny/parent at time t; j for parent activity at time 0)
DCF_i = Dose Conversion Factor ($mrem.m^3/Ci.hr$)
CF_i = Areal exposure Correction factor
SF_i = Shielding factor provided by Water
n = Number of Radionuclides in Decay Chain Including Parent
i = Progeny or parent radionuclide i present after decay period

Using equations 1 and 2, the exposure rate was calculated using radionuclide specific dose conversion factors (DCFs), a shielding factor, an area exposure correction factor, an activity ratio of radionuclide progenies, and radionuclides present after the decay period. The DCF's were based on Federal Guidance Report No. 12 *(U.S. Environmental Protection Agency, External Exposure to Radionulcides in Air, Water, and Soil. Federal Guidance Report No. 12, EPA 402-R-93-081, September 1993*). For calculation of the gamma ray shielding factor shielding factor, Kaiser assumed an 0.83 m water layer to overlay the exhumed waste and the drill mud and used the Radiation Health Handbook for the mass attenuation coefficients and a formula from NRC's IMPACTS (NUREG/CR-3585). The areal exposure correction factor was also calculated based on NUREG/CR-3585. The penetrated waste thickness in the landfill was assumed 18.8 m, the depth of well was assumed 330 m, and the dilution factor was assumed 0.0538.

The Kaiser report (Appendix A) listed an estimate of potential exposure (mrem) from a unit concentration of 1.0 Ci/m^3 for each radionuclide. For example, the exposure rate per unit source per year for Ra-226, Ra-228, Th-230, and Th-232 were estimated at 1.9 E+1; 2.1E-4; 8.5E-1; and 2.7E+1 ($mrem.m^3$)/(yr.Ci) respectively. For calculation of the total exposure rate from Kaiser waste the unit exposure rate must be multiplied by the actual radionuclide inventory in Ci and the bulk waste volume. Using equations (1) and (2), Kaiser calculated an individual intruder (i.e., well digger) dose of 2.4E-03 mrem/yr. It should be noted that the kaiser analysis assumed that the well digger (intruder) scenario is the realistic scenario that should be used for a potential onsite dose receiver evaluation.

3.3 Dose Analysis for Disposal of Whittaker Waste at WCS:

Whittaker Waste Stream Model:

Using the same modeling approach and methodology, as was described above for Kaiser, SCIENTECH (Whittaker contractor) modeled the dose exposure to the same recipients using Whittaker waste stream and characteristics. Table 2 presents a comparison of Whittaker and Kaiser waste streams. The major difference between Whittaker's waste and Kaiser's waste is the presence of U-238 and decay chain in Whittaker's waste whereas it is essentially absent in Kaiser's. Therefore, WAC for U-238, U-234, Th-230, Ra-226, and Pb-210 must be included in the source-term evaluation. Another difference is the waste volume of Kaiser's waste is approximately 500 times greater than Whittaker's waste. Therefore, the number of Whittaker's waste shipments would be far less than Kaiser. Further, Whittaker waste would require an additional transportation step for shipment of waste via trucks to the rail transfer station and the distance of rail shipment (2000 miles) is much longer than Kaiser's 460 miles. These differences should be taken into consideration when developing Whittaker's dose analysis.

Whittaker Dose Exposure Analysis Using Microshield:

WCS Radiation Protection Technician Scenario:

Considering Whittaker's waste stream and using Microshield code, dose exposures were evaluated for an WCS RP technician who surveys incoming railcars. The time allotted for loading, transportation, and downloading the waste is assumed to be 0.5 hour per truck shipment. The total exposure rate for an RP technician from Whittaker waste was found to be 5.33E-02 mR/hr. However, the exposure rate under the same

Table 2: Comparison of Whittaker's and Kaiser's Waste Streams

Radionuclide or Parameter (unit)	Whittaker	Kaiser
U-238 (pCi/g)	166.5	0.0
U-234 (pCi/g)	166.5	0.0
Th-230 (pCi/g)	166.5	1.9
Ra-226 (pCi/g)	166.5	4.5
Pb-210 (pCi/g)	166.5	2.4
Th-232 (pCi/g)	54.5	55
Ra-228 (pCi/g)	54.5	55
Th-228 (pCi/g)	54.5	55
Waste Volume (cy)	700*	37,040
Number of Rail Shipments	1	44
Distance of Rail Shipments (mile)	2,000	461
Number of Truck Shipments	42	0
Distance of Truck Shipments (mile)	100	0

* See the discussion presented in Section 3.2 regarding Whittaker's waste volume.

scenario for Kaiser was found to be 2.355E-05 mR/hr. The main factor influencing the difference in these exposure rates is the U-238 and its decay progenies. Another factor is the shielding material used in the exposure model where iron was used in Kaiser's model, in addition to air and soil, whereas only air and soil materials were considered for the Whittaker's shielding model. Table 3 presents a comparison of Microshield input parameters for Kaiser and Whittaker analysis using this exposure scenario. Considering a volume of 85 cy for a rail car, and considering a total volume of 700 cy for Whittaker's waste, the total number of rail cars used for waste shipment would be 9. Assuming an exposure time of 0.5 hour for each railcar, the total exposure dose for an RP technician would be approximately 0.024 mrem. Assuming that the volume is 7000 cy, the dose would be 0.24 mrem.

Whittaker calculated the total dose to an RP technician as 2.4E-02 mrem by assuming that there will be 9 different RP technicians conducting the survey. This assumption was also used by Kaiser; however, for Kaiser's case, the waste volume is approximately 5 to 50 times greater than Whittaker waste (e.g., depending on the waste volume whether 7000 or 700 cy). Therefore, it is more likely that 1 or 2 RP technicians would be needed to conduct the survey for the 9 rail cars (assuming 700 cy volume) since the bulk waste would be transported in one rail shipment. Nevertheless, the dose to the RP technician is still far less than the public dose limit (100 mrem/yr) or the dose criteria under the NRC's decommissioning license termination rule, LTR (e.g., 25 mrem/yr).

Further, the RP technician is a radiation worker who is allowed to receive a much higher dose than the public dose limit (e.g., 5 rem/yr) if necessary.

- WCS Onsite Truck Driver Scenario:

Using Microshield, Whittaker evaluated dose exposure of a WCS driver who loads a truck from the rail container, drives to the disposal cell, and unloads the waste into the cell. The time assumed for loading, transportation, and downloading the waste is 0.5 hour per truck shipment. The exposure rate for WCS driver of Whittaker waste was found to be 1.045E-02 mR/hr. However, the exposure rate under the same scenario for Kaiser was found to be 8.011E-06 mR/hr. The main factor influencing the difference between these exposure rates is the U-238 and its decay progenies present in Whittaker's waste. Another factor is the shielding material assumed in the exposure model. Iron shielding material was used, in addition to air and soil, in the Kaiser model whereas only air and soil materials were considered for the Whittaker's shielding model. Table 3 presents a comparison of Microshield input parameters for Kaiser and Whittaker analysis for the WCS onsite driver exposure scenario. Considering a volume of 16.7 cy per truck load, and considering a total volume of 700 cy for Whittaker waste, the total number of truck loads for the bulk waste would be approximately 42. However, for a waste volume of 7000 cy, the number of truck loads would be approximately 420. Considering an exposure time of 0.5 hour for each truck load, the total exposure dose for a single driver would be approximately 0.22 mrem. Whittaker calculated the total dose to WCS driver as 7.3E-02 mrem by assuming that there will be 3 different drivers conducting this activity. This assumption could be appropriate for a waste volume of 7000 cy. Therefore, considering a waste volume of 7000 cy and three truck drivers, the dose is realistically evaluated at 0.73 mrem. Regardless of the number of drivers, the dose to WCS driver is far less than the public dose limit (100 mrem/yr) or the dose criteria under the NRC's decommissioning license termination rule (e.g., 25 mrem/yr). Further, the onsite WCS driver is considered a radiation worker who may receive a much higher dose than the public dose limit (e.g., 5 rem/yr) if necessary.

- Railroad Crew Member and Rail Station Employee Scenarios:

In addition to the radiation worker exposure evaluation using the above two scenarios, Whittaker used Microshield code to evaluate the dose exposures to members of the public represented by a railroad crew member and for a railroad employee at the rail station. For the <u>railroad crew member</u>, it was assumed that the crew member would travel by rail for a distance of 2,000 miles at a speed of 25 miles per hour. The exposure rate was estimated at 1.267 E-05 mrem/hr and only one rail shipment would be needed for Whittaker's waste. The total exposure to the railroad crew member was calculated as 1.0E-03 mrem.

Wittaker assumed that there will be a need for only one rail shipment to transport 700 cy. For a waste volume of 7000 cy, there would be a need for 10 rail shipments. Assuming that the same crew member is exposed to these shipments, the conservative dose estimate to a railroad crew member would be o.3 mrem. Kaiser evaluated the dose to a railroad crew member as 2.20E-07 mrem. The difference between these dose rates is attributed to the radioactive source and the longer rail transportation distance for Whittaker. As can be noted, this dose is a very small fraction of public dose limit or the LTR dose limit.

Table 3: Comparison of Microshield Input Parameters for Kaiser and Whittaker

Scenario & Dose	Parameter	Whittaker	Kaiser
RP Technician Whittaker: 2.4E-02 mrem Kaiser: 5.7E-04 mrem	Source Dimension (L, W, H)	2.90 m, 16.00m, 1.67m	2.90 m, 16.00m, 1.52 m
	Dose Point Location(X, Y, Z)	3.80 m, 0.84 m, 8.1 m	3.80 m, 0.76 m, 8.0 m
	Nuclide Inventory (in Ci for Pb-210, Ra-226, and Th-232)	6.4E-03, 6.4E-03, 2.1 E-03	2.3E-04, 4.3E-04, 5.3 E-03
	Shields Materials	Soil & Air	Soil, Iron & Air
Rail Car Station Whittaker: 6.9E-04 mrem Kaiser: 1.01E-05 mrem	Source Dimension (L, WW, H)	2.90 m, 16.00m, 1.67m	2.90 m, 16.00m, 1.67m
	Dose Point Location(X, Y, Z)	15 m, 0.84 m, 8.1 m	15 m, 0.84 m, 8.1 m
	Nuclide Inventory (in Ci for Pb-210, Ra-226, and Th-232)	6.4E-03, 6.4E-03, 2.1 E-03	6.4E-03, 6.4E-03, 2.1 E-03
	Shields Materials	Soil & Air	Soil & Air
Rail car Crew Member Whittaker: 1.0E-03 mrem Kaiser: 2.2E-07 mrem	Source Dimension (L, WW, H)	2.90 m, 16.00m, 1.67m	2.90 m, 16.00m, 1.52m
	Dose Point Location(X, Y, Z)	15 m, 0.84 m, 8.1 m	17.9 m, 0.76 m, 8.0 m
	Nuclide Inventory (in Ci for Pb-210, Ra-226, and Th-232)	6.4E-03, 6.4E-03, 2.1 E-03	2.7E-04, 4.3E-04, 5.3 E-03
	Shields Materials	Soil & Air	Soil, Iron & Air
Truck Driver Whittaker: 3.7E-01 mrem Kaiser: 2.96E-03 mrem	Source Dimension (L, WW, H)	7.62 m, 1.82 m, 0.91 m	7.62 m, 1.82 m, 0.91 m
	Dose Point Location(X, Y, Z)	9.1 m, 0.45 m, 0.91 m	9.1 m, 0.45 m, 0.91 m
	Nuclide Inventory (in Ci for Pb-210, Ra-226, and Th-232)	6.4E-03, 6.4E-03, 2.1 E-03	4.1E-05, 7.8E-05, 9.5 E-04
	Shields Materials	Soil & Air	Soil, Iron & Air

For the railroad employee, Microshield was also used assuming exposure of a station employee to the waste shipment. The employee is assumed to spend 15 minutes at a distance of 15 m from the railcar for one waste shipment. The dose to the rail employee from one shipment was calculated as 6.9E-04 mrem. Assuming 10 shipments, this dose would be 6.9E-03 mrem. The Kaiser dose exposure analysis for the same scenario resulted in a dose of 1.01 E-05 mrem.

- WCS Off-Site Truck Driver

Whittaker also calculated dose exposure to an off-site WCS driver who spends 2.5 hours driving a truck loaded with one waste shipment from the rail station to the WCS facility. The exposure rate for the off-site truck driver should be the same as the onsite driver. Considering a duration of 2.5 hours, the dose to the off-site driver was calculated at 3.7 E-01 mrem. Whittaker assumed that there will be three drivers transferring one rail waste shipment (700 cy) of 42 truck loads for a distance of 100 miles. Considering a volume of 7000 cy, there will be a need for transfer of 10 rail shipments presumably by same drivers. Therefore, the dose to an offsite WCS driver is conservatively evaluated at 3.7 mrem for a waste volume of 7000 cy. This dose is a very small fraction of public dose limit or the LTR dose limit.

Whittaker Dose Analysis of Inadvertent intruder, Well Digger, Scenario:

Whittaker used the same intruder scenario used by Kaiser and Molycorp for evaluation of a potential intruder into the WCS landfill. Whittaker assumed the intruder as a well installer who drills through the cap of the closed facility and is exposed to buried materials. Because Kaiser developed dose factors (e.g., in units of mrem/yr per Ci/m^3) for each radionuclide independent of the waste (see Section 3.2 above), Whittaker directly used these dose factors for Th-232 decay chain radionuclides (e.g., Th-232, Th-228, and Ra-228). For U-238 decay chain radionuclides, Whittaker used Molycorp dose conversion factors. It should be noted that Molycorp dose factors were also derived using the same approach and formulas as described above in Section 3.2. By multiplying the dose conversion factor for each radionulcide by its maximum concentration in Whittaker's waste, the maximum dose to the inadvertent intruder corresponding to each radionuclide present in the waste was calculated. The total dose was evaluated for this exposure scenario by summing radionuclide doses. Table 4 presents a summary of radionuclide maximum activity (Ci) in one cubic meter of Whittaker waste, the dose factors (mrem/yr per Ci/m^3), and the dose (mrem/yr) corresponding to each radionuclide.

Table 4: Dose To Inadvertent Intruder (Driller) Exposed to Whittaker's Waste

Radionuclide	Radioactivity (Ci) in 1 m^3	Dose Factor (mrem/yr per Ci/m^3)	Dose (mrem/yr)
U-238	3.3E-04	1.1E-01 (from Molycorp)	3.7E-05
U-234	3.3E-04	3.9E-04 (from Molycorp)	1.3E-07
Th-230	3.3E-04	8.5E-01 (from Molycorp)	2.8E-04
Ra-226	3.3E-04	1.9E+01 (from Kaiser)	6.3E-03
Th-232	1.1E-04	2.7E+01 (from Kaiser)	2.9E-03
Ra-228	1.1E-04	2.1E-04 (from Kaiser)	2.3E-08
U-235	1.6E-05	5.9E-03 (from Molycorp)	9.2E-08
Total Dose			**9.6E-03**

The maximum derived dose to a future potential intruder drilling into Whittaker waste is estimated to be less than 0.01 mrem/yr. This dose is far less than the public dose limit or the LTR dose limit.

Whittaker Dose Analysis Using RESRAD:

Whittaker conducted dose analysis using the RESRAD (Version 6.2) code and using a hypothetical scenario to evaluate potential exposure to an onsite residents. In this regard Whittaker presented in Appendix F output data from RESRAD runs for an onsite resident farmer scenario. Whittaker used WCS landfill site specific parameters and the same scenario assumptions as those used by Kaiser (Table 1). The source term used is the maximum radionulcide concentrations of unimportant quantities in Whittaker waste as was given in Table 2. The integrity of the landfill cover was assumed to be essentially maintained with minimal erosion rate. It should be noted that this scenario is unrealistic because it would be unlikely that an individual would establish a resident and a farming activity on a landfill. Nevertheless, because a 5 m thick cover would be maintained and because the aquifer below the landfill site is non-potable due to the high contents of total dissolved solids, the radiological dose impacts from all exposure pathways for this scenario were found to be essentially zero within the 1,000 year performance period.

Summary, Conclusion, and Recommendation:

DWMEP staff conducted a review and analysis of Whittaker request to grant an exemption, based on the dose analysis, for disposal of Whittaker's blended waste (e.g., as an unimportant quantity of source material as defined under 10 CFR 40.13) at the Waste Control Specialists (WCS) landfill facility located in Andrews, Texas. In performing its dose analysis, Whittaker used Kaiser's approach, methodology, and scenarios. In addition, the WCS landfill disposal facility characteristics were the same. Therefore, the staff reviewed Whittaker's dose analysis as well Kaiser's analysis applicable to disposal of Whittaker's waste at WCS landfill facility. Staff found that the Whittaker's dose analysis approaches, assumptions, and methods are essentially acceptable and appropriate for all exposure scenarios. The dose exposure rate assumptions were found to be conservative, specifically those used in the shielding calculations. Nevertheless, staff found that a few assumptions or parameters to be inconsistent particularly those related to the waste volume and the number of rail shipments. Whittaker's dose analysis for all exposure scenarios showed rather small dose values (less than one mrem/yr). Using more conservative assumptions or parameters for consistency with the waste volume and waste shipments may increase the dose. However, the dose values would still remain far less than the public dose limit under 10 CFR 20.1301 and the radiological criteria for license termination for unrestricted use under 10 CFR 20.1402. Therefore, the dose analysis presented by Whittaker in its amendment request package should be accepted.