



U. S. Department of Energy
National Nuclear Security Administration
Pantex Site Office
P. O. Box 30030
Amarillo, TX 79120-0030



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CERTIFIED MAIL/RETURN RECEIPT REQUESTED

Ms. Camille Hueni, Remedial Project Manager
U. S. Environmental Protection Agency
Region 6, Superfund Division
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

CONTRACTS
pmcc-04 - 24289

Re: U.S. Department of Energy, National Nuclear Security Administration, Pantex Plan
TCEQ Solid Waste Registration No. 30459; TCEQ Hazardous Waste Permit No. HW-50284
EPA ID No. TX 4890110527; Updated Radiological Risk Equations for the *Baseline Risk Assessment (BRA) Work Plan* (February 2003)

Dear Ms. Hueni:

During Environmental Protection Agency, Region 6, final review of the above-referenced work plan, it was noted that the equations in Appendix C converted risk to dose. Although the risk equation in Section 6.3.5 of the document provided conversion to risk, the equations did not provide the final unit of measure input required for the concentration term. As discussed in an April 28, 2004, teleconference, the equations have been updated for use in the current risk assessment work.

To clarify how the risk will be calculated for radionuclides, we have enclosed an updated set of equations and explanations for the applicable sections of the Work Plan. Please note that only the current pathway equations for the onsite receptors have been updated. Those equations pertaining to the groundwater have not been changed, because there are no radiological contaminants that are currently required to be assessed in the groundwater. Additionally, the offsite receptor equations were not updated because we do not anticipate future movement of radionuclide contaminants to the groundwater and subsequent offsite exposure, due to the properties of the radionuclides of interest at Pantex.

As discussed during the teleconference, your agency plans to provide final approval of the *Baseline Risk Assessment Work Plan* pending final approval of the enclosed equations. Therefore, the Pantex Site Office requests this approval by June 25, 2004, so work can begin on critical activities in support of the BRA.

If you have any questions, please contact Johnnie Guelker of my staff at (806) 477-3183.

Sincerely,

Jerry S. Johnson
Assistant Manager for Environmental
& Site Engineering Programs

Enclosures

cc: See page 2

SS:FY04:180, FY04:17329:SS

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Ms. Camille Hueni, EPA, Dallas

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M. Layton, A/R ERS, BWXT

Attachment
Updated Equations for Calculation of Radiological Effects
For the Pantex Plant Baseline Risk Assessment Work Plan (February 2003)
Work Plan Update Effective May 2004

**Updated Equations for Calculation of Radiological Effects
For the Pantex Plant Baseline Risk Assessment Work Plan (February 2003)
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BRA Work Plan Section 6.3.5 Radiological Effects

As discussed in Section 6.3.5 of the Pantex Baseline Risk Assessment (BRA) Work Plan, radiological effects are evaluated for the ingestion, inhalation, and external exposure pathways. For risk evaluation, risk is calculated without a conversion to dose (rem) as presented in the Pantex BRA Work Plan. The risk will be calculated using the following equation for the ingestion and inhalation pathways.

$$\text{Risk} = (\text{CI})(\text{SF}) \quad \text{(Equation 8 revised)}$$

where:

- Risk = Risk from ingestion or inhalation pathways (risk)
- CI = Chronic intake of a radionuclide from ingestion or inhalation of soils, pCi
- SF = Slope Factor for ingestion or inhalation of soil, risk/pCi

Risk from external exposure is calculated by the following equation:

$$\text{Risk}_e = (\text{CI}_e)(\text{SF}_e) \quad \text{(Equation 9 revised)}$$

where:

- Risk_e = Risk from external exposure (dimensionless)
- CI_e = Chronic intake of a radionuclide from external exposure to soil levels, pCi-yr/g
- SF_e = Slope Factor for external exposure, risk/yr per pCi/g

BRA Work Plan Appendix C.3.1 Incidental Ingestion of Contaminated Soil (from measured soil concentrations)

The calculation of chronic intake and subsequent risk, using the revised equations in this document, is consistent with EPA methodology presented on the EPA Radiological preliminary remediation goal calculator website. The differences in the EPA equations and those presented below are that the equation terms were modified to be consistent with those presented in the BRA Work Plan, and the decay factors (decay constant [λ] and years of exposure [t]) in the EPA equations were not included in the following equations. The resultant intakes were the same for the radionuclides of interest at Pantex (all have long half-lives), with and without the decay factors.

Equation C4 in the BRA Work Plan estimates total lifetime dose (rem) from ingestion of radionuclides in soil for applicable relevant appropriate requirements (ARAR) comparison. The corresponding equation for estimating chronic intake used to determine incremental lifetime risk is as follows:

$$\text{CI}_{\text{ing}} = (\text{SMF})(\text{U}_{\text{ds}})(\text{ED})(\text{F}_{\text{ds}})(\text{CF}_1) \quad \text{(Equation C4a)}$$

where:

- CI_{ing} = Chronic intake for a radionuclide from ingestion of soils, pCi
- SMF = Average soil concentration of radionuclide over the exposure duration, pCi/g dry soil
- U_{ds} = Ingestion rate of soil, g/day
- ED = Exposure duration, years
- F_{ds} = Fraction of year that soil ingestion occurs, dimensionless
- CF₁ = Conversion Factor 1, 365 days/year

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Equation C6, in the BRA Work Plan for dermal intake to radionuclides, is not an applicable pathway because there is little absorption of the radionuclides through the skin, as occurs with chemicals. However, radiation does penetrate through the skin and this is accounted for by evaluation of the external exposure pathway. The BRA Work Plan contains equation C7, that presents the lifetime dose (rem) from external exposure, that is useful for comparison to ARARs; however, the dose conversion is not used for cumulative risk evaluation. The chronic intake from external exposure to radionuclides in soil is calculated by the following equation:

$$CI_e = (SMF)(ED)(ACF)(U_{de})(F_{de}) \quad (\text{Equation C7a})$$

where:

- CI_e = Chronic intake for a radionuclide from external exposure to measured soil levels, pCi-yr/g
- ACF = Area Correction Factor, dimensionless, (for 6 or 12 acres = 1) - replaces t_{ms} and p_{ms} in equation C7 of the BRA Work Plan
- SMF = Average soil concentration of radionuclide over the exposure duration, pCi/g dry soil
- U_{de} = Exposure time to radionuclide-contaminated soil: Onsite workers - 8 hours/24 hours = 0.333 unitless; Offsite resident farmer - 24 hours/24 hours = 1.0 unitless
- F_{de} = Fraction of days per year that exposure to radionuclides on a ground plane occurs, dimensionless
- ED = Exposure duration for the pathway, yr

Additionally, the BRA Work Plan does not present an equation for the inhalation pathway for radionuclides. The chronic intake from the inhalation pathway is calculated by the following equation:

$$CI_{inh} = (SMF)(ED)(U_{de})(F_{ds})(U_a)(CF_1)(CF_2)(1/PEF) \quad (\text{Equation C12b})$$

where:

- CI_{inh} = Chronic intake for a radionuclide from inhalation pathway from soils, pCi/m³
- SMF = Average soil concentration of radionuclide over the exposure duration, pCi/g dry soil
- U_{de} = Exposure time to radionuclide-contaminated soil: Onsite workers - 8 hours/24 hours = 0.333 unitless; Off-site resident farmer - 24 hours/24 hours = 1.0 unitless
- U_a = Inhalation Rate of air, 20 m³/day
- F_{ds} = Fraction of days per year that exposure occurs: dimensionless
- PEF = Particulate Emission Factor, 1.53E+08 m³/kg, BRA Work Plan Equation C11
- CF_1 = Conversion factor, 365 days/yr
- CF_2 = Conversion factor, 1000 g/kg
- ED = Exposure duration, years

The BRA will also calculate the lifetime dose from exposure to radionuclides through inhalation of soils for comparison to ARARs. The following equation will be used for the lifetime dose evaluation:

$$D_{di} = (SMF)(ED)(U_{de})(F_{ds})(U_a)(DF_2)(CF_1)(CF_2)(1/PEF) \quad (\text{Equation C12c})$$

where:

- D_{di} = Total lifetime dose for a radionuclide from inhalation of soils, rem
- SMF = Average soil concentration of radionuclide over the exposure duration, pCi/g dry soil

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- U_{de} = Exposure time to radionuclide-contaminated ground: Onsite workers - 8 hours/24 hours = 0.333 unitless; Offsite resident farmer - 24 hours/24 hours = 1.0 unitless
- U_a = Inhalation Rate of air, 20 m³/day
- F_{ds} = Fraction of days per year that exposure occurs: dimensionless
- PEF = Particulate Emission Factor, 1.53E+08 m³/kg, BRA Work Plan Equation C11
- DF_g = Dose conversion factor for exposure of radionuclides through inhalation of radionuclide contaminated soils, rem/pCi^a (^aContaminant-specific parameter)
- CF_1 = Conversion factor, 365 days/yr
- CF_2 = Conversion factor, 1000 g/kg
- ED = Exposure duration, years