Table F.47. Ratios of Dose and Risk to Children over Dose and Risk to Adults from 1-Year Ingestion of Contaminated Drinking Water

Radionuclide	Dose Ratio (Child/Adult)	Risk Ratio (Child/Adult)
C-14	1.4	2.3
Tc-99	6.0	11
I-129	1.4	0.2
U-233	0.88	1.1
U-234	0.87	1.1
U-235	0.90	1.2
U-236	0.87	1.1
U-238	0.88	1.1

F.2 Accident Impact Assessment Methods

In this HSW EIS, estimates of accident consequences for Hanford waste management facilities and operations are based on analyses of accident scenarios identified in existing Hanford nuclear facility safety analyses, including Bushore (2001), Tomaszewski (2001), Vail (2001a, 2001b, 2001c), and WHC (1991). Details of the accident analyses are presented in these documents and are summarized in Section 5.11.

The accident consequences presented in this HSW EIS differ from those in the Hanford safety documents because of differences and calculation adjustments that are described in the following paragraphs. Adjustments were made to the analysis results to update calculations and to meet the needs of the environmental impact analysis rather than those of the safety analyses for which the analyses were originally prepared. Except for those changes and adjustments specifically noted, all calculations and assumptions remain the same.

Changes and adjustments to safety document calculations include the following:

1. Updated Hanford meteorological data were used to estimate atmospheric dispersion factors. Composite joint frequency data, including the years 1983 through 1996, were used for this HSW EIS analysis.

2. The environmental impact analysis used 95^{th} percentile atmospheric dispersion factors, whereas safety analyses typically used 99.5 percentile atmospheric dispersion factors. (Building wake and plume meander factors used in the safety analyses remain incorporated in this HSW EIS consequence estimates.)

3. The locations of the MEI member of the public and the MEI non-involved worker were changed from those in the safety analyses. For this HSW EIS analysis, the MEI was located at the nearest publicly accessible location on U.S. State Route 240 (generally 3 to 5 km [1.9 to 3.1 mi] distant), and the

maximally exposed non-involved worker was located 100 m (109 yd) away. For the safety analyses, the MEI member of the public was located at the Hanford Site boundary, typically a distance of 12 km (7.4 mi), and the co-located worker was at the nearest facility, typically a distance of 800 m (872 yd). The difference in the locations of hypothetically exposed individuals is the most important reason for differences in the dose estimates between this HSW EIS and safety analyses.

4. Only the period of plume passage was considered for exposure pathways and doses in this HSW EIS analysis. Thus, inhalation is the most important exposure pathway, particularly for TRU radionuclides with much smaller contributions from immersion and ground deposition.

5. Doses are presented only as total effective dose equivalent (TEDE) in this HSW EIS.

6. This HSW EIS presents estimates of dose and radiological impact (as the probability of LCFs) to exposed individuals, whereas the safety analyses present only estimates of dose.

7. This HSW EIS presents estimates of collective dose and radiological impact (as the postulated number of LCFs) to the exposed population of the general public from an accident scenario. Safety analyses do not present this information.

8. The environmental impact analysis used an updated temporary emergency exposure limits (TEELs) list to evaluate potential impacts from exposure to non-radiological hazardous chemicals. Additional information on TEELs is presented in Section F.2.3.

9. This HSW EIS presents estimated impacts from industrial and occupational accidents. Safety analyses do not present this information. Additional information for each alternative group is presented under Section 4.10 and in the industrial accidents sections of Section 5.11.

F.2.1 Adjustment Method

The method for adjusting dose results presented in the safety analyses for the environmental impact analysis is shown in the following equations (Equations 5.5 through 5.8). It is a simple ratio of acute release atmospheric dispersion factors (E/Q) and the calculated doses. The E/Q is a measure of atmospheric dispersion for short-term (acute) atmospheric releases using Gaussian dispersion plume modeling, with units of s/m^3. For a given point or location at some distance from the source, it represents the time-integrated air concentration ($Ci{\cdot}s/m^3$) divided by the total release from the source (Ci). E/Qs are typically used for releases lasting no longer than 8 to 24 hours. The effective dose equivalent (EDE) used in the safety analyses (SA) is equivalent to the TEDE used in the environmental impact analysis.

$$\frac{TEDE_{EIS}}{EDE_{SA}} = \frac{E/Q_{EIS}}{E/Q_{SA}} \qquad \text{(F.5)}$$

or

$$TEDE_{EIS} = EDE_{SA} * \frac{E/Q_{EIS}}{E/Q_{SA}} \quad \text{(F.6)}$$

where EIS = used in this EIS
SA = used in the SA.

A similar method was used for estimating collective dose to the population within 80 km (50 mi), except that a population-weighted atmospheric dispersion factor was used instead of the single-point dispersion factor. Collective dose estimates were based on the atmospheric dispersion and dose to the maximally exposed individual member of the public presented in the safety analyses.

$$TEDE_{pop,EIS} = EDE_{MEI,SA} * \frac{E/Q_{pop,EIS}}{E/Q_{MEI,SA}} \quad \text{(F.7)}$$

where pop,EIS = population – weighted atmospheric factor used in this EIS
MEI,SA = maximally exposed individual member of the public used in the SA.

A similar method was used for adjusting air concentrations at the point of exposure of individuals to non-radiological hazardous chemicals. These adjusted air concentrations were then compared to the revised TEELs list,

$$C_{EIS} = C_{SA} * \frac{E/Q_{pop,EIS}}{E/Q_{MEI,SA}} \quad \text{(F.8)}$$

where C is the air concentration of a particular hazardous chemical at the point of exposure.

Table F.46 presents the atmospheric dispersion parameters used in the accident analysis for the onsite non-involved worker, and offsite locations of the exposed individuals and population.

F.2.2 Accident Frequency

As part of the safety analysis process, a preliminary hazard analysis was performed to identify potential accident scenarios for each facility. Accident scenarios in each of three frequency categories were selected for further analysis. The accidents selected for evaluation represent what were considered the bounding consequences for the frequency category, although other accidents in the frequency category may also have been analyzed to better represent the range of potential impacts. It is important to note that in this HSW EIS, accident consequences are presented without regard to frequency of occurrence and that estimated frequencies of the accidents were not incorporated into the statement of risk.

F.2.3 Non-Radiological Impact Endpoints

Estimates of consequences of exposure to potentially hazardous chemicals were based on one-hour exposures, consistent with the assumptions of the Emergency Response Planning Guidelines (ERPGs). Also used were TEELs that are interim, temporary, or equivalent exposure limits for chemicals for which official ERPGs have not yet been developed. At its April 1996 meeting in Knoxville, Tennessee, the DOE Subcommittee on Consequence Assessment and Protective Actions (SCAPA) adopted the term TEEL. These exposure limits must be regarded as dynamic; if new concentration limits are issued (for example, ERPG, permissible exposure level, or threshold limit value) or if new or additional toxicity data are found, the TEEL would be revised. At the time of this analysis, TEEL values were provided for over 1,340 additional chemicals. ERPGs adopted through January 1, 2000, are located on the SCAPA Internet Web site (DOE 2002). The most recent TEELs list revision is *ERPGs and TEELs for Chemicals of Concern: Rev 18* (Craig 2001).

Potential consequences of exposure to hazardous materials are evaluated by comparing them to the air concentrations of the applicable ERPG or TEEL. Definitions for the different TEEL levels are based on those for ERPGs that follow:

- ERPG-1 The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor

- ERPG-2 The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action

- ERPG-3 The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Temporary Emergency Exposure Limits:

- TEEL-1 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor

- TEEL-2 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action

- TEEL-3 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

It is recommended that, for application of TEELs, the concentration at the receptor point of interest be calculated as the peak 15-minute time-weighted average concentration. It should be emphasized that TEELs are default values, following the published methodology (on the SCAPA web page [DOE 2002]) explicitly.

F.2.3.1 Impacts from Industrial Accidents

Impacts of potential industrial and occupational accidents were predicted using five-year average statistics for the U.S. DOE Richland Operations Office, reported in Computerized Accident/Incident Reporting System, or CAIRS, for the years 1996 – 2000 (DOE 2001). The baseline statistics, applied separately for construction and operations activities, are presented in Section 4.10. Impacts are presented as the predicted number of total recordable cases, lost workday cases, lost workdays, and fatalities for construction and operation activities, based on the number of worker-years for that activity. A full-time worker is assumed to work 2,000 hours per year.

F.3 Intruder Impact Assessment Methods

In the assessment of intruder impacts, inadvertent intrusion is defined as an inadvertent activity that results in direct contact with the waste from a LLW disposal facility. Two types of inadvertent intrusions are considered: excavation of a basement for construction of a dwelling and drilling a well. In each case, the waste would be extracted from the disposal facility and the extracted waste, with the exception of activated metal and concrete (or grout), is assumed to be indistinguishable from soil. Pathways by which an intruder might be exposed to radiation from the exhumed waste include the following:

- ingestion of vegetables grown in the contaminated soil

- ingestion of soil

- inhalation of radionuclides on dust suspended in the air by gardening activities or wind

- external exposure to direct radiation from contaminated soil while working in the garden or residing in the house built on top of the waste disposal facility.

Calculations were performed via a spreadsheet using dose rate per unit concentration conversion factors contained in performance assessments for the disposal of LLW in the LLBGs and peak radionuclide concentrations (WHC 1995, 1998). Peak radionuclide concentrations are shown in Table F.48 along with a short description of the waste origin. The peak concentration values are based on information extracted from the Solid Waste Information Tracking System, or SWITS, database (Anderson and Hagel 1996; Hagel 1999) and decay corrected to 2046. These radionuclides would not all occur within the same waste container, or even within the same disposal facility. Therefore, the peak values represent a hypothetical maximum waste package.