



INSTITUTE FOR ENERGY AND  
ENVIRONMENTAL RESEARCH  
HEIDELBERG

---

# Review of LANL radiation dose assessment for the Venting of Flanged Tritium Waste Containers (FTWCs) at TA-54 of Los Alamos National Laboratory

Prepared for Tewa Women United, Santa Cruz, NM, USA

Bernd Franke

Heidelberg, 14 September 2024

---





# Inhalt

---

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Input data</b>	<b>3</b>
2.1	Source term	3
2.2	Location of nearest receptor	3
2.3	Weather Data	4
2.4	Dose age group	7
2.5	Other modeling parameters	7
2.6	Foodstuff model	7
2.7	Intake rates	7
<b>3</b>	<b>LANL reference scenario</b>	<b>8</b>
<b>4</b>	<b>Exposure scenarios</b>	<b>10</b>
<b>5</b>	<b>Scenario based on December 1, 2018 weather data</b>	<b>12</b>
<b>6</b>	<b>Conclusions</b>	<b>13</b>
<b>7</b>	<b>References</b>	<b>14</b>
	<b>Appendix A. CAP88 model runs</b>	<b>16</b>
	<b>Appendix B. Age- and gender specific usage rates [from USEPA 1999]</b>	<b>44</b>
	<b>Appendix C. December 1, 2018 scenarios</b>	<b>45</b>

# 1 Introduction

---

The proposed action is described in LANL's *Application for Pre-Construction Approval and Notice of Intent to Start Operations under 40 CFR 61 Subparts A and H for Venting of Flanged Tritium Waste Containers (FTWCs) at TA-54* [LANL 2019] as follows:

*This project will vent headspace gases from specialized high-pressure storage vessels, called Flanged Tritium Waste Containers, or FTWCs. These containers are located in LANL's TA-54, Building 1028. The FTWC headspace gas contains hydrogen and oxygen, accompanied by radioactive tritium which will be vented along with the headspace gases. The tritium may be in the form of water vapor or as elemental hydrogen gas. There are four FTWCs with significant tritium inventory, called out later in this document; other containers within Building 1028 are not part of this Application.*

*The FTWCs at TA-54 contain tritium-contaminated metal parts and molecular sieve media, which is a pebble-like material used to absorb water vapor from exhaust air streams. This molecular sieve media inside the FTWCs is contained in metal canisters, along with some loose media material in bags. Over time, tritiated water vapor that had been adsorbed onto the media can become liberated into the FTWC headspace. Radiolysis can cause separation of the water vapor, possibly resulting in a hazardous hydrogen-oxygen mixture within the FTWC. The Applicants have determined that continued tritium storage in these containers could pose an unsafe condition. To mitigate this hazard, the FTWCs will be vented in-place to remove hazardous gases.*

In its application, LANL determined the tritium inventory as of June 1<sup>st</sup> 2019 was 114,683 curies. LANL further assumed that tritium is in the form of water vapor. Based on model runs with CAP88-PC Version 4, LANL generated a dose factor of  $1.76 \times 10^{-4}$  mrem/Ci and calculated the uncontrolled off-site dose at the critical receptor 2,195 meters to the ESE from the release of the entire inventory to be 20.2 mrem/year PEDE.<sup>1</sup>

Upon request by TEWA women United, I prepared an analysis of the uncertainties in this calculation, including those arising from

- The impact of weather condition, such as wind speed, humidity in the air, stability class;
- The age of the member of the public who would be at the location with the maximum exposure;
- The impact of decay-correction of the tritium, since the tritium has decayed since the five years since the source term was estimated for the Application.

The following model runs were performed as part of this assessment.

---

<sup>1</sup> PEDE = potential effective dose equivalent

- Attempt to approximately reproduce the LANL dose estimate of 20 mrem, including the millirem per curie factor, to the most exposed receptor, using annual weather data and the source term at the time of the LANL estimate.
- Use the decay-corrected tritium source term (to September 1, 2024) and release durations, as defined in LANL documents worst-case modeling.
- Select three cases of reasonable worst case weather (stability classes, humidity, etc.) and estimate doses the most exposed receptor. Include calculations for receptors of various ages (infants, one year, five years, 10 years, 15 years and adult), according to dose conversion factors available in the latest version of the CAP88-PC model.

The above calculations enable an approximate assessment whether the 10 mrem/year dose limit under Subpart H of 40 CFR 61 might plausibly be exceeded under worst case conditions. It is recognized that LANL has changed its proposed venting protocol since the 2019 Application cited above. This will be discussed to put this verification and evaluation exercise in context.

In attempting to reproduce LANL's calculations in the Application, we have used CAP88-PC version 4.1; this personal computer version is officially approved by the EPA for use in Subpart H compliance calculations, though with some restrictions that may apply to this case, as discussed below.

It should be noted that the CAP88-PC version 4.1 User Guide [USEPA 2023] specifies the limitations as follows:

*Dose and risk estimates from CAP88-PC are applicable only to low-level chronic exposures, since the health effects and dosimetric data are based on low-level chronic intakes. CAP88-PC should not be used for either short-term or acute high-level radionuclide.*

The tritium release is planned to occur over a short term (probably 24-hour period or less per FTWC)), therefore the results of the program are not truly applicable. In order to show the limitations of the model, the CAP88-PC version 4.1 model was nevertheless used as described above and further specified below.

# 2 Input data

## 2.1 Source term

Tritium has a radioactive half-life of 12.3 years. If the inventory as of June 1, 2019 was 114,683 Ci, it would be reduced by 26% to 85,312 Ci as of September 1, 2024.<sup>1</sup> The source term for the FTWC with the largest inventory of tritium is 32,000 Ci, decay-corrected to September 1, 2024.

## 2.2 Location of nearest receptor

The nearest receptor is the La Vista Church of Nazarene in a distance of 2,195 m ESE.



©Google Maps, 2024

Figure 2.1 Location of TA-54 Building 1028 and White Rock

<sup>1</sup> Assuming a half-life of 4500 +/- 8 days [NIST 2000]

### 2.3 Weather Data

LANL used the average weather data from the TA-54 meteorological tower for the years 2007 through 2011. Since this input data is not available to this author, data from the from LANL Radionuclide Air Emissions Reports 2019 to 2022 for TA-54 instead (see Figure 2.2).

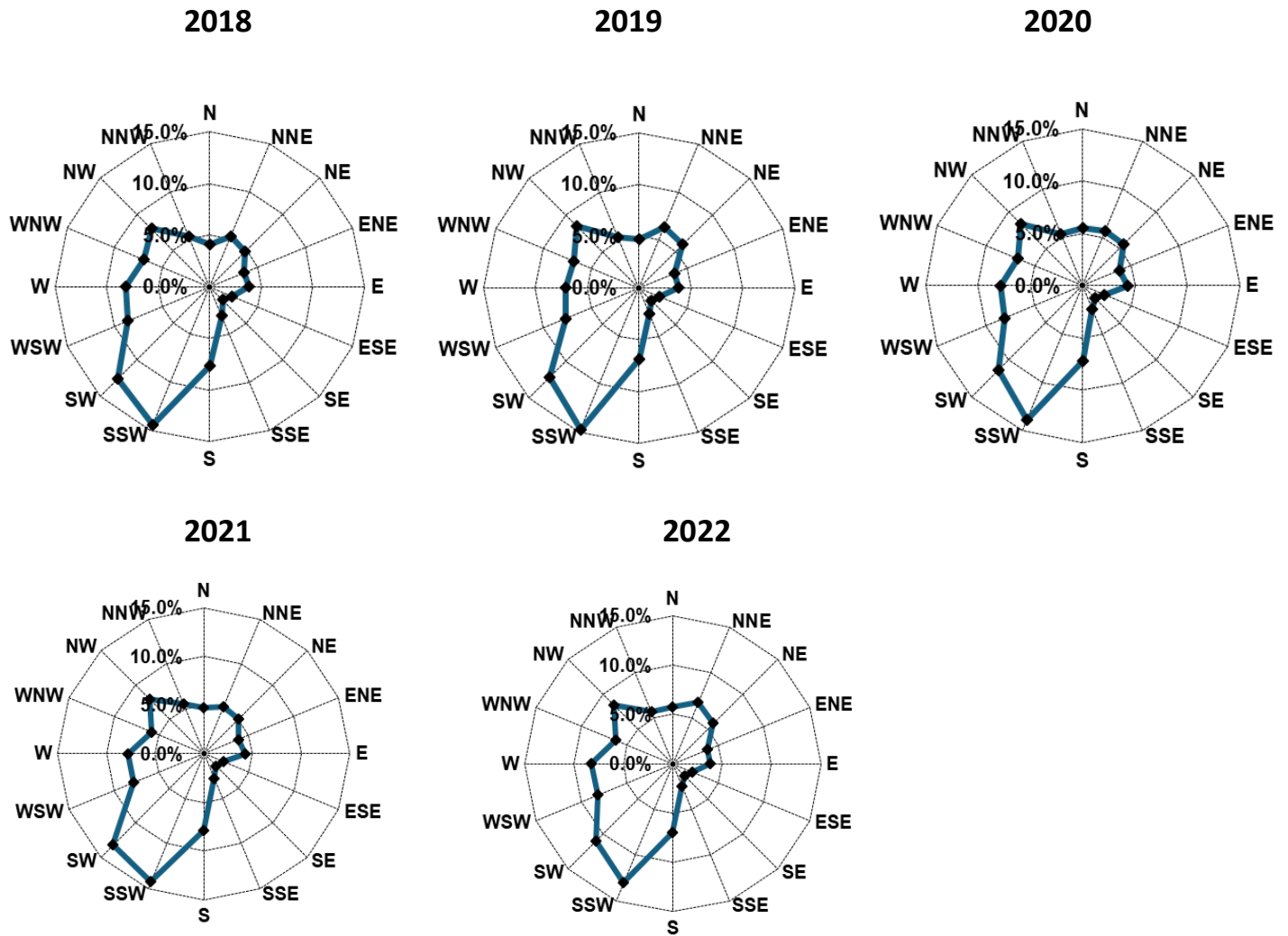


Figure 2.2 Wind roses for TA-54 from LANL Radionuclide Air Emissions Reports 2019 to 2022<sup>1</sup>

The frequency of wind direction towards White Rock was calculated (Table 2.1). In the average, wind was blowing in 6.5% of the year towards the critical receptor in ESE.

Table 2.1 Frequency of wind direction towards White Rock

Wind from	Wind towards	2018	2019	2020	2021	2022	Average
W	E	8.1%	7.0%	7.8%	7.8%	8.2%	7.8%
WNW	ESE	7.0%	6.8%	6.7%	5.9%	6.3%	6.5%
NW	SE	8.0%	8.5%	8.4%	7.9%	8.4%	8.2%

<sup>1</sup> Lattin [2019], Fuehne [2020], Lattin [2021], Fuehne [2023], Fuehne [2023c]

For CAP88-PC calculations, the data for the TA-54 meteorological tower in the years 2018 to 2022 in STAR format was used<sup>1</sup>. The STAR format files were converted into WND file for use in CAP88-PC using the StarGet program.

One major issue is the frequency of wind towards ESE on the day of the release. To illustrate the variability of wind directions, the 15-minute data for the TA-54 tower for the year 2023 was downloaded from the LANL weather machine. The highest frequency of wind direction towards ESE during a 24-hr periods following the 15-minute starting point was 42% starting at 4:00 am January 11, 2023. This case was selected as a reasonable worst-case scenario.

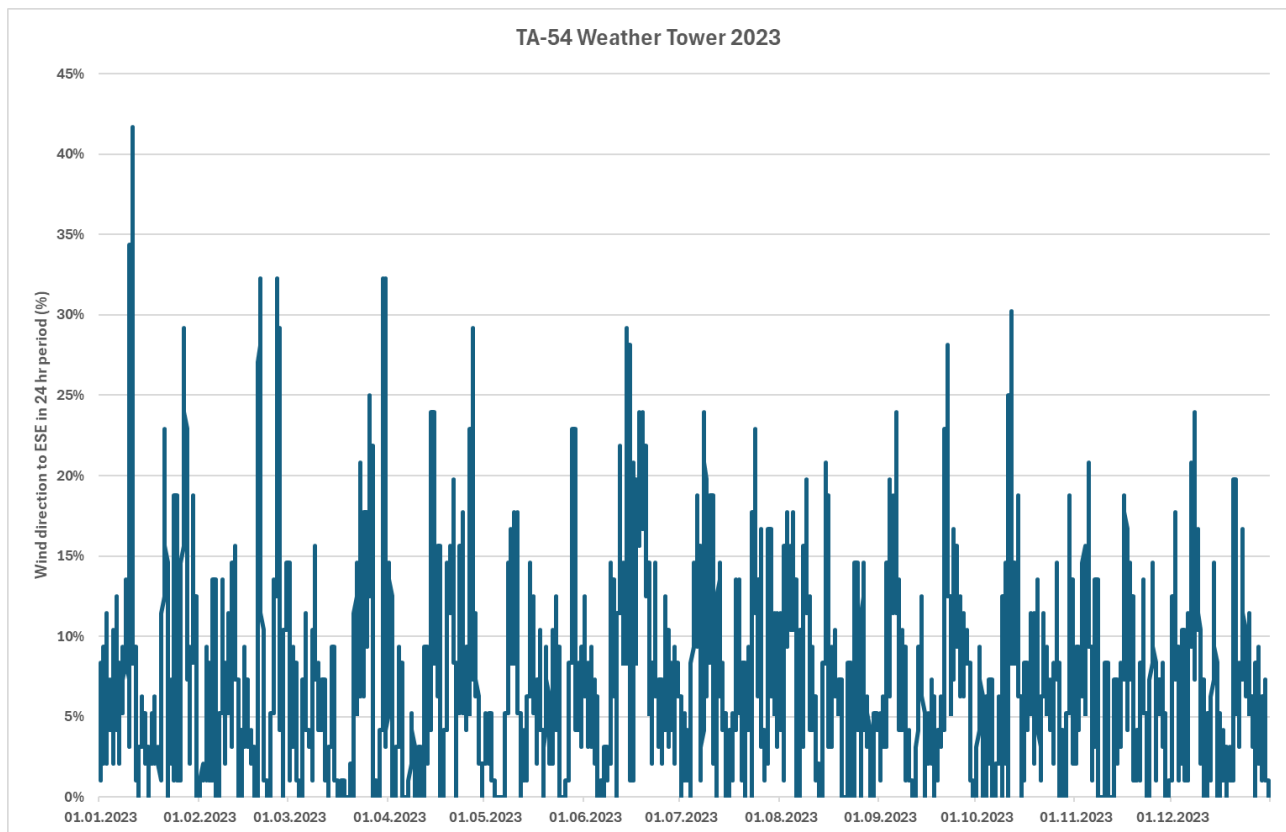


Figure 2.3 Wind direction in 24 hr. period at TA-54 in 2023, calculated from 15-minute data from the LANL weather machine

Since humidity in air is an important input variable for CAP88-PC, the absolute humidity in  $\text{g H}_2\text{O}/\text{m}^3$  was calculated from the 15-minute data for the TA-54 tower for the year 2023. The results are presented in Figure 2.4. The annual average is  $4.4 \text{ g}/\text{m}^3$  with a low of  $0.8 \text{ g}/\text{m}^3$  and a high of  $14.2 \text{ g}/\text{m}^3$ . The highest humidity is observed during the summer months.

The wind speed from 15-minute data for the TA-54 tower for the year 2023 is shown in Figure 2.5. Wind speeds are below 3 knots (1.55 m/s) in about 55 hrs. per year.

<sup>1</sup> Based on data in Lattin [2019], Fuehne [2020], Lattin [2021], Fuehne [2023], Fuehne [2023c]



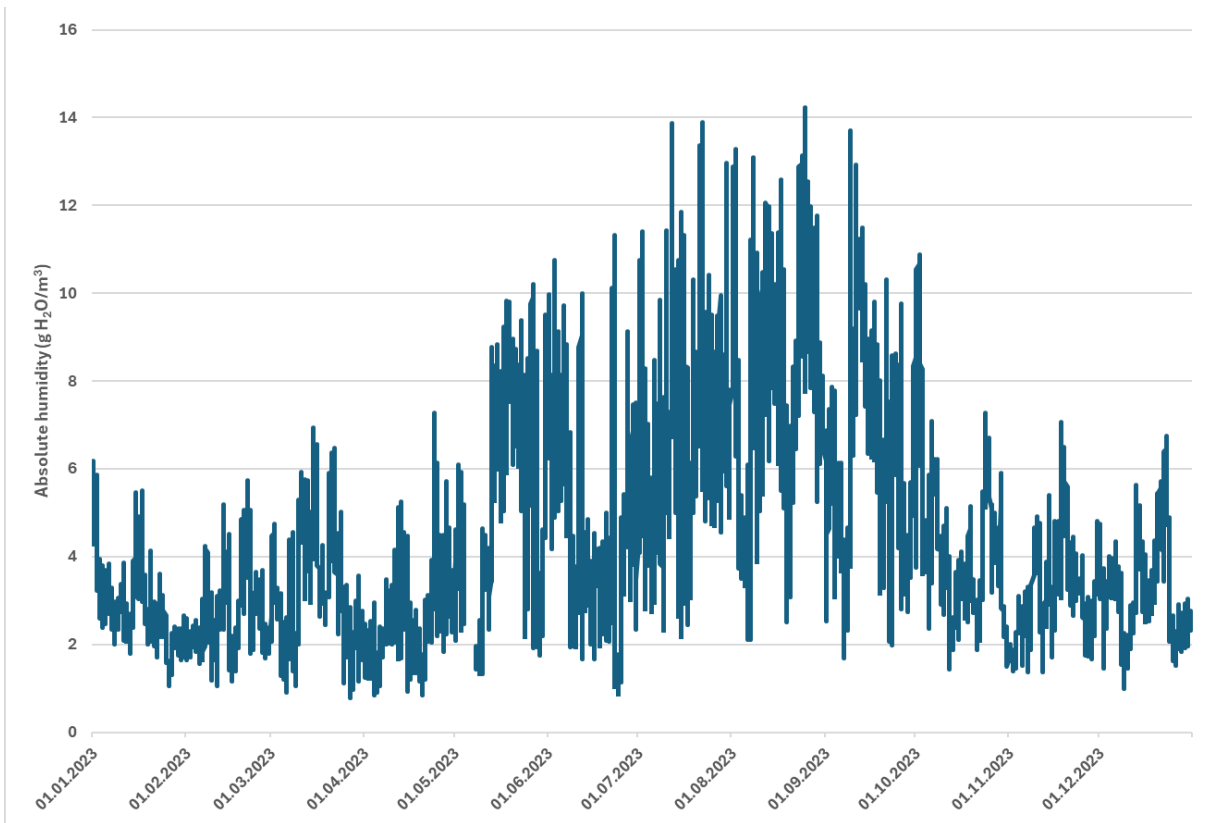


Figure 2.4 Absolute humidity data at TA-54 in 2023, calculated from 15-minute data from the LANL weather machine

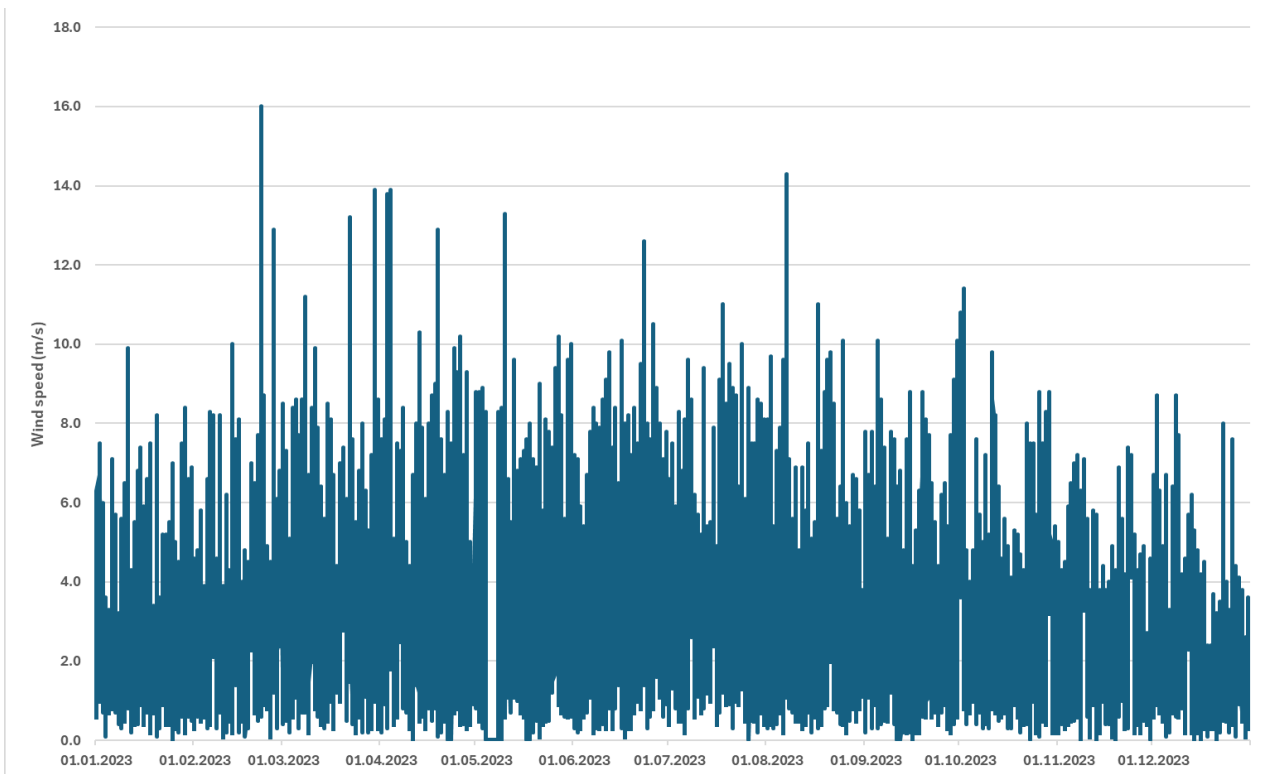


Figure 2.5 Wind speed at TA-54 in 2023, based on 15-minute data from the LANL weather machine

## 2.4 Dose age group

While the documentation of the calculations in [LANL 2019] did not specify the age group for which calculations were done, the paper by Hyatt [2023] clearly states that doses were calculated for the age group adult.

## 2.5 Other modeling parameters

The following parameters were used based on [LANL 2019]:

- area of the source: 22 m<sup>2</sup>
- source height 0 m
- no plume rise (momentum)
- annual precipitation: 45 cm
- lid height: 1600 m
- average humidity: 5.5 g/m<sup>3</sup>
- agricultural scenario: local

## 2.6 Foodstuff model

The CAP88-PC model assumes that concentrations in vegetation are calculated on the assumption that the water content in vegetation are from the atmosphere and has the same specific activity as in the atmosphere [USEPA, 2023].

## 2.7 Intake rates

Age-specific breathing rates and food intake rates are implemented into CAP88-PC version 4 by way of FGR 13 age-dependent dose and risk factors [USEPA 1999], see also Appendix B.

### 3 LANL reference scenario

In Table 3.1, the results for the CAP88-PC runs for years 2018 to 2022 are presented.

Table 3.1 CAP88-PC effective doses (mrem) for LANL reference case (114,683 Ci of tritium as HTO)

Year	2018	2019	2020	2021	2022	LANL
Effective (PEDE)	19.0	18.0	17.7	16.9	18.0	20.2

These results are in general agreement with the LANL 2019 estimate of 20.2 mrem at the White Rock church. Exact agreement is not to be expected given the differences in weather data files used here from those used in the LANL 2019. Table 3.2 presents organ doses using the weather data for 2020 which was selected as representative.

Table 3.2 CAP88-PC doses (mrem) (weather data for the year 2020) as a function of age group

Organ	Infant	1-yr old	5-yr old	10-yr old	15-yr old	Adult
Adrenals	47.3	46.5	25.8	21.3	17.6	16.8
UB_Wall	47.3	46.5	25.8	21.3	17.6	16.8
Bone_Sur	47.3	46.5	25.8	21.3	17.6	16.8
Brain	47.3	46.5	25.8	21.3	17.6	16.8
Breasts	47.3	46.5	25.8	21.3	17.6	16.8
St_Wall	108.0	89.1	43.5	32.2	25.2	22.4
SI_Wall	48.7	47.7	26.3	21.6	17.8	16.9
ULI_Wall	55.9	53.7	28.9	23.3	18.7	17.6
LLI_Wall	71.8	66.7	34.6	26.9	20.9	19.3
Kidneys	47.3	46.5	25.8	21.3	17.6	16.8
Liver	47.3	46.5	25.8	21.3	17.6	16.8
Muscle	47.3	46.5	25.8	21.3	17.6	16.8
Ovaries	47.3	46.5	25.8	21.3	17.6	16.8
Pancreas	47.3	46.5	25.8	21.3	17.6	16.8
R_Marrow	47.3	46.5	25.8	21.3	17.6	16.8
Skin	47.3	46.5	25.8	21.3	17.6	16.8
Spleen	47.3	46.5	25.8	21.3	17.6	16.8
Testes	47.3	46.5	25.8	21.3	17.6	16.8
Thymus	47.3	46.5	25.8	21.3	17.6	16.8
Thyroid	47.3	46.5	25.8	21.3	17.6	16.8
GB_Wall	47.3	46.5	25.8	21.3	17.6	16.8
Ht_Wall	47.3	46.5	25.8	21.3	17.6	16.8

Uterus	47.3	46.5	25.8	21.3	17.6	16.8
ET_Reg	47.3	46.5	25.8	21.3	17.6	16.8
Lung	47.3	46.5	25.8	21.3	17.6	16.8
<b>Effective</b>	<b>56.5</b>	<b>53.2</b>	<b>28.6</b>	<b>23.0</b>	<b>18.8</b>	<b>17.7</b>

Table 3.2 shows that all age groups younger than “Adult” would experience higher doses. The highest effective dose is calculated for the infant and is a factor of 3.2 larger than the adult dose – or about 56.5 millirem – more than five times the Subpart H limit of 10 mrem/year. CAP88 uses an age of three months to define the term “infant” for purposes of dose calculations. Intake factors are those specified by the EPA in the US Federal Guidance Report 13 [USEPA 1999], see also Appendix B.

The pathway contribution to CAP88-PC calculated effective doses from tritium are summarized in Table 3.3. Ingestion dominates the effective dose and accounts for 97.9% of the infant dose and 92.1% of the adult dose.

Table 3.3 Pathway contribution to the effective doses from tritium calculated with CAP88-PC

Pathway	Infant	1-yr old	5-yr old	10-yr old	15-yr old	Adult
Ingestion	97.9%	97.6%	96.2%	94.8%	92.6%	92.1%
Inhalation	2.1%	2.3%	4.0%	5.1%	7.4%	7.6%

The results in Table 3.3 indicate that under the assumptions used in the CAP88 model, almost the entire dose is due to ingestion of contaminated food. The agricultural scenario assumes A local food model (i.e. 100% home produced vegetables, milk and meat) but no drinking water intake.

## 4 Exposure scenarios

---

The use of annual or longer-term average weather data, as assumed by LANL (which used five year average data) is scientifically questionable since the proposed activity consists of short term releases from four FTWCs. These would take place over a few days, when the weather may be very different. Further, two additional factors need to be taken into account in regard to the source term. First the tritium has decayed since LANL's initial calculation; this would decrease the doses. Second, LANL proposes to vent one FTWC at a time and assess the doses during the venting. Therefore, the scenarios below use three source terms: (i) the entire LANL source term (114,683 Ci); (ii) the entire source term, decay-corrected to September 1, 2024 (85,312 Ci); and (iii) the source term for the FTWC with the largest inventory of tritium, decay-corrected to September 1, 2024 (32,000 Ci). The first two are done for comparison with LANL's 20.2 mrem estimate. The last is the appropriate one for assessing compliance, given LANL phased venting plan.

A third factor, the short-term weather during the release is also critical. In light of the above considerations, the following additional scenarios were selected to illustrate the variability of doses from the proposed tritium emissions:

- **Low humidity (Scenario 12)**  
 As shown Figure 2.4, there is quite a variability of humidity in air over the course of the year. A reasonable worst-case value of 1 g H<sub>2</sub>O/m<sup>3</sup> was selected for this scenario. The CAP88-PC model assumes that the specific activity of tritium in air moisture is in equilibrium with the activity in food. The concentration of tritium in air (e.g. 100 pCi/m<sup>3</sup>) is attributed to the amount of water in air. In the above example, the specific activity of water (and all foodstuffs) for 1 g H<sub>2</sub>O/m<sup>3</sup> would be 100 pCi/g; for 5.5 g H<sub>2</sub>O/m<sup>3</sup> it would be 18.2 pCi/g. Therefore, doses are higher if the air humidity is low. Calculations were done for the age group infants.
- **High prevalence of direction towards ESE ( Scenario 14, 15 and 16)**  
 As shown in Figure 2.3, the highest prevalence of is was wind towards ESE over a 24-hr period was 42%. This value was used as a reasonable worst-case scenario. The relative frequency of wind speed and stability classes was assumed to be identical to the annual average of 2020. Calculations were done for the age group infants with humidity of 5.5 g H<sub>2</sub>O/m<sup>3</sup> (scenario 14), 2.5 g H<sub>2</sub>O/m<sup>3</sup> (scenario 15), and 1 g H<sub>2</sub>O/m<sup>3</sup> (scenario 16).
- **Low wind speed (scenario 17).** Based on the data shown in Figure 2.5, wind speeds are below 3 knots (1.55 m/s) in about 55 hrs. per year.. Therefore, a reasonable worst-case scenario is to assume that during the tritium releases, the wind speed is 3 knots. In this scenario calculations were done for the age group infants. The frequency of stability classes A to F was assumed to be identical to the reported annual average of 2020, and the wind blows towards ESE during 42% of the time. The humidity was assumed to be 1 g H<sub>2</sub>O/m<sup>3</sup>.

The results for different tritium emissions are presented in Table 4.1.

Table 4.1 Pathway contribution to the effective doses from tritium calculated with CAP88-PC

No.	Description	Wind direction	Wind speed	Stability class	Humidity	Age group	Effective dose in mrem/yr for tritium emission of		
							114,683 Ci	85,312 Ci	32,000Ci
1	Reference [LANL 2019]	TA-54 (2007-2011)	TA-54 (2007-2011)	TA-54 (2007-2011)	5.5 g/m <sup>3</sup>	adult	20.2	15.0	5.64
2	As in #1, TA-54 2018 weather data	TA-54 2018	TA-54 2018	TA-54 2018	5.5 g/m <sup>3</sup>	adult	18.9	14.1	5.23
3	As in #1, TA-54 2019 weather data	TA-54 2019	TA-54 2019	TA-54 2019	5.5 g/m <sup>3</sup>	adult	17.9	13.3	4.99
4	As in #1, TA-54 2020 weather data	TA-54 2020	TA-54 2020	TA-54 2020	5.5 g/m <sup>3</sup>	adult	17.6	13.1	4.91
5	As in #1, TA-54 2021 weather data	TA-54 2021	TA-54 2021	TA-54 2021	5.5 g/m <sup>3</sup>	adult	15.6	11.6	4.35
6	As in #1, TA-54 2022 weather data	TA-54 2022	TA-54 2022	TA-54 2022	5.5 g/m <sup>3</sup>	adult	18.4	13.7	5.13
7	As in #4, age group infants	TA-54 2020	TA-54 2020	TA-54 2020	5.5 g/m <sup>3</sup>	infant	56.3	41.9	15.7
8	As in #4, age group 1-yr old	TA-54 2020	TA-54 2020	TA-54 2020	5.5 g/m <sup>3</sup>	1-yr old	53.0	39.5	14.8
9	As in #4, age group 5-yr old	TA-54 2020	TA-54 2020	TA-54 2020	5.5 g/m <sup>3</sup>	5-yr old	28.5	21.2	7.95
10	As in #4, age group 10-yr old	TA-54 2020	TA-54 2020	TA-54 2020	5.5 g/m <sup>3</sup>	10-yr old	22.9	17.1	6.40
11	As in #4, age group 15-yr old	TA-54 2020	TA-54 2020	TA-54 2020	5.5 g/m <sup>3</sup>	15-yr old	18.7	13.9	5.22
12	As in #7, low humidity	TA-54 2020	TA-54 2020	TA-54 2020	1 g/m <sup>3</sup>	infant	301	224	84.0
13	As in #7, medium humidity	TA-54 2020	TA-54 2020	TA-54 2020	2.5 g/m <sup>3</sup>	infant	121	90.4	33.9
14	As in # 7, max 24-hr wind to ESE	42% to ESE	TA-54 2020 <sup>a)</sup>	TA-54 2020 <sup>b)</sup>	5.5 g/m <sup>3</sup>	infant	332	247	92.8
15	As in # 14, medium humidity	42% to ESE	TA-54 2020 <sup>a)</sup>	TA-54 2020 <sup>b)</sup>	2.5 g/m <sup>3</sup>	infant	762	567	213
16	As in # 14, low humidity	42% to ESE	TA-54 2020 <sup>a)</sup>	TA-54 2020 <sup>b)</sup>	1 g/m <sup>3</sup>	infant	1,887	1,404	527
17	As in # 14, low wind speed <3 knots	42% to ESE	< 3 knots	TA-54 2020 <sup>b)</sup>	1 g/m <sup>3</sup>	infant	3,041	2,262	848

a) Frequency of wind speed classes identical to the reported annual average at TA-54 for 2020

b) Frequency of stability classes A to F identical to the reported annual average at TA-54 for 2020

## 5 Scenario based on December 1, 2018 weather data

---

In [Fuehne 2022b], the weather data for the ten-hour period from 7 am to 5 pm on 01 December 2018 as a “worst case” for the CAP88-PC modelling. Based on 15-minute data from the LANL weather machine, the average wind direction towards ESE was 63% compared to the 2018 annual average of 7.0%. The average wind speed in the ten hour time period was 5.4 m/s compared to the 2018 annual average of 2.7 m/s. The humidity was 2.4 g H<sub>2</sub>O/m<sup>3</sup> compared to the 2018 annual average of 3.7 g H<sub>2</sub>O/m<sup>3</sup>.

The additional CAP88-PC calculations were performed using the following input data:

Source term:	32,000 Ci of HTO
Stack height:	2 m
Stack diameter:	0.25 m
Weather data:	LANL TA-54 for the year 2018
Temperature:	9° C
Precipitation:	45 cm/y
Lid height:	1,600 m
Humidity:	2.4 g H <sub>2</sub> O/m <sup>3</sup>
Dose age groups:	(a) infant and (b) adult
Food source:	Local (New Mexico)
Location of the individual:	2195 Meters ESE

The resulting doses to the maximum exposed individual were as follows (see :

Infant:	37.6 mrem effective dose equivalent
Adult:	11.4 mrem effective dose equivalent

The wind direction towards ESE 7 am to 5 pm on 1 Dec 2018 of 63%, which is a factor of nine higher than in the annual average of 7%. If the frequency of wind speed and stability classes for the wind towards ESE was the same for 7 am to 5 pm on 1 Dec 2018 as in the annual average, the infant dose would be 37.6 mrem \* 9 = 340 mrem (rounded), the adult dose would be 11.4 mrem \* 9 = 103 mrem.

Unfortunately, the frequency of stability classes cannot be inferred from the TA-54 data because the algorithms that LANL uses are not publicly available. The wind speed for wind direction towards ESE on 1 Dec 2018 from 7 am to 5 pm was 5.4 m/s as compared to the annual average of 2.7 m/s for wind direction towards ESE during 2018. A higher wind speed leads to more dispersion; the doubling the wind speed reduces the dispersion coefficient CHI/Q and thus the doses by a factor of two. If a wind speed of 5.4 m/s would be used for the calculation, assuming that the frequency of stability classes in the ten-hour period was identical to the annual average for the wind direction towards ESE, the resulting doses to the maximum exposed individual would be as follows

Infant:	170 mrem effective dose equivalent
Adult:	51 mrem effective dose equivalent

## 6 Conclusions

---

### **The dose calculations in LANL [2019] could be verified.**

The doses presented in the CAP88-PC in [LANL 2019] were calculated for adults using the TA-54 weather data for 2007 to 2011. The result is between 6% and 26% higher than the doses calculated here using the TA-54 weather data for 2018 to 2022. The results are close.

### **LANL ignored the radiation doses to the critical age group of infants.**

The calculations in [LANL 2019] are based on the age group adults. The dose to infants is a factor of 3.2 larger than those to adults.

### **LANL did not consider the impact of low air humidity on radiation doses.**

The CAP88-PC model assumes that the specific activity of tritium in air moisture is in equilibrium with the activity in food. Hence, doses are higher if the air humidity is low. If one assumes that the air humidity is 1 g H<sub>2</sub>O/m<sup>3</sup> rather than the LANL estimate of 5.5 g H<sub>2</sub>O/m<sup>3</sup>, doses would be a factor of 5.35 larger for the infant age group or a factor of (5.35 \* 3.2) = 17.1 larger than for the adult age group.

### **LANL incorrectly assumed five-year average weather data.**

For the short duration of the tritium emissions, the LANL assessment assumed an annual average weather data. This is not a realistic assumption. In the years 2018 to 2022, the wind was blowing in 6.5% of the time towards the critical receptor in 2.195 km distance ESE (Church Rock, La Vista Church of Nazarene). During 2023, the highest prevalence of wind towards ESE over a 24-hr period was 42%. This value was used as a reasonable worst-case scenario. Frequency of wind speed classes and stability classes was assumed to be identical to the 2023 average. For a 24-hr release of 32,000 Ci, the effective dose to infants was calculated to be from 92.8 mrem (humidity of 5.5 g H<sub>2</sub>O/m<sup>3</sup>) to 527 mrem (humidity of 1 g H<sub>2</sub>O/m<sup>3</sup>).

### **Doses would be even larger for low windspeeds.**

In 2023, wind speeds below 3 knots (1.55 m/s) occurred during 55 hrs. per year. Therefore, a reasonable worst-case scenario is to assume that the tritium releases occur during a low wind speed period; the wind direction towards ESE over a 24-hr period was again assumed to be 42%, the humidity was assumed to be 1 g H<sub>2</sub>O/m<sup>3</sup>. Under these circumstances, a 24-hr release of 32,000 Ci would result in an effective dose to infants of 848 mrem.

### **Worst-case Infant dose is 151 times larger than that for adults using the LANL model.**

The worst-case calculations CAP88-PC presented in this report for a combination of low wind speed, low humidity and short-term (24-hour) wind direction that is predominantly in the ESE direction, indicate that infant doses could be 848 mrem for a release of 32,000 Ci in a 24-hr time period. This dose is 151 times higher than the one calculated by LANL standard model for adults (see No. 1 (Reference) line compared to Scenario 17 in Table 4.1 above).

### **The ten-hour release scenario using weather data for December 1, 2018 would result in an effective dose to infants of 170 mrem.**



# 7 References

---

- 40CFR61 Subpart H [1989]. National Archives. 15 12 1989  
<https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-61/subpart-H>
- Fuehne [2020]. Fuehne DP, Lattin RR. 2019 LANL Radionuclide Air Emissions Report. LA-UR-23-25741. 2020-12-17 (rev.1). <https://www.osti.gov/servlets/purl/1739904>
- Fuehne [2022a]. Fuehne DP. Notification of Operational Scope Change for the FTWC Venting Project at Los Alamos National Laboratory (LANL). 2020-03-12 (rev.1). LA-UR-20-22148.
- Fuehne [2022b]. Fuehne DP. Supplemental Information Regarding the Application for Remediation of the Flanged Tritium Waste Containers at Los Alamos National Laboratory. Response to information request from EPA Region 6 Environmental Regulatory Document. LA-UR-21-31397. 2022-02-22 (rev.2).  
<https://www.osti.gov/servlets/purl/1846123>
- Fuehne [2023]. Fuehne DP, Lattin RR. 2021 LANL Radionuclide Air Emissions Report. LA-UR-22-24785. 2023-01-17 (rev.3). <https://www.osti.gov/servlets/purl/1875776>
- Fuehne [2022c]. Fuehne DP, Lattin RR. 2022 LANL Radionuclide Air Emissions Report. LA-UR-23-25741. 2023-07-06 (rev.2). <https://doi.org/10.2172/1808813>
- Lattin [2019]. Lattin RR, Fuehne DP,. 2018 LANL Radionuclide Air Emissions Report. LA-UR-19-25248. 2019-07-03 (rev.1) <https://www.osti.gov/servlets/purl/1532679>
- Lattin [2021]. Lattin RR, Fuehne DP. 2020 LANL Radionuclide Air Emissions Report. LA-UR-23-25741. 2021-07-16 (rev.1). <https://www.osti.gov/servlets/purl/1808813>
- Hyatt [2023]. Hyatt K M. Fuehne DP, Lattin RR [2023]. Flanged Tritium Waste Containers Operational Concerns: How to Address the Issues through the Venting Design. LA-UR-22-31991. 2023-01-03 (rev. 1). [1907769 \(osti.gov\)](https://www.osti.gov/servlets/purl/1907769)
- ICRP [1996]. International Commission on Radiological Protection. Age-dependent Doses to Members of the Public from Intake of Radionuclides - Part 4 Inhalation Dose Coefficients. ICRP Publication 71. Ann. ICRP 25 (3-4), 1995
- ICRP [2011]. International Commission on Radiological Protection. ICRP Database of Dose Coefficients: Workers and Members of the Public Version 3.0. 1988-2011.
- LANL [2019]. Transmittal of Application for Pre-Construction Approval and Notice of Intent to Start Operations under 40 CFR 61 Subparts A and H for Venting of Flanged Tritium Waste Containers (FTWCs) at TA-54. Letter from LANL to EPA Region 6, May 17, 2019
- Lattin [2020]. Lattin RR, Fuehne DP. Evaluation of FTWC Vent System. 2020-07-28 (rev.2). LA-UR-19-30127. <https://www.osti.gov/servlets/purl/1569721>
- NIST [2000]. Lucas L L & Unterweger MP Comprehensive Review and Critical Evaluation of the Half-Life of Tritium. [J. Res. Natl. Inst. Stand. Technol. 105, 541 (2000).  
[j54luc2.pdf \(nist.gov\)](https://www.nist.gov/pml/j54luc2.pdf)

USEPA [1999]. EPA 402-R-99-001 Federal Guidance Report 13, “Cancer Risk Coefficients for Environmental Exposure to Radionuclides”, USEPA Office of Radiation and Indoor Air, Washington, DC, 1999

USEPA [2023]. U.S. Environmental Protection Agency, Office of Radiation and Indoor Air. CAP88-PC Version 4.1. available at <https://www.epa.gov/system/files/other-files/2022-07/Cap88PCV411B5Install.exe>  
[https://www.epa.gov/sites/default/files/2019-11/documents/cap88-pc\\_4.1\\_user\\_guide.pdf](https://www.epa.gov/sites/default/files/2019-11/documents/cap88-pc_4.1_user_guide.pdf) (accessed on June 1, 2024)

# Appendix A. CAP88 model runs

---

## Scenario 4: 32,000 Ci HTO – ground level - adult - 2020 TA-54 weather data

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment  
Thu Sep 12 10:41:03 2024

Facility:  
Address:  
City:  
State: NM                      Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Adult

Comments:

Effective Dose Equivalent  
(mrem)

---

4.91E+00

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 2020 TA-54 weather - ground level - 32000 Ci - adult.DAT  
Dataset Date: Sep 12, 2024 10:41  
Wind File: C:\Users\bernd\Documents\CAP88\Wind Files\LANL TA-54 2020.wnd

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East Southeast  
 Lifetime Fatal Cancer Risk: 3.05E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	4.67E+00
UB_Wall	4.67E+00
Bone_Sur	4.67E+00
Brain	4.67E+00
Breasts	4.67E+00
St_Wall	6.22E+00
SI_Wall	4.71E+00
ULI_Wall	4.90E+00
LLI_Wall	5.36E+00
Kidneys	4.67E+00
Liver	4.67E+00
Muscle	4.67E+00
Ovaries	4.67E+00
Pancreas	4.67E+00
R_Marrow	4.67E+00
Skin	4.67E+00
Spleen	4.67E+00
Testes	4.67E+00
Thymus	4.67E+00
Thyroid	4.67E+00
GB_Wall	4.67E+00
Ht_Wall	4.67E+00
Uterus	4.67E+00
ET_Reg	4.67E+00
Lung	4.67E+00
Effectiv	4.91E+00

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source	
			#1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04

SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 5.500 g/cu m  
 Mixing Height: 1600.0 m

User specified location of max exposed individual.  
 (ILOC, JLOC): ESE, 2195 meters





SOURCE INFORMATION

Source Number: 1

Stack Height (m): 0.00  
 Diameter (m): 22.00

Plume Rise							
Pasquill Cat:	A	B	C	D	E	F	G
Fixed (m):	None	None	None	None	None	None	None

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	1.0000	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000	0.0000
Fraction Imported:	0.0000	0.0000	0.0000

Food Arrays were not generated for this run.  
 Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250 750 1500 2195 3500 4500 7500  
 15000 25000 35000 45000 55000 70000

**Scenario 7: 32,000 Ci HTO – ground level - infant - 2020 TA-54 weather data**

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment  
Thu Sep 12 10:46:09 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Infant

Comments:

Effective Dose Equivalent  
(mrem)

---

1.57E+01

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 2020 TA-54 weather - ground level - 32000 Ci  
- infant.DAT  
Dataset Date: Sep 12, 2024 10:46  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2020.wnd

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-east  
 Lifetime Fatal Cancer Risk: 2.50E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	1.32E+01
UB_Wall	1.32E+01
Bone_Sur	1.32E+01
Brain	1.32E+01
Breasts	1.32E+01
St_Wall	3.01E+01
SI_Wall	1.35E+01
ULI_Wall	1.55E+01
LLI_Wall	2.00E+01
Kidneys	1.32E+01
Liver	1.32E+01
Muscle	1.32E+01
Ovaries	1.32E+01
Pancreas	1.32E+01
R_Marrow	1.32E+01
Skin	1.32E+01
Spleen	1.32E+01
Testes	1.32E+01
Thymus	1.32E+01
Thyroid	1.32E+01
GB_Wall	1.32E+01
Ht_Wall	1.32E+01
Uterus	1.32E+01
ET_Reg	1.32E+01
Lung	1.32E+01
Effectiv	1.57E+01

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04



SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 5.500 g/cu m  
 Mixing Height: 1600.0 m

individual. User specified location of max exposed

(ILOC, JLOC): ESE, 2195 meters  
 SOURCE INFORMATION

Source Number: 1

Stack Height (m): 0.00  
 Diameter (m): 22.00

Plume Rise	A	B	C	D	E	F
Pasquill Cat:						
G						
Fixed (m):	None	None	None	None	None	None

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
Fraction Home Produced:	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000
Fraction Imported:	0.0000	0.0000

Food Arrays were not generated for this run.

Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250 750 1500 2195 3500 4500 7500  
 15000 25000 35000 45000 55000 70000



**Scenario 8: 32,000 Ci HTO – ground level – 1-yr old - 2020 TA-54 weather data**

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment  
Thu Sep 12 11:08:32 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: One

Comments:

Effective Dose Equivalent  
(mrem)

---

1.48E+01

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 2020 TA-54 weather - ground level - 32000 Ci  
- 1-yr.DAT  
Dataset Date: Sep 12, 2024 11:08  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2020.wnd

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-east  
 Lifetime Fatal Cancer Risk: 3.22E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	1.29E+01
UB_Wall	1.29E+01
Bone_Sur	1.29E+01
Brain	1.29E+01
Breasts	1.29E+01
St_Wall	2.48E+01
SI_Wall	1.32E+01
ULI_Wall	1.49E+01
LLI_Wall	1.85E+01
Kidneys	1.29E+01
Liver	1.29E+01
Muscle	1.29E+01
Ovaries	1.29E+01
Pancreas	1.29E+01
R_Marrow	1.29E+01
Skin	1.29E+01
Spleen	1.29E+01
Testes	1.29E+01
Thymus	1.29E+01
Thyroid	1.29E+01
GB_Wall	1.29E+01
Ht_Wall	1.29E+01
Uterus	1.29E+01
ET_Reg	1.29E+01
Lung	1.29E+01
Effectiv	1.48E+01

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04



SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 5.500 g/cu m  
 Mixing Height: 1600.0 m

individual. User specified location of max exposed

(ILOC, JLOC): ESE, 2195 meters

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 0.00  
 Diameter (m): 22.00

Plume Rise	A	B	C	D	E	F
Pasquill Cat:						
G						
Fixed (m):	None	None	None	None	None	None

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
Fraction Home Produced:	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000
Fraction Imported:	0.0000	0.0000

Food Arrays were not generated for this run.

Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250 750 1500 2195 3500 4500 7500  
 15000 25000 35000 45000 55000 70000



**Scenario 9: 32,000 Ci HTO – ground level – 5-yr old - 2020 TA-54 weather data**

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment  
Thu Sep 12 11:11:39 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Five

Comments:

Effective Dose Equivalent  
(mrem)

---

7.95E+00

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 2020 TA-54 weather - ground level - 32000 Ci  
- 5-yr.DAT  
Dataset Date: Sep 12, 2024 11:11  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2020.wnd

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-east  
 Lifetime Fatal Cancer Risk: 2.82E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	7.18E+00
UB_Wall	7.18E+00
Bone_Sur	7.18E+00
Brain	7.18E+00
Breasts	7.18E+00
St_Wall	1.21E+01
SI_Wall	7.32E+00
ULI_Wall	8.03E+00
LLI_Wall	9.60E+00
Kidneys	7.18E+00
Liver	7.18E+00
Muscle	7.18E+00
Ovaries	7.18E+00
Pancreas	7.18E+00
R_Marrow	7.18E+00
Skin	7.18E+00
Spleen	7.18E+00
Testes	7.18E+00
Thymus	7.18E+00
Thyroid	7.18E+00
GB_Wall	7.18E+00
Ht_Wall	7.18E+00
Uterus	7.18E+00
ET_Reg	7.18E+00
Lung	7.18E+00
Effectiv	7.95E+00

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04



SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 5.500 g/cu m  
 Mixing Height: 1600.0 m

individual.  
 User specified location of max exposed  
 (ILOC, JLOC): ESE, 2195 meters

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 0.00  
 Diameter (m): 22.00

Plume Rise	A	B	C	D	E	F
Pasquill Cat:						
G						
Fixed (m):	None	None	None	None	None	None

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
Fraction Home Produced:	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000
Fraction Imported:	0.0000	0.0000

Food Arrays were not generated for this run.  
 Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250 750 1500 2195 3500 4500 7500  
 15000 25000 35000 45000 55000 70000



**Scenario 10: 32,000 Ci HTO – ground level – 10-yr old - 2020 TA-54 weather data**

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment

Thu Sep 12 11:14:25 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Ten

Comments:

Effective Dose Equivalent  
(mrem)

---

6.40E+00

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 2020 TA-54 weather - ground level - 32000 Ci  
- 10-yr.DAT  
Dataset Date: Sep 12, 2024 11:14  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2020.wnd



MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-east  
 Lifetime Fatal Cancer Risk: 3.13E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	5.91E+00
UB_Wall	5.91E+00
Bone_Sur	5.91E+00
Brain	5.91E+00
Breasts	5.91E+00
St_Wall	8.96E+00
SI_Wall	6.00E+00
ULI_Wall	6.46E+00
LLI_Wall	7.49E+00
Kidneys	5.91E+00
Liver	5.91E+00
Muscle	5.91E+00
Ovaries	5.91E+00
Pancreas	5.91E+00
R_Marrow	5.91E+00
Skin	5.91E+00
Spleen	5.91E+00
Testes	5.91E+00
Thymus	5.91E+00
Thyroid	5.91E+00
GB_Wall	5.91E+00
Ht_Wall	5.91E+00
Uterus	5.91E+00
ET_Reg	5.91E+00
Lung	5.91E+00
Effectiv	6.40E+00

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04



SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 5.500 g/cu m  
 Mixing Height: 1600.0 m

individual. User specified location of max exposed

(ILOC, JLOC): ESE, 2195 meters

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 0.00  
 Diameter (m): 22.00

Plume Rise	A	B	C	D	E	F
Pasquill Cat:						
G						
Fixed (m):	None	None	None	None	None	None

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
Fraction Home Produced:	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000
Fraction Imported:	0.0000	0.0000

Food Arrays were not generated for this run.

Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250 750 1500 2195 3500 4500 7500  
 15000 25000 35000 45000 55000 70000



**Scenario 11: 32,000 Ci HTO – ground level – 15-yr old - 2020 TA-54 weather data**

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment

Thu Sep 12 11:17:45 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Fifteen

Comments:

Effective Dose Equivalent  
(mrem)

---

5.22E+00

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 2020 TA-54 weather - ground level - 32000 Ci  
- 15-yr.DAT  
Dataset Date: Sep 12, 2024 11:17  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2020.wnd

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-east  
 Lifetime Fatal Cancer Risk: 3.26E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	4.89E+00
UB_Wall	4.89E+00
Bone_Sur	4.89E+00
Brain	4.89E+00
Breasts	4.89E+00
St_Wall	7.02E+00
SI_Wall	4.94E+00
ULI_Wall	5.21E+00
LLI_Wall	5.80E+00
Kidneys	4.89E+00
Liver	4.89E+00
Muscle	4.89E+00
Ovaries	4.89E+00
Pancreas	4.89E+00
R_Marrow	4.89E+00
Skin	4.89E+00
Spleen	4.89E+00
Testes	4.89E+00
Thymus	4.89E+00
Thyroid	4.89E+00
GB_Wall	4.89E+00
Ht_Wall	4.89E+00
Uterus	4.89E+00
ET_Reg	4.89E+00
Lung	4.89E+00
Effectiv	5.22E+00

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04



SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 5.500 g/cu m  
 Mixing Height: 1600.0 m

individual.  
 User specified location of max exposed  
 (ILOC, JLOC): ESE, 2195 meters

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 0.00  
 Diameter (m): 22.00

Plume Rise	A	B	C	D	E	F
Pasquill Cat:						
G						
Fixed (m):	None	None	None	None	None	None

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
Fraction Home Produced:	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000
Fraction Imported:	0.0000	0.0000

Food Arrays were not generated for this run.  
 Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250 750 1500 2195 3500 4500 7500  
 15000 25000 35000 45000 55000 70000



**Scenario 12: 32,000 Ci HTO – ground level - infant - 2020 TA-54 weather data – low humidity (1 g H<sub>2</sub>O/m<sup>3</sup>)**

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment  
Thu Sep 12 10:58:27 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Infant

Comments:

Effective Dose Equivalent  
(mrem)

---

8.40E+01

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 2020 TA-54 weather - ground level - 32000 Ci  
- infant - low humidity.DAT  
Dataset Date: Sep 12, 2024 10:58  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2020.wnd

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-east  
 Lifetime Fatal Cancer Risk: 1.34E-05

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	7.01E+01
UB_Wall	7.01E+01
Bone_Sur	7.01E+01
Brain	7.01E+01
Breasts	7.01E+01
St_Wall	1.62E+02
SI_Wall	7.23E+01
ULI_Wall	8.31E+01
LLI_Wall	1.07E+02
Kidneys	7.01E+01
Liver	7.01E+01
Muscle	7.01E+01
Ovaries	7.01E+01
Pancreas	7.01E+01
R_Marrow	7.01E+01
Skin	7.01E+01
Spleen	7.01E+01
Testes	7.01E+01
Thymus	7.01E+01
Thyroid	7.01E+01
GB_Wall	7.01E+01
Ht_Wall	7.01E+01
Uterus	7.01E+01
ET_Reg	7.01E+01
Lung	7.01E+01
Effectiv	8.40E+01

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04

SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 1.000 g/cu m  
 Mixing Height: 1600.0 m

individual.  
 User specified location of max exposed  
 (ILOC, JLOC): ESE, 2195 meters

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 0.00  
 Diameter (m): 22.00

Plume Rise	A	B	C	D	E	F
Pasquill Cat:						
G						
Fixed (m):	None	None	None	None	None	None

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
Fraction Home Produced:	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000
Fraction Imported:	0.0000	0.0000

Food Arrays were not generated for this run.  
 Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250 750 1500 2195 3500 4500 7500  
 15000 25000 35000 45000 55000 70000





**Scenario 13: 32,000 Ci HTO – ground level - infant - 2020 TA-54 weather data – medium humidity (2.5 g H<sub>2</sub>O/m<sup>3</sup>)**

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment  
Thu Sep 12 11:31:05 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Infant

Comments:

Effective Dose Equivalent  
(mrem)

---

3.39E+01

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 2020 TA-54 weather - ground level - 32000 Ci  
- infant - medium humidity.DAT  
Dataset Date: Sep 12, 2024 11:30  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2020.wnd

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-east  
 Lifetime Fatal Cancer Risk: 5.41E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	2.83E+01
UB_Wall	2.83E+01
Bone_Sur	2.83E+01
Brain	2.83E+01
Breasts	2.83E+01
St_Wall	6.54E+01
SI_Wall	2.92E+01
ULI_Wall	3.36E+01
LLI_Wall	4.32E+01
Kidneys	2.83E+01
Liver	2.83E+01
Muscle	2.83E+01
Ovaries	2.83E+01
Pancreas	2.83E+01
R_Marrow	2.83E+01
Skin	2.83E+01
Spleen	2.83E+01
Testes	2.83E+01
Thymus	2.83E+01
Thyroid	2.83E+01
GB_Wall	2.83E+01
Ht_Wall	2.83E+01
Uterus	2.83E+01
ET_Reg	2.83E+01
Lung	2.83E+01
Effectiv	3.39E+01

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04



SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 2.500 g/cu m  
 Mixing Height: 1600.0 m

individual.  
 User specified location of max exposed  
 (ILOC, JLOC): ESE, 2195 meters

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 0.00  
 Diameter (m): 22.00

Plume Rise	A	B	C	D	E	F
Pasquill Cat:						
G						
Fixed (m):	None	None	None	None	None	None

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
Fraction Home Produced:	1.0000	1.0000
Fraction From Assessment Area:	0.0000	0.0000
Fraction Imported:	0.0000	0.0000

Food Arrays were not generated for this run.  
 Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250 750 1500 2195 3500 4500 7500  
 15000 25000 35000 45000 55000 70000



**Scenario 17: 32,000 Ci HTO – ground level - infant - low wind speed <3 knots – low humidity (1 g H<sub>2</sub>O/m<sup>3</sup>) (the results for 100% wind direction towards ESE and have to be multiplied with 0.42 to adjust for 42% wind direction frequency towards ESE**

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment  
Thu Sep 12 11:43:59 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Area  
Emission Year:  
DOSE Age Group: Infant

Comments:

Effective Dose Equivalent  
(mrem)

---

2.02E+03

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 13 knots - ground level - 32000 Ci - infant - low humidity.DAT  
Dataset Date: Sep 12, 2024 11:43  
Wind File: C:\Users\bernd\Documents\CAP88\Wind Files\E1-3knots\_WNW.wnd

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-east  
 Lifetime Fatal Cancer Risk: 3.22E-04

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	1.68E+03
UB_Wall	1.68E+03
Bone_Sur	1.68E+03
Brain	1.68E+03
Breasts	1.68E+03
St_Wall	3.90E+03
SI_Wall	1.74E+03
ULI_Wall	2.00E+03
LLI_Wall	2.58E+03
Kidneys	1.68E+03
Liver	1.68E+03
Muscle	1.68E+03
Ovaries	1.68E+03
Pancreas	1.68E+03
R_Marrow	1.68E+03
Skin	1.68E+03
Spleen	1.68E+03
Testes	1.68E+03
Thymus	1.68E+03
Thyroid	1.68E+03
GB_Wall	1.68E+03
Ht_Wall	1.68E+03
Uterus	1.68E+03
ET_Reg	1.68E+03
Lung	1.68E+03
Effectiv	2.02E+03

RADIONUCLIDE EMISSIONS DURING THE YEAR

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
H-3	V	0.000	3.2E+04	3.2E+04



SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 1.000 g/cu m  
 Mixing Height: 1600.0 m

individual.  
 User specified location of max exposed  
 (ILOC, JLOC): ESE, 2195 meters

SOURCE INFORMATION

Source Number: 1

Source Height (m): 0.00  
 Area (sq m): 22.00

Plume Rise  
 Momentum (m/s): 0.00  
 (Exit Velocity)

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
1.0000	Fraction Home Produced: 1.0000	1.0000
0.0000	Fraction From Assessment Area: 0.0000	0.0000
0.0000	Fraction Imported: 0.0000	0.0000

run.  
 Food Arrays were not generated for this  
 Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250	750	1500	2195	3500	4500	7500
15000	25000	35000	45000	55000	70000	



# Appendix B. Age- and gender specific usage rates [from USEPA 1999]

**Table 3.1. Age- and gender-specific usage rates of environmental media, for selected ages.<sup>a</sup>**

Age (y)	Air <sup>b</sup> (m <sup>3</sup> d <sup>-1</sup> )		Tap water <sup>c</sup> (L d <sup>-1</sup> )		Food energy <sup>d</sup> (kcal d <sup>-1</sup> )		Cow's milk <sup>e</sup> (L d <sup>-1</sup> )	
	M	F	M	F	M	F	M	F
0	2.9	2.9	0.191	0.188	478	470	0.339	0.350
1	5.2	5.2	0.223	0.216	791	752	0.349	0.358
5	8.8	8.8	0.542	0.499	1566	1431	0.413	0.409
10	15.3	15.3	0.725	0.649	1919	1684	0.486	0.428
15	20.1	15.7	0.900	0.712	2425	1828	0.519	0.356
20	22.2	17.7	1.137	0.754	2952	1927	0.414	0.249
50	22.2	17.7	1.643	1.119	2570	1758	0.192	0.139
75	22.2	17.7	1.564	1.179	1990	1508	0.192	0.139
Lifetime average	19.2	16.5	1.29	0.93	2418	1695	0.282	0.207
Combined lifetime average <sup>f</sup>	17.8		1.11		2048 <sup>g</sup>		0.243	

<sup>a</sup>All values are based on estimated averages for the U.S. population for the indicated age. Ages refer to birthdays; e.g., age 5 y indicates the fifth birthday. Data reported for age intervals were converted to point estimates by preserving the total intake in each interval using a cubic spline fitting method (Fritsch and Carlson, 1980). Fitted curves were smoothed using a 3-point moving average. The listed usage rates are the values used in the calculation and are generally more precise than the data would support.

<sup>b</sup>From Tables B.16A and B.16B of ICRP Publication 66, 1994a.

<sup>c</sup>Based on survey data of the U.S. Department of Agriculture (Ershow and Cantor, 1989). Includes drinking water, water added to beverages, and water added to foods during preparation, but not water intrinsic in food as purchased.

<sup>d</sup>Based on data from the Third National Health and Nutrition Examination Survey (McDowell et al., 1994).

<sup>e</sup>Used in one of two scenarios for ingestion of radioisotopes of iodine in diet. The other scenario assumes that iodine intake is proportional to food energy usage. Milk usage is based on data from EPA report 520/1-84-021 (1984b).

<sup>f</sup>Based on the male-to-female ratio at birth, the gender-specific survival function, and the gender-specific usage function.

<sup>g</sup>For a typical U.S. diet, equivalent to a lifetime average intake of about 1.2 kg food d<sup>-1</sup> (see text).



# Appendix C. December 1, 2018 scenarios

---

C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment  
Mon Sep 9 15:58:24 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Infant

Comments:

Effective Dose Equivalent  
(mrem)

---

3.76E+01

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 32000 Ci - stack - 2018 weather - infant.DAT  
Dataset Date: Sep 9, 2024 03:58  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2018.wnd



Mon Sep 9 15:58:24 2024  
 SYNOPSIS

Page 1

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-  
 east  
 Lifetime Fatal Cancer Risk: 6.00E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	3.15E+01
UB_Wall	3.15E+01
Bone_Sur	3.15E+01
Brain	3.15E+01
Breasts	3.15E+01
St_Wall	7.26E+01
SI_Wall	3.24E+01
ULI_Wall	3.72E+01
LLI_Wall	4.80E+01
Kidneys	3.15E+01
Liver	3.15E+01
Muscle	3.15E+01
Ovaries	3.15E+01
Pancreas	3.15E+01
R_Marrow	3.15E+01
Skin	3.15E+01
Spleen	3.15E+01
Testes	3.15E+01
Thymus	3.15E+01
Thyroid	3.15E+01
GB_Wall	3.15E+01
Ht_Wall	3.15E+01
Uterus	3.15E+01
ET_Reg	3.15E+01
Lung	3.15E+01
Effectiv	3.76E+01

RADIONUCLIDE EMISSIONS DURING THE YEAR

Source  
 #1 TOTAL



Nuclide	Type	Size	Ci/y	Ci/y
H-3	V	0.000	3.2E+04	3.2E+04

SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 2.400 g/cu m  
 Mixing Height: 1600.0 m

individual.  
 User specified location of max exposed  
 (ILOC, JLOC): ESE, 2195 meters

Mon Sep 9 15:58:24 2024  
 SYNOPSIS

Page 2

SOURCE INFORMATION

Source Number: 1  
 \_\_\_\_\_  
 Stack Height (m): 2.00  
 Diameter (m): 0.25  
 Plume Rise  
 Momentum (m/s): 7.01  
 (Exit Velocity)

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
_____	_____	_____
1.0000	Fraction Home Produced: 1.0000	1.0000
0.0000	Fraction From Assessment Area: 0.0000	0.0000
0.0000	Fraction Imported: 0.0000	0.0000

Food Arrays were not generated for this run.  
 Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250	750	1500	2195	3500	4500	7500
15000	25000	35000	45000	55000	70000	



C A P 8 8 - P C

Version 4.1

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment

Mon Sep 9 15:59:39 2024

Facility:  
Address:  
City:  
State: NM Zip:

Source Category:  
Source Type: Stack  
Emission Year:  
DOSE Age Group: Adult

Comments:

Effective Dose Equivalent  
(mrem)

---

1.14E+01

---

At This Location: 2195 Meters East Southeast  
Dataset Name: 32000 Ci - stack - 2018 weather - adult.DAT  
Dataset Date: Sep 9, 2024 03:59  
Wind File: C:\Users\bernd\Documents\CAP88\Wind  
Files\LANL TA-54 2018.wnd

Mon Sep 9 15:59:39 2024  
 SYNOPSIS

Page 1

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2195 Meters East South-  
 east  
 Lifetime Fatal Cancer Risk: 7.13E-06

ORGAN DOSE EQUIVALENT SUMMARY  
 (RN-222 Working Level Calculations Excluded)

Organ	Dose Equivalent (mrem)
Adrenals	1.08E+01
UB_Wall	1.08E+01
Bone_Sur	1.08E+01
Brain	1.08E+01
Breasts	1.08E+01
St_Wall	1.46E+01
SI_Wall	1.09E+01
ULI_Wall	1.14E+01
LLI_Wall	1.25E+01
Kidneys	1.08E+01
Liver	1.08E+01
Muscle	1.08E+01
Ovaries	1.08E+01
Pancreas	1.08E+01
R_Marrow	1.08E+01
Skin	1.08E+01
Spleen	1.08E+01
Testes	1.08E+01
Thymus	1.08E+01
Thyroid	1.08E+01
GB_Wall	1.08E+01
Ht_Wall	1.08E+01
Uterus	1.08E+01
ET_Reg	1.08E+01
Lung	1.08E+01
Effectiv	1.14E+01

RADIONUCLIDE EMISSIONS DURING THE YEAR

Source  
 #1 TOTAL



Nuclide	Type	Size	Ci/y	Ci/y
H-3	V	0.000	3.2E+04	3.2E+04

SITE INFORMATION

Temperature: 9.000 degrees C  
 Precipitation: 45.000 cm/y  
 Humidity: 2.400 g/cu m  
 Mixing Height: 1600.0 m

individual.  
 User specified location of max exposed  
 (ILOC, JLOC): ESE, 2195 meters

Mon Sep 9 15:59:39 2024  
 SYNOPSIS

Page 2

SOURCE INFORMATION

Source Number: 1  
 \_\_\_\_\_  
 Stack Height (m): 2.00  
 Diameter (m): 0.25  
 Plume Rise  
 Momentum (m/s): 7.01  
 (Exit Velocity)

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk
Meat		
_____	_____	_____
1.0000	1.0000	1.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000

Food Arrays were not generated for this run.  
 Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

250	750	1500	2195	3500	4500	7500
15000	25000	35000	45000	55000	70000	

