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ACRONYMS AND ABBREVIATIONS

avg	average
Bq	Becquerel
Ci	curie
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
hr	hour
km	kilometer
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
LASL	Los Alamos Scientific Laboratory
m	meter
max	maximum
MFP	mixed fission products
mrem	millirem
NIOSH	National Institute for Occupational Safety and Health
P/VAP	particulate and vapor activation products
pCi	picocurie
s	second
SPD	site profile document
Sv	sievert
TA	technical area
TBD	technical basis document
TLD	thermoluminescent dosimeter
U.S.C.	United States Code
yr	year
μCi	microcurie

4.1 INTRODUCTION

Occupational environmental exposure refers to exposures received by workers outside facilities at Los Alamos National Laboratory (LANL) from elevated ambient radiation, from facility effluents to the environment, and from resuspension of radionuclides in soils. Effluents can result in internal and external exposures by inhalation of airborne radionuclides and by submersion in an effluent, respectively. This technical basis document (TBD) provides estimated annual intakes for inhalation exposure and estimated doses as a result of submersion and ambient exposure at LANL.

As discussed in Part 2 of the LANL Site Profile Document (SPD, ORAU pending), operations at Los Alamos have occurred in land divisions called technical areas (TAs). Table 2-1 of Part 2 lists each designated TA with information on the types of radionuclides present at some time during operations there. Activities that have occurred at LANL since operations began in 1943 have been highly variable on the site and over time. This TBD addresses occupational environmental exposure by considering available source term information that has been compiled for some of the TAs, as well as results of published environmental measurements for a larger number of TAs.

This analysis recognized that effluents from a particular LANL TA would have the greatest impact on workers in that TA, but that such effluents could affect workers present in nearby TAs. A comprehensive site-wide atmospheric model for predicting onsite worker exposures resulting from the highly variable releases of radionuclides to the air would be useful to evaluating these impacts, but LANL has not developed such a model. This TBD relies to a great extent on environmental measurements (i.e., air monitoring data) in estimating worker exposures, and to a lesser extent on source term emission estimates. Environmental measurements do not distinguish the source of emissions and, therefore, will reflect air concentrations from nearby as well as more distant sources. The emissions estimates are useful in filling in some gaps in measurement data, and are critical to estimating exposures before the start of comprehensive and routine measurement data reports.

TBDs and SPDs are general working documents that provide guidance concerning the preparation of dose reconstructions at particular sites or categories of sites. They will be revised in the event additional relevant information is obtained about the affected site(s). These documents may be used to assist the National Institute for Occupational Safety and Health (NIOSH) in the completion of the individual work required for each dose reconstruction.

In this document the word “facility” is used as a general term for an area, building, or group of buildings that served a specific purpose at a site. It does not necessarily connote an “atomic weapons employer facility” or a “Department of Energy facility” as defined in the Energy Employees Occupational Illness Compensation Program Act of 2000 [EEOICPA; 42 U.S.C. § 7384l (5) and (12)].

4.2 INTERNAL EXPOSURE FROM ONSITE ATMOSPHERIC RADIONUCLIDE CONCENTRATIONS

4.2.1 Onsite Releases to Air

In Part 2 of the LANL SPD, Table 2-1 lists LANL TAs and potential sources of radioactive materials that are or were present at some time at each TA. Enriched and depleted uranium, as well as plutonium isotopes, are commonly listed sources. Due to the many different types of applied research conducted at LANL, Table 2-1 also lists tritium, noble gases, fission and activation products.

LANL has reported effluents for many of the TAs from 1971 to 1995. In recent years, the reporting of air emissions has been by stack or vent. It is not possible to ascertain at this point how comprehensive the reporting of effluents is. Estimates of emissions from the Omega Reactors (TA-2), for example, have not been obtained. Furthermore, LANL has not assessed the exact location of releases in relation to potential receptors in a TA.

An ambient, air-monitoring program at LANL began as early as 1958 with a single station on the roof of the Administration Building in TA-3. In the late 1960s and early 1970s, a network of about 25 stations was put into operation. At present, about 60 stations conduct continuous air sampling. About 20 of the presently operational stations are on the site, with the remainder being offsite or perimeter stations. Figure 4-1 shows the location of active on- and off-site monitoring stations. Historical results of the AIRNET monitoring network through the year 2000 are available on the LANL website (web address http://www.lanl.gov/orgs/rres/maq/AirConc_AllData.htm#LOS), and annual environmental surveillance reports summarize yearly results. However, many TAs have unreported results and data are missing for some radionuclides and some years, or there have not been data to report due to changing conditions at LANL over time. Unless it is provided in the claimant files, locations of the air monitoring stations in relation to a specific worker's location(s) in a TA are not well known.

Due to the lack of comprehensiveness of both effluent and air monitoring data, the approach to estimating worker intakes of radionuclides from air due to emissions from LANL's TAs relied on a combination of the effluent and air monitoring data in this TBD. Because air monitoring data in a TA include concentrations due to effluents from that TA and resuspension of previously deposited radionuclides and effluents from nearby TAs, this analysis preferred these data in estimating air concentrations and ultimately worker intakes. The analysis used emissions data in filling some of the acknowledged gaps in monitoring data.

4.2.1.1 Emissions Data

Tables 4A-1 through 4A-22 in Attachment 4A to this TBD list emissions data. The tables list source emissions data by year and TA. If effluents were reported by stack or building vent (recent years), the tables sum effluents from the stacks and vents in each TA. For earlier years (1945 to 1971), the effluent releases reported in this document rely on data from the Center for Disease Control and Prevention's Los Alamos Historical Document Retrieval and Assessment project (ENSR 2002), including unpublished data.

4.2.1.1.1 Episodic Releases

LANL reported accidental releases of tritium and plutonium in the 1970s. Before that time, LANL noted some accidental releases (for example, a fire at TA-21 in July 1957), but accurate release estimates were not available (ENSR 2002). There were two tritium releases from TA-3 and one from TA-33. There was also a plutonium release from TA-21 in October 1970 (ENSR 2002). The emissions estimates (Tables 4A-1 through 4A-22 in Attachment 4A) include these and other episodic releases for which data were available along with routine stack releases for those years. The intake estimates are the same whether based on an assumed release period of one year or if releases occurred over some fraction of one year.

4.2.1.1.2 Bayo Canyon Releases

Experiments conducted in TA-10, Bayo Canyon, involved detonation of explosives around radioactive materials. These detonations dispersed materials, principally ^{140}La, to the atmosphere and could have caused exposure to LANL employees. The dominant dose pathway would have been exposure to gamma radiation from ^{140}La deposited on the ground. Internal exposure to ^{140}La via inhalation was insignificant based on the screening analysis (Section 4.2.1.2).

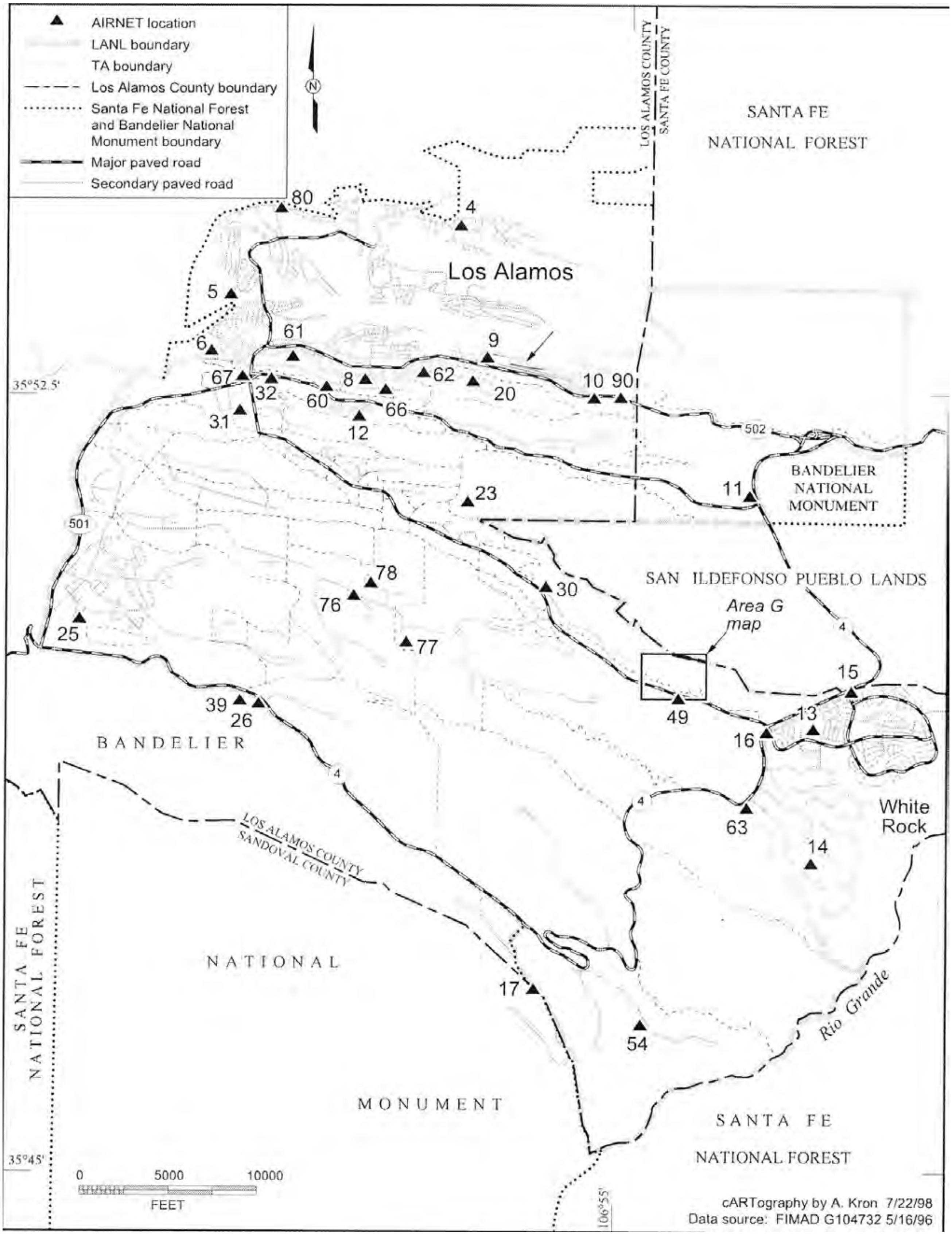

Figure 4-1. Offsite, perimeter, and onsite LANL AIRNET locations (from LANL 2002, p. 167).

4.2.1.2 Radionuclides of Significance

Before describing how this analysis estimated air concentrations in the TAs from emissions and monitoring data, it is important to focus the analysis on radionuclides potentially significant to dose. The basis for selection of radionuclides for estimating air concentrations was screening calculations to estimate which radionuclides listed as effluents were unlikely to contribute more than one millirem to a worker's effective 50-year committed dose during one year or more than 10 mrem to the organ with the highest 50-year committed dose factor. Because the assumptions in screening overestimate potential exposures, it is believed these criteria will correctly eliminate insignificant radionuclides from further concern.

The screening analysis (see Table 4B-1 of Attachment 4B) evaluated the potential inhalation dose associated with the maximum annual reported emission of each radionuclide in the data in Tables 4A-1 through 4A-22. This analysis calculated inhalation dose for each radionuclide by estimating maximum air concentrations using a screening-level dispersion model (NCRP 1996). An annual inhalation rate of 3,400 m^3/yr was assumed, corresponding to continuous moderate activity (1.7 m^3/hr) over a 2,000-hr workyear. The maximum effective and organ dose factors for each radionuclide are from International Commission on Radiological Protection (ICRP) Publication 68 (ICRP 2001, from the CD1 compilation).

The NCRP (1996) screening model adopted for these calculations is a simple dispersion model that accounts for potential increases in exposure due to building wake effects for close-in receptors (i.e., those less than 100 m from the source location). A calculated generic dispersion factor represents the ratio of air concentration (χ) to emission rate (Q) for any radionuclide:

$$\chi/Q = f/(\pi\ u\ h\ k)\ \ s/m^3 \qquad \text{Eq. 4-1}$$

where:

χ = concentration at receptor (Ci/m^3)
Q = stack or building vent release rate (Ci/s)
f = wind frequency
u = wind speed (m/s)
h = height of effluent release (m)
k = constant (m)

Values used for the independent factors f and k correspond to defaults provided in NCRP (1996), such that f is assumed equal to 0.25 (the maximum frequency for any compass point), and k is 1 m. The calculation assumed site-specific values for u (2.2 m/s, LANL average for 2002 and 2003) and h (10 m, average LANL building height). The assumption that the building height was equivalent to the effluent release height was because releases were generally from small stacks or vents on the roofs. The calculated dispersion factor was 0.0036 s/m^3.

If the results of these maximum dose calculations indicated annual 50-year committed doses less than 10^{-5} Sv (1 millirem), this analysis assumed that the radionuclide was insignificant in comparison to other potential contributors to dose. The analysis indicated that the relatively significant radionuclides for which intakes should be evaluated were ^{3}H, ^{131}I, ^{232}Th, ^{234}U, ^{238}U, ^{238}Pu, and ^{239}Pu and the groups of radionuclides specified as mixed fission products (MFP) and particulate and vapor activation products (P/VAP). Although there were indications that ^{241}Am was at concentrations below concern based on the available effluent information, this radionuclide was included with the others due to the concern that emissions might have been under-reported. Americium-241 is often emitted in certain plutonium operations at a fairly significant level in relation to plutonium isotopes, yet many of the early years in which plutonium appeared to be emitted in significant amounts did not show any ^{241}Am emissions, which is an issue that needs further consideration.

4.2.1.3 Estimation of Air Concentrations

Air monitoring data, when available, formed the basis for estimates of air concentrations at each TA. For some areas, especially TA-21 and TA-54, more than one monitoring station was active during many years. In this case, the analysis averaged concentrations over all stations in the TA. For years and locations when monitoring data were not available, the analysis based an estimate on the relationship between source emission rate and air concentration for years when data were available.

Air concentration data from before 1970 were not available for this analysis. For some TAs, air concentration data were not available for any year or for many of the years since 1970. Therefore, a method had to be devised to provide reasonable estimates of air concentrations for those years and TAs. For other instances, LANL reportedly discontinued analysis in some years for selected radionuclides that were deemed insignificant.

For TA-3 and TA-21, both ambient air-monitoring data and release estimates for plutonium were available for several years of interest. Based on the relationship between plutonium air concentrations and releases for these TAs, a ratioing method was developed for estimating concentrations in other TAs where effluent estimates are available, but ambient air-monitoring data are absent. This method involved calculating the average ratio of plutonium air concentration to the estimated emission rate over all years for which both quantities were available. For TA-3, this average ratio (representing 14 years of data) was calculated to be 2.2×10^{-12} pCi/m^3 per pCi/yr released. The maximum ratio calculated for that period was 2.9×10^{-11} pCi/m^3 per pCi/yr released. A regression analysis gave a correlation coefficient (r) of 0.93, indicating a strong correlation between source emission rate and measured air concentrations for TA-3. For TA-21, this average ratio (representing 25 years of data) was also calculated to be 2.2×10^{-12} pCi/m^3 per pCi/yr released. The maximum ratio for TA-21 was 1.4×10^{-11} pCi/m^3 per pCi/yr released. A regression analysis of the TA-21 data gave a correlation coefficient (r) of 0.65 for the TA-21 ratios, indicating a moderate correlation.

While this ratioing method requires the assumption that dispersion at all TAs is similar to that in TA-21 and TA-3, that same assumption would be required of a simplistic model such as the one used for screening. Therefore, the ratioing method provides a reasonable estimate of average air concentrations at the LANL TAs for years in which monitoring results were not available. Because the average ratio tends to reflect the strong influence of one or two high ratios during the periods represented, this method provides a reasonable estimation of concentrations that would result in a value more claimant-favorable than a more in-depth modeling effort might produce.

This ratio of plutonium air concentration to plutonium source emission rate, with units of years per cubic meter, was used to estimate air concentrations of all radionuclides at TAs for years in which ambient monitoring data were not available. The reason for not developing separate ratios for other radionuclides is that monitoring data tended to be more limited for most other radionuclides (with the exception of ^{3}H). The justification for applying the plutonium ratios to other radionuclides was in the ratios calculated for other radionuclides when monitoring data were available. For ^{3}H, the average of 88 calculated ratios of measured air concentration to source emission rate was 1.7×10^{-12} yr/m^3, with a maximum ratio of 3.8×10^{-11} yr/m^3. For uranium, the average of 13 calculated ratios of measured air concentration to source emission rate was 2.3×10^{-12} yr/m^3, with a maximum ratio of 1.9×10^{-11} yr/m^3. The ratios for ^{3}H and uranium, are very similar to those calculated for plutonium; therefore, the plutonium values can reasonably be applied for estimating air concentrations for all radionuclides of significance.

Tables 4C-1 to 4C-26 in Attachment 4C list estimated average air concentrations for selected TAs. The selected TAs correspond to those for which either monitoring data were available or source emissions were listed in Tables 4A-1 through 4A-22. To summarize, when monitoring data were available, average air concentrations represent annual measured results from AIRNET monitoring stations (LANL 2003). In the absence of monitoring data, the tables list estimated air concentrations that correspond to the ratioing method described above, using the ratios developed for plutonium. Footnotes to the tables indicate when the ratioing method was applied.

In years prior to 1992, the monitoring data did not report concentrations of uranium in an isotope-specific manner. That is, the data reported concentrations as mass of uranium element per unit volume. In this case, the analysis made an assumption regarding the isotopic makeup of the uranium to convert to units of radioactivity. Assuming the mass concentration of uranium corresponds to the isotopic makeup of enriched uranium, which exhibits a higher specific activity than depleted or natural uranium due largely to the increase in the amount of ^{234}U present (DOE 2001), the activity concentration of uranium was maximized. Assuming an isotopic ratio, in atom percent, of 0.02%:2.96%:97.02% for ^{234}U:^{235}U:^{238}U, the specific activity of enriched uranium (activity of uranium per mass) is 1.55×10^{-6} Ci/g. Using this specific activity to convert uranium mass concentration to activity concentration does not in itself assign an isotopic ratio to the uranium. However, once this conversion is made, the approach is to assume all uranium activity is ^{234}U, because the dose factor for ^{234}U is slightly higher than those for ^{235}U and ^{238}U. Thus, Tables 4C-1 through 4C-26 report all uranium activity as ^{234}U.

The air monitoring data listed concentrations of plutonium isotopes separately for ^{238}Pu and ^{239}Pu. Rather than track the concentrations separately, there was a decision to add activities for both isotopes and report them as ^{239}Pu, which has a slightly higher dose coefficient. Thus, Tables 4C-1 through 4C-26 report all plutonium as ^{239}Pu.

Tables 4C-1 through 4C-26 sometimes list the categories MFP and P/VAP, corresponding respectively to mixed fission products and particulate/vapor activation products. These are not measured categories, but are present only when emissions data specified these groupings. The table below lists information on the constituents of these groupings. For simplicity, the analysis selected the constituent with the highest dose factor as the radionuclide representing these groupings, as listed below.

Isotope grouping	Isotopes	Isotope with maximum inhalation dose factor[a]
MFP (mixed fission products)	Predominantly Sr-90, Cs-137	Sr-90
P/VAP (particulate and vapor activation products)[b]	As-73, As-74, Br-76, B.-77r, Br-82, Ga-68, Ge-68, Hg-193, Hg-195m, Hg-197, Se-75	Ge-68 (class W)

a. Based on Federal Guidance Report No. 11 dose factors (Eckerman, Wolbarst, and Richardson, 1988).
b. Based on LANL (2000).

4.2.1.4 Estimation of Occupational Intakes

The following discussion addresses estimation of two different sets of occupational intakes: the pre-1971 intakes, when air monitoring data are not available in a consistent format (i.e., preannual environmental reports), and post-1970, when monitoring data became more consistently available.

4.2.1.4.1 Pre-1971 Intakes

Prior to 1971, air monitoring data for most TAs were not available, and estimates of occupational intakes must rely on emissions data provided by LANL. The emissions data listed in Tables 4A-1 through 4A-22 of Attachment 4A indicate several years in which potentially significant releases, and thus intakes, might have occurred prior to 1971. In particular, early plutonium releases at TA-1 are high in relation to those in other years, and there are two years of very high ^{232}Th releases (TA-15, 1967-1968). The fact of these apparently high releases surrounded by years of either zero releases, or at least missing emissions information, suggests that more investigation into the accuracy of the reported releases and completeness of the emissions data is necessary before intakes during the pre-1971 years can be addressed adequately. Therefore, estimated worker intakes in this revision of the TBD are restricted to post-1970 years. Efforts are currently in progress for developing pre-1971 intakes that can be presented in a future revision of this TBD.

4.2.1.4.2 Post-1970 Intakes

Using the average air concentrations from Tables 4C-1 to 4C-26 of Attachment 4C, this analysis estimated annual inhalation intakes in Bq/yr for each radionuclide and TA in the years after 1970 by assuming a breathing rate of 2,400 m^3/yr, based on an occupancy of 2,000 hr/yr. Tables 4-1 to 4-23 list the annual intakes for each TA by year. Table 4-30 lists site-wide maximum intakes, representing the yearly maximum of all averages across the LANL, for each radionuclide. If worker location during the period of employment is not accurately known, dose reconstructors can use the sitewide maximum to estimate intake for the years of interest.

Even from the post-1970 monitoring and emissions data, intake values for all radionuclides for every year are not available for many of the TAs. In cases where only a few years of data were missing for a given radionuclide, but the trend indicated that operations had probably not changed, this analysis made an estimate based on data in other years. The footnotes of Tables 4-1 through 4-23 indicate the bases for this type of estimates. If there was no clearly established trend, such estimates could not be made. Some of the gaps might exist because previous measurements indicated further yearly monitoring for a particular radionuclide was not warranted based on previous low-level measurements or estimates. Further, some TAs probably were not in operation at the time of the data gap. Until further research provides explanations for these gaps in knowledge, there can be no recommendation other than those provided in the tables.

Section 4.2.1.3 describes specific representative isotopes for the MFP and P/VAP groupings, which are listed in the footnotes of tables containing these designations. To calculate doses associated with these groupings, dose reconstructors should use the dose factor for the representative radionuclide specified.

Information on solubility and particle sizes was not available for the radionuclides listed in Tables 4-1 to 4-23. Therefore, reconstructions should assume that all activity intakes in Tables 4-1 to 4-23 are respirable and should make selections of solubility designations to maximize calculated dose to the organ of interest in the absence of relevant solubility data.

4.2.2 Resuspension

Resuspension of radionuclides from contaminated soil was and is a potential source of internal dose to workers at LANL since the beginning of operations. A work area in which radionuclide emissions took place is a potential area of exposure to resuspended radionuclides deposited on the soil. The radionuclide emissions listed in Tables 4A-1 through 4A-22 do not include contributions from resuspended soil. For recently contaminated soil, resuspension is generally more important than for soil with older contamination because erosion and downward migration of radionuclides from the upper soil layers diminish the source term over time. In Section 4.2.1, measured concentrations of radionuclides are the basis for the estimates of intake in the listed TAs; these estimates include resuspended radionuclides at those TAs.

A more comprehensive consideration of resuspension is an area of ongoing work for this TBD, and is not complete at this time. There are probably areas susceptible to resuspension that the air monitoring network that exists today does not represent adequately. The following discussion provides details that are important to this ongoing effort.

In its early years of operation, LANL discharged liquid effluents from TA-1, TA-21, and TA-50 (formerly TA-35 and TA-45) to Acid/Pueblo, Los Alamos, and Mortandad Canyons. These canyon areas became contaminated with radionuclides. Due to the extent of soil contamination, these areas pose the greatest potential for significant historical intake from resuspension, particularly if recently contaminated soil was exposed to wind erosion or excavation activities. In addition, experiments with radioactive lanthanum in Bayo Canyon (TA-10) led to contamination of soil at that work area. The canyon areas are presently not part of work areas in any TA. LANL had decommissioned the TA-10 worksite by 1963, at which time it had cleaned up surface debris and excavated contaminated waste disposal facilities (LASL 1979). With the exception of TA-10, TA-21, and TA-50, TAs at LANL received minor contamination, if any (Kennedy and Purtymun 1971a). Nevertheless, if workers spent significant time in these canyons in areas where air monitoring was not conducted, dose reconstructions should consider intakes and exposures from resuspension.

LANL has investigated resuspension in Acid, Pueblo, and Bayo Canyons (Ferenbaugh et al. 1982; LASL 1979). Table 4-24 lists estimated air concentrations of selected radionuclides in the canyons for conditions during the 1970s. For Mortandad and Los Alamos Canyons, information on soil contamination levels is available for estimating resuspension (Purtymun et al. 1980); this study indicated that plutonium isotopes, ^{137}Cs, and ^{90}Sr were found in soil during the 1970s at levels in excess of those expected due to fallout. Estimates of air concentrations require the application of a resuspension factor to the measured levels. Assuming a resuspension factor of 1×10^{-9}/m (LASL 1979; Kennedy and Purtymun 1971b; Purtymun et al. 1980), Table 4-24 lists estimated air concentrations for these areas. Additional work should focus on developing a historical air concentration due to resuspension, taking into account that a constant resuspension factor over time is unlikely to be appropriate.

4.3 EXTERNAL EXPOSURE

4.3.1 Ambient Radiation

Thirty-plus years of environmental monitoring reports (for example, LASL 1959, 1960) contain measured ambient gamma radiation levels. Figure 4-2 shows the network of TLDs currently in use at LANL for this purpose. Table 4-25 lists data for TA-3, TA-18, TA-53, and TA-54. TA-36 reported elevated exposures from experiments at TA-18 for several years. All of these areas recorded gamma doses above natural background (terrestrial and cosmic) radiation. Results are cumulative mrem/year based on 8760 hours. A conversion factor is provided with Table 4-25 to convert these values to a 2080 hr-based annual dose. It is noted that TLD results demonstrate the gamma-shine influence on other monitoring stations from TA-18's critical assembly experiments. LANL environmental TLD data is represented by a log-normal distribution. Site-wide maximum and geometric mean values are also presented and are based on results from these four TAs. LANL annual reports also present a site background dose and are presented in Table 4-25 as the reported value. If no background is given, a 10-yr average of reported site background is presented.

Data are available only from 1965. Reports from 1959 and 1960 indicate that 100 area badges were in use at LANL and in the Los Alamos area, however, attempts to locate these data have been unsuccessful. Reports from those years state that 100 area badges (film) were used in 1959 and 1960, and gave

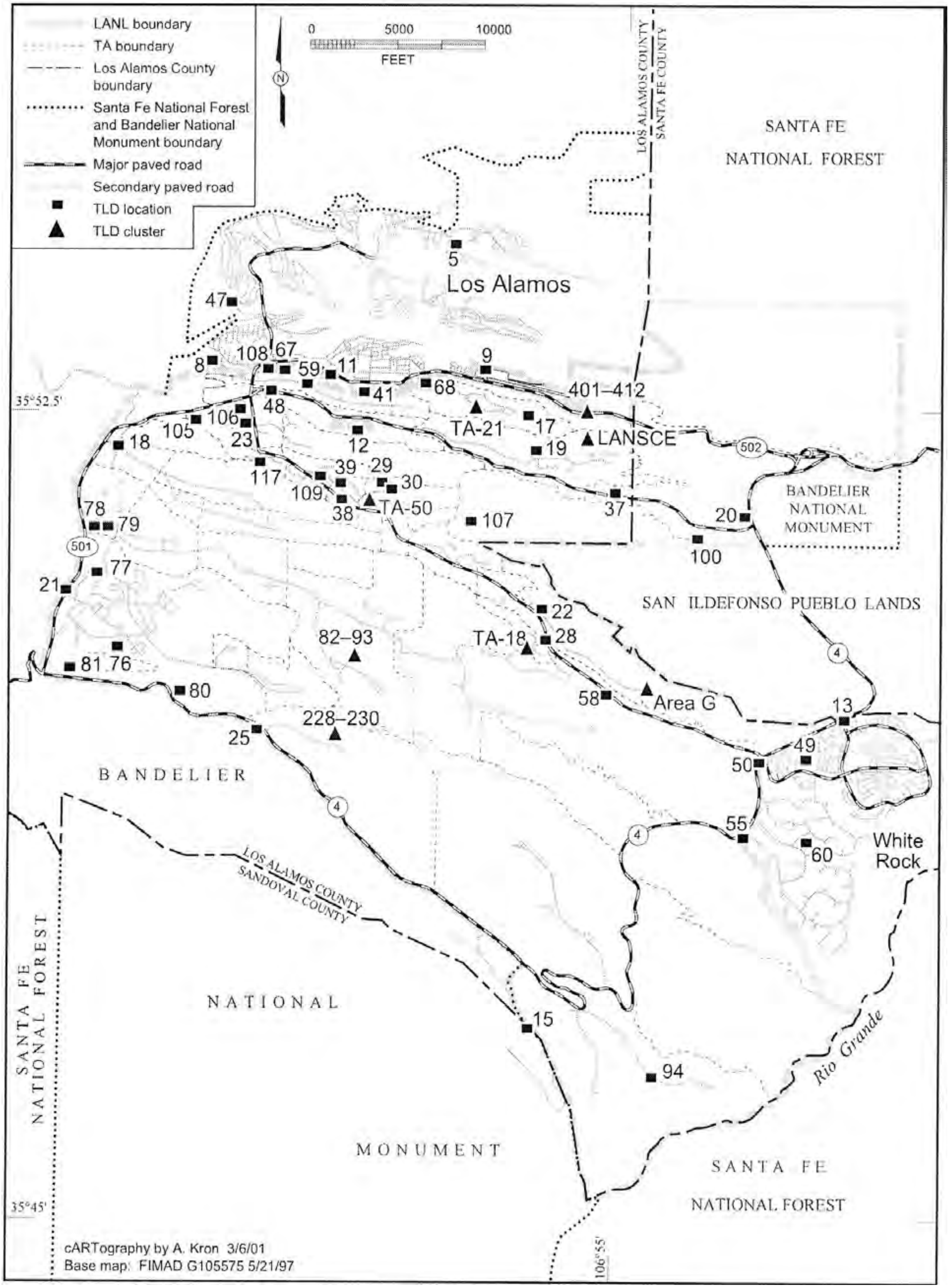

Figure 4-2. Offsite, perimeter, and onsite LANL TLD locations (from LANL 2002, p. 81).

1-year results of "less than 0.5 rem/yr" (LASL 1959, 1960). Reports indicate that elevated gamma levels occurred in the early years of TA-2 activities (ENSR 2002). Area badge data (pre-1971) from TA-2 (see Section 4.3.2), TA-3, and TA-18 would be useful in estimating dose to unmonitored workers for those years.

A special survey found elevated ambient radiation in Acid Canyon, which LANL used from 1951 to 1964 for liquid waste discharge from TA-45. LANL remediated the contaminated parts of Acid Canyon in 1967. Radiation data from before that time were not available. Data that are available indicate that in 1978 two areas of the canyon still exhibited elevated gamma dose rates. The areas are characterized by steep cliffs and were not routine work locations. Nevertheless, if workers spent significant time in these areas, exposures are possible. The above-background dose rates reported by LANL for 1978 were 1.1 μrem/hr on average with a maximum of 50 μrem/hr (Ferenbaugh et al. 1982). Before remediation in 1967, dose rates in the canyon could have been an order of magnitude higher.

The annual site wide maximum ambient radiation dose rates are given in Table 4-30, along with the side wide maximum intakes. These dose rates may be used in the event worker location during the period of employment is not accurately known.

Bayo Canyon Releases
Experiments from 1944 to 1962 in TA-10, Bayo Canyon, involved detonation of explosives around radioactive materials. These detonations dispersed materials, principally ^{140}La, to the atmosphere and could have caused exposure to LANL workers. LANL has studied the impacts of these experiments extensively (Courtwright et al. 1996). Although the focus was on impacts off the LANL site, the Courtwright et al. analysis examined a receptor at the town site (TA-0). These results are applicable to LANL workers in TA-0, TA-2, TA-21, TA-35, TA-41, TA-43, TA-48, TA-53, TA-60, and TA-61 to the extent that these TAs were occupied during the years of the tests.

Exposures are weighted by direction from TA-10. The prevailing wind direction is from Bayo Canyon to the west and north (that is, away from the laboratory). On average, the wind carried ^{140}La to the east (TA-0) and to the southeast (TA-2, etc.) about 3% of the time, so no adjustment for wind frequency is necessary. The distance to the receptor at TA-0 is 2.9 km, which is less than distances to the other TAs. An adjustment for distance is not possible from the available information. Therefore, impacts calculated by LANL for TA-0 apply to nearby TAs. More distant TAs would have impacts at least 1 order of magnitude smaller.

Table 4-26 lists doses to the receptor at TA-0 calculated for 1945 to 1960 by Kraig (1997). The dominant dose pathway would be exposure to gamma radiation from ^{140}La deposited on the ground. Other pathways such as inhalation and other radionuclides are much less important (Kraig 1997). In addition to dose, Table 4-26 lists the annual average deposition calculated from the available information.

4.3.2 Release of Noble Gases

TA-2 (nuclear reactor area) and TA-53 [Los Alamos Neutron Science Center (LANSCE) accelerator] have a history of noble gas releases. The following paragraphs describe the estimation of external dose resulting from these releases.

4.3.2.1 Omega Reactors TA-2

The Omega reactors in TA-2 were in operation from 1944 to 1992, and during that time emitted predominantly noble gases. LANL did not routinely measure effluents from the Omega reactors (LOPO, HYPO, Omega West), predominantly noble gases, until 1967. After that time, LANL monitored ^{41}Ar emissions until the reactors ceased operation. In 1973, LANL reported ^{133}Xe and ^{135}Xe emissions, but at a combined rate less than that of ^{41}Ar. Because dose coefficients for xenon isotopes are 3 to 5 times less than those for ^{41}Ar, estimated doses for xenon isotopes are insignificant in relation to the ^{41}Ar doses.

Only ^{41}Ar is listed consistently in the source emissions for this TA. The annual average air concentrations of ^{41}Ar listed in Table 4D-1 of Attachment 4D for TA-2 were calculated using screening-level models in NCRP (1996). Because there was no mention of a stack associated with TA-2 in the early years, this analysis assumed that releases and receptors were at essentially the same height for all years.

To calculate average annual air concentrations using the emissions data in Table 4A-2, this analysis used the following model (NCRP 1996, p. 12):

$$\chi/Q = f\,B / u \ (\text{s/m}^3), \qquad \text{Eq. 4-2}$$

where:

- χ = concentration at receptor (Ci/m3)
- Q = stack or building vent release rate (Ci/s)
- f = wind frequency
- B = Gaussian plume model diffusion factor modified for building wake effects (1/m^2)
- u = wind speed (m/s)

The value for the independent factor f corresponds to the default of 0.25 (the maximum frequency for any compass point) provided in NCRP (1996), and the site-specific value for u is 2.2 m/s, equivalent to the LANL average for 2002 and 2003. The value for B of 2×10^{-4} is from Figure 2.3 in NCRP (1996) for a distance of 500 m. This is the average distance a receptor was assumed to be from the release point. This B value was the largest value for this receptor distance provided for any projected cross-sectional frontal area (A_G) of the building influencing air flow. The resultant average χ/Q was 2.3×10^{-5} s/m^3.

The analysis calculated average annual doses corresponding to these concentrations assuming an individual was exposed to this air concentration for 2,000 hr/yr. The analysis used dose coefficients for skin and whole body from the Federal Guidance Report No. 12 (Eckerman and Ryman 1993). The dose coefficient for skin dose is 3.74×10^{-6} mrem- per μCi-s-m^{-3} (1.01×10^{-13} Sv per Bq-s-m^{-3}) and for whole body is 2.41×10^{-6} mrem per μCi -/s- /m^{-3} (6.50×10^{-14} Sv per Bq-s-m^{-3}). For pre-1967 years, exposures to noble gases in TA-2 could be estimated from area badge data (which has not been located as of this writing) or by assuming that the annual dose for 2,000-hr/yr exposure is the peak average annual doses in Table 4-27.

4.3.2.2 Los Alamos Neutron Science Center (TA-53)

The large, high-current accelerator at TA-53 began operation in 1976. Since then, this facility released megacurie quantities of activation products annually through the exhaust stack. In addition to ^{41}Ar, the accelerator stack released significant activities of ^{11}C, ^{13}N, and ^{15}O. While not noble gases, these three nuclides have extremely short half-lives and cause radiation exposure more like noble gases than long-lived particulates. Therefore, this discussion considers emissions for all these radionuclides.

After 1981, emissions were often reported as gaseous/mixed activation products without differentiating the radionuclides represented in that category. Submersion dose coefficients for the four radionuclides(^{11}C, ^{13}N, ^{15}O, and ^{41}Ar) are less than or equal to the skin dose factor for ^{15}O (1.04×10^{-13} Sv/Bq, or 3.85×10^{-6} mrem/μCi) or the whole-body dose factor for ^{41}Ar (6.50×10^{-14} Sv/Bq, or 2.41×10^{-6} mrem/μCi) according to Federal Guidance Report No. 11 (Eckerman, Wolbarst, and Richardson 1988). Therefore, this analysis simplified the calculations by assuming that the composite emissions activity reported for all four radionuclides was equal to that for ^{15}O alone when calculating skin dose, and for ^{41}Ar alone when calculating whole-body dose.

In estimating air concentrations resulting from the LANSCE stack, the analysis considered three work locations: TA-53, TA-21, and TA-72. TA-53 was the location where the accelerator operated. The two nearby locations were the east end of TA-21 (DP East; 2,000 m south-southeast of TA-53) and the west end of TA-72 (on East Jemez Road; 700 m south-southeast of TA-53). An average wind rose for each of five meteorological stations at LANL, discussed in the 1999 Site-Wide Environmental Impact Statement for LANL (DOE 1999), indicates that the predominant wind directions from TA-53 are to the north and northeast (Figure 4-3).

For TA-53, this analysis used the same approach adopted for TA-2 to estimate average air concentrations. Again, this assumed no stack release and resulted in an average χ/Q of 2.3×10^{-5} s/m^3 (receptor 500 m from the emission point).

Bowen (1987) modeled dispersion from the LANSCE stack using Gaussian equations. However, the calculations were for a receptor at the site boundary (East Gate) rather than for onsite work locations. The East Gate is approximately 800 m east of TA-53. The dispersion factor arising from this modeling effort was adjusted for this work to apply to TA-21 and TA-72 in developing average annual concentrations. The adjustment was based on distances from TA-53, and differential wind frequencies were ignored. Wind frequencies, as measured at the East Gate, indicate that frequencies toward both TA-21 and TA-72 are 3%, consistent with Figure 4-3. The wind frequency toward the public receptor is 13%. Therefore, the assumption that wind frequency is 13% (i.e., not adjusting the dispersion factor based on wind frequencies) is a claimant-favorable approach.

The χ/Q calculated for the East Gate receptor (800 m from TA-53) by Bowen (1987) was 3.8×10^{-6} s/m^3. Because TA-72 is approximately the same distance (700 m) from TA-53 as the East Gate, this χ/Q was used to estimate average annual air concentrations at this location. This value of χ/Q was adjusted to account for the increased distance that TA-21 is from TA-53 (2,000 m) by multiplying the χ/Q for the East Gate by a factor of one-third. The factor of one-third was derived by comparing the Gaussian plume model diffusion factor, P, reported in NCRP (1996, Figure 2.2) for a 30-m stack and the two different distances (800 m and 2,000 m). The resultant estimate of χ/Q is approximately 1.3×10^{-6} s/m3. This information is summarized below.

Receptor	**Dist./dir. from TA-53**	**Average X/Q (s/m^3)**
East Gate	800m / East	3.8 E-06
TA-21	2,000m / SSE	1.3 E-06
TA-72	700m / SSE	3.8 E-06

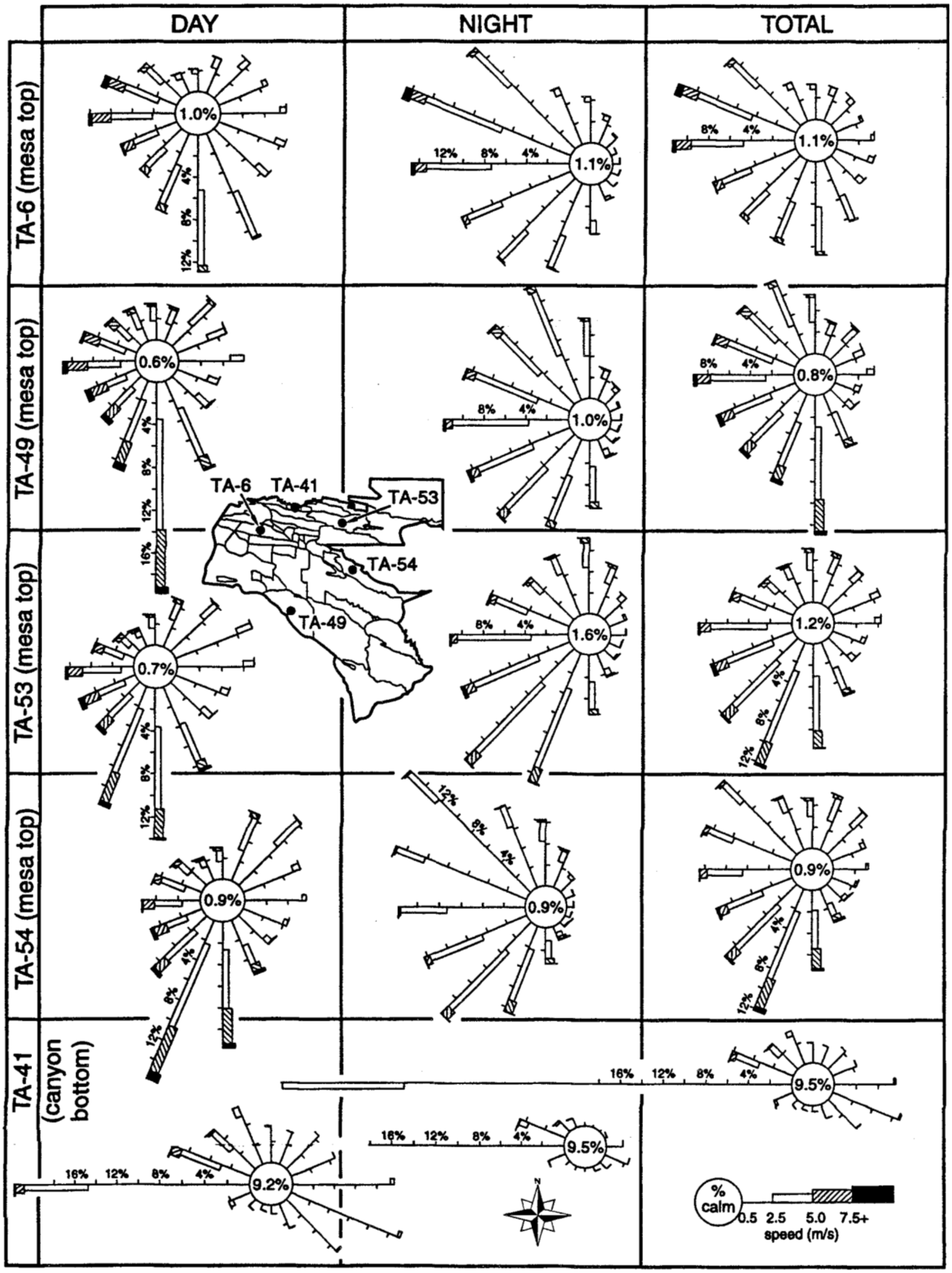

Figure 4-3. Average wind rose for five LANL meteorological stations (DOE 1999).

Table 4D-2 of Attachment 4D lists the results of these calculations for TA-53, TA-21 and TA-72.

This analysis calculated estimates of external dose (skin and whole body) from LANSCE emissions for TA-53, TA-21, and TA-72. The estimated doses in Tables 4-28 and 4-29 are based on average annual air concentrations in TA-53, TA-21, and TA-72 from Table 4D-2. The concentrations at TA-53 assumed a ground-level release. Therefore, the air concentration estimates for TA-53 account for the fact that a percentage of the emissions from that location were diffuse, rather than from the 30-m stack.

4.4 UNCERTAINTY

As discussed in previous sections, estimates of annual intakes employed conservative assumptions when information was lacking. Due to the lack of information on particle size and solubility, this analysis compensated for the uncertainty of these elements by assuming that all effluents were in the respirable size range and selected solubility based on the highest dose rate.

Effluent data for years around 1971 and later have an estimated uncertainty of ±20%. However, data from earlier years are much less accurate because of less reliable measurement technology and less stringent reporting requirements.

The accuracy of the area badge data is also about ±20%. However, subtracting background from these measurements adds more uncertainty, due to the variability and selection of background information.

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GLOSSARY

Ambient gamma radiation
Refers to the external dose rate due to penetrating gamma radiation in the outside air environment. Includes gamma radiation from natural cosmic and terrestrial sources, as well as man-made sources.

Noble gases
Here, referring to radioactive isotopes of noble gases, such as ^{41}Ar, ^{133}Xe, and ^{135}Xe. Radioactive noble gases are chemically-inert gases of the Helium Group (Group 8A in the periodic table of elements), and pose an external hazard only.

Resuspension
A process by which small particulates (generally of soil, which may have radionuclides attached) are eroded by wind resulting in an air concentration of “resuspended” particles and/or radioactivity. Referred to as “re”-suspension as there exists a cyclical process of suspension, deposition, resuspension, and redeposition. However, the initial suspension process is generally included in this term, if the initial contaminating event did not result from deposition of airborne material.

Technical Area (TA)
A land division within Los Alamos National Laboratory in which operations take, or have taken, place.

Table 4-1. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-2 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U
1971		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1972		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1973		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1974		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1975		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1976		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1977		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1978		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1979		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1980		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1981		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1982		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1983		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1984		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1985		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1986		2.4E+03[c]	4.4E-04[c]	4.5E-03[c]
1987		3.6E+03	8.9E-05	4.7E-03
1988		1.0E+04	2.0E-03	6.3E-03
1989		3.0E+03	2.0E-04	8.9E-03
1990		1.5E+03	1.2E-04	3.2E-03
1991		6.9E+02	4.4E-05	6.6E-03
1992		5.7E+02	1.3E-04	3.3E-03
1993		3.3E+02	5.7E-04	2.4E-03
1994		5.6E+02	2.8E-04	1.5E-03
1995	4.6E-04	4.5E+02	5.5E-04	3.7E-03
1996		5.2E+02[d]	3.1E-04[d]	3.5E-03[d]
1997		5.2E+02[d]	3.1E-04[d]	3.5E-03[d]
1998		5.2E+02[d]	3.1E-04[d]	3.5E-03[d]
1999		5.2E+02[d]	3.1E-04[d]	3.5E-03[d]
2000	0.0E+00	2.4E+02	1.3E-04	1.6E-03
2001		2.4E+02[e]	1.3E-04[e]	1.6E-03[e]
2002		2.4E+02[e]	1.3E-04[e]	1.6E-03[e]
2003		2.4E+02[e]	1.3E-04[e]	1.6E-03[e]

a. Calculated from estimated air concentrations in Table 4C-2, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. Estimated from average of values from 1987 through 1995.
d. Estimated from average of values from 1991 through 1995.
e. Assumed to be the same as value in 2000.

Table 4-2. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, ^{232}Th, ^{234}U, MFP, and P/VAP for TA-3 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{131}I	^{239}Pu	^{232}Th	^{234}U	MFP[c]	P/VAP[d]
1971		8.90E+07	2.7E+04	8.9E-01	2.5E-02		2.3E-02	
1972	2.8E-03	4.80E+07	4.4E+03	1.4E+00	1.2E-02		6.9E-03	
1973	6.2E-04		4.7E+03	8.3E-01	1.2E-02	3.0E-03	1.4E-02	2.5E+00
1974				9.2E-01	2.9E-01		3.9E-02	6.7E-02
1975		2.20E+07	6.4E+03	2.7E-01	8.2E-02		3.8E-02	3.6E-02
1976				5.9E-02	7.7E-03		7.1E-02	8.1E-02
1977		4.00E+08	1.2E+05	1.7E-02	6.5E-03		6.6E-02	9.4E-02
1978		9.98E+07	2.9E+04	1.6E-02	1.1E-02		3.6E-02	7.9E-02
1979		3.02E+09	8.8E+05	3.1E-02	2.1E-01		5.1E-02	9.2E-02
1980		4.55E+06	1.3E+03	1.8E-02	1.4E-01		3.0E-02	8.3E-02
1981		8.99E+08	2.6E+05	8.6E-03	7.7E-03		4.6E-02	3.4E-02
1982		1.94E+09	5.7E+05	1.5E-01	1.5E-02		6.3E-02	1.5E-02
1983		2.28E+09	6.7E+05	1.6E-02	1.7E-02		3.5E-02	3.3E-03
1984		1.78E+09	5.2E+05	1.4E-02	2.2E-02		4.2E-02	8.1E-03
1985		2.12E+09	6.2E+05	2.9E-02	3.8E-02		6.7E-02	6.8E-03
1986		1.23E+09	3.6E+05	7.4E-03	3.8E-02		1.2E-01	9.4E-03
1987		8.51E+08	2.5E+05		1.3E-02		1.7E-01	4.2E-03
1988		8.35E+09	2.4E+06		1.0E-02		9.8E-02	5.8E-03
1989		2.91E+08	8.5E+04		7.6E-03		7.1E-02	7.5E-03
1990		4.96E+08	1.3E+05		4.2E-03		3.8E-02	7.6E-03
1991	1.3E-04	2.05E+08	2.0E+03		1.1E-04		8.2E-03	2.8E-03
1992	2.8E-04	1.15E+08	3.6E+03		2.2E-04		3.2E-03	1.6E-03
1993	1.7E-03	7.63E+07	7.1E+02		4.9E-03		1.3E-03	1.2E-03
1994	5.2E-04	5.38E+07	2.7E+02		2.8E-04		3.3E-03	7.5E-03
1995	1.3E-03	2.25E+06	8.0E+02		2.6E-04		1.8E-03	1.8E-01
1996	1.3E-04		1.7E+02		2.4E-04	3.2E-05	2.1E-03	
1997	2.2E-04		4.8E+02		2.4E-04	7.4E-05	1.5E-03	
1998	3.1E-04		3.6E+02		3.6E-05	8.2E-05	1.3E-03	
1999	2.0E-04		3.6E+02		2.4E-04	4.3E-05	1.7E-03	
2000	0.0E+00		3.2E+02		2.3E-04	2.5E-05	2.7E-03	
2001	0.0E+00		4.1E+02		5.3E-05	2.7E-05	2.4E-03	
2002	1.5E-04[e]		3.4E+02[e]		1.6E-04[e]	5.0E-05[e]	1.9E-03	
2003	1.5E-04[e]		3.9E+02[e]		1.6E-04[e]	5.0E-05[e]	1.9E-03[e]	

a. Calculated from estimated air concentrations in Table 4C-3, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. MFP = mixed fission products; claimant-favorable to assume all is ^{90}Sr.
d. P/VAP = Particulate/vapor activation products; claimant-favorable to assume all is ^{68}Ge, Class W.
e. Estimated from average of corresponding values for 1997-2001.

Table 4-3. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-5 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U
1971				
1972				
1973		1.4E+04	1.7E-03	4.1E-02
1974		1.1E+04	2.2E-03	1.4E-02
1975		2.3E+04	1.9E-03	9.9E-03
1976		1.6E+04	4.4E-04	8.4E-03
1977		7.6E+03	1.9E-03	1.1E-02
1978		2.1E+03	2.6E-03	8.4E-03
1979		2.0E+03	7.5E-04	1.1E-02
1980		2.3E+03	8.9E-05	7.7E-03
1981		5.9E+02	5.4E-04	5.8E-03
1982		3.3E+03	1.3E-04	5.8E-03
1983		2.3E+03	2.8E-04	6.6E-03
1984		2.4E+03	1.2E-04	5.1E-03
1985		1.7E+03	0.0E+00	4.5E-03
1986		1.3E+03	8.9E-05	3.7E-03
1987		2.6E+03	1.8E-05	5.4E-03
1988		2.0E+03	1.8E-05	9.7E-03
1989		4.7E+02	3.6E-05	1.1E-02
1990		4.3E+02	1.6E-04	4.4E-03
1991		4.9E+02	6.2E-05	7.6E-03
1992	1.2E-04	5.9E+02	7.1E-05	3.0E-03
1993		3.5E+02	1.3E-04	3.1E-03
1994		2.0E+02	1.1E-04	3.1E-03
1995	3.0E-04	3.2E+02	3.9E-04	4.2E-03
1996	2.2E-04	1.5E+02	1.1E-04	5.0E-03
1997	2.1E-04	7.3E+02	4.4E-05	2.2E-03
1998	1.8E-04	4.4E+03	8.9E-05	2.1E-03
1999	3.2E-04	2.9E+02	1.8E-05	1.9E-03
2000	2.7E-05	3.6E+02	1.8E-04	4.8E-03
2001	0.0E+00	5.6E+02	0.0E+00	3.0E-03
2002	1.5E-04[c]	1.3E+03[c]	6.6E-05[c]	2.8E-03[c]
2003	1.5E-04[c]	1.3E+03[c]	6.6E-05[c]	2.8E-03[c]

a. Calculated from estimated air concentrations in Table 4C-4, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.

b. ^{3}H intake multiplied by 1.5 to account for submersion dose.

c. Estimated from average of corresponding values for 1997-2001.

Table 4-4. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-6 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U
1971		4.8E+03	3.6E-03	3.3E-02
1972		3.9E+03	1.3E-02	8.3E-03
1973				
1974		2.1E+03	2.3E-03	6.9E-03
1975	9.8E-04	2.9E+03	4.8E-03	3.7E-03
1976		3.3E+03	3.5E-04	8.1E-03
1977	2.7E-05	3.3E+03	1.5E-03	2.3E-02
1978	2.7E-05	6.7E+02	2.4E-03	9.9E-03
1979	0.0E+00	3.7E+02	2.9E-04	4.5E-03
1980	8.9E-06	5.1E+02	2.3E-04	3.9E-03
1981	4.0E-03	8.9E+02	5.1E-04	4.4E-03
1982	1.8E-05	1.5E+03	1.1E-04	4.3E-03
1983		1.5E+03	1.1E-04	4.7E-03
1984		5.9E+02	1.1E-04	2.8E-03
1985		1.1E+03	1.7E-04	5.3E-03
1986	2.8E-04	4.8E+02	1.1E-04	5.1E-03
1987	1.3E-04	1.5E+03	5.3E-05	5.5E-03
1988	5.7E-04	1.3E+03	6.2E-05	7.2E-03
1989	2.5E-04	3.1E+02	4.1E-04	9.0E-03
1990	1.4E-04	1.9E+02	1.9E-04	6.4E-03
1991	8.0E-05	2.1E+02	8.9E-05	7.4E-03
1992	4.0E-04	3.6E+02	1.5E-04	2.4E-03
1993	1.3E-04	4.4E+02	2.0E-04	2.0E-03
1994	3.6E-04	1.7E+02	7.1E-05	2.5E-03
1995	5.1E-04	4.8E+02	1.1E-03	1.8E-03
1996		0.0E+00		
1997-2003				

a. Calculated from estimated air concentrations in Table 4C-5 assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.

b. ^{3}H intake multiplied by 1.5 to account for submersion dose.

Table 4-5. Estimated annual average intakes of ^{3}H for TA-9 (Bq/yr).[a]

Year	^{3}H[b]
1971	
1972	2.1E+05
1973	1.1E+04
1974	3.8E+02
1975	
1976	3.8E+04
1977	7.6E+03
1978	7.6E+02
1979	1.5E+03
1980	1.5E+03
1981-2003	

a. Calculated from estimated air concentrations in Table 4C-6 assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.

Table 4-6. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-11 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U
1971		5.6E+03	4.2E-03	1.2E-02
1972	2.9E-03	3.2E+03	4.3E-03	8.3E-03
1973		1.7E+03	2.0E-03	1.4E-02
1974-2003				

a. Calculated from estimated air concentrations in Table 4C-8 assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.

Table 4-7. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-15 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U
1971		1.1E+04	3.7E-03	6.2E-02
1972	2.0E-03	3.7E+03	4.5E-03	8.3E-03
1973	1.8E-04	2.8E+03	1.4E-03	2.8E-02
1974-1977				
1978		2.1E+04		
1979-1991				
1992				4.5E-01
1993		1.4E+02		9.7E-01
1994		2.6E+02	3.6E-05	5.9E-03
1995	4.5E-04	2.3E+02	3.3E-04	1.3E-03
1996	2.0E-04	1.5E+02	1.2E-04	4.6E-03
1997	1.7E-04	2.5E+02	5.8E-05	2.6E-03
1998	1.9E-04	2.7E+02	7.1E-05	1.3E-03
1999	2.0E-04	2.3E+02	7.1E-05	1.7E-03
2000	3.6E-05	2.4E+02	4.4E-06	2.4E-03
2001	2.2E-04	3.1E+02	0.0E+00	5.8E-03
2002	1.8E-06	3.7E+02	0.0E+00	3.4E-03
2003	1.3E-04[c]	2.8E+02[c]	2.9E-05[c]	2.9E-03[c]

a. Calculated from estimated air concentrations in Table 4C-9, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7 × 10^{-2} Bq/pCi; blanks indicate no data are available for those years).

b. ^{3}H intake multiplied by 1.5 to account for submersion dose.

c. Estimated from average of corresponding values for 1998-2002.

Table 4-8. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, and ^{234}U for TA-16 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{131}I	^{239}Pu	^{234}U
1971		6.0E+03	8.9E-01	5.4E-03	2.8E-02
1972	3.6E-03	4.1E+03		5.1E-03	8.3E-03
1973	2.7E-04	2.1E+03		2.5E-03	1.4E-02
1974		1.6E+03		2.7E-03	9.6E-03
1975	3.6E-04	2.4E+03		1.7E-03	3.6E-03
1976		2.7E+03		4.2E-04	4.8E-03
1977	0.0E+00	4.0E+03		1.7E-03	3.8E-02
1978	0.0E+00	8.0E+02		3.2E-03	6.6E-03
1979	0.0E+00	2.9E+02		1.8E-03	3.6E-03
1980	0.0E+00	1.5E+03		9.8E-05	4.1E-03
1981	1.7E-04	2.5E+02		3.2E-04	3.2E-03
1982	2.7E-05	1.3E+03		8.9E-05	3.2E-03
1983		1.5E+03		4.9E-05	3.2E-03
1984		1.7E+03		0.0E+00	1.8E-03
1985		1.3E+03		3.5E-04	3.8E-03
1986	2.4E-04	6.3E+02		5.3E-05	1.8E-03
1987	8.9E-05	1.3E+03		6.7E-05	2.6E-03
1988	1.7E-04	5.7E+02		7.5E-05	4.7E-03
1989	2.1E-04	3.5E+02		5.3E-05	8.1E-03
1990	2.5E-04	1.5E+02		1.4E-04	4.6E-03
1991	1.1E-04	6.7E+01		8.9E-05	5.4E-03
1992	9.8E-05	2.1E+02		5.3E-04	2.5E-03
1993		1.2E+02		4.4E-05	1.7E-03
1994		1.2E+03		0.0E+00	2.3E-03
1995	4.1E-04	2.4E+04		2.9E-04	1.7E-03
1996	1.6E-04	3.2E+03		3.6E-05	2.4E-03
1997	2.0E-04	8.3E+03		7.1E-05	1.7E-03
1998	2.3E-04	3.3E+04		8.0E-05	2.6E-03
1999	2.8E-04	7.3E+03		1.1E-04	1.3E-03
2000	0.0E+00	8.1E+03		0.0E+00	1.3E-03
2001	1.8E-05	9.1E+03		0.0E+00	1.7E-03
2002	1.5E-04[c]	1.3E+04[c]		5.2E-05[c]	1.7E-03[c]
2003	1.5E-04[c]	1.3E+04[c]		5.2E-05[c]	1.7E-03[c]

a. Calculated from estimated air concentrations in Table 4C-10, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. Estimated from average of corresponding values for 1997-2001.

Table 4-9. Estimated annual average intakes of ^{234}U for TA-18 (pCi/yr).[a]

Year	^{234}U
1971-1978	
1979	7.7E-04
1980-2003	

a. Calculated from estimated air concentrations in Table 4C-11, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi; blanks indicate no data are available for those years).

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Table 4-10. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, ^{234}U, and MFP for TA-21 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{131}I	^{239}Pu	^{234}U	MFP[c]
1971	5.7E-04[d]	1.1E+04		2.6E-03	1.1E-02	
1972	5.7E-04[d]	2.0E+04[e]		7.5E-03	9.6E-03	
1973	5.7E-04[d]	2.0E+04		2.0E-03	1.4E-02	2.0E-04
1974	5.7E-04[d]	2.0E+04[e]		2.1E-03	6.9E-03	5.7E-04
1975	5.7E-04[d]	8.5E+03		1.6E-03	4.3E-03	2.8E-04
1976	5.7E-04[d]	5.3E+03		6.7E-04	5.8E-03	1.1E-04
1977	5.7E-04[d]	6.9E+03		1.9E-03	1.3E-02	6.4E-04
1978	6.9E-06	6.9E+03[e]		2.0E-03	1.3E-02	2.0E-04
1979	3.8E-06	5.1E+02		5.4E-04	1.1E-02	9.1E-05
1980	1.2E-05	1.5E+03		2.8E-03	9.9E-03	8.2E-04
1981	5.9E-06	7.5E+02		4.1E-04	5.0E-03	5.5E-04
1982	7.1E-06	2.1E+03		5.3E-04	1.3E-02	8.5E-05
1983	1.9E-05	2.7E+03		8.0E-05	4.3E-03	1.6E-04
1984	5.7E-04[d]	1.2E+03		1.3E-04	8.9E-03	6.1E-05
1985	5.7E-04[d]	2.1E+03		3.6E-05	5.8E-03	7.1E-05
1986	5.7E-04[d]	2.2E+03		1.2E-04	4.8E-03	6.3E-05
1987	5.7E-04[d]	6.9E+03		9.8E-05	4.8E-03	3.7E-05
1988	5.7E-04[d]	5.3E+03		7.1E-05	7.2E-03	3.0E-05
1989	5.7E-04[d]	2.2E+03		1.2E-04	1.1E-02	6.1E-06
1990	5.7E-04[d]	1.7E+03		2.0E-04	6.7E-03	2.5E-06
1991	0.0E+00	1.1E+03		1.7E-04	7.5E-03	5.9E-06
1992	2.4E-04	1.2E+03	8.9E+01	2.2E-04	3.3E-03	4.7E-06
1993	3.2E-04	5.6E+02		4.4E-04	2.4E-03	2.0E-06
1994	5.7E-04	4.5E+02		5.9E-04	2.5E-03	9.8E-06
1995	5.5E-04	1.1E+03		1.1E-03	2.8E-03	
1996	3.7E-04	4.1E+02		1.5E-03	2.2E-02	
1997	3.8E-04	6.3E+02		1.5E-03	1.9E-03	
1998	5.0E-04	1.5E+03		2.3E-03	1.4E-03	
1999	2.6E-04	8.2E+02		3.1E-04	1.9E-03	
2000	8.3E-05	9.7E+02		3.3E-04	1.8E-03	
2001	0.0E+00	9.6E+02		3.3E-04	2.3E-03	
2002	2.4E-04[f]	9.8E+02[f]		9.5E-04[f]	1.9E-03[f]	
2003	2.4E-04[f]	9.8E+02[f]		9.5E-04[f]	1.9E-03[f]	

a. Calculated from estimated air concentrations in Table 4C-12, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. MFP = mixed fission products; claimant-favorable to assume all is ^{90}Sr.
d. Assumed to be the highest value of all years for which data are available.
e. Assumed to be the highest value of the two adjacent years.
f. Estimated from average of corresponding values for 1997-2001.

Table 4-11. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, and ^{234}U for TA-33 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{131}I	^{239}Pu	^{234}U
1971		6.6E+04	8.9E-01	7.4E-03	1.1E-02
1972		2.4E+04		4.9E-03	1.2E-02
1973		8.0E+03		1.5E-03	2.8E-02
1974		1.9E+04		2.5E-03	9.6E-03
1975		2.1E+04		2.0E-03	3.4E-03
1976		7.9E+03		4.7E-04	5.6E-03
1977		1.1E+03		1.6E-03	1.1E-02
1978		3.3E+03		2.5E-03	8.4E-03
1979		5.3E+03		6.1E-04	5.4E-03
1980		5.9E+03		3.1E-04	6.2E-03
1981		4.0E+03		3.5E-04	5.0E-03
1982		1.2E+04		2.1E-04	5.1E-03
1983		4.8E+03		0.0E+00	2.9E-03
1984		7.5E+03		6.2E-04	2.5E-03
1985		1.4E+04		0.0E+00	2.7E-03
1986		4.2E+03		5.3E-05	2.0E-03
1987		2.6E+03		7.1E-05	4.5E-03
1988		7.7E+03		3.6E-05	1.3E-02
1989		2.4E+03		0.0E+00	7.3E-03
1990		1.1E+03		6.5E-04	7.7E-03
1991		4.3E+02		6.2E-05	1.7E-03
1992		4.9E+02		8.0E-05	1.3E-03
1993		4.0E+02		1.6E-04	1.4E-03
1994		2.4E+02		4.4E-05	1.3E-03
1995	3.5E-04	4.7E+02		1.4E-03	1.5E-03
1996	3.5E-04[c]	1.9E+02		1.4E-03[c]	1.5E-03[c]
1997	2.8E-04	1.2E+02		1.2E-04	1.2E-03
1998	2.1E-04	1.7E+02		1.2E-04	1.4E-03
1999	2.2E-04	5.3E+02		1.1E-04	1.8E-03
2000	0.0E+00	4.5E+02		1.8E-05	9.9E-04
2001		4.4E+02		0.0E+00	1.3E-03
2002		3.4E+02[d]		7.5E-05[d]	1.3E-03[d]
2003		3.4E+02[d]		7.5E-05[d]	1.3E-03[d]

Calculated from estimated air concentrations in Table 4C-13, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7 × 10^{-2} Bq/pCi); blanks indicate no data are available for those years.
^{3}H intake multiplied by 1.5 to account for submersion dose.
Assumed to be the highest value of the two adjacent years.
Estimated from average of corresponding values for 1997-2001.

Table 4-12. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, ^{234}U, MFP, and P/VAP for TA-35 (Bq /yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U	MFP[c]	P/VAP[d]
1971		9.2E+05	1.4E-03			
1972		7.3E+05	3.5E-03			
1973		3.6E+05	4.6E-04			
1974		4.1E+05	1.6E-03			
1975		7.0E+05	1.2E-03			
1976		4.9E+05	4.6E-04			
1977		2.3E+05	1.6E-04			
1978		2.0E+05	3.8E-04			
1979		3.8E+05	1.4E-03			
1980		7.3E+03	4.0E-05			
1981		9.2E+05[e]	5.2E-05			
1982		9.2E+05[e]	2.5E-04			
1983		1.8E+03	1.8E-04			
1984		6.0E+04	8.1E-05			
1985		1.5E+03	1.1E-04			
1986		1.4E+04	7.1E-05			
1987		4.5E+04	1.2E-04			
1988		3.5E+04	3.4E-05			
1989		5.3E+03	1.3E-04			
1990		1.2E+01	1.7E-04			
1991		1.3E-03	2.4E-04			
1992		2.9E+01	7.0E-05			
1993			5.3E-05			
1994			7.6E-05			
1995	6.9E-06		5.8E-05	1.4E-04	3.2E-04	3.2E-04
1996-2003						

a. Calculated from estimated air concentrations in Table 4C-14, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. MFP = mixed fission products; claimant-favorable to assume all is ^{90}Sr.
d. P/VAP = Particulate/vapor activation products; claimant-favorable to assume all is ^{68}Ge, Class W.
e. Assume highest average value for ^{3}H in 1981 and 1982; there are no source terms or environmental data readily available.

Table 4-13. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-36 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U
1971		5.1E+03	2.4E-03	7.8E-02
1972		3.9E+03	5.1E-03	8.3E-03
1973		3.9E+03	2.0E-03	1.4E-02
1974-1992				
1993		1.5E+02		
1994		1.7E+02	1.0E-03	6.2E-03
1995	4.1E-04	4.9E+02	1.0E-03	8.0E-03
1996	1.3E-04	1.5E+02	7.1E-05	4.3E-03
1997	1.8E-04	1.8E+02	5.8E-05	3.4E-03
1998	1.9E-04	2.4E+02	2.2E-05	3.1E-03
1999	3.2E-04	2.3E+02	4.0E-05	3.1E-03
2000	4.4E-05	2.1E+02	1.3E-05	2.9E-03
2001	0.0E+00	3.3E+02	0.0E+00	1.4E-02
2002	1.8E-06	3.7E+02	0.0E+00	3.4E-03
2003	1.1E-04[c]	2.8E+02[c]	1.5E-05[c]	5.2E-03[c]

a. Calculated from estimated air concentrations in Table 4C-15, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. Estimated from average of corresponding values for 1998-2002.

Table 4-14. Estimated annual average intakes of ^{3}H, ^{239}Pu, and ^{234}U for TA-39 (Bq/yr).[a]

Year	^{3}H[b]	^{239}Pu	^{234}U
1971			1.7E+01
1972			2.1E+01
1973-1976			
1977	5.2E+03	8.9E-06	1.1E-02
1978	2.0E+03	3.1E-03	1.1E-02
1979	2.1E+03	3.3E-04	3.6E-03
1980	3.7E+03	3.9E-04	6.5E-03
1981	1.6E+03	1.8E-04	4.3E-03
1982	2.0E+04	2.4E-04	7.4E-03
1983	4.1E+03	1.6E-04	1.4E-03
1984	1.9E+03	0.0E+00	3.2E-03
1985	5.5E+03	0.0E+00	4.6E-03
1986	3.3E+03	1.3E-04	2.7E-03
1987-2003			

a. Calculated from estimated air concentrations in Table 4C-16, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.

Table 4-15. Estimated annual average intakes of ^{3}H, ^{239}Pu, and ^{234}U for TA-41 (Bq/yr).[a]

Year	^{3}H[b]	^{239}Pu	^{234}U
1971	8.5E+04	3.7E-03	
1972	2.9E+04	2.1E-03	
1973	1.6E+04	3.0E-04	
1974-1978			
1979	9.4E+04		
1980	3.2E+04		
1981	1.7E+04		
1982	3.8E+04		
1983	2.9E+05		
1984	1.4E+06		
1985	3.7E+05		
1986	3.9E+05		
1987	4.2E+04		
1988	1.2E+05		
1989	3.7E+04		
1990	3.8E+04		
1991	2.9E+05		
1992	1.4E+06		
1993	3.7E+05	2.0E-06	
1994	3.9E+05	3.9E-06	
1995	1.4E+05	3.0E-06	1.8E-06
1996	5.1E+05		
1997	3.4E+06		
1998	1.3E+06		
1999	1.1E+06		
2000	8.6E+04		
2001	1.4E+05		
2002	1.2E+06[c]		
2003	1.2E+06[c]		

a. Calculated from estimated air concentrations in Table 4C-17, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.

b. ^{3}H intake multiplied by 1.5 to account for submersion dose.

c. Estimated from average of corresponding values for 1997-2001.

Table 4-16. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-43 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U
1971		5.7E+03	9.8E-03	1.9E-02
1972		3.7E+03	8.9E-03	8.3E-03
1973		1.9E+03	4.6E-03	1.4E-02
1974			1.3E-03	
1975			3.2E-04	
1976			1.5E-03	
1977			9.1E-04	
1978			3.0E-04	
1979			1.5E-04	
1980			3.6E-05	
1981			7.2E-05	
1982			2.7E-04	
1983			6.5E-04	
1984			2.1E-04	
1985			3.5E-04	
1986			5.7E-04	
1987			9.9E-05	
1988			2.9E-04	
1989-1994				
1995	5.3E-05		1.0E-04	2.2E-04
1996-2003				

a. Calculated from estimated air concentrations in Table 4C-19, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.

b. ^{3}H intake multiplied by 1.5 to account for submersion dose.

Table 4-17. Estimated annual average intakes of ^{234}U for TA-46 (Bq/yr).[a]

Year	^{234}U
1971	7.8E-04
1972	2.3E-02
1973	4.2E-04
1974	8.0E-05
1975	1.0E-04
1976	6.1E-05
1977	7.8E-07
1978	4.9E-03
1979	4.4E-04
1980	2.9E-04
1981	2.7E-03
1982	4.0E-04
1983	7.0E-06
1984	1.0E-05
1985	5.5E-06
1986	7.8E-07
1987-2003	

a. Calculated from estimated air concentrations in Table 4C-20, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.

Table 4-18. Estimated annual average intakes of ^{241}Am, ^{239}Pu, ^{234}U, MFP, and P/VAP for TA-48 (Bq/yr).[a]

Year	^{241}Am	^{239}Pu	^{234}U	MFP[b]	P/VAP[c]
1971		3.7E-03			
1972		2.2E-02	1.6E-03		
1973		3.9E-03	3.8E-04	2.0E-01	
1974		4.7E-03	2.5E-04	1.8E-01	
1975		2.4E-03	6.7E-04	1.4E-01	
1976		9.8E-04	2.2E-02	2.4E-01	
1977		1.6E-03	1.1E-02	4.3E-01	
1978		3.7E-04	2.2E-03	2.3E-01	
1979		6.6E-05	2.1E-03	2.1E-01	
1980		3.1E-04	1.3E-04	3.4E-01	
1981		2.6E-04	4.5E-04	2.7E-01	
1982		1.9E-03	1.4E-03	2.1E-01	
1983		6.4E-04	1.0E-04	1.6E-01	
1984		5.0E-04	2.6E-04	3.1E-01	
1985		4.0E-04	3.7E-04	2.4E-01	
1986		5.6E-04	1.2E-04	4.9E-01	
1987		1.2E-04	3.1E-04	2.4E-01	
1988		1.4E-04	4.3E-05	2.2E-01	
1989		2.9E-04	5.3E-05	8.5E+01	
1990		2.9E-04	3.3E-05	2.0E-01	
1991		1.1E-04		2.1E-01	2.0E+01
1992		1.3E-03	8.1E-05	5.4E-01	7.4E+00
1993		6.2E-04	2.8E-04	2.6E-01	1.5E+01
1994		6.3E-04	7.8E-05	7.6E-02	1.6E+01
1995	3.3E-04	6.1E-04	1.0E-04	5.2E+00	5.2E+00
1996	9.8E-07	2.1E-06			2.0E-02
1997	7.0E-08	4.9E-07	2.7E-05		3.5E-01
1998	7.2E-08				2.1E-02
1999			1.2E-07		7.6E-01
2000					3.3E+00
2001					4.5E-01
2002					9.8E-01[d]
2003					9.8E-01[d]

a. Calculated from estimated air concentrations in Table 4C-21, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. MFP = mixed fission products; claimant-favorable to assume all is ^{90}Sr.
c. P/VAP = Particulate/vapor activation products; claimant-favorable to assume all is ^{68}Ge, Class W.
d. Estimated from average of corresponding values for 1997-2001.

Table 4-19. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, and ^{234}U for TA-49 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{131}I	^{239}Pu	^{234}U
1971	5.9E-04[c]	2.0E+04	8.9E-01	7.4E-03	3.3E-02
1972	5.9E-04[c]	2.8E+03		6.7E-03	1.7E-02
1973	5.9E-04[c]	4.3E+03		1.7E-03	1.4E-02
1974	5.9E-04[c]	2.9E+03		2.8E-03	1.2E-02
1975	8.9E-05	2.8E+03		1.9E-03	3.7E-03
1976	5.9E-04[c]	2.9E+03		3.8E-04	7.4E-03
1977	0.0E+00	1.6E+03		1.4E-03	1.5E-02
1978	0.0E+00	6.7E+02		2.3E-03	8.4E-03
1979	0.0E+00	7.2E+02		4.1E-04	5.6E-03
1980	2.0E-04	2.8E+02		5.7E-04	5.2E-03
1981	8.0E-05	5.9E+02		5.2E-04	4.5E-03
1982	0.0E+00	9.2E+02		1.6E-04	6.6E-03
1983	5.9E-04[c]	1.5E+03		8.9E-06	8.9E-04
1984	5.9E-04[c]	1.7E+03		7.1E-05	2.2E-03
1985	5.9E-04[c]	4.8E+03		4.6E-04	3.5E-03
1986	5.9E-04[c]	3.3E+02		8.9E-05	2.8E-03
1987	1.1E-04	2.4E+03		5.3E-05	2.8E-03
1988	5.9E-04	1.3E+03		6.2E-05	4.1E-03
1989	5.9E-04[c]	3.5E+02		0.0E+00	6.1E-03
1990	1.5E-04	1.5E+02		7.1E-05	3.7E-03
1991	9.8E-05	1.2E+02		1.5E-04	3.2E-03
1992	4.4E-05	2.1E+02		1.1E-03	4.5E-03
1993	1.3E-04	3.2E+02		2.5E-04	3.0E-03
1994	4.1E-04	1.9E+02		2.3E-04	1.8E-03
1995	3.0E-04	2.9E+02		2.8E-04	1.7E-03
1996	4.3E-04	2.3E+02		4.6E-04	2.2E-03
1997	1.8E-04	4.7E+02		5.3E-05	7.6E-04
1998	2.8E-04	9.0E+02		1.1E-04	1.6E-03
1999	2.4E-04	4.5E+02		4.0E-05	1.6E-03
2000	1.3E-03	4.7E+02		1.8E-05	1.2E-03
2001	4.9E-04[d]	5.0E+02[d]		1.4E-04[d]	1.5E-03[d]
2002	4.9E-04[d]	5.0E+02[d]		1.4E-04[d]	1.5E-03[d]
2003	4.9E-04[d]	5.0E+02[d]		1.4E-04[d]	1.5E-03[d]

a. Calculated from estimated air concentrations in Table 4C-22, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7 × 10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. Assumed to be the highest value of all years for which data are available.
d. Estimated from average of corresponding values for 1996-2000.

Table 4-20. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, ^{232}Th, ^{234}U, and MFP for TA-50 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{131}I	^{239}Pu	^{232}Th	^{234}U	MFP[c]
1971		8.4E+04	8.9E-01	3.1E-03			
1972				5.4E-03			
1973				4.9E-04			3.4E-03
1974				7.6E-04			1.9E-02
1975				8.0E-04			8.9E-03
1976				2.1E-04			5.8E-03
1977				1.4E-02			1.8E-02
1978				3.4E-03			8.4E-03
1979				5.7E-04			2.2E-03
1980				2.3E-04			1.7E-03
1981				3.5E-04			5.1E-03
1982				1.3E-03			3.1E-03
1983				1.1E-03			1.9E-03
1984				7.2E-04			1.9E-03
1985				3.9E-04			1.8E-03
1986				5.6E-04			4.2E-03
1987				8.8E-04			4.6E-03
1988				4.0E-04			2.9E-03
1989				9.0E-05			2.1E-03
1990				2.9E-05			8.3E-04
1991				2.7E-04			6.5E-04
1992				1.1E-04			7.5E-04
1993				5.5E-05			7.9E-04
1994				6.1E-05			1.4E-03
1995	1.2E-05			1.4E-04			
1996	2.1E-06			8.2E-06		3.7E-05	
1997	1.6E-06			1.1E-05		2.5E-07	
1998	1.3E-06			2.9E-06	1.5E-05	3.7E-05	
1999	2.5E-05			1.0E-05	7.2E-06	3.7E-06	
2000	2.7E-05			1.9E-06	1.0E-05		
2001	1.1E-08			8.4E-06			
2002	1.1E-05[d]			6.8E-06[d]			
2003	1.1E-05[d]			6.8E-06[d]			

a. Calculated from estimated air concentrations in Table 4C-23, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. MFP = mixed fission products; claimant-favorable to assume all is ^{90}Sr.
d. Estimated from average of corresponding values for 1997-2001.

Table 4-21. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, ^{234}U, and P/VAP for TA-53 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{131}I	^{239}Pu	^{234}U[c]	P/VAP[d]
1971		1.1E+04		5.9E-03	2.2E-02	
1972	2.4E-06	4.4E+03		5.7E-03	9.6E-03	
1973	1.1E-07	4.2E+03		2.2E-03	1.4E-02	
1974		1.3E+04		2.8E-03	1.5E-02	
1975	1.7E-07	9.5E+03		2.0E-03	7.3E-03	
1976		6.5E+03		4.4E-04	8.5E-03	
1977	6.7E-08	4.7E+03		1.6E-03	1.5E-02	
1978	0.0E+00	1.7E+03		1.5E-03	5.5E-03	
1979	0.0E+00	5.7E+02		4.4E-04	1.1E-02	
1980	5.0E-08	8.3E+02		6.4E-04	1.1E-02	
1981	7.2E-08	7.2E+02		5.6E-04	3.6E-03	
1982	5.6E-09	9.7E+02		2.0E-04	7.3E-03	3.6E+04
1981		1.5E+03		8.9E-05	3.4E-03	5.2E+05
1984		1.2E+03		5.3E-05	4.5E-03	4.9E+05
1985		1.6E+03		1.1E-04	3.7E-03	3.9E+01
1986	1.7E-07	1.3E+03		7.1E-05	4.2E-03	2.0E+01
1987	4.4E-08	2.0E+03		3.6E-05	4.2E-03	3.9E+01
1988	1.2E-07	3.2E+03		2.0E-04	7.9E-03	2.0E+01
1989	1.8E-07	4.5E+02		8.9E-05	9.9E-03	2.0E+01
1990	1.2E-07	5.2E+02		2.1E-04	9.7E-03	1.6E+01
1991	3.9E-08	1.5E+02		2.7E-04	5.4E-03	3.9E+01
1992	1.0E-07	6.5E+02		2.2E-04	6.9E-03	1.4E+02
1993	2.1E-07	3.2E+02		1.2E-04	1.7E-03	2.0E+03
1994	2.2E-07	2.5E+02		2.2E-04	1.9E-03	6.1E+01
1995	3.4E-07	3.6E+02		9.6E-04	1.6E-03	5.6E+01
1996		1.1E+02	6.8E-02			2.7E+01
1997		5.0E+03				1.8E+02
1998		1.1E+03				6.4E+02
1999		6.7E+02				4.9E-01
2000		8.5E+02				1.8E+02
2001		1.9E+03				2.1E+02
2002		1.9E+03[e]				2.4E+02[e]
2003		1.9E+03[e]				2.4E+02[e]

a. Calculated from estimated air concentrations in Table 4C-24, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. MFP = mixed fission products; claimant-favorable to assume all is ^{90}Sr.
d. P/VAP = Particulate/vapor activation products; claimant-favorable to assume all is ^{68}Ge, Class W.
e. Estimated from average of corresponding values for 1997-2001.

Table 4-22. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-54 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{234}U
1971-1975				
1976	8.6E-03[c]	4.4E+04	2.8E-03	1.5E-02
1977	4.6E-04	2.5E+04	3.2E-03	2.3E-02
1978	2.0E-04	7.6E+03	7.4E-03	1.4E-02
1979	4.4E-04	4.7E+03	2.0E-03	1.1E-02
1980	3.7E-04	7.1E+03	1.3E-03	1.2E-02
1981	1.4E-04	2.9E+03	9.7E-04	1.2E-02
1982	8.0E-05	3.1E+03	1.3E-03	1.2E-02
1983	8.6E-03[c]	2.4E+03	6.2E-05	4.1E-03
1984	8.6E-03[c]	8.4E+03	1.6E-03	9.2E-03
1985	8.6E-03[c]	1.0E+04	2.1E-03	8.8E-03
1986	1.6E-03	3.7E+03	2.0E-03	8.5E-03
1987	8.4E-04	4.3E+03	1.2E-03	7.4E-03
1988	3.4E-04	3.1E+03	1.6E-03	2.2E-02
1989	7.9E-04	3.8E+03	1.5E-03	1.3E-02
1990	2.8E-04	2.2E+03	4.3E-04	7.2E-03
1991	3.6E-04	1.1E+04	1.6E-03	8.4E-03
1992	1.7E-04	5.9E+03	4.4E-04	2.9E-03
1993	3.4E-04	5.2E+03	7.1E-04	3.1E-03
1994	5.6E-04	4.4E+03	6.3E-04	8.8E-03
1995	1.2E-03	5.8E+03	1.6E-03	5.2E-03
1996	5.6E-03	6.8E+03	7.5E-03	4.9E-03
1997	8.6E-03	1.1E+04	1.3E-02	5.5E-03
1998	1.4E-03	1.7E+04	2.0E-03	6.8E-03
1999	1.4E-03	1.3E+04	2.1E-03	1.1E-02
2000	1.1E-03	1.6E+04	9.0E-04	7.5E-03
2001	9.0E-04	3.1E+04	5.2E-04	5.2E-03
2002	4.6E-03	1.6E+04	9.2E-03	5.3E-03
2003	1.9E-03[d]	1.9E+04[d]	3.0E-03[d]	7.1E-03[d]

a. Calculated from estimated air concentrations in Table 4C-25, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. Assumed to be the highest value of all years for which data are available.
d. Estimated from average of corresponding values for 1998-2002.

Table 4-23. Estimated annual average intakes of ^{241}Am, ^{3}H, ^{239}Pu, ^{232}Th, and ^{234}U for TA-55 (Bq/yr).[a]

Year	^{241}Am	^{3}H[b]	^{239}Pu	^{232}Th	^{234}U
1971-1977					
1978			7.8E-05		
1979			2.1E-05		
1980			5.7E-05		
1981			1.9E-05		
1982		5.5E+03	5.1E-04		
1983		1.3E+04	2.1E-04		
1984		4.5E+04	2.0E-04		
1985			2.1E-04		
1986		3.0E+05	4.6E-05		
1987		2.5E+04	4.8E-05		
1988		9.2E+04	3.0E-03		
1989		7.8E+04	4.3E-04		
1990		4.9E+04	9.1E-05		
1991		2.7E+04	3.9E-04		
1992		3.0E+04	2.2E-04		
1993		1.9E+04	3.3E-05		
1994		6.6E+03	2.3E-05		
1995	1.1E-06	4.6E+03	3.2E-06		
1996	6.1E-06	9.1E+03	1.7E-05		1.1E-05
1997	7.0E-05	3.5E+03	2.1E-05	8.6E-06	
1998	7.4E-07	3.5E+03	1.2E-05	5.9E-06	
1999	1.1E-05	5.3E+02	1.2E-05		1.4E-05
2000	6.4E-05	1.9E+03	4.9E-04		
2001	1.2E-06	9.7E+02	8.4E-06	2.9E-05	3.3E-05
2002	2.9E-05[c]	2.1E+03[c]	1.1E-04[c]		
2003	2.9E-05[c]	2.1E+03[c]	1.1E-04[c]		

a. Calculated from estimated air concentrations in Table 4C-26, assuming an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no data are available for those years.
b. ^{3}H intake multiplied by 1.5 to account for submersion dose.
c. Estimated from average of corresponding values for 1997-2001.

Table 4-24. Estimated air concentrations from resuspension (pCi/m^3).

Nuclide	Bayo Canyon	LA Canyon	Mortendad Canyon	Acid Canyon	Pueblo Canyon
Pu-239		3E-05	4E-04	7E-05	2.5E-05
Pu-238			5E-04		
Cs-137		1.3E-03	7E03		
Sr/Y-90	1E-05				
U-238	8E-04				
Year of data	1978	1977	1977	1978	1978

Table 4-25. Area badge data - Annual TLD/film results (mrem).[a]

Year	Site-wide Maximum	TA-3[b]	TA-18[b]	TA-53[b]	TA-54[b]	Background[c,d]	Geometric mean	Geometric standard deviation
2002	156	*115*	156	*129*	236	*150*	152	1.31
2001[e]	570	*570*	*224*	*170*	236	*150*	238	1.69
2000[e]	268	*268*	*195*	*212*	236	*150*	208	1.24
1999[e]	241	*143*	*216*	*241*	*233*	*150*	192	1.28
1998	426	*157*	153	*426*	*213*	*150*	201	1.56
1997[e]	462	*145*	*197*	*462*	*181*	*150*	205	1.60
1996	173	*127*	241	159	*173*	*150*	166	1.27
1995	378	*123*	378	142	*161*	*150*	174	1.56
1994	160	*130*	127	152	*160*	*150*	143	1.11
1993	148	*118*	128	142	*148*	*150*	137	1.11
1992	236	*122*	123	135	*236*	144	147	1.31
1991	178	*130*	136	178	*162*	*150*	150	1.14
1990	178	*137*	136	178	*162*	164	155	1.13
1989	149	*115*	149	94	*129*	152	126	1.22
1988	188	*150*	188	113	*131*	155	145	1.21
1987	166	*166*	153	115	*132*	152	142	1.16
1986	183	*183*	181	143	*160*	152	163	1.11
1985	187	*143*	187	145	160	150	156	1.12
1984	183	*139*	183	161	*159*	150	158	1.11
1983	188	*150*	188	163	*157*	150	161	1.10
1982	163	163	153	138	116	146	142	1.14
1981	175	156	175	123	91	139	134	1.29
1980	303	*211*	303	146	134	152	180	1.40
1979	252	*141*	*252*	150	150	153	165	1.27
1978	234	*144*	*182*	*234*	112	137	157	1.33
1977	273	*273*	*164*	*203*	NM	151	183	1.29
1976	261	*238*	*261*	*172*	NM	145	188	1.31
1975	380	*380*	*220*	*169*	NM	158	202	1.47
1974	137	NA	345	169	150	151	191	1.49
1973[f]	345	128	*345*	178	NA	184	195	1.54
1972[f]	160	150	*225*	NA	NA	176	181	1.23
1971	106	138	*276*	NA	NA	169	186	1.43
1970	132	NA	NA	NA	NA	NA	NA	NA
1969	302	NA	NA	NA	NA	NA	NA	NA
1968	302	NA	NA	NA	NA	NA	NA	NA
1967	302	NA	NA	NA	NA	NA	NA	NA
1966	354	NA	NA	NA	NA	NA	NA	NA
1965	423	NA	NA	NA	NA	NA	NA	NA

a. Dose is based on 8760 hr/yr and can be adjusted to 2080 hr/yr by multiplying by 0.237. NA= data not available.
b. Numbers in *italics* are averages of several area badges in the TA.
c. Backgrounds in *italics* are a 10- yr average, because actual background is not given.
d. Reported background is the average background for Los Alamos town site plus 2-sigma (or 20%).
e. Neutron dose included for 1997 and 1999 at TA-18 and 2000 and 2001 at TA-3, TA-18.
f. In these years, TA-36 exposure was elevated due to experiments at adjacent TA-18: 1973 dose, 81 mrem (net); 1972 dose, 53 mrem (net). For the only other year of data, 1971, dose was not elevated.

Table 4-26. Estimated annual deposition of ^{140}La and doses from radioactive lanthanum experiments.[a]

Year	Dose[b] (mrem)	Deposition[c] ($\mu Ci/m^2$)
1945	8	4.2E3
1946	8	4.2E3
1947	9	4.7E3
1948	3	1.6E3
1949	12	6.3E3
1950	8	4.2E3
1951	3	1.6E3
1952	1	5.3E2
1953	9	4.7E3
1954	15	7.9E3
1955	23	1.2E4
1956	21	1.1E4
1957	10	5.3E3
1958	6	3.2E3
1959	5	2.6E3
1960	3	1.6E3
Geometric mean	6.9	
Geometric std. Dev.	2.2	

a. Applicable to town site, TA-2, and vicinity.
b. Source: Kraig (1997, Figure 5).
c. Calculated from Kraig (1997, Equations 2 and 3).

Table 4-27. Estimated average external doses from ^{41}Ar released from TA-2 (mrem/yr).[a]

Year	Skin[b]	Whole body[c]
1971	3.1E+00	2.0E+00
1972	1.3E+00	8.1E-01
1973	5.4E-01	3.4E-01
1974	6.1E-03	3.9E-03
1975	4.7E-01	3.0E-01
1976	6.7E-01	4.3E-01
1977	6.2E-01	4.0E-01
1978	4.7E-01	3.0E-01
1979	6.9E-01	4.4E-01
1980	1.0E+00	6.5E-01
1981	5.9E-01	3.8E-01
1982	6.7E-01	4.3E-01
1983	8.2E-01	5.3E-01
1984	6.6E-01	4.2E-01
1985	7.7E-01	4.9E-01
1986	5.4E-01	3.5E-01
1987	4.6E-01	2.9E-01
1988	5.2E-01	3.3E-01
1989	4.4E-01	2.8E-01
1990	3.1E-01	2.0E-01
1991	4.0E-01	2.6E-01
1992	2.7E-01	1.8E-01
Geometric mean	5.0E-01	3.2E-01
Geometric std. Dev.	3	3

a. Assumes receptor is at 500 m from the source 2,000 hr per yr, no plume depletion, no plume rise (stack height is zero).
b. Calculated using skin dose factor for ^{41}Ar from Eckerman and Ryman (1993).
c. Calculated using whole-body dose factor for ^{41}Ar from Eckerman and Ryman (1993).

Table 4-28. Estimated average external doses from gaseous/mixed activation products released from TA-53 (mrem/yr).[a]

Year	Skin[b]	Whole body[c]
1943-1976	Not in operation	
1976	1.2E+01	7.4E+00
1977	9.6E+01	6.0E+01
1978	2.4E+02	1.5E+02
1979	2.4E+02	1.5E+02
1980	3.0E+02	1.8E+02
1981	7.1E+02	4.5E+02
1982	5.1E+02	3.2E+02
1983	9.3E+02	5.8E+02
1984	1.5E+03	9.3E+02
1985	2.5E+02	1.6E+02
1986	2.3E+02	1.4E+02
1987	3.0E+02	1.9E+02
1988	2.4E+02	1.5E+02
1989	3.2E+02	2.0E+02
1990	2.5E+02	1.6E+02
1991	1.2E+02	7.2E+01
1992	1.5E+02	9.1E+01
1993	6.5E+01	4.0E+01
1994	1.0E+02	6.3E+01
1995	8.8E+01	5.5E+01
1996	2.2E+01	1.4E+01
1997	4.0E+01	2.5E+01
1998	1.6E+01	9.9E+00
1999	6.1E-01	3.8E-01
2000	1.4E+00	8.7E-01
2001	1.2E+01	7.5E+00
2002	1.4E+01[d]	8.8E+00[d]
2003	1.4E+01[d]	8.8E+00[d]
Geometric mean	8.5E+01	5.3E+01
Geometric std. Dev.	6.5	6.5

a. Assumes receptor is at 500 m from the source 2,000 hr per yr, no plume depletion, no plume rise (stack height is zero).
b. Calculated using skin dose factor for ^{15}O from Eckerman and Ryman (1993).
c. Calculated using whole-body dose factor for ^{41}Ar from Eckerman and Ryman (1993).
d. Estimated assuming equal to average of corresponding values for 1997-2001.

Table 4-29. Estimated average external doses from gaseous/mixed activation products released from TA-21 and TA-72 (mrem/yr).

	TA-21		TA-72	
Year	**Skin[a]**	**Whole body[b]**	**Skin[a]**	**Whole body[b]**
1976	6.55E-01	4.10E-01	1.97E+00	1.23E+00
1977	5.30E+00	3.31E+00	1.59E+01	9.93E+00
1978	1.30E+01	8.14E+00	3.91E+01	2.44E+01
1979	1.32E+01	8.28E+00	3.97E+01	2.48E+01
1980	1.62E+01	1.02E+01	4.87E+01	3.05E+01
1981	3.93E+01	2.46E+01	1.18E+02	7.37E+01
1982	2.79E+01	1.75E+01	8.38E+01	5.24E+01
1983	5.13E+01	3.21E+01	1.54E+02	9.62E+01
1984	8.17E+01	5.11E+01	2.45E+02	1.53E+02
1985	1.40E+01	8.76E+00	4.21E+01	2.63E+01
1986	1.25E+01	7.79E+00	3.74E+01	2.34E+01
1987	1.67E+01	1.04E+01	5.01E+01	3.13E+01
1988	1.35E+01	8.42E+00	4.04E+01	2.52E+01
1989	1.74E+01	1.08E+01	5.21E+01	3.25E+01
1990	1.37E+01	8.55E+00	4.11E+01	2.57E+01
1991	6.37E+00	3.98E+00	1.91E+01	1.19E+01
1992	8.01E+00	5.01E+00	2.40E+01	1.50E+01
1993	3.56E+00	2.23E+00	1.07E+01	6.68E+00
1994	5.56E+00	3.48E+00	1.67E+01	1.04E+01
1995	4.85E+00	3.03E+00	1.46E+01	9.10E+00
1996	1.22E+00	7.65E-01	3.67E+00	2.30E+00
1997	2.23E+00	1.39E+00	6.68E+00	4.17E+00
1998	8.68E-01	5.42E-01	2.60E+00	1.63E+00
1999	3.34E-02	2.09E-02	1.00E-01	6.26E-02
2000	7.68E-02	4.80E-02	2.30E-01	1.44E-01
2001	6.57E-01	4.10E-01	1.97E+00	1.23E+00
2002	7.72E-01[c]	4.83E-01[c]	2.32E+00[c]	1.45E+00[c]
2003	7.72E-01[c]	4.83E-01[c]	4.83E-01[c]	1.45E+00[c]
Geometric mean	4.6E+00	2.9E+00	1.4E+01	8.7E+00
Geometric std. dev.	6.5E+00	6.5E+00	6.5E+00	6.5E+00

a. Calculated using skin dose factor for ^{15}O from Eckerman and Ryman (1993).
b. Calculated using whole-body dose factor for ^{41}Ar from Eckerman and Ryman (1993).
c. Estimated assuming equal to average of corresponding values for 1997-2001.

Table 4-30. Estimated annual site wide maximum intakes and ambient dose rates for all radionuclides .

Year	Maximum intakes (Bq/yr)[a]								Maximum ambient dose rates (mrem/yr)
	^{241}Am	^{3}H	^{131}I	^{239}Pu	^{232}Th	^{234}U	MFP[b]	P/VAP[c]	
1971		9.2E+05	8.9E-01	2.5E-02		1.7E+01			276
1972	3.6E-03	7.3E+05	1.4E+00	2.2E-02		2.1E+01			225
1973	6.2E-04	3.6E+05	8.3E-01	1.2E-02	3.0E-03	4.1E-02	2.5E+00		345
1974		4.1E+05	9.2E-01	2.9E-01		3.9E-02	1.8E-01		137
1975	9.8E-04	7.0E+05	2.7E-01	8.2E-02		3.8E-02	1.4E-01		380
1976		4.9E+05	5.9E-02	7.7E-03		7.1E-02	2.4E-01		238
1977	4.6E-04	2.3E+05	1.7E-02	1.4E-02		6.6E-02	4.3E-01		273
1978	2.0E-04	2.0E+05	1.6E-02	1.1E-02		3.6E-02	2.3E-01		234
1979	4.4E-04	3.8E+05	3.1E-02	2.1E-01		5.1E-02	2.1E-01		252
1980	3.7E-04	3.2E+04	1.8E-02	1.4E-01		3.0E-02	3.4E-01		303
1981	4.0E-03	1.7E+04	8.6E-03	7.7E-03		4.6E-02	2.7E-01		175
1982	8.0E-05	3.8E+04	1.5E-01	1.5E-02		6.3E-02	2.1E-01	3.6E+04	163
1983	1.9E-05	2.9E+05	1.6E-02	1.7E-02		3.5E-02	1.6E-01	5.2E+05	188
1984		1.4E+06	1.4E-02	2.2E-02		4.2E-02	3.1E-01	4.9E+05	183
1985		3.7E+05	2.9E-02	3.8E-02		6.7E-02	2.4E-01	3.9E+01	187
1986	1.6E-03	3.9E+05	7.4E-03	3.8E-02		1.2E-01	4.9E-01	2.0E+01	183
1987	8.4E-04	4.5E+04		1.3E-02		1.7E-01	2.4E-01	3.9E+01	166
1988	5.9E-04	1.2E+05		1.0E-02		9.8E-02	2.2E-01	2.0E+01	188
1989	7.9E-04	7.8E+04		7.6E-03		7.1E-02	8.5E+01	2.0E+01	149
1990	2.8E-04	4.9E+04		4.2E-03		3.8E-02	2.0E-01	1.6E+01	178
1991	3.6E-04	2.9E+05		1.6E-03		8.4E-03	2.1E-01	3.9E+01	178
1992	4.0E-04	1.4E+06	8.9E+01	1.3E-03		4.5E-01	5.4E-01	1.4E+02	236
1993	1.7E-03	3.7E+05		4.9E-03		9.7E-01	2.6E-01	2.0E+03	148
1994	5.7E-04	3.9E+05		1.0E-03		8.8E-03	7.6E-02	6.1E+01	160
1995	1.3E-03	1.4E+05		1.6E-03		8.0E-03	5.2E+00	4.4E+02	161
1996	5.6E-03	5.1E+05	6.8E-02	7.5E-03	3.2E-05	2.2E-02		2.7E+01	241
1997	8.6E-03	3.4E+06		1.3E-02	7.4E-05	5.5E-03		1.8E+02	462
1998	1.4E-03	1.3E+06		2.3E-03	8.2E-05	6.8E-03		6.4E+02	426
1999	1.4E-03	1.1E+06		2.1E-03	4.3E-05	1.1E-02		7.6E-01	241
2000	1.3E-03	8.6E+04		9.0E-04	2.5E-05	7.5E-03		1.8E+02	268
2001	9.0E-04	1.4E+05		5.2E-04	2.9E-05	1.4E-02		2.1E+02	570
2002	4.6E-03	1.2E+06		9.2E-03	5.0E-05	5.3E-03		2.4E+02	156
2003	1.9E-03	1.2E+06		3.0E-03	5.0E-05	7.1E-03		2.4E+02	

a. Values are the maximum annual average intake reported for all technical areas in Tables 4-1 through 4-23 for each radionuclide, and are based on an inhalation rate of 2,400 m^3/yr (and multiplying by 3.7×10^{-2} Bq/pCi); blanks indicate no release or air concentration data were available.

b. MFP = mixed fission products; claimant-favorable to assume all is ^{90}Sr.

c. P/VAP = Particulate/vapor activation products; claimant-favorable to assume all is ^{68}Ge, Class

ATTACHMENT 4A, 4B, 4C, 4D
TABLES OF SOURCE EMISSIONS, SCREENING ESTIMATES, AIR CONCENTRATIONS

LIST OF TABLES

Tables 4A-1 through 4A-22 contain emissions data that have been reported by year and radionuclide for many of the Technical Areas (TAs) at Los Alamos National Laboratory (LANL). In recent years, effluents have been reported by stack and/or building vent; in these cases, the effluents were summed within a TA. For years prior to 1971, the reported effluent releases rely on data from the Center for Disease Control and Prevention's Los Alamos Historical Document Retrieval and Assessment project; after 1971, the reported releases are found in annual environmental surveillance reports.

Table 4A-1. Estimated source emissions from TA-1 (μCi/yr).

Year	Pu
1943	No source estimates for this year
1944	No source estimates for this year
1945	2.11E+05
1946	2.65E+05
1947	4.21E+05
1948-2001	No source estimates for these years
2002	
2003	

Table 4A-2. Estimated source emissions from TA-2 (μCi/yr).

Year	^{4}Ar
1943-1966	No source estimates for this year
1967	1.55E+10
1968	6.48E+09
1969	1.80E+09
1970	1.30E+09
1971	1.57E+09
1972	6.40E+08
1973	2.73E+08
1974	3.12E+06
1975	2.37E+08
1976	3.39E+08
1977	3.15E+08
1978	2.39E+08
1979	3.51E+08
1980	5.13E+08
1981	3.01E+08
1982	3.42E+08
1983	4.18E+08
1984	3.35E+08
1985	3.90E+08
1986	2.76E+08
1987	2.32E+08
1988	2.64E+08
1989	2.22E+08
1990	1.60E+08
1991	2.03E+08
1992	1.40E+08
1993-2003	Not in operation

Table 4A-3. Estimated source emissions from TA-3 (µCi/yr).

Year	^{241}Am	^{3}H	^{131}I	Pu	^{232}Th	U	MFP	P/VAP
1943-1951	No source estimates for these years							
1952				1.00E+01				
1953				2.30E+02				
1954				1.30E+03				
1955				1.89E+03				
1956				1.49E+03				
1957				1.12E+03				
1958				3.21E+03				
1959				8.90E+02				
1960				2.97E+03				
1961				1.92E+03				
1962				1.80E+03				
1963			6.52E+05	8.60E+02				
1964			2.97E+05	6.50E+02				
1965			3.81E+05	1.59E+03				
1966				1.88E+03				
1967				4.19E+03				
1968				6.05E+03				
1969				1.16E+04				
1970				1.35E+04				
1971		8.90E+07	6.95E+03	1.43E+04		5.80E+02		
1972		4.80E+07[a]	7.40E+03[a]	7.90E+03[a]		3.60E+02[a]		
1973			4.23E+03	7.30E+03	1.56E+01	5.93E+02	1.28E+04	
1974			4.73E+03	1.47E+03		2.02E+02	3.42E+02	
1975		2.20E+07	1.36E+03	4.20E+02		1.94E+02	1.84E+02	
1976		0.00E+00	3.00E+02	3.95E+01		3.63E+02	4.15E+02	
1977		4.00E+08	8.80E+01	3.35E+01		3.38E+02	4.81E+02	
1978		9.98E+07	8.10E+01	5.83E+01		1.85E+02	4.03E+02	
1979		3.02E+09	1.58E+02	1.07E+03		2.61E+02	4.72E+02	
1980		4.55E+06	9.40E+01	7.41E+02		1.55E+02	4.24E+02	
1981		8.99E+08	4.40E+01	3.96E+01		2.36E+02	1.72E+02	
1982		1.94E+09	7.85E+02	7.44E+01		3.21E+02	7.63E+01	
1983		2.28E+09	8.30E+01	8.85E+01		1.81E+02	1.71E+01	
1984		1.78E+09	7.30E+01	1.15E+02		2.14E+02	4.15E+01	
1985		2.12E+09	1.46E+02	1.95E+02		3.44E+02	3.47E+01	
1986		1.23E+09	3.80E+01	1.94E+02		6.31E+02	4.79E+01	
1987		8.51E+08		6.49E+01		8.68E+02	2.16E+01	
1988		8.35E+09		5.19E+01		5.00E+02	2.97E+01	
1989		2.91E+08		3.91E+01		3.65E+02	3.82E+01	
1990		4.96E+08		2.16E+01		1.96E+02	3.89E+01	
1991		2.05E+08		3.08E+01		2.44E+02	1.41E+01	
1992		1.15E+08		2.73E+00		1.98E+02	8.42E+00	
1993		7.63E+07		1.74E+00		2.18E+02	6.05E+00	
1994		5.38E+07		6.00E+00		1.96E+02	3.84E+01	
1995	4.02E+00	2.25E+06		5.35E+01		1.53E+02	9.38E+02	9.38E+02
1996	1.22E+00			2.31E+01	1.64E-01	3.87E+01		
1997	3.70E-01			3.50E+00	3.80E-01	2.20E+01		
1998	1.60E+00			1.10E+01	4.20E-01	3.10E+01		6.70E+00
1999	2.60E+00			2.10E+01	2.20E-01	7.60E+00		
2000	1.80E-01			3.20E+00	1.30E-01	6.80E+00		
2001	2.60E-01			9.20E+00	1.40E-01	7.10E+00		
2002								
2003								

a. Value taken from LASL (1972) due to inconsistencies or omissions noted in database for 1972.

Table 4A-4. Estimated source emissions from TA-9 (µCi/yr).

Year	^3H
1943-1971	No source estimates for these years
1972	7.00E+08[a]
1973	3.60E+07[b]
1974	1.30E+06
1975	No source estimates for this year
1976	1.29E+08
1977	2.60E+07
1978	2.60E+06
1979	5.00E+06
1980	5.00E+06
1981-2001	No source estimates for these years
2002	
2003	

a. Value taken from LASL (1972) due to inconsistencies or omissions noted in database for 1972.
b. Value taken from LASL (1973) due to inconsistencies noted in database for 1973.

Table 4A-5. Estimated source emissions from TA-10 (µCi/yr).

Year	U
1943	No source estimates for this year
1944	1.00E+04
1945	1.00E+04
1946	3.00E+04
1947	4.00E+04
1948	6.00E+04
1949	1.00E+05
1950	5.00E+05
1951	2.00E+05
1952	2.00E+05
1953	2.00E+05
1954	4.00E+03
1955	3.30E+04
1956	3.50E+04
1957	1.10E+04
1958	7.00E+03
1959	1.20E+04
1960	7.00E+03
1961	8.82E+05
1962	1.82E+05
1963	5.00E+04
1964-2001	No source estimates for these years
2002	
2003	

Table 4A-6. Estimated source emissions from TA-15 (µCi/yr).

Year	^{3}H	^{232}Th	U
1943	No source estimates for this year		
1944			6.00E+04
1945			1.20E+05
1946			2.40E+05
1947			3.60E+05
1948			5.40E+05
1949			8.70E+05
1950			4.50E+06
1951			2.00E+06
1952			1.80E+06
1953			1.60E+06
1954			1.49E+06
1955			1.19E+06
1956			7.93E+05
1957			1.20E+06
1958			1.07E+06
1959			5.16E+05
1960			7.14E+05
1961			3.48E+05
1962			4.73E+05
1963			3.96E+05
1964			5.97E+05
1965			5.72E+05
1966			9.42E+05
1967	3.59E+09	2.00E+09	7.20E+05
1968	4.50E+09	2.00E+09	5.37E+05
1969	4.50E+09		4.28E+05
1970	2.87E+10		3.07E+05
1971	2.66E+09		4.95E+05
1972	1.81E+09		1.64E+05
1973	9.30E+08[a]		
1974-1977	No source estimates for these years		
1978	7.16E+07		
1979-1991	No source estimates for these years		
1992			2.29E+03
1993			4.94E+03
1994			7.87E+03
1995-2001	No source estimates for these years		
2002			
2003			

a. Value taken from LASL (1973) due to omission noted in database for 1973.

Table 4A-7. Estimated source emissions from TA-16 (µCi/yr).

Year	^{3}H	U
1943-53	No source estimates for these years	
1954		3.80E+04
1955	No source estimates for this year	
1956	No source estimates for this year	
1957		1.40E+04
1958	No source estimates for this year	
1959		1.00E+03
1960		5.00E+04
1961	No source estimates for this year	
1962	No source estimates for this year	
1963		4.80E+04
1964		3.00E+03
1965		4.00E+03
1966	No source estimates for this year	
1967		5.00E+03
1968		3.90E+04
1969		3.00E+03
1970		1.10E+04
1971		2.00E+03
1972-1991	No source estimates for these years	
1992	6.28E+04	
1993	7.73E+05	
1994	2.46E+07	
1995	8.90E+07	
1996	9.90E+07	
1997	9.80E+07	
1998	2.40E+08	
1999	1.60E+08	
2000	2.60E+08	
2001	7.90E+09	
2002		
2003		

Table 4A-8. Estimated source emissions from TA-18 (µCi/yr).

Year	U
1943-1978	No source estimates for these years
1979	3.95E+00
1980-2001	No source estimates for these years
2002	
2003	

Table 4A-9. Estimated source emissions from TA-21 (µCi/yr).

Year	^{241}Am	^{3}H	Pu	U	MFP
1943-1947	No source estimates for these years (see TA-1 data)				
1948			1.55E+05		
1949			1.55E+05		
1950			1.85E+05		
1951			2.70E+04		
1952			5.70E+04		
1953			3.50E+04		
1954			2.20E+04		
1955			8.80E+04		
1956			7.60E+04		
1957			7.40E+04		
1958			8.00E+04		
1959			1.86E+05		
1960			3.53E+04		
1961			6.24E+03		
1962			7.99E+03	6.29E+03	
1963			2.87E+04	3.05E+04	
1964			1.24E+04	2.31E+03	
1965			9.31E+03	9.13E+03	
1966			1.04E+04	1.00E+04	
1967			9.99E+03	6.91E+03	
1968			1.94E+03	1.30E+03	
1969			4.17E+03	3.56E+03	
1970			2.82E+03	1.03E+03	
1971		5.00E+06	1.79E+03	1.18E+03	
1972			2.17E+03	1.20E+03[a]	
1973		4.00E+06[b]	1.40E+03	9.08E+02	1.00E+00
1974			5.71E+00	6.00E+02	2.90E+00
1975		3.06E+08	1.11E+01	7.21E+02	1.44E+00
1976		9.50E+07	1.22E+01	8.70E+02	5.50E-01
1977		1.33E+08	9.99E+00	3.17E+02	3.26E+00
1978	3.40E-02		3.07E+01	3.05E+02	1.03E+00
1979	1.90E-02	9.49E+07	6.46E+00	6.55E+02	4.68E-01
1980	6.10E-02	1.06E+08	2.27E+00	6.33E+02	4.18E+00
1981	2.90E-02	1.08E+08	1.31E+01	1.02E+03	2.80E+00
1982	3.50E-02	1.69E+08	1.58E+01	1.04E+03	4.35E-01
1983	9.50E-02	1.80E+08	9.92E+00	7.06E+02	7.94E-01
1984		8.02E+08	1.73E+01	9.90E+02	3.14E-01
1985		3.67E+08	1.06E+01	3.82E+02	3.61E-01
1986		4.48E+08	3.57E+00	2.12E+02	3.24E-01
1987		5.96E+08	1.43E+00	2.07E+02	1.88E-01
1988		5.28E+08	7.13E-01	5.88E+01	1.54E-01
1989		4.55E+08	1.39E+00	2.89E+01	3.10E-02
1990		4.39E+08	9.01E-01	4.32E+01	1.30E-02
1991		3.24E+08	8.45E-01	9.20E+01	3.00E-02
1992		4.29E+08	8.70E-01	5.20E+01	2.40E-02
1993		4.26E+08	8.10E-01	5.17E+01	1.00E-02
1994		3.32E+08	2.40E+00	1.82E+02	5.00E-02
1995	7.72E-03	7.12E+08	6.41E-01	1.71E+00	
1996		3.90E+08			
1997		2.10E+08			
1998		4.60E+08			
1999		4.90E+08			
2000		9.40E+08			
2001		4.90E+08			
2002					
2003					

a. Value taken from LASL (1972) due to inconsistencies or omissions noted in database for 1972.
b. Value taken from LASL (1973) due to inconsistencies noted in database for 1973.

Table 4A-10. Estimated source emissions from TA-33 (μCi/yr).

Year	^{3}H	U
1943-1965	No source estimates for these years	
1966		1.00E+04
1967-1970	No source estimates for these years	
1971	4.10E+09	
1972	2.90E+09[a]	
1973	3.90E+09[b]	
1974	5.92E+09	
1975	3.48E+09	
1976	1.35E+09	
1977	3.70E+10	
1978	1.78E+10	
1979	1.05E+10	
1980	6.97E+09	
1981	6.09E+09	
1982	1.36E+10	
1983	4.41E+09	
1984	7.11E+09	
1985	4.87E+09	
1986	6.66E+09	
1987	1.00E+09	
1988	No source estimates for this year	
1989	1.77E+09	
1990	8.54E+08	
1991	2.54E+08	
1992	3.18E+08	
1993	3.50E+08	
1994	4.56E+08	
1995	1.09E+08	
1996	No source estimates for this year	
1997	4.30E+07	
1998	6.50E+07	
1999	9.40E+08	
2000	1.20E+09	
2001	4.60E+08	
2002		
2003		

a. Value taken from LASL (1972) due to inconsistencies or omissions noted in database for 1972.
b. Value taken from LASL (1973) due to inconsistencies noted in database for 1973.

Table 4A-11. Estimated source emissions from TA-35 (µCi/yr).

Year	^{241}Am	^{3}H	Pu	U	MFP	PVAP
1943-1966	No source estimates for these years					
1967			6.60E+00			
1968			5.90E+00			
1969			5.57E+00			
1970			4.21E+00			
1971		3.13E+09	7.37E+00			
1972		2.50E+09[a]	1.79E+01			
1973		1.23E+09	2.35E+00			
1974		1.40E+09	8.01E+00			
1975		2.39E+09	5.91E+00			
1976		1.66E+09	2.37E+00			
1977		7.86E+08	8.19E-01			
1978		6.76E+08	1.96E+00			
1979		1.30E+09	7.40E+00			
1980		2.50E+07	2.07E-01			
1981			2.66E-01			
1982			1.30E+00			
1983		6.00E+06	9.26E-01			
1984		2.06E+08	4.17E-01			
1985		5.28E+06	5.61E-01			
1986		4.76E+07	3.63E-01			
1987		1.55E+08	6.36E-01			
1988		1.18E+08	1.72E-01			
1989		1.82E+07	6.80E-01			
1990		4.00E+04	8.95E-01			
1991		4.30E+00	1.22E+00			
1992		1.00E+05	3.58E-01			
1993		MDA	2.70E-01			
1994			3.90E-01			
1995	3.55E-02		2.97E-01	6.93E-01	1.63E+00	1.63E+00
1996-2001	No source estimates for these years					
2002						
2003						

a. Value taken from LASL (1972) due to inconsistencies or omissions noted in database for 1972.

Table 4A-12. Estimated source emissions from TA-36 (μCi/yr).

Year	U
1943-1957	No source estimates for these years
1958	4.30E+04
1959	8.00E+03
1960	1.40E+04
1961	No source estimates for this year
1962	1.00E+04
1963	1.40E+04
1964	4.00E+03
1965	2.00E+04
1966	2.80E+04
1967	4.80E+04
1968	2.70E+04
1969	1.90E+04
1970	6.00E+03
1971	1.00E+04
1972	4.00E+03
1973-2001	No source estimates for these years
2002	
2003	

Table 4A-13. Estimated source emissions from TA-39 (μCi/yr).

Year	U
1943-53	No source estimates for these years
1954	1.91E+05
1955	1.48E+05
1956	1.73E+05
1957	2.66E+05
1958	2.85E+05
1959	1.89E+05
1960	1.16E+05
1961	1.63E+05
1962	1.63E+05
1963	1.26E+05
1964	1.15E+05
1965	1.07E+05
1966	1.23E+05
1967	2.00E+05
1968	5.00E+04
1969	6.60E+04
1970	5.10E+04
1971	8.70E+04
1972	1.10E+05
1973-2001	No source estimates for these years
2002	
2003	

Table 4A-14. Estimated source emissions from TA-41 (μCi/yr).

Year	^{3}H	Pu	U
1943-1966	No source estimates for these years		
1967		1.20E+02	
1968		3.30E+01	
1969		9.00E+00	
1970		7.80E+00	
1971	3.20E+08	1.90E+01	
1972	1.10E+08[a]	1.10E+01	
1973	5.90E+07	1.52E+00	
1974-1978	No source estimates for these years		
1979	1.43E+08		
1980	4.14E+08		
1981	1.26E+08		
1982	1.30E+08		
1983	9.74E+08		
1984	4.78E+09		
1985	1.27E+09		
1986	1.32E+09		
1987	4.70E+08		
1988	1.73E+09		
1989	1.16E+10		
1990	4.44E+09		
1991	3.84E+09		
1992	2.92E+08		
1993	4.83E+08	1.00E-02	
1994	1.72E+08	2.00E-02	
1995	7.85E+07	1.56E-02	9.02E-03
1996	1.10E+08		
1997	4.20E+07		
1998	3.60E+07		
1999	1.30E+07		
2000	6.30E+06		
2001	5.30E+08		
2002			
2003			

a. Value taken from LASL (1972) due to inconsistencies or omissions noted in database for 1972.

Table 4A-15. Estimated source emissions from TA-42 (μCi/yr).

Year	Pu source
1943-1968	No source estimates for these years
1969	8.10E+02
1970-2001	No source estimates for this year
2002	
2003	

Table 4A-16. Estimated source emissions from TA-43 (μCi/yr).

Year	^{241}Am	Pu	U
1943-1972	No source estimates for these years		
1973		4.80E-01	
1974		6.91E+00	
1975		1.65E+00	
1976		7.72E+00	
1977		4.65E+00	
1978		1.55E+00	
1979		7.55E-01	
1980		1.84E-01	
1981		3.68E-01	
1982		1.39E+00	
1983		3.33E+00	
1984		1.05E+00	
1985		1.80E+00	
1986		2.91E+00	
1987		5.06E-01	
1988		1.46E+00	
1989-1994	No source estimates for these years		
1995	2.69E-01	5.27E-01	1.12E+00
1996-2001	No source estimates for these years		
2002			
2003			

Table 4A-17. Estimated source emissions from TA-46 (μCi/yr).

Year	U source
1950-70	Operations started in 1950; No source estimates for these years
1971	4.00E+00
1972	1.20E+02[a]
1973	2.17E+00
1974	4.10E-01
1975	5.20E-01
1976	3.10E-01
1977	4.00E-03
1978	2.53E+01
1979	2.27E+00
1980	1.48E+00
1981	1.38E+01
1982	2.03E+00
1983	3.60E-02
1984	5.10E-02
1985	2.80E-02
1986	4.00E-03
1987-2001	No source estimates for these years
2002	
2003	

a. Value taken from LASL (1972) due to inconsistencies or omissions noted in database for 1972.

Table 4A-18. Estimated source emissions from TA-48 (μCi/yr).

Year	^{241}Am	Pu	U	MFP	PVAP	GMAP
19-1966	Started operations in mid 1950s; No source estimates for these years					
1967		1.10E+02				
1968		1.50E+02				
1969		1.30E+02				
1970		5.70E+01				
1971		1.89E+01				
1972		1.13E+02	8.00E+00[a]			
1973		1.98E+01	1.96E+00	1.02E+03		
1974		2.39E+01	1.26E+00	9.41E+02		
1975		1.23E+01	3.44E+00	7.22E+02		
1976		5.02E+00	1.12E+02	1.23E+03		
1977		8.38E+00	5.52E+01	2.19E+03		
1978		1.91E+00	1.12E+01	1.17E+03		
1979		3.36E-01	1.08E+01	1.07E+03		
1980		1.57E+00	6.66E-01	1.75E+03		
1981		1.32E+00	2.31E+00	1.37E+03		
1982		9.95E+00	7.33E+00	1.09E+03		
1983		3.30E+00	5.11E-01	8.16E+02		
1984		2.55E+00	1.34E+00	1.57E+03		
1985		2.07E+00	1.91E+00	1.21E+03		
1986		2.85E+00	6.11E-01	2.50E+03		
1987		6.15E-01	1.58E+00	1.25E+03		
1988		7.24E-01	2.20E-01	1.11E+03		
1989		1.49E+00	2.70E-01	4.35E+05		
1990		1.48E+00	1.70E-01	1.04E+03		
1991		5.86E-01		1.08E+03	1.00E+05	1.78E+05
1992		6.72E+00	4.17E-01	2.74E+03	3.79E+04	
1993		3.16E+00	1.42E+00	1.35E+03	7.59E+04	
1994		3.22E+00	4.00E-01	3.90E+02	8.13E+04	
1995	1.71E+00	3.10E+00	5.37E-01	2.64E+04	2.64E+04	
1996	5.00E-03	1.10E-02			1.00E+02	
1997	3.60E-04	2.50E-03	1.40E-01		1.80E+03	
1998	3.70E-04				1.10E+02	
1999			6.10E-04		3.90E+03	
2000					1.70E+04	
2001					2.30E+03	
2002						
2003						

a. Value taken from LASL (1972) due to inconsistencies or omissions noted in database for 1972.

Table 4A-19. Estimated source emissions from TA-50 (µCi/yr).

Year	^{241}Am	Pu	^{232}Th	U	MFP
1943-1966	No source estimates for these years				
1967		1.01E+02			
1968		6.88E+01			
1969		4.20E+01			
1970		2.04E+01			
1971		1.60E+01			
1972		2.74E+01			
1973		2.49E+00			1.72E+01
1974		3.90E+00			8.83E+01
1975		4.11E+00			4.22E+01
1976		1.10E+00			2.75E+01
1977		6.96E+01			8.58E+01
1978		1.74E+01			3.99E+01
1979		2.90E+00			1.06E+01
1980		1.17E+00			8.25E+00
1981		1.79E+00			2.42E+01
1982		6.54E+00			1.45E+01
1983		5.55E+00			9.08E+00
1984		3.67E+00			8.90E+00
1985		2.02E+00			8.49E+00
1986		2.88E+00			2.01E+01
1987		4.51E+00			2.16E+01
1988		2.05E+00			1.38E+01
1989		4.59E-01			9.78E+00
1990		1.48E-01			3.92E+00
1991		1.38E+00			3.09E+00
1992		5.50E-01			3.57E+00
1993		2.80E-01			3.75E+00
1994		3.10E-01			6.79E+00
1995	6.26E-02	7.21E-01			
1996	1.10E-02	4.20E-02		1.90E-01	
1997	8.40E-03	5.41E-02		1.30E-03	
1998	6.50E-03	1.50E-02	7.70E-02	1.90E-01	
1999	1.30E-01	5.11E-02	3.70E-02	1.90E-02	
2000		9.80E-03	5.30E-02		
2001	5.80E-05	4.30E-02			
2002					
2003					

Table 4A-20. Estimated source emissions from TA-53 (μCi/yr).

Year	^{3}H	^{131}I	PVAP	GMAP
1943-1973	No source estimates for these years			
1974				1.00E-02
1975				1.00E-02
1976	1.71E+08			5.89E+09
1977	2.90E+08			4.76E+10
1978				1.17E+11
1979				1.19E+11
1980				1.46E+11
1981	6.59E+06			3.53E+11
1982	2.72E+05		1.8E+08	2.51E+11
1983			2.6E+09	4.61E+11
1984	2.70E+07		2.5E+09	7.34E+11
1985	6.96E+06		2.0E+05	1.26E+11
1986	6.10E+06		1.0E+05	1.12E+11
1987	1.52E+07		2.0E+05	1.50E+11
1988	4.27E+06		1.0E+05	1.21E+11
1989	8.20E+06		1.0E+05	1.56E+11
1990	2.84E+06		8.0E+04	1.23E+11
1991	8.87E+05		2.0E+05	5.72E+10
1992	4.21E+07		7.3E+05	7.20E+10
1993	4.86E+07		1.0E+07	3.20E+10
1994	1.46E+07		3.1E+05	5.00E+10
1995	3.17E+06		2.9E+05	4.36E+10
1996	4.80E+06	3.50E+02	1.4E+05	1.10E+10
1997	1.70E+07		9.0E+05	2.00E+10
1998	3.80E+06		3.3E+06	7.80E+09
1999	2.30E+06		2.5E+03	3.00E+08
2000	2.90E+06		9.3E+05	6.90E+08
2001	6.37E+06		1.1E+06	5.90E+09
2002				
2003				

Table 4A-21. Estimated source emissions from TA-54 (µCi/yr).

Year	Pu	U
1943-1976	No source estimates for these years	
1977	3.00E-03	
1978	2.60E-02	
1979	1.30E-02	
1980	3.00E-03	
1981	1.00E-02	
1982	2.00E-02	
1983	2.00E-03	
1984	2.30E-02	
1985	6.00E-03	
1986	1.65E-01	
1987	2.60E-02	
1988	1.40E-02	
1989	2.20E-02	
1990	8.40E-02	
1991	4.50E-02	
1992	1.00E-02	
1993	<MDA	
1994	1.00E-02	
1995	8.48E-04	
1996		
1997		2.80E-02
1998-2001	No source estimates for these years	
2002		
2003		

Table 4A-22. Estimated source emissions from TA-55 (μCi/yr).

Year	^{241}Am	^{3}H	Pu	^{232}Th	U
1943-1977	No source estimates for these years				
1978			3.99E-01		
1979			1.08E-01		
1980			2.94E-01		
1981			9.70E-02		
1982		1.87E+07	2.59E+00		
1983		4.42E+07	1.07E+00		
1984		1.52E+08	1.04E+00		
1985			1.07E+00		
1986		1.01E+09	2.34E-01		
1987		8.54E+07	2.45E-01		
1988		3.14E+08	1.53E+01		
1989		2.66E+08	2.22E+00		
1990		1.67E+08	4.68E-01		
1991		9.12E+07	2.00E+00		
1992		1.02E+08	1.12E+00		
1993		6.46E+07	1.70E-01		
1994		2.26E+07	1.20E-01		
1995	5.45E-03	1.56E+07	1.63E-02		
1996	3.10E-02	3.10E+07	8.85E-02		5.50E-02
1997		1.20E+07	1.10E-01	4.40E-02	
1998	3.80E-03	1.20E+07	6.20E-02	3.00E-02	
1999	5.40E-02	1.80E+06	6.30E-02		7.10E-02
2000	3.30E-01	6.40E+06	2.50E+00		
2001	6.20E-03	3.30E+06	4.30E-02	1.50E-01	1.70E-01
2002					
2003					

Table 4B-1 presents results of a screening analysis used to identify radionuclides of potential significance to inhalation dose. The analysis evaluated the potential 50-year committed inhalation dose associated with the maximum annual reported emission of each radionuclides from data in Tables 4A-1 through 4A-22. Inhalation doses were calculated by estimating maximum air concentrations using a screening-level dispersion model, assuming an annual inhalation rate of 3,400 m^3/yr, and maximum effective and organ dose factors from the CD1 compilation for ICRP 68 (ICRP 2001).

Table 4B-1. Data and results of screening analysis for potential contributors to inhalation dose.

Radionuclide	Year of max release	Maximum release[a] (µCi/yr)	Estimated max intake[b] (Bq/yr)	Organ with highest dose factor[c]	Max organ dose coefficient ICRP 68[c] (Sv/Bq)	Effective dose coefficient ICRP 68[c] (Sv/Bq)	Estimated max organ dose (Sv/yr)	Estimated max effective dose (Sv/yr)	<$10E^{-5}$ effective dose (Sv/yr)?
H-3	1977	3.70E+10	5.31E+08	All	1.8E-11	1.8E-11	9.6E-03	9.6E-03	
Be-7	1991	1.94E+04	2.79E+02	ET airways	4.2E-10	4.6E-11	1.2E-07	1.3E-08	Screened
P-32	1977	3.04E+02	4.37E+00	Lung	1.6E-08	2.9E-09	7.0E-08	1.3E-08	Screened
As-72	1991	8.72E+04	1.25E+03	ET airways	1.0E-08	1.3E-09	1.3E-05	1.6E-06	Screened
Br-76	1991	2.00E+03	2.87E+01	ET airways	1.0E-08	5.8E-10	2.9E-07	1.7E-08	Screened
Rb-88	1973	3.00E+06	4.31E+04	ET airways	3.8E-10	2.8E-11	1.6E-05	1.2E-06	Screened
Sr-90	1971	1.48E+03	2.13E+01	Lung	6.3E-07	7.7E-08	1.3E-05	1.6E-06	Screened
I-131	1963	6.52E+05	9.36E+03	Thyroid	2.1E-07	1.1E-08	2.0E-03	1.0E-04	
Cs-137	1971	5.60E+02	8.04E+00	ET airways	1.3E-08	6.7E-09	1.0E-07	5.4E-08	Screened
Cs-138	1971	2.60E+04	3.73E+02	ET airways	9.4E-10	4.6E-11	3.5E-07	1.7E-08	Screened
La-140	1955	5.43E+04	7.80E+02	ET airways	1.4E-08	1.5E-09	1.1E-05	1.2E-06	Screened
Ir-192	1971	9.67E-01	1.39E-02	Lung	3.4E-08	4.9E-09	4.7E-10	6.8E-11	Screened
Hg-203	1980	4.67E+01	6.71E-01	Lung	5.1E-08	7.0E-09	3.4E-08	4.7E-09	Screened
Th-232	1967	2.00E+09	2.87E+07	Bone surface	1.5E-03	2.9E-05	4.3E+04	8.3E+02	
Th-234	1975	6.56E+03	9.42E+01	Lung	3.7E-08	5.8E-09	3.5E-06	5.5E-07	Screened
U-234	1950	3.33E+06	4.78E+04	ET airways	7.5E-05	6.8E-06	3.6E+00	3.3E-01	
U-235	1950	1.80E+05	2.58E+03	ET airways	6.9E-05	6.1E-06	1.8E-01	1.6E-02	
U-238	1950	9.45E+05	1.36E+04	ET airways	6.5E-05	5.7E-06	8.8E-01	7.7E-02	
Pu-238	1947	2.65E+05	3.81E+03	Bone surface	9.1E-04	3.0E-05	3.5E+00	1.1E-01	
Pu-239	1947	2.65E+05	3.81E+03	Bone surface	1.0E-03	3.2E-05	3.8E+00	1.2E-01	
Am-241	1995	4.02E+00	5.77E-02	Bone surface	1.1E-03	2.7E-05	6.3E-05	1.6E-06	
MFP[d]	1989	4.35E+05	6.25E+03	Lung	6.3E-07	4.7E-08	3.9E-03	2.9E-04	
P/VAP[e]	1983	2.64E+09	3.79E+07	Lung	5.9E-08	9.3E-09	2.2E+00	3.5E-01	

a. From Table 4A -1 through 4A-22.
b. Calculated assuming dispersion factor of .0036 s/m^3 and an annual inhalation rate of 3,400 m^3/hr.
c. From ICRP CD1 Database containing ICRP 68 dose coefficients (ICRP 2001).
d. Assume MFP is ^{90}Sr to give maximum estimate.
e. Assume P/VAP is ^{68}Ge to give maximum estimate.

Tables 4C-1 through 4C-26 provide estimated average air concentrations for TAs at LANL for which air monitoring data and/or emissions data were available. Air monitoring data, when available, formed the basis for estimates at each TA. For some TAs, more than one monitoring stations was active during many years. In these cases, the concentrations were averaged over all stations within the TA. For years and locations when monitoring data were not available, an estimate was made based on the relationship between source emission rate and air concentration for years when data were available (See Section 4.2.1.3).

Table 4C-1. Estimated average air concentrations for ^{239}Pu for TA-1 (pCi/m^3).[a]

Year	^{239}Pu Average Air Concentration
1943-1944	Not available[b]
1945	4.6E-01
1946	5.8E-01
1947	9.3E-01
1948-1975	Not available[b]
1976-2003	TA was decontaminated in 1975

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10^{-12} yr/m^3.
b. Source term estimates or measured air concentrations not available during these years.

Table 4C-2. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-2(pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{234}U
1943-1986	Not available[b]			
1987		2.7E+01	1.0E-06	5.3E-05
1988		7.8E+01	2.3E-05	7.1E-05
1989		2.3E+01	2.2E-06	1.0E-04
1990		1.1E+01	1.3E-06	3.7E-05
1991		5.2E+00	5.0E-07	7.5E-05
1992		4.3E+00	1.5E-06	3.7E-05
1993		2.5E+00	6.4E-06	2.7E-05
1994		4.2E+00	3.1E-06	1.7E-05
1995	5.2E-06	3.4E+00	6.2E-06	4.2E-05
1996	Not available[b]			
2000	0.00E+00	1.8E+00	1.5E-06	1.8E-05
2001-2003	Not available[b]			

a. From AIRNET database of summarized measured concentrations for TA-2, averaged over results reported at locations within the TA (LANL 2003).
b. Source term estimates or measured air concentrations not available during these years.

Table 4C-3. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, ^{232}Th, ^{234}U, MFP, and P/VAP for TA-3 (pCi/m^{3}).[a]

Year	^{241}Am	^{3}H	^{131}I	^{239}Pu	^{232}Th	^{234}U	MFP[,b]	P/VAP
1943-1951	Not available[c]							
1952				2.2E-05[d]				
1953				5.1E-04[d]				
1954				2.9E-03[d]				
1955				4.2E-03[d]				
1956				3.3E-03[d]				
1957				2.5E-03[d]				
1958				7.1E-03[d]				
1959				2.0E-03[d]				
1960				6.5E-03[d]				
1961				4.2E-03[d]				
1962				4.0E-03[d]				
1963			1.4E+00[d]	1.9E-03[d]				
1964			6.5E-01[d]	1.4E-03[d]				
1965			8.4E-01[d]	3.5E-03[d]				
1966				4.1E-03[d]				
1967				9.2E-03[d]				
1968				1.3E-02[d]				
1969				2.6E-02[d]				
1970				3.0E-02[d]				
1971		2.0E+02	1.0E-02	2.8E-04		2.6E-04		
1972	3.2E-05	3.3E+01	1.6E-02[d]	1.4E-04		7.8E-05		
1973	7.0E-06	3.5E+01	9.3E-03[d]	1.4E-04	3.4E-05[d]	1.6E-04	2.8E-02[d]	
1974			1.0E-02[d]	3.2E-03[d]		4.4E-04[d]	7.5E-04[d]	
1975		4.8E+01	3.0E-03[d]	9.2E-04[d]		4.3E-04[d]	4.0E-04[d]	
1976			6.6E-04[d]	8.7E-05[d]		8.0E-04[d]	9.1E-04[d]	
1977		8.8E+02[d]	1.9E-04[d]	7.4E-05[d]		7.4E-04[d]	1.1E-03[d]	
1978		2.2E+02[d]	1.8E-04[d]	1.3E-04[d]		4.1E-04[d]	8.9E-04[d]	
1979		6.6E+03[d]	3.5E-04[d]	2.4E-03[d]		5.7E-04[d]	1.0E-03[d]	
1980		1.0E+01[d]	2.1E-04[d]	1.6E-03[d]		3.4E-04[d]	9.3E-04[d]	
1981		2.0E+03[d]	9.7E-05[d]	8.7E-05[d]		5.2E-04[d]	3.8E-04[d]	
1982		4.3E+03[d]	1.7E-03[d]	1.6E-04[d]		7.1E-04[d]	1.7E-04[d]	
1983		5.0E+03[d]	1.8E-04[d]	1.9E-04[d]		4.0E-04[d]	3.8E-05[d]	
1984		3.9E+03[d]	1.6E-04[d]	2.5E-04[d]		4.7E-04[d]	9.1E-05[d]	
1985		4.7E+03[d]	3.2E-04[d]	4.3E-04[d]		7.6E-04[d]	7.6E-05[d]	
1986		2.7E+03[d]	8.4E-05[d]	4.3E-04[d]		1.4E-03[d]	1.1E-04[d]	
1987		1.9E+03[d]		1.4E-04[d]		1.9E-03[d]	4.8E-05[d]	
1988		1.8E+04[d]		1.1E-04[d]		1.1E-03[d]	6.5E-05[d]	
1989		6.4E+02[d]		8.6E-05[d]		8.0E-04[d]	8.4E-05[d]	
1990		1.1E+03[d]		4.8E-05[d]		4.3E-04[d]	8.6E-05[d]	
1991	1.5E-06	1.5E+01		1.2E-06		9.3E-05	3.1E-05[d]	
1992	3.2E-06	2.7E+01		2.5E-06		3.6E-05	1.9E-05[d]	
1993	1.9E-05	5.3E+00		5.6E-05		1.4E-05	1.3E-05[d]	
1994	5.8E-06	2.0E+00		3.2E-06		3.7E-05	8.4E-05[d]	
1995	1.4E-05	6.0E+00		2.9E-06		2.0E-05	2.1E-03[d]	2.1E-03[d]
1996	1.5E-06	1.3E+00		2.7E-06	3.6E-07[d]	2.3E-05		
1997	2.5E-06	3.6E+00		2.7E-06	8.4E-07[d]	1.7E-05		
1998	3.5E-06	2.7E+00		4.0E-07	9.2E-07[d]	1.5E-05		1.5E-05[d]
1999	2.2E-06	2.7E+00		2.7E-06	4.8E-07[d]	1.9E-05		
2000	0.0E+00	2.4E+00		2.6E-06	2.9E-07[d]	3.0E-05		
2001	0.0E+00	3.1E+00		6.0E-07	3.1E-07[d]	2.7E-05		
2002-2003	Not available[b]							

a. From AIRNET database of summarized measured concentrations for TA-3, averaged over results reported at locations in the TA (LANL 2003), unless otherwise indicated.
b. MFP – Mixed Fission Products; P/VAP = Particulate and Vapor Activation Products
c. Source term estimates or measured air concentrations not available during these years.
d. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 of 2.2 × 10-12 yr/m3.

Table 4C-4. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-5 (pCi/m^{3}).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{234}U
1943-1972	Not available[b]			
1973		1.0E+02	1.9E-05	4.7E-04
1974		8.1E+01	2.4E-05	1.6E-04
1975		1.7E+02	2.2E-05	1.1E-04
1976		1.2E+02	4.9E-06	9.5E-05
1977		5.7E+01	2.2E-05	1.3E-04
1978		1.6E+01	2.9E-05	9.5E-05
1979		1.5E+01	8.4E-06	1.2E-04
1980		1.7E+01	1.0E-06	8.7E-05
1981		4.4E+00	6.1E-06	6.5E-05
1982		2.5E+01	1.5E-06	6.5E-05
1983		1.7E+01	3.1E-06	7.4E-05
1984		1.8E+01	1.3E-06	5.7E-05
1985		1.2E+01	0.0E+00	5.0E-05
1986		9.8E+00	1.0E-06	4.1E-05
1987		1.9E+01	2.0E-07	6.1E-05
1988		1.5E+01	2.0E-07	1.1E-04
1989		3.5E+00	4.0E-07	1.2E-04
1990		3.2E+00	1.8E-06	5.0E-05
1991		3.7E+00	7.0E-07	8.6E-05
1992	1.4E-06	4.4E+00	8.0E-07	3.4E-05
1993		2.6E+00	1.5E-06	3.5E-05
1994		1.5E+00	1.2E-06	3.5E-05
1995	3.4E-06	2.4E+00	4.4E-06	4.8E-05
1996	2.5E-06	1.1E+00	1.2E-06	5.6E-05
1997	2.4E-06	5.5E+00	5.0E-07	2.4E-05
1998	2.0E-06	3.3E+01	1.0E-06	2.4E-05
1999	3.6E-06	2.2E+00	2.0E-07	2.1E-05
2000	3.0E-07	2.7E+00	2.0E-06	5.4E-05
2001	0.0E+00	4.2E+00	0.0E+00	3.4E-05
2002-2003	Not available[b]			

a. From AIRNET database of summarized measured concentrations for TA-3, averaged over results reported at locations in the TA (LANL 2003).

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-5. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-6 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{234}U
1943-1970	Not available[b]			
1971		3.6E+01	4.1E-05	3.7E-04
1972		2.9E+01	1.5E-04	9.3E-05
1973				
1974		1.6E+01	2.6E-05	7.8E-05
1975	1.1E-05	2.2E+01	5.5E-05	4.2E-05
1976		2.5E+01	3.9E-06	9.1E-05
1977	3.0E-07	2.5E+01	1.7E-05	2.6E-04
1978	3.0E-07	5.0E+00	2.7E-05	1.1E-04
1979	0.0E+00	2.8E+00	3.3E-06	5.1E-05
1980	1.0E-07	3.8E+00	2.6E-06	4.3E-05
1981	4.5E-05	6.7E+00	5.7E-06	5.0E-05
1982	2.0E-07	1.1E+01	1.2E-06	4.8E-05
1983		1.1E+01	1.2E-06	5.3E-05
1984		4.4E+00	1.2E-06	3.1E-05
1985		8.3E+00	1.9E-06	6.0E-05
1986	3.1E-06	3.6E+00	1.2E-06	5.8E-05
1987	1.5E-06	1.1E+01	6.0E-07	6.2E-05
1988	6.4E-06	9.4E+00	7.0E-07	8.1E-05
1989	2.8E-06	2.3E+00	4.6E-06	1.0E-04
1990	1.6E-06	1.4E+00	2.1E-06	7.2E-05
1991	9.0E-07	1.6E+00	1.0E-06	8.3E-05
1992	4.5E-06	2.7E+00	1.7E-06	2.7E-05
1993	1.5E-06	3.3E+00	2.2E-06	2.2E-05
1994	4.1E-06	1.3E+00	8.0E-07	2.8E-05
1995	5.7E-06	3.6E+00	1.2E-05	2.1E-05
1996		0.0E+00		
1997-2003	Not available[b]			

a. From AIRNET database of summarized measured concentrations for TA-3, averaged over results reported at locations within the TA (LANL 2003).

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-6. Estimated average air concentrations for ^{3}H for TA-9 (pCi/m^3).[a]

Year	^{3}H
1943-1971	Not available[b]
1972	1.5E+03
1973	7.9E+01
1974	2.9E+00
1975	Not available[b]
1976	2.8E+02
1977	5.7E+01
1978	5.7E+00
1979	1.1E+01
1980	1.1E+01
1981-2003	Not available[b]

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^3.

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-7. Estimated average air concentrations for ^{234}U for TA-10 (pCi/m3).[a]

Year	^{234}U
1943	Not available[b]
1944	2.2E-02
1945	2.2E-02
1946	6.6E-02
1947	8.8E-02
1948	1.3E-01
1949	2.2E-01
1950	1.1E+00
1951	4.4E-01
1952	4.4E-01
1953	4.4E-01
1954	8.8E-03
1955	7.3E-02
1956	7.7E-02
1957	2.4E-02
1958	1.5E-02
1959	2.6E-02
1960	1.5E-02
1961	1.9E+00
1962	4.0E-01
1963	1.1E-01
1964-2003	Not available[b]

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10-12 yr/m^3.

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-8. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-11 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{234}U
1943-1970	Not available[b]			
1971		4.2E+01	4.7E-05	1.4E-04
1972	3.3E-05	2.4E+01	4.8E-05	9.3E-05
1973		1.3E+01	2.3E-05	1.6E-04
1974-2003	Not available[b]			

a. From AIRNET database of summarized measured concentrations for TA-3, averaged over results reported at locations within the TA (LANL 2003).

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-9. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, ^{232}Th, and ^{234}U for TA-15 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{232}Th	^{234}U
1944					1.3E-01[b]
1945					2.6E-01[b]
1946					5.3E-01[b]
1947					7.9E-01[b]
1948					1.2E+00[b]
1949					1.9E+00[b]
1950					9.9E+00[b]
1951					4.4E+00[b]
1952					4.0E+00[b]
1953					3.5E+00[b]
1954					3.3E+00[b]
1955					2.6E+00[b]
1956					1.7E+00[b]
1957					2.6E+00[b]
1958					2.4E+00[b]
1959					1.1E+00[b]
1960					1.6E+00[b]
1961					7.7E-01[b]
1962					1.0E+00[b]
1963					8.7E-01[b]
1964					1.3E+00[b]
1965					1.3E+00[b]
1966					2.1E+00[b]
1967		7.9E+03[b]		4.4E+03[b]	1.6E+00[b]
1968		9.9E+03[b]		4.4E+03[b]	1.2E+00[b]
1969		9.9E+03[b]			9.4E-01[b]
1970		6.3E+04[b]			6.8E-01[b]
1971		8.2E+01	4.2E-05		7.0E-04
1972	2.2E-05	2.8E+01	5.1E-05		9.3E-05
1973	2.0E-06	2.1E+01	1.6E-05		3.1E-04
1974-1977	Not available[c]				
1978		1.6E+02[b]			
1979-1991	Not available[c]				
1992					5.0E-03[b]
1993		1.1E+00			1.1E-02[b]
1994		2.0E+00	4.0E-07		6.7E-05
1995	5.1E-06	1.8E+00	3.7E-06		1.4E-05
1996	2.3E-06	1.1E+00	1.4E-06		5.2E-05
1997	2.0E-06	1.9E+00	6.5E-07		2.9E-05
1998	2.2E-06	2.1E+00	8.0E-07		1.4E-05
1999	2.3E-06	1.7E+00	8.0E-07		1.9E-05
2000	4.0E-07	1.8E+00	5.0E-08		2.7E-05
2001	2.5E-07	2.3E+00	0.0E+00		6.6E-05
2002	2.0E-08	2.8E+00	0.0E+00		3.8E-05
2003	Not available[c]				

a. From AIRNET database of summarized measured concentrations for TA-15, averaged over results reported at locations within the TA (LANL 2003), unless otherwise indicated.

b. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^3.

c. Source term estimates or measured air concentrations not available during these years.

Table 4C-10. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, and ^{234}U for TA-16 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{131}I	^{239}Pu	^{234}U
1943-1953	Not available[b]				
1954					8.4E-02[c]
1955					
1956					
1957					3.1E-02[c]
1958					
1959					2.2E-03[c]
1960					1.1E-01[c]
1961					
1962					
1963					1.1E-01[c]
1964					6.6E-03[c]
1965					8.8E-03[c]
1966					
1967					1.1E-02[c]
1968					8.6E-02[c]
1969					6.6E-03[c]
1970					2.4E-02[c]
1971		4.5E+01	1.0E-02	6.1E-05	3.2E-04
1972	4.0E-05	3.1E+01		5.7E-05	9.3E-05
1973	3.0E-06	1.6E+01		2.8E-05	1.6E-04
1974		1.2E+01		3.0E-05	1.1E-04
1975	4.0E-06	1.8E+01		1.9E-05	4.0E-05
1976		2.0E+01		4.7E-06	5.4E-05
1977	0.0E+00	3.0E+01		1.9E-05	4.3E-04
1978	0.0E+00	6.0E+00		3.6E-05	7.4E-05
1979	0.0E+00	2.2E+00		2.0E-05	4.0E-05
1980	0.0E+00	1.1E+01		1.1E-06	4.7E-05
1981	1.9E-06	1.9E+00		3.6E-06	3.6E-05
1982	3.0E-07	1.0E+01		1.0E-06	3.6E-05
1983		1.1E+01		5.5E-07	3.6E-05
1984		1.3E+01		0.0E+00	2.0E-05
1985		9.5E+00		3.9E-06	4.3E-05
1986	2.7E-06	4.7E+00		6.0E-07	2.1E-05
1987	1.0E-06	9.9E+00		7.5E-07	2.9E-05
1988	1.9E-06	4.3E+00		8.5E-07	5.3E-05
1989	2.4E-06	2.7E+00		6.0E-07	9.1E-05
1990	2.8E-06	1.1E+00		1.6E-06	5.2E-05
1991	1.2E-06	5.0E-01		1.0E-06	6.1E-05
1992	1.1E-06	1.6E+00		6.0E-06	2.8E-05
1993		9.0E-01		5.0E-07	1.9E-05
1994		9.1E+00		0.0E+00	2.6E-05
1995	4.6E-06	1.8E+02		3.3E-06	1.9E-05
1996	1.8E-06	2.4E+01		4.0E-07	2.7E-05
1997	2.2E-06	6.2E+01		8.0E-07	1.9E-05
1998	2.6E-06	2.5E+02		9.0E-07	2.9E-05
1999	3.2E-06	5.5E+01		1.2E-06	1.5E-05
2000	0.0E+00	6.1E+01		0.0E+00	1.4E-05
2001	2.0E-07	6.8E+01		0.0E+00	1.9E-05
2002-2003	Not available[b]				

a. From AIRNET database of summarized measured concentrations for TA-16, averaged over results reported at locations within the TA (LANL 2003), unless otherwise indicated.

b. Source term estimates or measured air concentrations not available during these years.

c. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10-12 yr/m^3.

Table 4C-11. Estimated average estimated air concentrations for ^{234}U for TA-18 (pCi/m).[a]

Year	^{234}U
1943-1978	Not available[b]
1979	8.7E-06
1980-2003	Not available[b]

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10-12 yr/m^3.

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-12. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, ^{234}U, and MFP for TA-21 (pCi/m^{3}).[a]

Year	^{241}Am	^{3}H	^{131}I	^{239}Pu	^{234}U	MFP[b]
1943-1947	Not available[c]					
1948				3.4E-01[d]		
1949				3.4E-01[d]		
1950				4.1E-01[d]		
1951				5.9E-02[d]		
1952				1.3E-01[d]		
1953				7.7E-02[d]		
1954				4.8E-02[d]		
1955				1.9E-01[d]		
1956				1.7E-01[d]		
1957				1.6E-01[d]		
1958				1.8E-01[d]		
1959				4.1E-01[d]		
1960				7.8E-02[d]		
1961				1.4E-02[d]		
1962				1.8E-02[d]	1.4E-02[d]	
1963				6.3E-02[d]	6.7E-02[d]	
1964				2.7E-02[d]	5.1E-03[d]	
1965				2.0E-02[d]	2.0E-02[d]	
1966				2.3E-02[d]	2.2E-02[d]	
1967				2.2E-02[d]	1.5E-02[d]	
1968				4.3E-03[d]	2.9E-03[d]	
1969				9.2E-03[d]	7.8E-03[d]	
1970				6.2E-03[d]	2.3E-03[d]	
1971		8.5E+01		2.9E-05	1.2E-04	
1972		3.6E+01		8.4E-05	1.1E-04	
1973		1.5E+02		2.3E-05	1.6E-04	2.2E-06[d]
1974		6.8E+01		2.4E-05	7.8E-05	6.4E-06[d]
1975		6.4E+01		1.8E-05	4.8E-05	3.2E-06[d]
1976		4.0E+01		7.6E-06	6.5E-05	1.2E-06[d]
1977		5.2E+01		2.1E-05	1.5E-04	7.2E-06[d]
1978	7.5E-08[d]	2.3E+01		2.3E-05	1.5E-04	2.3E-06[d]
1979	4.2E-08[d]	3.8E+00		6.1E-06	1.3E-04	1.0E-06[d]
1980	1.3E-07[d]	1.1E+01		3.1E-05	1.1E-04	9.2E-06[d]
1981	6.4E-08[d]	5.6E+00		4.6E-06	5.6E-05	6.2E-06[d]
1982	7.7E-08[d]	1.6E+01		6.0E-06	1.5E-04	9.6E-07[d]
1983	2.1E-07[d]	2.0E+01		9.0E-07	4.8E-05	1.7E-06[d]
1984		8.8E+00		1.5E-06	1.0E-04	6.9E-07[d]
1985		1.6E+01		4.0E-07	6.6E-05	7.9E-07[d]
1986		1.6E+01		1.4E-06	5.4E-05	7.1E-07[d]
1987		5.2E+01		1.1E-06	5.4E-05	4.1E-07[d]
1988		4.0E+01		8.0E-07	8.1E-05	3.4E-07[d]
1989		1.7E+01		1.3E-06	1.3E-04	6.8E-08[d]
1990		1.3E+01		2.2E-06	7.6E-05	2.9E-08[d]
1991	0.0E+00	8.5E+00		1.9E-06	8.4E-05	6.6E-08[d]
1992	2.7E-06	9.4E+00	1.0E+00	2.5E-06	3.8E-05	5.3E-08[d]
1993	3.6E-06	4.2E+00		4.9E-06	2.8E-05	2.2E-08[d]
1994	6.4E-06	3.4E+00		6.6E-06	2.8E-05	1.1E-07[d]
1995	6.2E-06	8.0E+00		1.2E-05	3.2E-05	
1996	4.2E-06	3.1E+00		1.7E-05	2.5E-04	
1997	4.3E-06	4.8E+00		1.7E-05	2.1E-05	
1998	5.6E-06	1.1E+01		2.6E-05	1.6E-05	
1999	2.9E-06	6.1E+00		3.5E-06	2.2E-05	
2000	9.3E-07	7.3E+00		3.7E-06	2.0E-05	
2001	0.0E+00	7.2E+00		3.7E-06	2.6E-05	
2002-2003	Not available[c]					

a. From AIRNET database of summarized measured concentrations for TA-21, averaged over results reported at locations within the TA (LANL 2003), unless otherwise indicated.
b. MFP – Mixed Fission Products.
c. Source term estimates or measured air concentrations not available during these years.
d. Based on estimated average ratio of plutonium activity:source emission activity for TA-21 of 2.28×10^{-12} yr/m^{3}.

Table 4C-13. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, and ^{234}U for TA-33 (pCi/m^{3}).[a]

Year	^{241}Am	^{3}H	^{131}I	^{239}Pu	^{234}U
1943-1965	Not available[b]				
1966					2.2E-02[c]
1967-1870	Not available[b]				
1971		5.0E+02	1.0E-02	8.3E-05	1.2E-04
1972		1.8E+02		5.5E-05	1.4E-04
1973		6.0E+01		1.7E-05	3.1E-04
1974		1.4E+02		2.8E-05	1.1E-04
1975		1.6E+02		2.3E-05	3.9E-05
1976		5.9E+01		5.3E-06	6.4E-05
1977		8.0E+00		1.8E-05	1.2E-04
1978		2.5E+01		2.8E-05	9.5E-05
1979		4.0E+01		6.9E-06	6.0E-05
1980		4.4E+01		3.5E-06	7.0E-05
1981		3.0E+01		3.9E-06	5.6E-05
1982		8.8E+01		2.4E-06	5.7E-05
1983		3.6E+01		0.0E+00	3.3E-05
1984		5.6E+01		7.0E-06	2.8E-05
1985		1.1E+02		0.0E+00	3.0E-05
1986		3.1E+01		6.0E-07	2.2E-05
1987		2.0E+01		8.0E-07	5.1E-05
1988		5.8E+01		4.0E-07	1.5E-04
1989		1.8E+01		0.0E+00	8.2E-05
1990		7.9E+00		7.3E-06	8.7E-05
1991		3.2E+00		7.0E-07	1.9E-05
1992		3.7E+00		9.0E-07	1.5E-05
1993		3.0E+00		1.8E-06	1.6E-05
1994		1.8E+00		5.0E-07	1.5E-05
1995	3.9E-06	3.5E+00		1.5E-05	1.7E-05
1996		1.4E+00			
1997	3.1E-06	9.0E-01		1.4E-06	1.3E-05
1998	2.4E-06	1.3E+00		1.4E-06	1.5E-05
1999	2.5E-06	4.0E+00		1.2E-06	2.0E-05
2000	0.0E+00	3.4E+00		2.0E-07	1.1E-05
2001		3.3E+00		0.0E+00	1.4E-05
2002-2003					

a. From AIRNET database of summarized measured concentrations for TA-33, averaged over results reported at locations within the TA (LANL 2003), unless otherwise indicated.
b. Source term estimates or measured air concentrations not available during these years.
c. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10-12 yr/m^{3}.

Table 4C-14. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, ^{234}U, MFP, and P/VAP for TA-35 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{234}U	MFP[b]	P/VAP[b]
1943-1966	Not available[c]					
1967			1.5E-05			
1968			1.3E-05			
1969			1.2E-05			
1970			9.3E-06			
1971		6.9E+03	1.6E-05			
1972		5.5E+03	3.9E-05			
1973		2.7E+03	5.2E-06			
1974		3.1E+03	1.8E-05			
1975		5.3E+03	1.3E-05			
1976		3.7E+03	5.2E-06			
1977		1.7E+03	1.8E-06			
1978		1.5E+03	4.3E-06			
1979		2.9E+03	1.6E-05			
1980		5.5E+01	4.6E-07			
1981			5.9E-07			
1982			2.9E-06			
1983		1.3E+01	2.0E-06			
1984		4.5E+02	9.2E-07			
1985		1.2E+01	1.2E-06			
1986		1.0E+02	8.0E-07			
1987		3.4E+02	1.4E-06			
1988		2.6E+02	3.8E-07			
1989		4.0E+01	1.5E-06			
1990		8.8E-02	2.0E-06			
1991		9.5E-06	2.7E-06			
1992		2.2E-01	7.9E-07			
1993			5.9E-07			
1994			8.6E-07			
1995	7.8E-08		6.5E-07	1.5E-06	3.6E-06	3.6E-06
1996-2003	Not available[c]					

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10-12 yr/m^3.

b. MFP – Mixed Fission Products; P/VAP = Particulate and Vapor Activation Products

c. Source term estimates or measured air concentrations not available during these years.

Table 4C-15. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-36 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{234}U
1943-1957	Not available[b]			
1958				9.5E-02[c]
1959				1.8E-02[c]
1960				3.1E-02[c]
1961	Not available[b]			
1962				2.2E-02[c]
1963				3.1E-02[c]
1964				8.8E-03[c]
1965				4.4E-02[c]
1966				6.2E-02[c]
1967				1.1E-01[c]
1968				5.9E-02[c]
1969				4.2E-02[c]
1970				1.3E-02[c]
1971		3.8E+01	2.7E-05	9.5E-02
1972		2.9E+01	5.7E-05	1.8E-02
1973		2.9E+01	2.2E-05	3.1E-02
1974-1992	Not available[b]			
1993		1.1E+00		
1994		1.3E+00	1.2E-05	7.0E-05
1995	4.6E-06	3.7E+00	1.1E-05	9.0E-05
1996	1.5E-06	1.1E+00	8.0E-07	4.9E-05
1997	2.0E-06	1.4E+00	6.5E-07	3.8E-05
1998	2.1E-06	1.8E+00	2.5E-07	3.5E-05
1999	3.6E-06	1.7E+00	4.5E-07	3.5E-05
2000	5.0E-07	1.6E+00	1.5E-07	3.3E-05
2001	0.0E+00	2.5E+00	0.0E+00	1.5E-04
2002	2.0E-08	2.8E+00	0.0E+00	3.8E-05
2003	Not available[b]			

a. From AIRNET database of summarized measured concentrations for TA-36, averaged over results reported at locations within the TA (LANL 2003), unless otherwise indicated.
b. Source term estimates or measured air concentrations not available during these years.
c. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10-12 yr/m^3.

Table 4C-16. Estimated average air concentrations for ^{3}H, ^{239}Pu, and ^{234}U for TA-39 (pCi/m^3).[a]

Year	^{3}H	^{239}Pu	^{234}U
1943-1953	Not available[b]		
1954			4.2E-01[c]
1955			3.3E-01[c]
1956			3.8E-01[c]
1957			5.9E-01[c]
1958			6.3E-01[c]
1959			4.2E-01[c]
1960			2.6E-01[c]
1961			3.6E-01[c]
1962			3.6E-01[c]
1963			2.8E-01[c]
1964			2.5E-01[c]
1965			2.4E-01[c]
1966			2.7E-01[c]
1967			4.4E-01[c]
1968			1.1E-01[c]
1969			1.5E-01[c]
1970			1.1E-01[c]
1971			1.9E-01[c]
1972			2.4E-01[c]
1973-1976	Not available[b]		
1977	3.9E+01	1.0E-07	1.2E-04
1978	1.5E+01	3.5E-05	1.3E-04
1979	1.6E+01	3.7E-06	4.0E-05
1980	2.8E+01	4.4E-06	7.3E-05
1981	1.2E+01	2.0E-06	4.8E-05
1982	1.5E+02	2.7E-06	8.4E-05
1983	3.1E+01	1.8E-06	1.6E-05
1984	1.4E+01	0.0E+00	3.6E-05
1985	4.2E+01	0.0E+00	5.1E-05
1986	2.5E+01	1.5E-06	3.0E-05
1987-2003	Not available[b]		

a. From AIRNET database of summarized measured concentrations for TA-39, averaged over results reported at locations within the TA (LANL 2003), unless otherwise indicated.

b. Source term estimates or measured air concentrations not available during these years.

c. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10-12 yr/m^3.

Table 4C-17. Estimated average air concentrations for ^{3}H, Pu, and U for TA-41 (pCi/m^3).[a]

Year	^{3}H	^{239}Pu	^{234}U
1943-1966	Not available[b]		
1967		2.64E-04	
1968		7.26E-05	
1969		1.98E-05	
1970		1.72E-05	
1971	7.0E+02	4.18E-05	
1972	2.4E+02	2.42E-05	
1973	1.3E+02	3.34E-06	
1974-1978	Not available[b]		
1979	3.1E+02		
1980	9.1E+02		
1981	2.8E+02		
1982	2.9E+02		
1983	2.1E+03		
1984	1.1E+04		
1985	2.8E+03		
1986	2.9E+03		
1987	1.0E+03		
1988	3.8E+03		
1989	2.6E+04		
1990	9.8E+03		
1991	8.4E+03		
1992	6.4E+02		
1993	1.1E+03	2.2E-08	
1994	3.8E+02	4.4E-08	
1995	1.7E+02	3.4E-08	2.0E-08
1996	2.4E+02		
1997	9.2E+01		
1998	7.9E+01		
1999	2.9E+01		
2000	1.4E+01		
2001	1.2E+03		
2002-2003	Not available[b]		

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^3.

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-18. Estimated average air concentrations for ^{239}Pu for TA-42 (pCi/m^3).[a]

Year	^{239}Pu
1943-1968	Not available[b]
1969	1.8E-03
1970-2003	Not available[b]

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^3.

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-19. Estimated average air concentrations for ^{241}Am , ^{3}H, ^{239}Pu, and ^{234}U for TA-43 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{234}U
1943-1971	Not available[b]			
1971		4.3E+01	1.1E-04	2.2E-04
1972		2.8E+01	1.0E-04	9.3E-05
1973		1.4E+01	5.2E-05	1.6E-04
1974			1.5E-05[c]	
1975			3.6E-06[c]	
1976			1.7E-05[c]	
1977			1.0E-05[c]	
1978			3.4E-06[c]	
1979			1.7E-06[c]	
1980			4.0E-07[c]	
1981			8.1E-07[c]	
1982			3.1E-06	
1983			7.3E-06[c]	
1984			2.3E-06[c]	
1985			4.0E-06[c]	
1986			6.4E-06[c]	
1987			1.1E-06[c]	
1988			3.2E-06[c]	
1989-1994	Not available[b]			
1995	5.9E-07[c]		1.2E-06[c]	2.5E-06[c]
1996-2003	Not available[b]			

a. From AIRNET database of summarized measured concentrations for TA-43, averaged over results reported at locations in the TA (LANL 2003), unless otherwise indicated.

b. Source term estimates or measured air concentrations not available during these years.

c. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^3.

Table 4C-20. Estimated average air concentrations for ^{234}U for TA-46 (pCi/m^3).[a]

Year	^{234}U
1943-1970	Not available[b]
1971	8.8E-06
1972	2.6E-04
1973	4.8E-06
1974	9.0E-07
1975	1.1E-06
1976	6.8E-07
1977	8.8E-09
1978	5.6E-05
1979	5.0E-06
1980	3.3E-06
1981	3.0E-05
1982	4.5E-06
1983	7.9E-08
1984	1.1E-07
1985	6.2E-08
1986	8.8E-09
1987-2003	Not available[b]

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^3, unless otherwise indicated.

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-21. Estimated average air concentrations for ^{241}Am , ^{239}Pu, ^{234}U, MFP, and P/VAP for TA-48 (pCi/m^3).[a]

Year	^{241}Am	^{239}Pu	^{234}U	MFP[b]	P/VAP[b]
1943-1966	Not available[c]				
1967		2.4E-04			
1968		3.3E-04			
1969		2.9E-04			
1970		1.3E-04			
1971		4.2E-05			
1972		2.5E-04	1.8E-05		
1973		4.4E-05	4.3E-06	2.2E-03	
1974		5.3E-05	2.8E-06	2.1E-03	
1975		2.7E-05	7.6E-06	1.6E-03	
1976		1.1E-05	2.5E-04	2.7E-03	
1977		1.8E-05	1.2E-04	4.8E-03	
1978		4.2E-06	2.5E-05	2.6E-03	
1979		7.4E-07	2.4E-05	2.4E-03	
1980		3.5E-06	1.5E-06	3.9E-03	
1981		2.9E-06	5.1E-06	3.0E-03	
1982		2.2E-05	1.6E-05	2.4E-03	
1983		7.3E-06	1.1E-06	1.8E-03	
1984		5.6E-06	2.9E-06	3.5E-03	
1985		4.6E-06	4.2E-06	2.7E-03	
1986		6.3E-06	1.3E-06	5.5E-03	
1987		1.4E-06	3.5E-06	2.8E-03	
1988		1.6E-06	4.8E-07	2.4E-03	
1989		3.3E-06	5.9E-07	9.6E-01	
1990		3.3E-06	3.7E-07	2.3E-03	
1991		1.3E-06		2.4E-03	2.2E-01
1992		1.5E-05	9.2E-07	6.0E-03	8.3E-02
1993		7.0E-06	3.1E-06	3.0E-03	1.7E-01
1994		7.1E-06	8.8E-07	8.6E-04	1.8E-01
1995	3.8E-06	6.8E-06	1.2E-06	5.8E-02	5.8E-02
1996	1.1E-08	2.4E-08			2.2E-04
1997	7.9E-10	5.5E-09	3.1E-07		4.0E-03
1998	8.1E-10				2.4E-04
1999			1.3E-09		8.6E-03
2000					3.7E-02
2001					5.1E-03
200-2003	Not available[c]				

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2 × 10^{-12} yr/m^3.
b. MFP – Mixed Fission Products; P/VAP = Particulate and Vapor Activation Products
c. Source term estimates or measured air concentrations not available during these years.

Table 4C-22. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, and ^{234}U for TA-49 (pCi/m^{3}).[a]

Year	^{241}Am	^{3}H	^{131}I	^{239}Pu	^{234}U
1943-1970	Not available[b]				
1971		1.5E+02	1.0E-02	8.4E-05	3.7E-04
1972		2.1E+01		7.6E-05	1.9E-04
1973		3.2E+01		1.9E-05	1.6E-04
1974		2.2E+01		3.2E-05	1.4E-04
1975	1.0E-06	2.1E+01		2.1E-05	4.2E-05
1976		2.2E+01		4.3E-06	8.4E-05
1977	0.0E+00	1.2E+01		1.6E-05	1.7E-04
1978	0.0E+00	5.0E+00		2.6E-05	9.5E-05
1979	0.0E+00	5.4E+00		4.6E-06	6.4E-05
1980	2.2E-06	2.1E+00		6.4E-06	5.9E-05
1981	9.0E-07	4.4E+00		5.9E-06	5.1E-05
1982	0.0E+00	6.9E+00		1.8E-06	7.4E-05
1983		1.1E+01		1.0E-07	1.0E-05
1984		1.3E+01		8.0E-07	2.5E-05
1985		3.6E+01		5.2E-06	3.9E-05
1986		2.5E+00		1.0E-06	3.2E-05
1987	1.2E-06	1.8E+01		6.0E-07	3.1E-05
1988	6.6E-06	9.6E+00		7.0E-07	4.6E-05
1989		2.6E+00		0.0E+00	6.9E-05
1990	1.7E-06	1.1E+00		8.0E-07	4.2E-05
1991	1.1E-06	9.0E-01		1.7E-06	3.6E-05
1992	5.0E-07	1.6E+00		1.3E-05	5.1E-05
1993	1.5E-06	2.4E+00		2.8E-06	3.4E-05
1994	4.6E-06	1.5E+00		2.6E-06	2.1E-05
1995	3.4E-06	2.2E+00		3.1E-06	1.9E-05
1996	4.8E-06	1.7E+00		5.2E-06	2.4E-05
1997	2.1E-06	3.5E+00		6.0E-07	8.6E-06
1998	3.2E-06	6.7E+00		1.3E-06	1.8E-05
1999	2.8E-06	3.4E+00		4.5E-07	1.8E-05
2000	1.5E-05	3.6E+00		2.0E-07	1.3E-05
2001-2003	Not available[b]				

a. From AIRNET database of summarized measured concentrations for TA-49, averaged over results reported at locations in the TA (LANL 2003).
b. Source term estimates or measured air concentrations not available during these years.

Table 4C-23. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, ^{232}Th, ^{234}U, and MFP for TA-50 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{131}I	^{239}Pu	^{232}Th	^{234}U	MFP[b]
1943-1966	Not available[c]						
1967				2.2E-04[d]			
1968				1.5E-04[d]			
1969				9.2E-05[d]			
1970				4.5E-05[d]			
1971		6.3E+02	1.0E-02	3.5E-05[d]			
1972				6.0E-05[d]			
1973				5.5E-06[d]			3.8E-05[d]
1974				8.6E-06[d]			2.1E-04[d]
1975				9.0E-06[d]			1.0E-04[d]
1976				2.4E-06[d]			6.5E-05[d]
1977				1.5E-04[d]			2.0E-04[d]
1978				3.8E-05[d]			9.5E-05[d]
1979				6.4E-06[d]			2.5E-05[d]
1980				2.6E-06[d]			2.0E-05[d]
1981				3.9E-06[d]			5.8E-05
1982				1.4E-05[d]			3.5E-05[d]
1983				1.2E-05[d]			2.2E-05
1984				8.1E-06[d]			2.1E-05[d]
1985				4.4E-06[d]			2.0E-05[d]
1986				6.3E-06[d]			4.8E-05[d]
1987				9.9E-06[d]			5.1E-05[d]
1988				4.5E-06[d]			3.3E-05[d]
1989				1.0E-06[d]			2.3E-05[d]
1990				3.3E-07[d]			9.3E-06[d]
1991				3.0E-06[d]			7.4E-06[d]
1992				1.2E-06[d]			8.5E-06[d]
1993				6.2E-07[d]			8.9E-06[d]
1994				6.8E-07[d]			1.6E-05[d]
1995	1.4E-07[d]			1.6E-06[d]			
1996	2.4E-08[d]			9.2E-08[d]		4.2E-07[d]	
1997	1.8E-08[d]			1.2E-07[d]		2.9E-09[d]	
1998	1.4E-08[d]			3.3E-08[d]	1.7E-07[d]	4.2E-07[d]	
1999	2.9E-07[d]			1.1E-07[d]	8.1E-08[d]	4.2E-08[d]	
2000				2.2E-08[d]	1.2E-07[d]		
2001	1.3E-10[d]			9.5E-08[d]			
2002-2003	Not available[c]						

a. From AIRNET database of summarized measured concentrations for TA-50, averaged over results reported at locations in the TA (LANL 2003), unless otherwise noted.
b. 2.2MFP – Mixed Fission Products.
c. Source term estimates or measured air concentrations not available during these years.
d. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^3.

Table 4C-24. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{131}I, ^{239}Pu, ^{234}U, and P/VAP for TA-53 (pCi/m^3).[a]

Year	^{241}Am	^{3}H	^{131}I	^{239}Pu	^{234}U	P/VAP[b]
1943-1970	Not available[c]					
1971		7.9E+01		6.6E-05	2.5E-04	
1972	4.4E-05	3.3E+01		6.4E-05	1.1E-04	
1973	2.0E-06	3.2E+01		2.5E-05	1.6E-04	
1974		9.8E+01		3.1E-05	1.7E-04	
1975	3.0E-06	7.1E+01		2.3E-05	8.2E-05	
1976		4.9E+01		5.0E-06	9.6E-05	
1977	1.2E-06	3.5E+01		1.8E-05	1.7E-04	
1978	0.0E+00	1.3E+01		1.7E-05	6.2E-05	
1979	0.0E+00	4.3E+00		4.9E-06	1.2E-04	
1980	9.0E-07	6.2E+00		7.2E-06	1.3E-04	
1981	1.3E-06	5.4E+00		6.3E-06	4.0E-05	
1982	1.0E-07	7.3E+00		2.2E-06	8.2E-05	4.0E+02[d]
1983		1.1E+01		1.0E-06	3.9E-05	5.8E+03[d]
1984		8.9E+00		6.0E-07	5.1E-05	5.5E+03[d]
1985		1.2E+01		1.2E-06	4.2E-05	4.4E-01[d]
1986	3.0E-06	9.6E+00		8.0E-07	4.8E-05	2.2E-01[d]
1987	8.0E-07	1.5E+01		4.0E-07	4.7E-05	4.4E-01[d]
1988	2.1E-06	2.4E+01		2.3E-06	8.9E-05	2.2E-01[d]
1989	3.3E-06	3.4E+00		1.0E-06	1.1E-04	2.2E-01[d]
1990	2.2E-06	3.9E+00		2.4E-06	1.1E-04	1.8E-01[d]
1991	7.0E-07	1.1E+00		3.0E-06	6.1E-05	4.4E-01[d]
1992	1.8E-06	4.9E+00		2.5E-06	7.8E-05	1.6E+00[d]
1993	3.7E-06	2.4E+00		1.4E-06	1.9E-05	2.2E+01[d]
1994	3.9E-06	1.9E+00		2.5E-06	2.1E-05	6.9E-01[d]
1995	6.1E-06	2.7E+00		1.1E-05	1.8E-05	6.3E-01[d]
1996		8.0E-01	7.7E-04[d]			3.1E-01[d]
1997		3.7E+01[d]				2.0E+00[d]
1998		8.4E+00[d]				7.3E+00[d]
1999		5.1E+00[d]				5.5E-03[d]
2000		6.4E+00[d]				2.0E+00[d]
2001		1.4E+01				2.4E+00[d]
2002-2003	Not available[c]					

a. From AIRNET database of summarized measured concentrations for TA-53, averaged over results reported at locations in the TA (LANL 2003), unless otherwise indicated.
b. MFP – Mixed Fission Products; P/VAP = Particulate and Vapor Activation Products.
c. Source term estimates or measured air concentrations not available during these years.
d. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^3.

Table 4C-25. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, and ^{234}U for TA-54 (pCi/m^{3}).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{234}U
1943-1975	Not available[b]			
1976		3.3E+02	3.1E-05	1.7E-04
1977	5.2E-06	1.9E+02	3.6E-05	2.6E-04
1978	2.2E-06	5.7E+01	8.3E-05	1.6E-04
1979	5.0E-06	3.5E+01	2.3E-05	1.2E-04
1980	4.2E-06	5.3E+01	1.4E-05	1.4E-04
1981	1.6E-06	2.2E+01	1.1E-05	1.3E-04
1982	9.0E-07	2.3E+01	1.4E-05	1.3E-04
1983		1.8E+01	7.0E-07	4.7E-05
1984		6.3E+01	1.8E-05	1.0E-04
1985		7.6E+01	2.4E-05	9.9E-05
1986	1.8E-05	2.8E+01	2.3E-05	9.5E-05
1987	9.5E-06	3.2E+01	1.4E-05	8.3E-05
1988	3.8E-06	2.3E+01	1.8E-05	2.5E-04
1989	8.9E-06	2.9E+01	1.7E-05	1.4E-04
1990	3.2E-06	1.6E+01	4.8E-06	8.1E-05
1991	4.1E-06	8.1E+01	1.8E-05	9.5E-05
1992	1.9E-06	4.4E+01	4.9E-06	3.2E-05
1993	3.8E-06	3.9E+01	8.0E-06	3.5E-05
1994	6.3E-06	3.3E+01	7.1E-06	9.9E-05
1995	1.4E-05	4.4E+01	1.8E-05	5.8E-05
1996	6.3E-05	5.1E+01	8.5E-05	5.6E-05
1997	9.7E-05	8.4E+01	1.5E-04	6.2E-05
1998	1.5E-05	1.3E+02	2.3E-05	7.6E-05
1999	1.6E-05	1.0E+02	2.4E-05	1.2E-04
2000	1.3E-05	1.2E+02	1.0E-05	8.5E-05
2001	1.0E-05	2.3E+02	5.9E-06	5.9E-05
2002	5.2E-05	1.2E+02	1.0E-04	6.0E-05
2003	Not available[b]			

a. From AIRNET database of summarized measured concentrations for TA-54, averaged over results reported at locations in the TA (LANL 2003).

b. Source term estimates or measured air concentrations not available during these years.

Table 4C-26. Estimated average air concentrations for ^{241}Am, ^{3}H, ^{239}Pu, ^{232}Th, and ^{234}U for TA-55 (pCi/m^{3}).[a]

Year	^{241}Am	^{3}H	^{239}Pu	^{232}Th	^{234}U
1943-1977	Not available[b]				
1978			8.8E-07		
1979			2.4E-07		
1980			6.5E-07		
1981			2.1E-07		
1982		4.1E+01	5.7E-06		
1983		9.7E+01	2.4E-06		
1984		3.3E+02	2.3E-06		
1985			2.4E-06		
1986		2.2E+03	5.1E-07		
1987		1.9E+02	5.4E-07		
1988		6.9E+02	3.4E-05		
1989		5.9E+02	4.9E-06		
1990		3.7E+02	1.0E-06		
1991		2.0E+02	4.4E-06		
1992		2.2E+02	2.5E-06		
1993		1.4E+02	3.7E-07		
1994		5.0E+01	2.6E-07		
1995	1.2E-08	3.4E+01	3.6E-08		
1996	6.8E-08	6.8E+01	1.9E-07		1.2E-07
1997		2.6E+01	2.4E-07	9.7E-08	
1998	8.4E-09	2.6E+01	1.4E-07	6.6E-08	
1999	1.2E-07	4.0E+00	1.4E-07		1.6E-07
2000	7.3E-07	1.4E+01	5.5E-06		
2001	1.4E-08	7.3E+00	9.5E-08	3.3E-07	3.7E-07
2002-2003	Not available[b]				

a. Based on estimated average ratio of plutonium activity:source emission activity for TA-3 and TA-21 of 2.2×10^{-12} yr/m^{3}.

b. Source term estimates or measured air concentrations not available during these years.

Table 4D-1. Estimated average annual air concentrations of ^{41}Ar for TA-2 (uCi/m^3).[a]

Year	^{41}Ar
1944-1966	No emissions data available
1967	1.13E-02
1968	4.73E-03
1969	1.31E-03
1970	9.48E-04
1971	1.14E-03
1972	4.67E-04
1973	1.99E-04
1974	2.28E-06
1975	1.73E-04
1976	2.47E-04
1977	2.30E-04
1978	1.74E-04
1979	2.56E-04
1980	3.74E-04
1981	2.19E-04
1982	2.49E-04
1983	3.05E-04
1984	2.44E-04
1985	2.84E-04
1986	2.01E-04
1987	1.69E-04
1988	1.93E-04
1989	1.62E-04
1990	1.17E-04
1991	1.48E-04
1992	1.02E-04
1993-2003	Reactors not in operation

a. Receptor assumed to be at 500 m from ground-level release point.

Table 4D-2. Estimated average annual air concentrations of gaseous/mixed activation products for TA-53, TA-21, and TA-72 (uCi/m^3).

Year	TA-53[a]	TA-21[b]	TA-72[c]
1943-1975	LANSCE not in operation		
1976	4.30E-03	2.37E-04	7.10E-04
1977	3.47E-02	1.91E-03	5.73E-03
1978	8.53E-02	4.70E-03	1.41E-02
1979	8.68E-02	4.78E-03	1.43E-02
1980	1.06E-01	5.86E-03	1.76E-02
1981	2.57E-01	1.42E-02	4.25E-02
1982	1.83E-01	1.01E-02	3.02E-02
1983	3.36E-01	1.85E-02	5.55E-02
1984	5.35E-01	2.95E-02	8.84E-02
1985	9.19E-02	5.06E-03	1.52E-02
1986	8.17E-02	4.50E-03	1.35E-02
1987	1.09E-01	6.02E-03	1.81E-02
1988	8.82E-02	4.86E-03	1.46E-02
1989	1.14E-01	6.27E-03	1.88E-02
1990	8.97E-02	4.94E-03	1.48E-02
1991	4.17E-02	2.30E-03	6.89E-03
1992	5.25E-02	2.89E-03	8.67E-03
1993	2.33E-02	1.29E-03	3.86E-03
1994	3.65E-02	2.01E-03	6.02E-03
1995	3.18E-02	1.75E-03	5.25E-03
1996	8.02E-03	4.42E-04	1.33E-03
1997	1.46E-02	8.03E-04	2.41E-03
1998	5.69E-03	3.13E-04	9.40E-04
1999	2.19E-04	1.20E-05	3.61E-05
2000	5.03E-04	2.77E-05	8.31E-05
2001	4.30E-03	2.37E-04	7.11E-04
2002			
2003			

a. Receptor assumed to be at 500 m from ground-level release point.

b. Receptor assumed to be at 2,000 m from 30-m stack release height.

c. Receptor assumed to be at 700 m from 30-m stack release height.