

*Radioactive Air Emissions*

*1992 Summary*

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**MASTER**

EP

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## *Abstract*

This report summarizes, by radionuclide or product and by emitting facility, the Laboratory's 1992 radioactive air emissions. In 1992, the total activity of radionuclides emitted into the air from Laboratory stacks was approximately 73,500 Ci. This was an increase over the activity of the total 1991 radioactive air emissions, which was approximately 62,400 Ci.

Total 1992 Laboratory emissions of each radionuclide or product are summarized by tables and graphs in the first section of this report. Compared to 1991 radioactive air emissions,

- total tritium activity was decreased,
- total plutonium activity was decreased,
- total uranium activity was decreased,
- total mixed fission product activity was increased,
- total  $^{41}\text{Ar}$  activity was decreased,
- total gaseous/mixed activation product (except  $^{41}\text{Ar}$ ) activity was increased,
- total particulate/vapor activation product activity was increased, and
- total  $^{32}\text{P}$  activity was decreased.

Radioactive emissions from specific facilities are detailed in this report. Each section provides 1992 data on a single radionuclide or product and is further divided by emitting facility. For each facility from which a particular radionuclide or product was emitted,

- a bar chart displays the air emissions of each radionuclide or product from each facility over the 12 reporting periods of 1992,
- a line chart shows the trend in total emissions of that radionuclide or product from that facility for the past three years,
- the greatest activity during the 1990—1992 period is discussed, and
- unexpected or unusual results are noted.

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## *Introduction*

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## INTRODUCTION

### *Radioactive Air Emissions at the Laboratory*

Laboratory policy states that "no activity or operation will be done at the Laboratory unless it can be performed in a manner designed to protect employees, the public, and the environment." To ensure such protection, the Laboratory is required to meet all applicable federal, state, and local regulations.

In its operations, the Laboratory emits radionuclides into the air through various stacks and other emission points. Radioactive air emissions from DOE facilities such as the Laboratory are regulated by the Environmental Protection Agency (EPA). The Radioactive Air Emissions Management (RAEM) Program Office is charged with ensuring that the Laboratory is in compliance with EPA regulations for radioactive air emissions.

### *Managing Radioactive Air Emissions*

Before 1985, the Laboratory's Health, Safety, and Environment (HSE) Division had a program in place to sample Laboratory stacks. In 1985, EPA issued its first radioactive air emissions regulations for DOE facilities. On December 15, 1989, EPA revised the regulations that apply to DOE facilities.

The RAEM Program Office was established in May 1992. The primary mission of the RAEM Program is to

- ensure that reliable data are collected from Laboratory stacks and
- take a proactive approach to managing the Laboratory's radioactive air emissions.

The RAEM Program plays a management role at the Laboratory. Its functions are to

- establish criteria for assessing data reliability,
- provide technical guidance and support to Laboratory operations that emit radionuclides,
- coordinate Laboratory activities to ensure that all Laboratory operations are in full compliance with EPA regulations for radioactive air emissions,
- develop and implement new methods and systems to reduce radioactive air emissions to as low as reasonably achievable (ALARA), and
- serve as the Laboratory's point of contact with the EPA and DOE.

### *Summary of Radioactive Air Emissions for 1992*

This report summarizes, by radionuclide or product and by emitting facility, the Laboratory's 1992 radioactive air emissions. Radionuclides and products are grouped as

- tritium (gas and water vapor),
- plutonium,
- uranium ( $^{235}\text{U}$  and  $^{238}\text{U}$ ),
- mixed fission products,
- activation products ( $^{41}\text{Ar}$ , gaseous/mixed activation products, and particulate/vapor activation products), and
- other emissions ( $^{32}\text{P}$ ).

Emitting facilities are grouped by the technical area (TA) where they are located and when appropriate, by the building and stack that emitted each radionuclide or product.

Total 1992 Laboratory emissions of each radionuclide or product are summarized by tables and graphs in the first section. Each following section provides 1992 data on a single radionuclide or product and is further divided by emitting facility. For each facility from which a particular radionuclide or product was emitted,

- a bar chart displays the air emissions of each radionuclide or product from each facility over the 12 reporting periods of 1992;
- a line chart shows the trend in total emissions of that radionuclide or product from that facility for the past three years;
- the greatest activity during the 1990—1992 period is discussed; and
- unexpected or unusual results are noted.

At TA-53, the 12 reporting periods of 1992 correspond to the following dates.

- Period 1: December 23, 1991—February 3, 1992
- Period 2: February 3, 1992—March 2, 1992
- Period 3: March 2, 1992—March 30, 1992
- Period 4: March 30, 1992—May 4, 1992
- Period 5: May 4, 1992—June 1, 1992
- Period 6: June 1, 1992—June 29, 1992
- Period 7: June 29, 1992—August 3, 1992
- Period 8: August 3, 1992—August 31, 1992
- Period 9: August 31, 1992—October 5, 1992
- Period 10: October 5, 1992—November 2, 1992
- Period 11: November 2, 1992—November 23, 1992
- Period 12: November 23, 1992—December 21, 1992

At all other facilities, the 12 reporting periods of 1992 correspond to the following dates.

- Period 1: December 20, 1991—January 31, 1992
- Period 2: January 31, 1992—February 28, 1992
- Period 3: February 28, 1992—March 27, 1992
- Period 4: March 27, 1992—May 1, 1992
- Period 5: May 1, 1992—May 29, 1992
- Period 6: May 29, 1992—June 26, 1992
- Period 7: June 26, 1992—July 31, 1992
- Period 8: July 31, 1992—August 28, 1992
- Period 9: August 28, 1992—October 2, 1992
- Period 10: October 2, 1992—October 30, 1992
- Period 11: October 30, 1992—November 20, 1992
- Period 12: November 20, 1992—December 18, 1992

*Total Radioactive Air Emissions*

## TOTAL RADIOACTIVE AIR EMISSIONS

In 1992, the total activity of radionuclides emitted into the air from Laboratory stacks was approximately 73,500 Ci. This is an increase over the activity of the total 1991 radioactive air emissions, which was approximately 62,400 Ci. Table I details the type and amounts of radionuclides emitted from Laboratory stacks in 1992.

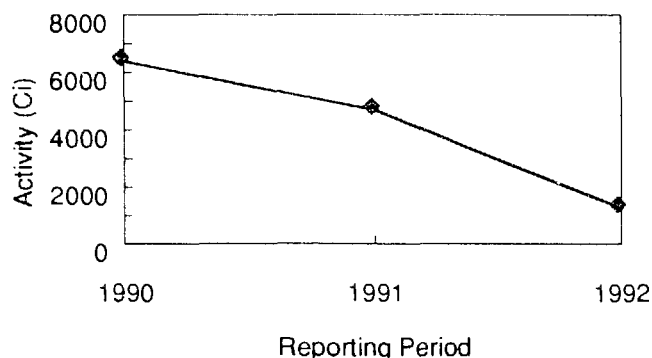
Throughout this section, activities are reported in microcuries ( $\mu\text{Ci}$ ) and curies (Ci), depending on the radionuclide (1 million  $\mu\text{Ci}$  equal 1 Ci).

**Table I. Total Emissions In 1992**

Principle Emission	Total Activity of Emission	
	$\mu\text{Ci}$	Ci
Tritium Gas	1,200,000,000	1200
Tritium Water Vapor	101,000,000	101
Plutonium	12.4	0.0000124
Uranium-235	189	0.000189
Uranium-238	59.2	0.0000592
Mixed Fission Products	2760	0.00276
Argon-41	390,000,000	390
Gaseous/Mixed Activation Products	71,800,000,000	71,800
Particulate/Vapor Activation Products	771,000	0.771
Phosphorus-32	9.41	0.00000941

## Total Tritium Air Emissions

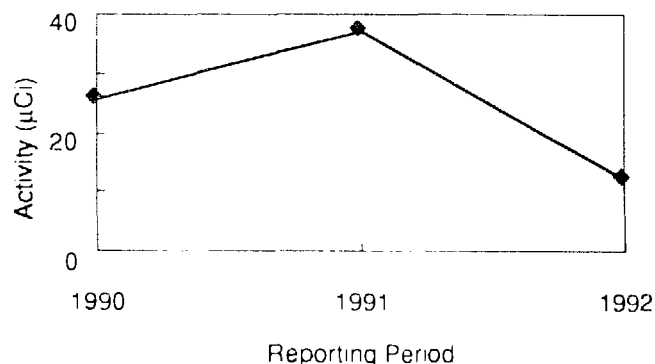
In 1992, tritium air emissions from all Laboratory stacks combined were decreased from 1991 and 1990 emissions. This trend is seen in Figure 1 in which the two forms of tritium, gas (elemental tritium) and water vapor (tritium oxide), are taken together to obtain the total activity of tritium emitted into the air.



**Figure 1. Total Tritium Emissions in 1990—1992**

## Total Plutonium Air Emissions

Plutonium emissions from all Laboratory stacks combined were decreased in 1992. Plutonium, as measured in Laboratory air emissions, includes several isotopes of plutonium ( $^{238}\text{Pu}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ , and  $^{241}\text{Pu}$ ) and a decay product of plutonium ( $^{241}\text{Am}$ ). The trend for the past three years is shown in Figure 2.



**Figure 2. Total Plutonium Emissions in 1990—1992**



### Total Uranium Air Emissions

Several isotopes of uranium (such as  $^{235}\text{U}$  and  $^{238}\text{U}$ ) and various uranium decay products (such as thorium) are emitted into the air by Laboratory stacks. In general, these radionuclides are referred to as uranium emissions. The combined activities of these radionuclides emitted into the air from 1990—1992 are displayed in Figure 3.

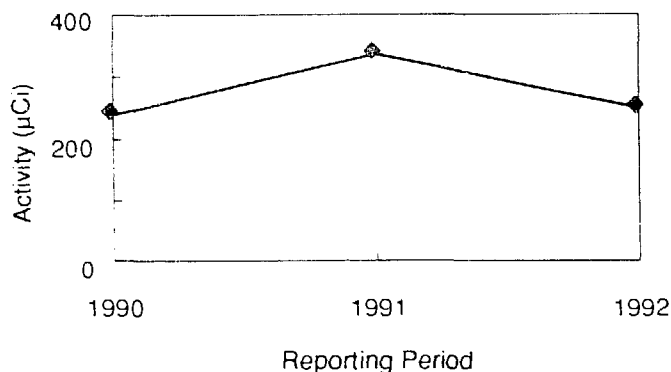


Figure 3. Total Uranium Emissions In 1990—1992

### Total Mixed Fission Product Air Emissions

Mixed fission products are formed when a heavy element breaks into two or more lighter elements. Each heavy element can break apart in various ways; for example,  $^{235}\text{U}$  splits into approximately 40 different combinations of lighter elements. Mixed fission product emissions into the air were increased in 1992, mainly because of an increase in emissions from TA-48 stacks. This increase is shown in Figure 4.

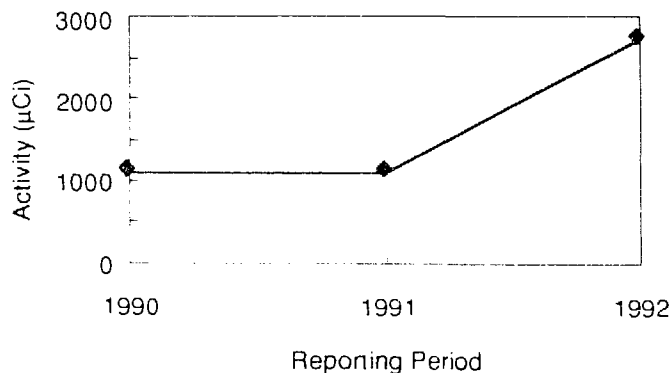


Figure 4. Total Mixed Fission Product Emissions In 1990—1992

### Total Activation Product Air Emissions

Activation products fall into two categories.

- Gaseous/mixed activation products (G/MAP) are a group of activated elements that includes isotopes of oxygen, carbon, and nitrogen. Argon-41 is a gaseous/mixed activation product that is reported separately throughout this document. Several gaseous/mixed activation products are produced by operations at the Los Alamos Meson Physics Facility (LAMPF) at TA-53;  $^{41}\text{Ar}$  is the only gaseous/mixed activation product from operations at Omega West Reactor at TA-2.
- Particulate/vapor activation products (P/VAP) are another group of activated elements. In 1992, this group included 29 isotopes produced by TA-53 operations and dominated by  $^{197\text{m}}\text{Hg}$ ,  $^7\text{Be}$ , and  $^{82}\text{Br}$ ; and 20 isotopes produced by TA-48 operations and dominated by  $^{75}\text{Se}$  and  $^{77}\text{Br}$ .

For the past three years, the Laboratory's air emissions of  $^{41}\text{Ar}$  are shown in Figure 5; gaseous/mixed activation products (except  $^{41}\text{Ar}$ ) are shown in Figure 6; and particulate/vapor activation products are shown in Figure 7.

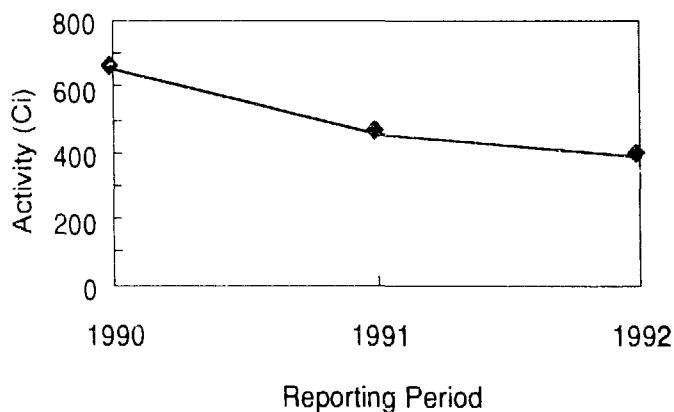
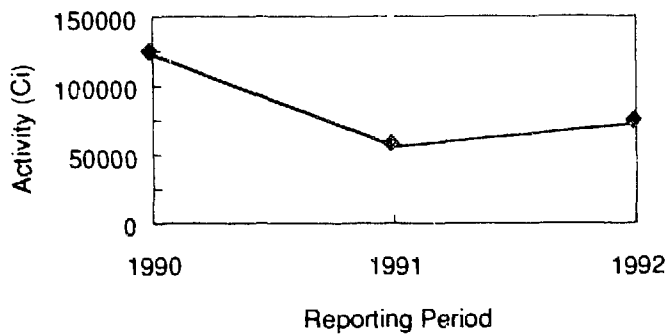
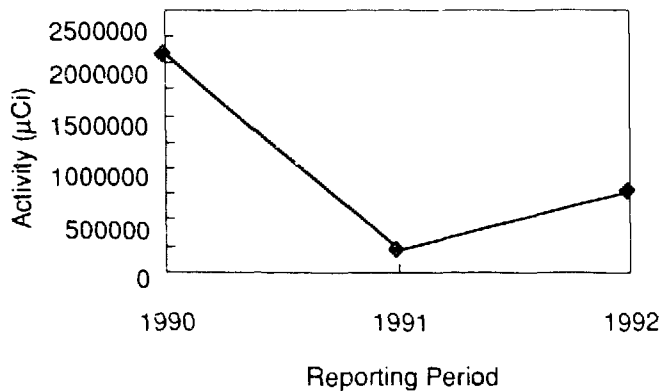


Figure 5.  $^{41}\text{Ar}$  Emissions In 1990—1992

*Total Radioactive Air Emissions*



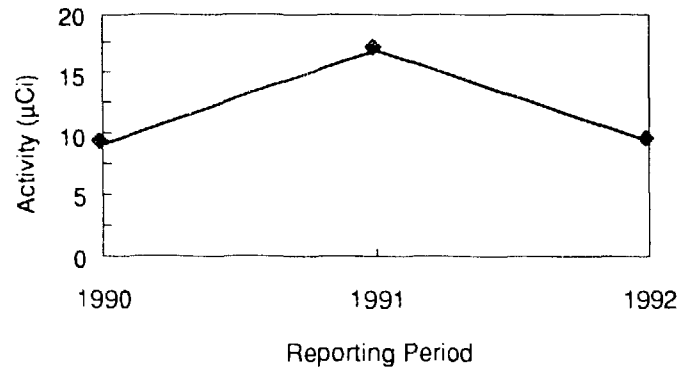
**Figure 6. Gaseous/Mixed Activation Product Emissions in 1990—1992**



**Figure 7. Particulate/Vapor Activation Product Emissions in 1990—1992**

*Other Radioactive Air Emissions*

In 1992, <sup>32</sup>P emissions into the air from all Laboratory stacks were decreased from 1991 emissions and were almost as low as 1990 emissions. These data are shown in Figure 8.



**Figure 8. Total <sup>32</sup>P Emissions in 1990—1992**

*Tritium Air Emissions*

## TRITIUM AIR EMISSIONS

In 1992, the total activity of tritium gas (elemental tritium) emitted from Laboratory stacks was approximately 1200 Ci, with most coming from stacks at TA-21, TA-33, and TA-41. The total activity of tritium water vapor (tritium oxide) emitted from Laboratory stacks was approximately 100 Ci. The main sources of these emissions were TA-21 and TA-53 stacks. Total tritium air emissions are detailed in Table II.

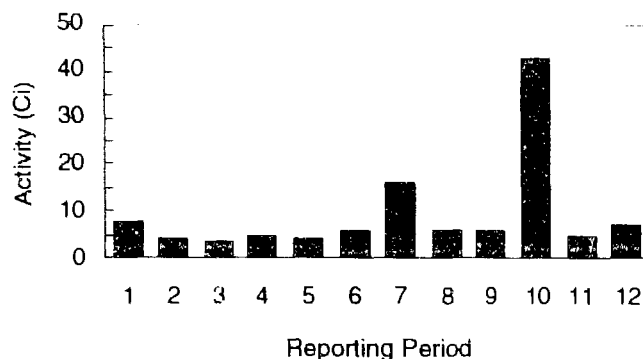
Throughout this section, tritium activities are reported in curies, Ci (1 Ci equals 1 million  $\mu\text{Ci}$ ). In addition, tritium activities are reported as total tritium, tritium gas, or tritium water vapor, depending on the sampling equipment at each facility.

**Table II. Total Tritium Air Emissions from Laboratory Facilities in 1992**

Facility	Stack Number	Activity of Emitted Tritium (Ci)	
		Tritium gas	Tritium water vapor
TA-3-16	FE-14	22	—
	FE-16	93	—
TA-3-40	FE-25	0.16	—
TA-16-205	FE-3	0.011	0.051
TA-21-155	FE-5	3.9	59
TA-21-209	FE-1, 10, 12	370	—
TA-33-86	FE-6, 11	320	—
TA-35-213	FE-5	0.10	—
TA-41-1	FE-4	65	—
TA-41-4	FE-17	230	—
TA-53-3	FE-3	—	1.5
TA-53-7	FE-2	—	41
TA-55-4	FE-16	100	—
Total (rounded)		1200	100

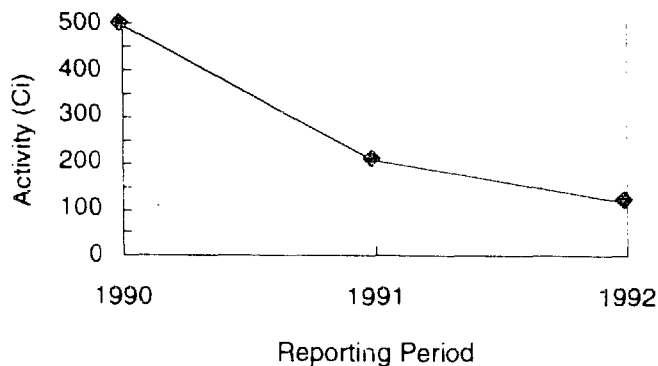
### TA-3 Tritium Air Emissions

In 1992, TA-3 tritium air emissions were reported as total tritium, which is assumed to be 100% tritium gas. These emissions peaked in the 10th reporting period of 1992, as shown in Figure 9.



**Figure 9. Tritium Gas Emissions at TA-3 for Each Reporting Period of 1992**

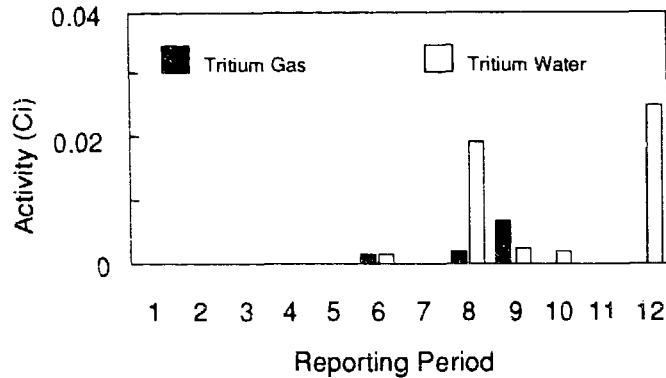
In 1992, tritium emissions from TA-3 stacks were less than in the previous two years. This trend is shown in Figure 10. During the 1990—1992 period, the activity of tritium emitted from TA-3 stacks was greatest in 1990 (496 Ci).



**Figure 10. Tritium Gas Emissions at TA-3 in 1990—1992**

**TA-16 Tritium Air Emissions**

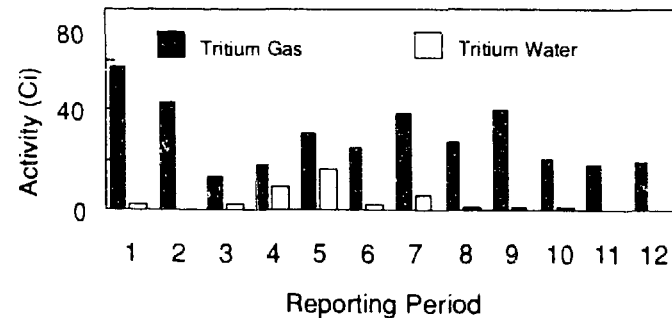
The TA-16 facility was a new tritium facility in 1992. As shown in Figure 11, tritium gas and water vapor were emitted by TA-16 stacks in small amounts beginning in June 1992.



**Figure 11. Tritium Emissions at TA-16 for Each Reporting Period of 1992**

**TA-21 Tritium Air Emissions**

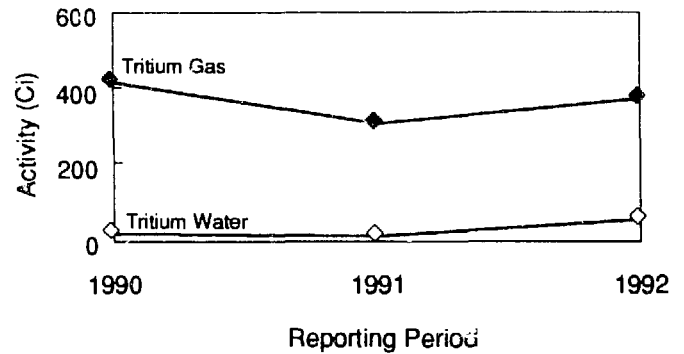
In 1992, TA-21 stacks emitted both tritium gas and tritium water vapor, although the activities of emitted tritium water vapor were less than those of emitted tritium gas. The activities of these emissions for each reporting period of 1992 are displayed in Figure 12.



**Figure 12. Tritium Emissions at TA-21 for Each Reporting Period of 1992**

In 1990, tritium emitted from TA-21 stacks was reported as total tritium gas activity. In 1991, where only tritium gas was measured, it was assumed that 5% of the activity was due to tritium water vapor, and this assumption was applied retrospectively to 1990 data. Comparisons of tritium gas and tritium water vapor emissions from TA-21 stacks in the past three years are made in Figure 13.

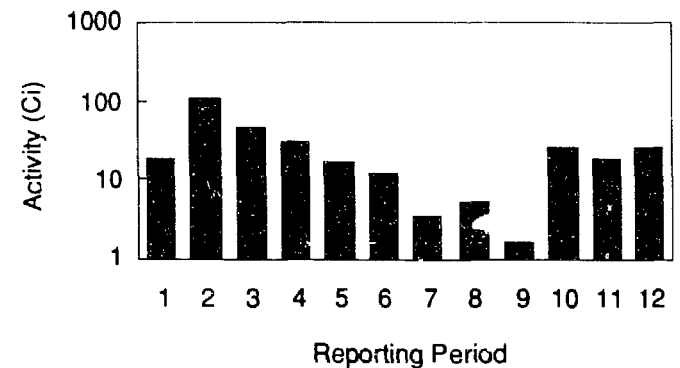
During the 1990—1992 period, the activity of tritium gas emitted from TA-21 stacks was greatest in 1990 (417 Ci). For the same period, the activity of tritium water vapor was greatest in 1992 (59 Ci).



**Figure 13. Tritium Emissions at TA-21 in 1990—1992**

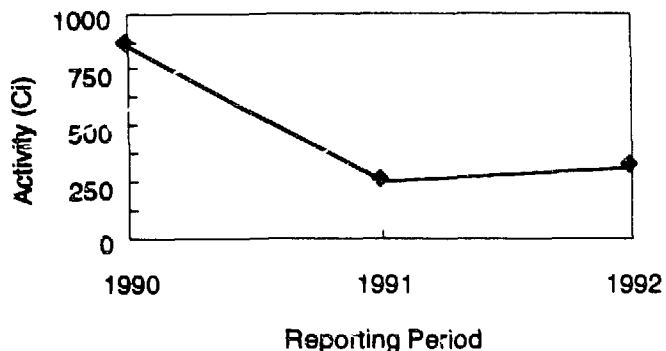
**TA-33 Tritium Air Emissions**

At TA-33, sampling and analysis do not distinguish between tritium gas and tritium water vapor. Thus in Figure 14, a single activity is reported for tritium emissions from TA-33 stacks for each 1992 reporting period.



**Figure 14. Total Tritium Emissions at TA-33 for Each Reporting Period of 1992**

In 1991 and 1992, activities of tritium emissions from TA-33 stacks were decreased from the 1990 activity (854 Ci). This trend is shown in Figure 15.



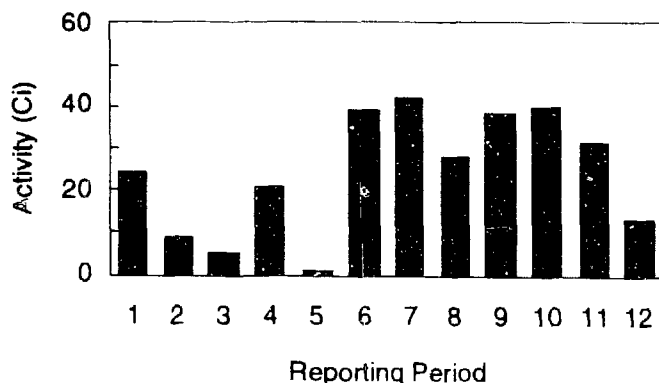
**Figure 15.** Total Tritium Emissions at TA-33 in 1990—1992

*TA-35 Tritium Air Emissions*

At TA-35, sampling and analysis do not distinguish between tritium gas and tritium water vapor. In 1990 and 1991, the activities of the tritium emissions from TA-35 stacks were less than 0.1 Ci. In 1992, the activity of the emissions was 0.1 Ci.

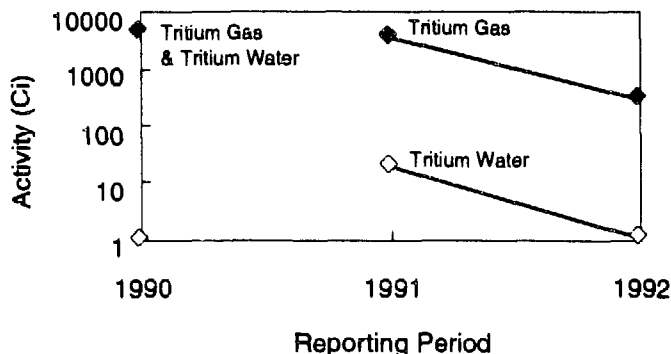
*TA-41 Tritium Air Emissions*

In 1992, tritium emissions from TA-41 stacks were reported as total tritium activities. These activities, detailed for each reporting period in 1992, are shown in Figure 16.



**Figure 16.** Total Tritium Emissions at TA-41 for Each Reporting Period of 1992

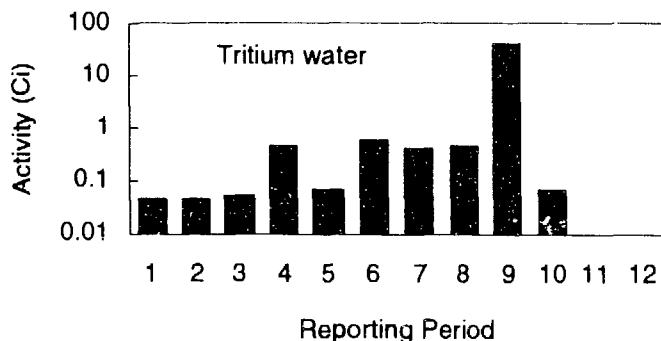
From 1990—1992, sampling and analysis at TA-41 made no distinction between tritium gas and tritium water vapor. In 1991 and 1992, however, it was assumed that 0.5% of the total tritium air emissions was tritium water vapor and 99.5% was tritium gas. Note that in 1992, tritium emissions from TA-41 stacks were decreased. This is displayed in Figure 17. During the 1990—1992 period, the activity of tritium (gas and water vapor combined) emitted from TA-41 stacks was greatest in 1990 (4440 Ci).



**Figure 17.** Tritium Emissions at TA-41 in 1990—1992

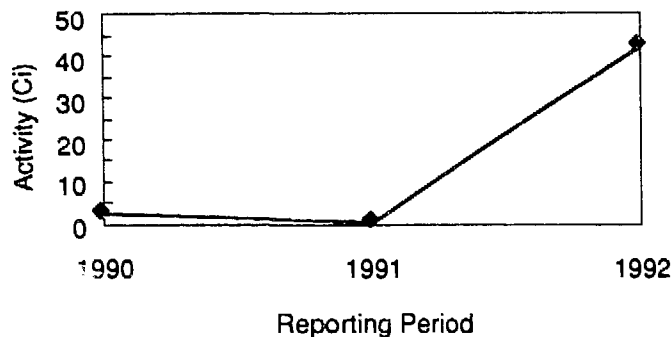
*TA-53 Tritium Air Emissions*

At TA-53, tritium air emissions are in the form of tritium water vapor only. For most of the 1992 reporting periods, these emissions were low, ranging from 0.007 to 0.6 Ci. In the 9th reporting period, however, the activity of these emissions peaked, as displayed in Figure 18. This was due to two unplanned releases of approximately 20 Ci each from stacks at TA-53.



**Figure 18.** Tritium Water Emissions at TA-53 for Each Reporting Period of 1992

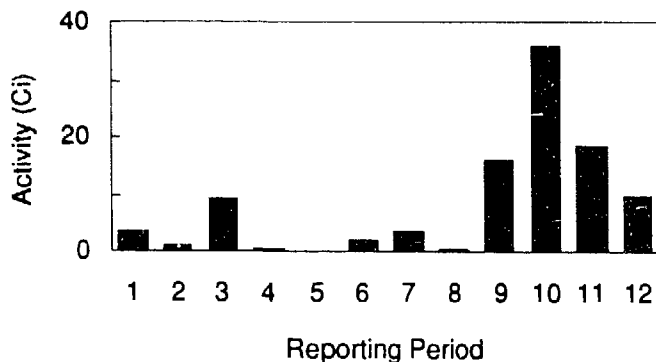
In 1992, tritium emissions from TA-53 stacks (42 Ci) were increased over the previous two years, as shown in Figure 19. This was mainly due to the increase seen in the 9th reporting period of 1992, as noted earlier.



**Figure 19.** Tritium Water Emissions at TA-53 in 1990—1992

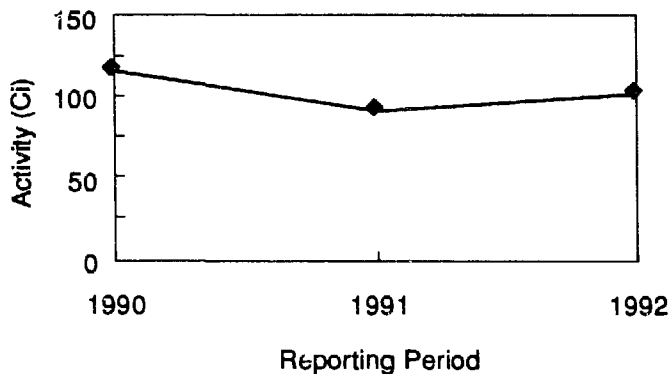
#### TA-55 Tritium Air Emissions

At TA-55, sampling and analysis do not distinguish between tritium gas and tritium water vapor. The activities of total tritium emitted from TA-55 stacks for each reporting period in 1992 are shown in Figure 20. Note that the activity in reporting period 5 was too low (0.051) to be displayed.



**Figure 20.** Total Tritium Emissions at TA-55 for Each Reporting Period of 1992

The trend in total tritium emissions from TA-55 stacks for 1990—1992 is shown in Figure 21. During this period, the activity of tritium emitted from TA-55 stacks was greatest in 1990 (116 Ci).



**Figure 21.** Total Tritium Emissions at TA-55 in 1990—1992

*Plutonium Air Emissions*



## PLUTONIUM AIR EMISSIONS

Plutonium, as measured in Laboratory air emissions, includes several isotopes of plutonium ( $^{238}\text{Pu}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ , and  $^{241}\text{Pu}$ ) and a decay product of plutonium ( $^{241}\text{Am}$ ). The activity of plutonium emissions from all Laboratory stacks combined totaled approximately 12  $\mu\text{Ci}$  in 1992. As shown in Table III, more than half of these emissions were from one stack at TA-48.

Throughout this section, plutonium activities are reported in microcuries,  $\mu\text{Ci}$  (1 million  $\mu\text{Ci}$  equal 1 Ci).

Table III. Plutonium Emissions in 1992

Facility	Stack Number	Activity of Emitted Plutonium ( $\mu\text{Ci}$ )
TA-3-29	FE-14	0.53
	FE-15	0.08
	FE-17	<MDA*
	FE-18	<MDA*
	FE-19	0.50
	FE-21	0.091
	FE-28	0.76
	FE-29	0.28
	FE-30	0.008
	FE-31	0.033
	FE-32	<MDA*
	FE-33	<MDA*
	FE-34	0.009
	FE-35	<MDA*
	FE-37	<MDA*
	FE-44	0.20
	FE-45	0.14
FE-46	0.10	
TA-21-4	FE-1	0.006
TA-21-5	FE-7	0.022
TA-21-150	FE-1	0.158
TA-21-257	FE-4	0.1
TA-21-313	FE-1	<MDA*
	FE-2	0.46

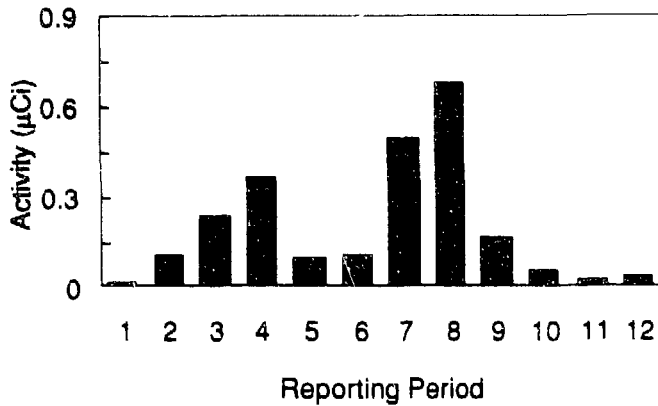
Table III. Plutonium Emissions in 1992 (continued)

Facility	Stack Number	Activity of Emitted Plutonium ( $\mu\text{Ci}$ )
TA-21-314	FE-1	0.04
	FE-7	0.074
TA-21-315	FE-1	<MDA*
TA-21-324	FE-1	0.012
TA-35-7	FE-2	0.31
	FE-7	0.043
	FE-8	0.007
TA-41-1	FE-4	<MDA*
TA-48-1	FE-15	6.5
	FE-45	0.12
	FE-46	0.11
	FE-51	0.002
	FE-54	<MDA*
TA-50-1	FE-60	0.003
	FE-1	0.30
	FE-2	0.15
	FE-3	0.053
	FE-6	0.011
	FE-17	<MDA*
TA-50-37	FE-25	0.009
	FE-27	<MDA*
TA-50-66	FE-1	0.011
TA-50-69	FE-1	0.003
	FE-2	0.018
TA-54-2	FE-3	<MDA*
	FE-1	0.001
TA-55-4	FE-2	0.002
	FE-1	0.008
Total (rounded)	FE-15	0.05
	FE-16	1.1

\*MDA is minimum detectable activity

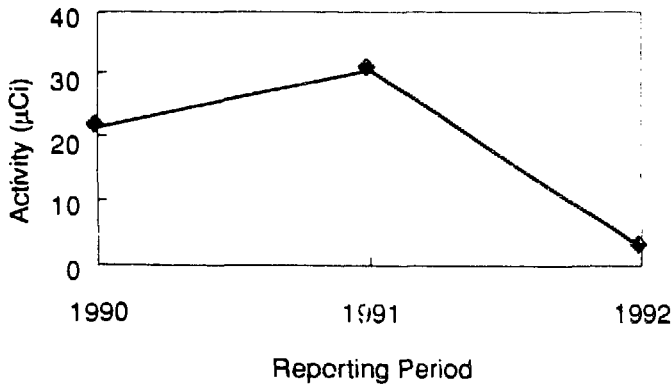
**TA-3 Plutonium Air Emissions**

Emissions of plutonium from TA-3 stacks peaked in the 7th and 8th reporting period of 1992, as shown in Figure 22.



**Figure 22. Plutonium Emissions at TA-3 for Each Reporting Period of 1992**

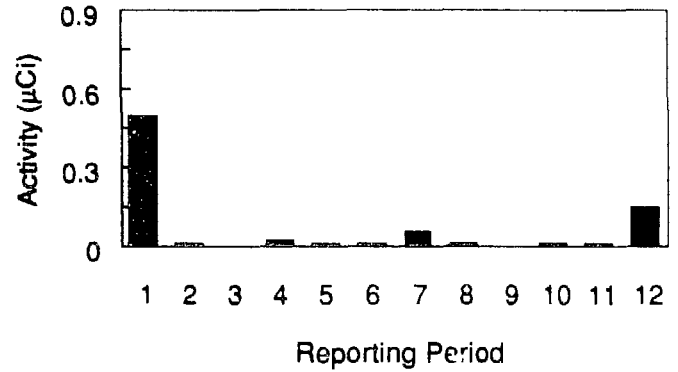
In 1992, plutonium emissions from TA-3 stacks decreased, as shown in Figure 23. During the 1990—1992 period, the activity of plutonium emitted from TA-3 stacks was greatest in 1991 (31 µCi).



**Figure 23. Plutonium Emissions at TA-3 In 1990—1992**

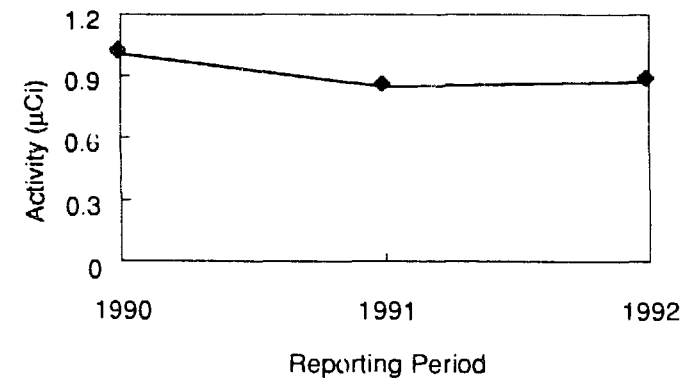
**TA-21 Plutonium Air Emissions**

During 1992, several TA-21 buildings were scheduled for decontamination and decommissioning. The details of TA-21 plutonium air emissions for 1992 are provided in Figure 24.



**Figure 24. Plutonium Emissions at TA-21 for Each Reporting Period of 1992**

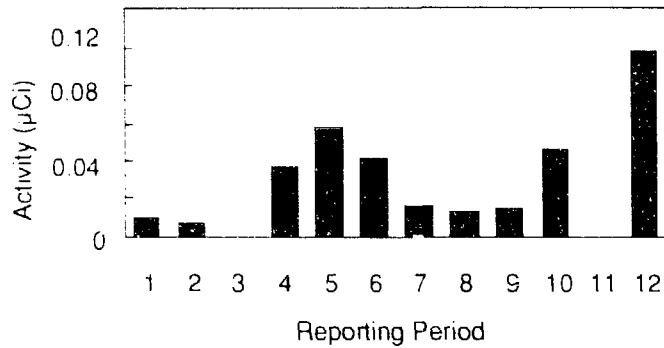
The trend in plutonium emissions from TA-21 stacks over the past three years is shown in Figure 25. During the 1990—1992 period, the activity of plutonium emitted from TA-21 stacks was greatest in 1990 (1.0 µCi).



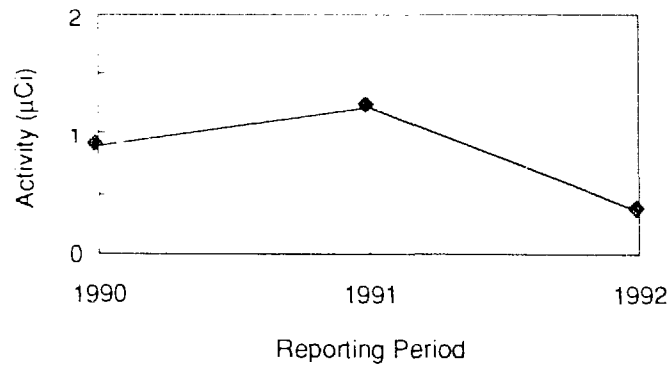
**Figure 25. Plutonium Emissions at TA-21 In 1990—1992**

**TA-35 Plutonium Air Emissions**

1992 emissions of plutonium from TA-35 stacks are displayed by reporting period in Figure 26, and the total TA-35 plutonium air emissions for 1990—1992 are shown in Figure 27. Note that 1992 emissions were decreased from previous years. During the 1990—1992 period, the activity of plutonium emitted from TA-35 stacks was greatest in 1991 (1.2  $\mu\text{Ci}$ ).



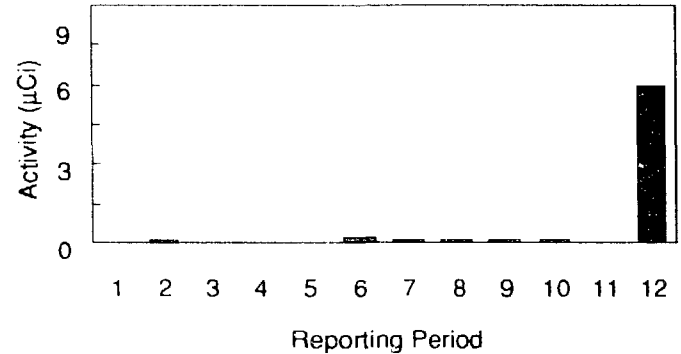
**Figure 26. Plutonium Emissions at TA-35 for Each Reporting Period of 1992**



**Figure 27. Plutonium Emissions at TA-35 in 1990—1992**

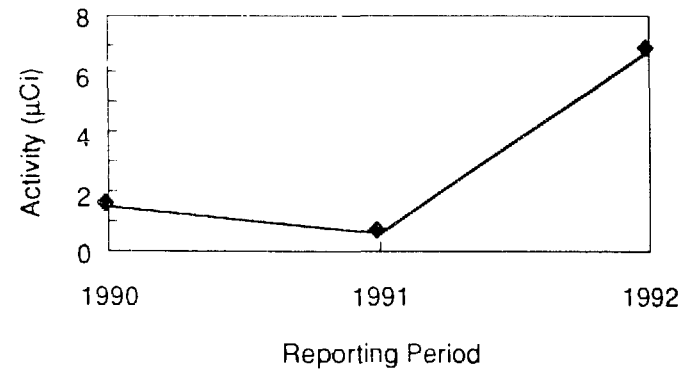
**TA-48 Plutonium Air Emissions**

In 1992, the greatest activity of plutonium from TA-48 stacks was emitted in the 12th period. This is displayed in Figure 28.



**Figure 28. Plutonium Emissions at TA-48 for Each Reporting Period of 1992**

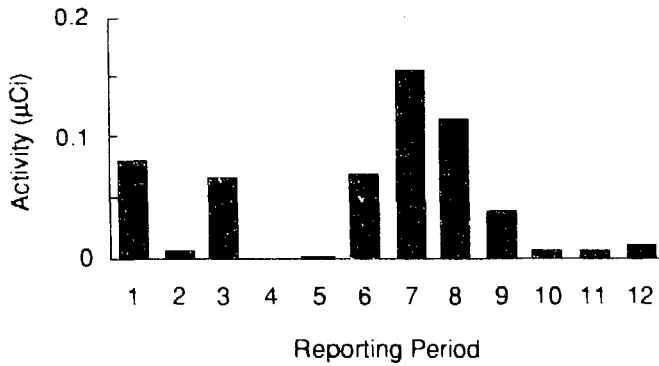
Mainly because of the increase in plutonium emissions during the 12th period of 1992, the total 1992 plutonium emission (6.7  $\mu\text{Ci}$ ) from TA-48 stacks was increased over 1990 and 1991 emissions. This increase is shown in Figure 29.



**Figure 29. Plutonium Emissions at TA-48 in 1990—1992**

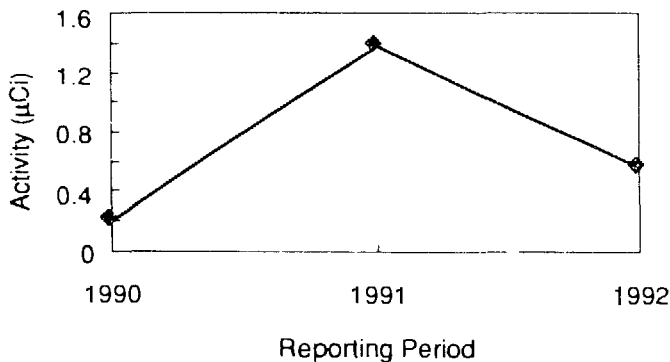
**TA-50 Plutonium Air Emissions**

Emissions of plutonium from TA-50 stacks are shown in Figure 30 for each reporting period of 1992. These emissions peaked in the 7th reporting period.



**Figure 30. Plutonium Emissions at TA-50 for Each Reporting Period of 1992**

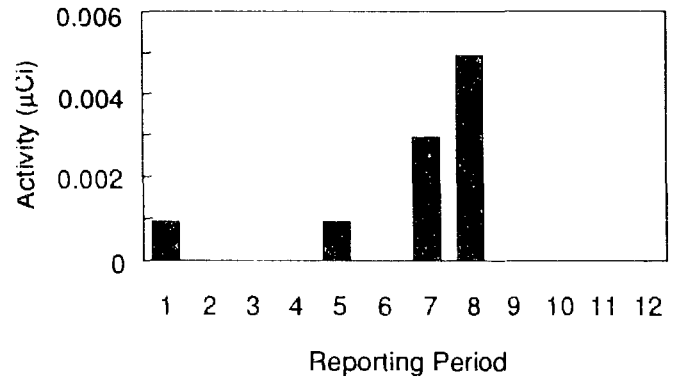
1992 plutonium emissions from TA-50 stacks were decreased from 1991 emissions. The trend for the three years from 1990—1992 is shown in Figure 31. During this period, the activity of plutonium emitted from TA-50 stacks was greatest in 1991 (1.4 µCi).



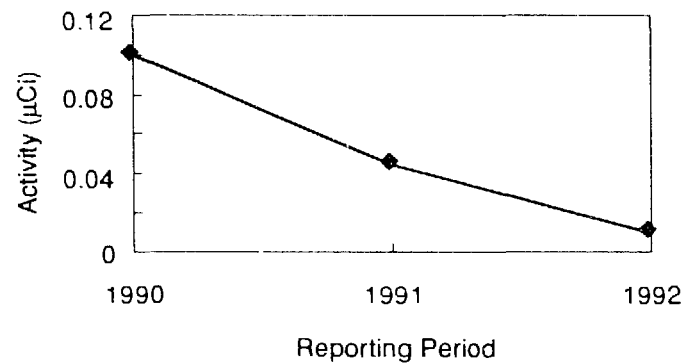
**Figure 31. Plutonium Emissions at TA-50 in 1990—1992**

**TA-54 Plutonium Air Emissions**

For each reporting period of 1992, plutonium emissions from TA-54 stacks are shown in Figure 32. These emissions have decreased every year since 1990, as displayed in Figure 33.



**Figure 32. Plutonium Emissions at TA-54 for Each Reporting Period of 1992**



**Figure 33. Plutonium Emissions at TA-54 in 1990—1992**

TA-55 Plutonium Air Emissions

Plutonium emissions from TA-55 stacks for each reporting period of 1992 are shown in Figure 34; the trend for the past three years is shown in Figure 35. During the 1990—1992 period, the activity of plutonium emitted from TA-55 stacks was greatest in 1991 (2.0  $\mu\text{Ci}$ ).

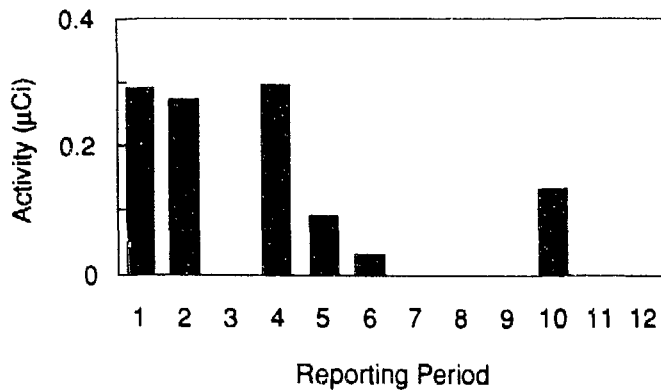


Figure 34. Plutonium Emissions at TA-55 for Each Reporting Period of 1992

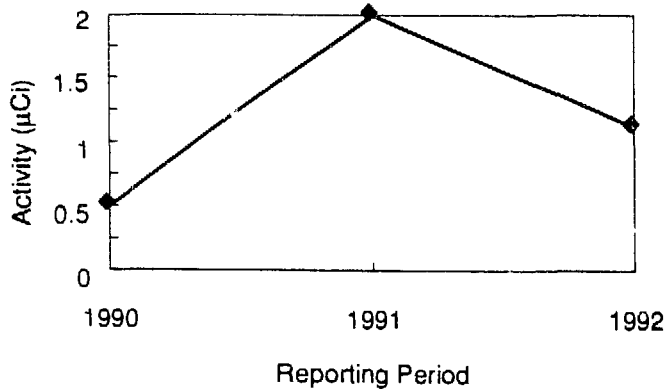


Figure 35. Plutonium Emissions at TA-55 in 1990—1992

*Uranium Air Emissions*

## URANIUM AIR EMISSIONS

Several isotopes of uranium and various uranium decay products are emitted into the air by Laboratory stacks. In general, these radionuclides are reported as total uranium emissions or are reported as one of two isotopes,  $^{235}\text{U}$  or  $^{238}\text{U}$ . From a particular building, the activities at that building determine which isotope is reported. For example, at TA-3, Buildings 29 and 35, only  $^{235}\text{U}$  is reported; at Buildings 66, 102, and 141 at TA-3, only  $^{238}\text{U}$  is reported.

In 1992, the reported  $^{235}\text{U}$  activity emitted from Laboratory stacks was approximately 190  $\mu\text{Ci}$ ; as shown in Table IV, more than half of this came from one stack at TA-3, Building 29. The reported  $^{238}\text{U}$  activity emitted from Laboratory stacks in 1992 was approximately 60  $\mu\text{Ci}$ , mostly from a stack at TA-3, Building 66.

Throughout this section, uranium activities are reported in microcuries,  $\mu\text{Ci}$  (1 million  $\mu\text{Ci}$  equal 1 Ci).

Table IV. Uranium Emissions in 1992

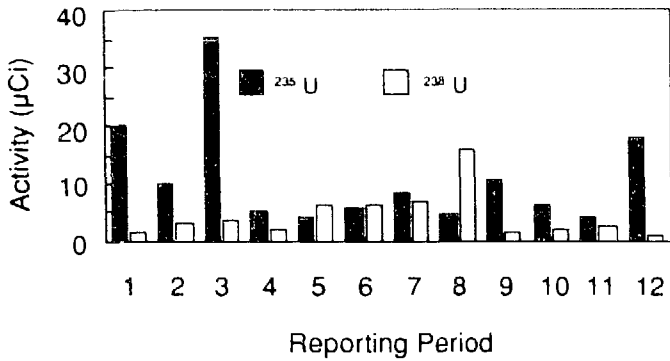
Facility	Stack Number	Activity of Emitted Uranium ( $\mu\text{Ci}$ )	
		$^{235}\text{U}$	$^{238}\text{U}$
TA-3-29	FE-20	0.13	NA <sup>a</sup>
	FE-22	0.24	NA <sup>a</sup>
	FE-23	110	NA <sup>a</sup>
	FE-24	26	NA <sup>a</sup>
	FE-26	0.32	NA <sup>a</sup>
	FE-27	0.30	NA <sup>a</sup>
TA-3-35	FE-1	0.14	NA <sup>a</sup>
TA-3-66	FE-8	NA <sup>a</sup>	2.8
	FE-9	NA <sup>a</sup>	1.2
	FE-10	1.3	NA <sup>a</sup>
	FE-13	NA <sup>a</sup>	42
	FE-24	NA <sup>a</sup>	9.4
	FE-25	NA <sup>a</sup>	0.12
	FE-26	NA <sup>a</sup>	1.2
TA-3-102	FE-18	NA <sup>a</sup>	1.9
	FE-25	NA <sup>a</sup>	0.008
TA-3-141	FE-6	NA <sup>a</sup>	0.017
	FE-9	NA <sup>a</sup>	0.32
	FE-10	NA <sup>a</sup>	0.063
TA-21-3	FE-6	42	NA <sup>a</sup>
TA-21-4	FE-3	9.7	NA <sup>a</sup>
TA-48-1	FE-4	0.42	NA <sup>a</sup>
	FE-40	NA <sup>a</sup>	<MDA <sup>b</sup>
Total (rounded)		190	60

<sup>a</sup>NA is not analyzed

<sup>b</sup>MDA is minimum detectable activity

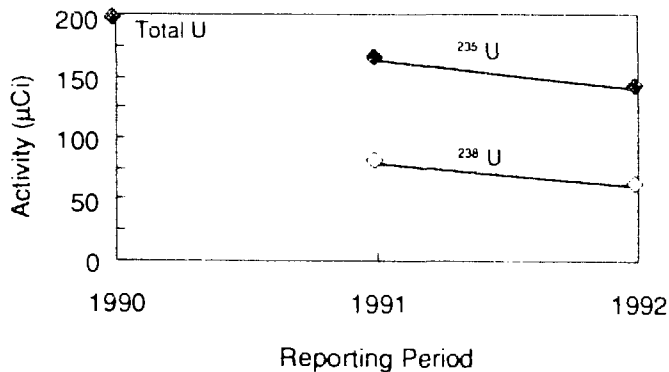
**TA-3 Uranium Air Emissions**

At TA-3 in 1992, air emissions of  $^{235}\text{U}$  peaked in the 3rd reporting period and emissions of  $^{238}\text{U}$  peaked in the 8th reporting period. These results are shown in Figure 36.



**Figure 36. Uranium Emissions at TA-3 for Each Reporting Period of 1992**

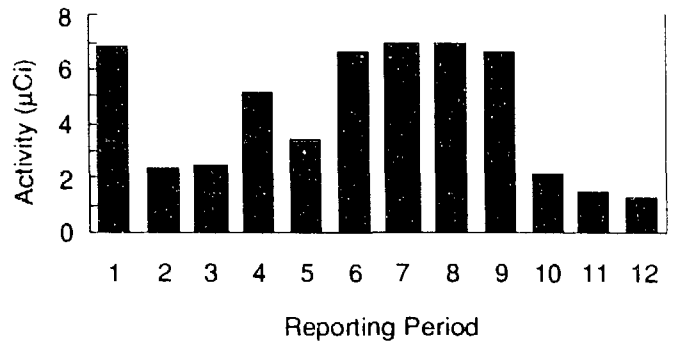
In 1990, uranium activity was not broken out by isotope; thus only 1991 and 1992 data for TA-3 uranium air emissions can be compared. In 1992, these emissions were decreased from the previous year, as displayed in Figure 37. During the 1990—1992 period, the activity of total uranium emitted from TA-3 stacks was greatest in 1991 (approximately 240 µCi).



**Figure 37. Uranium Emissions at TA-3 in 1990—1992**

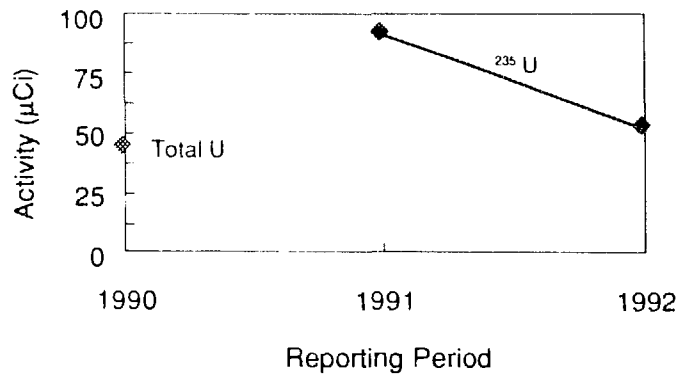
**TA-21 Uranium Air Emissions**

The only reported uranium isotope emitted from TA-21 stacks in 1992 was  $^{235}\text{U}$ , which is detailed by reporting period in Figure 38.



**Figure 38.  $^{235}\text{U}$  Emissions at TA-21 for Each Reporting Period of 1992**

In 1990, uranium emissions from TA-21 stacks were reported as total uranium; for 1991 and 1992, however, the isotope was specified as  $^{235}\text{U}$ . The uranium air emissions trend for these years is shown in Figure 39. During the 1990—1992 period, the reported activity of  $^{235}\text{U}$  emitted from TA-21 stacks was greatest in 1991 (92 µCi).



**Figure 39. Uranium Emissions at TA-21 in 1990—1992**



TA-48 Uranium Air Emissions

Only small amounts of  $^{235}\text{U}$  were reported for TA-48 stacks in 1992 (Figure 40); this is true also of the two years previous (Figure 41). In 1990, these emissions were not broken down by isotope but were reported as total uranium activity. During the 1990—1992 period, the reported activity of  $^{235}\text{U}$  emitted from TA-48 stacks was greatest in 1992 (0.42  $\mu\text{Ci}$ ).

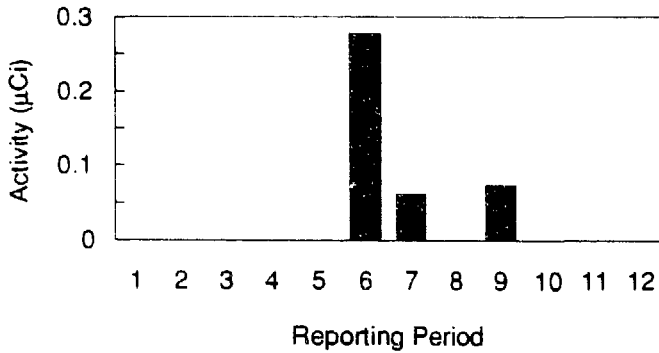


Figure 40. Uranium Emissions at TA-48 for Each Reporting Period of 1992

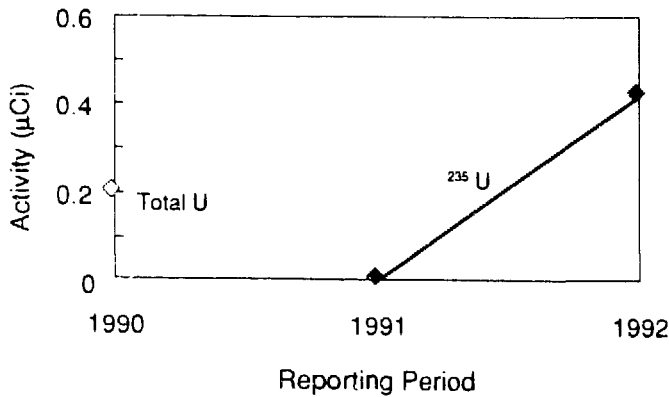


Figure 41. Uranium Emissions at TA-48 In 1990—1992

*Mixed Fission Product  
Air Emissions*

## MIXED FISSION PRODUCT AIR EMISSIONS

In 1992, mixed fission products, which are formed when a heavy element breaks into two or more lighter elements, were emitted from facilities at four technical areas. As shown in Table V, most of these fission products were emitted from one stack at TA-48, which is the radiochemistry site where the nuclear properties of radioactive materials are studied using analytical and physical chemistry.

Throughout this section, mixed fission product activities are reported in microcuries,  $\mu\text{Ci}$  (1 million  $\mu\text{Ci}$  equal 1 Ci).

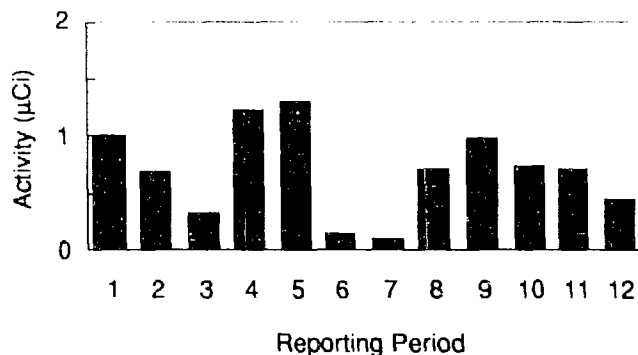
**Table V. Mixed Fission Product Emissions In 1992**

Facility	Stack Number	Activity of Emitted Mixed Fission Products ( $\mu\text{Ci}$ )
TA-3-29	FE-44	5.4
	FE-45	1.5
	FE-46	1.5
TA-21-4	FE-1	0.024
TA-48-1	FE-4	19
	FE-15	23
	FE-40	2600
	FE-45	62
	FE-46	48
	FE-51	0.092
	FE-54	0.90
	FE-60	1.1
	TA-50-1	FE-1
FE-2		2.2
FE-3		0.019
FE-6		0.007
FE-17		<MDA <sup>a</sup>
FE-25		0.005
FE-27		0.031
TA-50-37		FE-1
TA-50-66	FE-1	0.001
Total (rounded)		2800

<sup>a</sup>MDA is minimum detectable activity

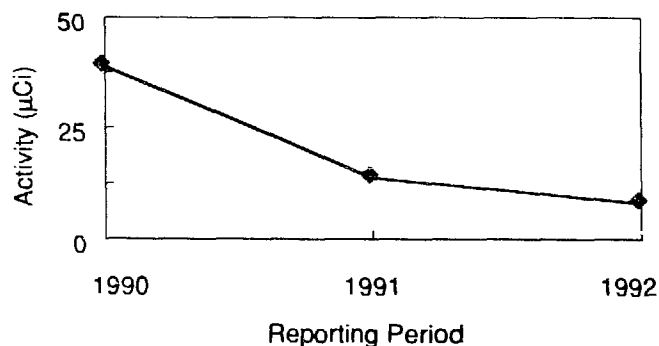
### TA-3 Mixed Fission Product Air Emissions

In 1992, emissions of mixed fission products from TA-3 stacks were greatest during the 4th and 5th reporting periods. This is displayed in Figure 42.



**Figure 42. Mixed Fission Product Emissions at TA-3 for Each Reporting Period of 1992**

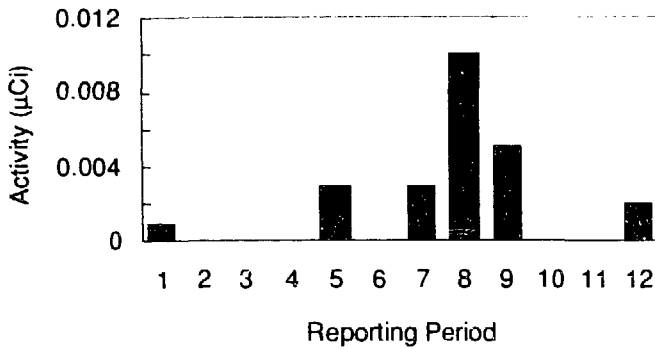
For the period from 1990—1992, mixed fission products emitted from TA-3 stacks decreased steadily. This trend is shown in Figure 43. During this period, the activity of mixed fission products emitted from TA-3 stacks was greatest in 1990 (39  $\mu\text{Ci}$ ).



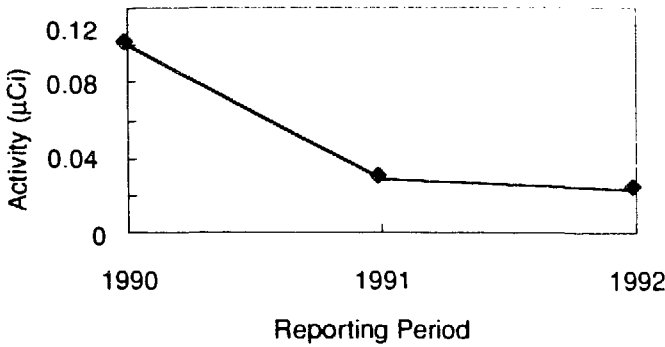
**Figure 43. Mixed Fission Product Emissions at TA-3 in 1990—1992**

**TA-21 Mixed Fission Product Air Emissions**

Mixed fission products emitted from TA-21 stacks are detailed by 1992 reporting period in Figure 44. For the past three years, these emissions have decreased, as displayed in Figure 45.



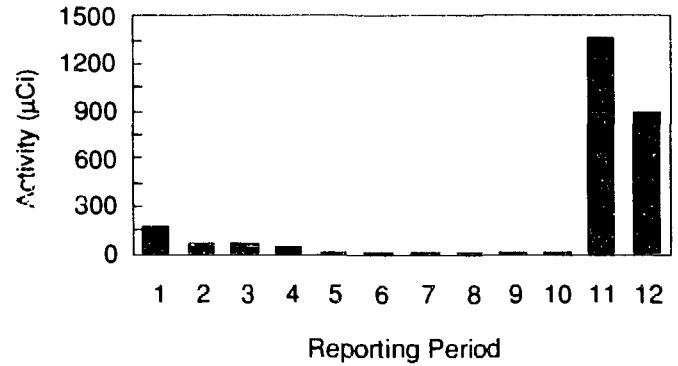
**Figure 44. Mixed Fission Product Emissions at TA-21 for Each Reporting Period of 1992**



**Figure 45. Mixed Fission Product Emissions at TA-21 In 1990—1992**

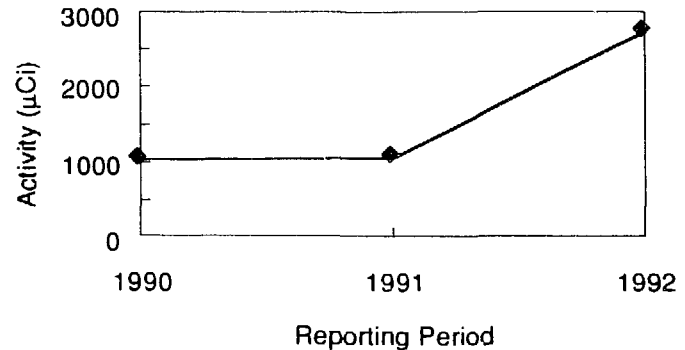
**TA-48 Mixed Fission Product Air Emissions**

Air emissions of mixed fission products at TA-48 varied in 1992 but were increased in the 11th and 12th reporting periods. This is shown in Figure 46.



**Figure 46. Mixed Fission Product Emissions at TA-48 for Each Reporting Period of 1992**

In 1992, mixed fission products emitted from TA-48 stacks (approximately 2700 µCi) were increased over the previous two years (Figure 47). This was due in part to the 11th and 12th reporting period increases previously noted.



**Figure 47. Mixed Fission Product Emissions at TA-48 In 1990—1992**

TA-50 Mixed Fission Product Air Emissions

Emissions from TA-50 stacks of mixed fission products are shown for each 1992 reporting period in Figure 48.

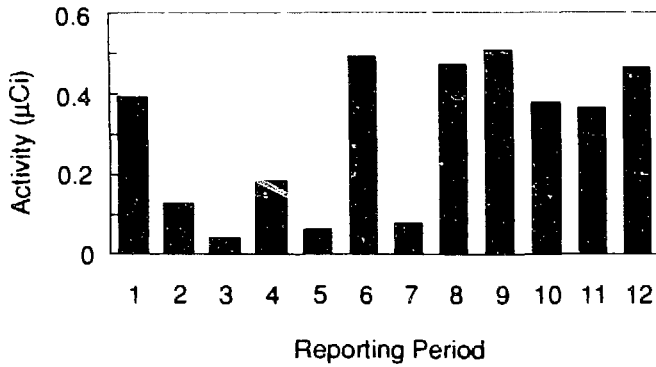


Figure 48. Mixed Fission Product Emissions at TA-50 for Each Reporting Period of 1992

For the three years from 1990—1992, mixed fission products emitted from TA-50 stacks did not change much, as shown in Figure 49. During this period, the activity of total mixed fission products emitted from TA-50 stacks was greatest in 1990 (3.9 µCi)

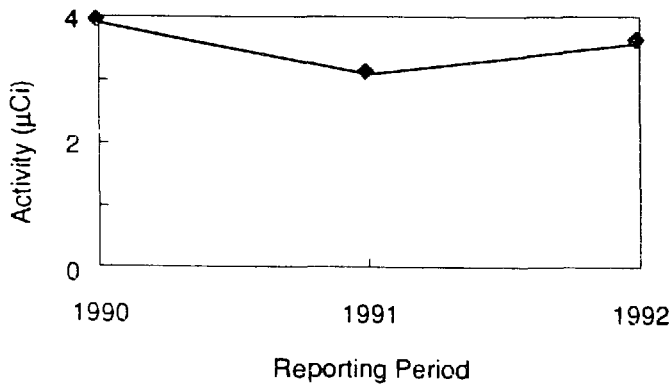


Figure 49. Mixed Fission Product Emissions at TA-50 in 1990—1992

*Activation Product Air Emissions*

## ACTIVATION PRODUCT AIR EMISSIONS

Activation products include

- gaseous/mixed activation products, which include  $^{41}\text{Ar}$  (reported separately) as well as isotopes of oxygen, carbon, and nitrogen; and
- particulate/vapor activation products, which include as many as 29 different isotopes.

In 1992, the total activity of  $^{41}\text{Ar}$  emitted from Laboratory stacks was approximately 390 Ci. The total activity of gaseous/mixed activation products was approximately 71,800 Ci, most of which were produced during operation of the high-power proton accelerator at the Los Alamos Meson Physics Facility (LAMPF) at TA-53. By comparison, the total activity of particulate/vapor activation products was much less: approximately 0.77  $\mu\text{Ci}$ , most of which also were produced at LAMPF. These results are shown in Table VI.

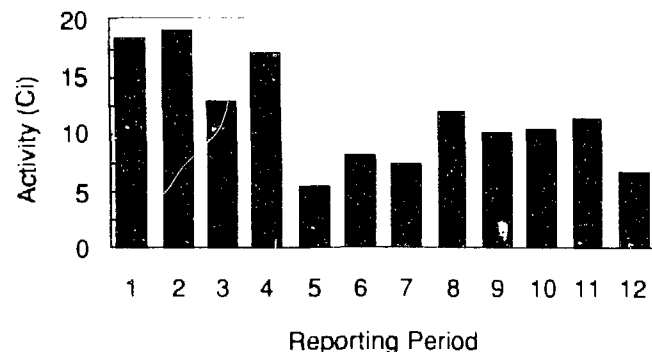
Throughout this section, activities of  $^{41}\text{Ar}$  and gaseous/mixed activation products are reported in curies, Ci, and activities of particulate/vapor activation products are reported in microcuries,  $\mu\text{Ci}$  (1 million  $\mu\text{Ci}$  equal 1 Ci).

**Table VI. Activation Product Emissions in 1992**

Facility	Stack Number	Activity of Emitted Activation Products		
		$^{41}\text{Ar}$ (Ci)	Gaseous/Mixed (Ci)	Particulate/Vapor ( $\mu\text{Ci}$ )
TA-2-1	Omega West Reactor	140	0	0
TA-48	FE-40	0	0	38,000
	FE-60	0	0	16
TA-53-3	FE-3	250	71400	730,000
TA-53-7	FE 2	0.99	400	45
Total (rounded)		390	71800	770,000

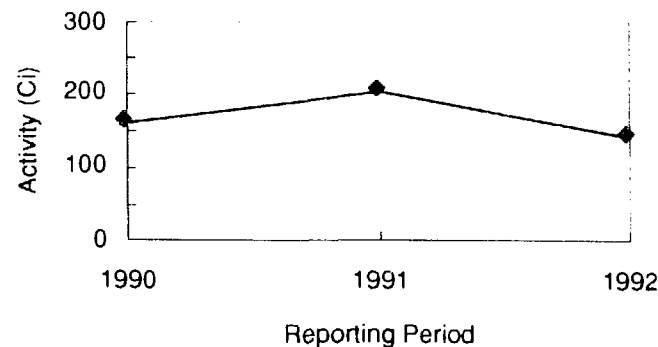
### TA-2 $^{41}\text{Ar}$ Air Emissions

Emissions of  $^{41}\text{Ar}$  from TA-2 stacks varied during 1992 but were greatest in the first four reporting periods. These data are displayed graphically in Figure 50.



**Figure 50.  $^{41}\text{Ar}$  at TA-2 for Each Reporting Period of 1992**

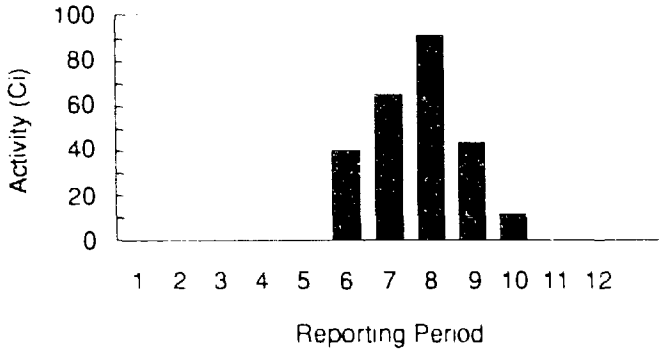
As shown in Figure 51, 1992 air emissions of  $^{41}\text{Ar}$  were decreased from 1990 and 1991 emissions. During the 1990—1992 period, the activity of  $^{41}\text{Ar}$  emitted from TA-2 stacks was greatest in 1991 (approximately 200 Ci).



**Figure 51.  $^{41}\text{Ar}$  Emissions at TA-2 in 1990—1992**

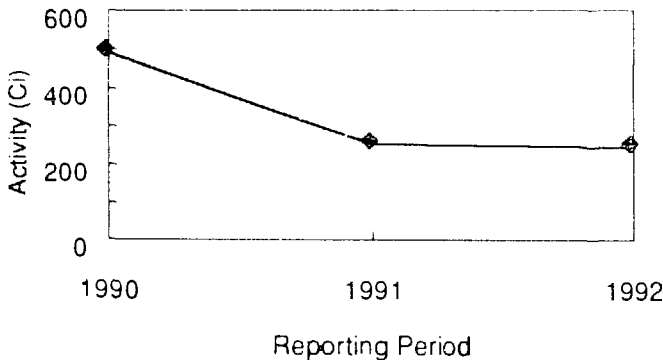
**TA-53 <sup>41</sup>Ar Air Emissions**

As shown in Figure 52, <sup>41</sup>Ar was emitted from TA-53 stacks only during the 6th through 10th reporting periods. This was due to the operating schedule of the Los Alamos Meson Physics Facility (LAMPF) at TA-53, which typically operates only four to six months each year.



**Figure 52. <sup>41</sup>Ar at TA-53 for Each Reporting Period of 1992**

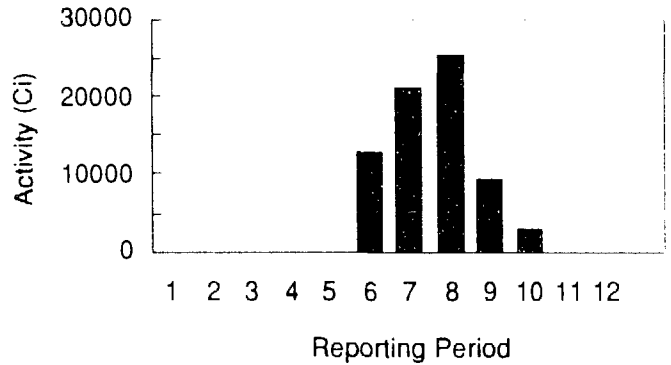
In 1992, <sup>41</sup>Ar emissions from TA-53 stacks were decreased from emissions in 1990 emissions and about the same as 1991 emissions. This trend is displayed in Figure 53. During the 1990—1992 period, the activity of <sup>41</sup>Ar emitted from TA-53 stacks was greatest in 1990 (approximately 490 Ci).



**Figure 53. <sup>41</sup>Ar Emissions at TA-53 In 1990—1992**

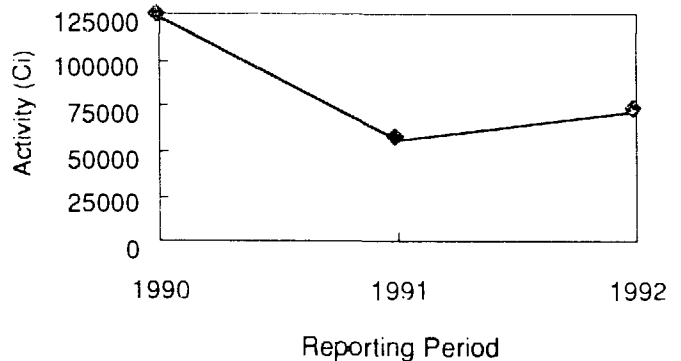
**TA-53 Gaseous/Mixed Activation Product Air Emissions**

As with <sup>41</sup>Ar emissions, other gaseous/mixed activation products were emitted from TA-53 stacks only during five reporting periods of 1992. These emissions are detailed in Figure 54.



**Figure 54. Gaseous/Mixed Activation Products at TA-53 for Each Reporting Period of 1992**

Total emissions of gaseous/mixed activation products (except <sup>41</sup>Ar) from TA-53 stacks for the years 1990—1992 are shown in Figure 55. In 1992, LAMPF operated longer than in the previous year. 1992 emissions were increased over 1991 emissions but still decreased from 1990 emissions. During the 1990—1992 period, the activity of gaseous/mixed activation products (except <sup>41</sup>Ar) emitted from TA-53 stacks was greatest in 1990 (123,000 Ci).

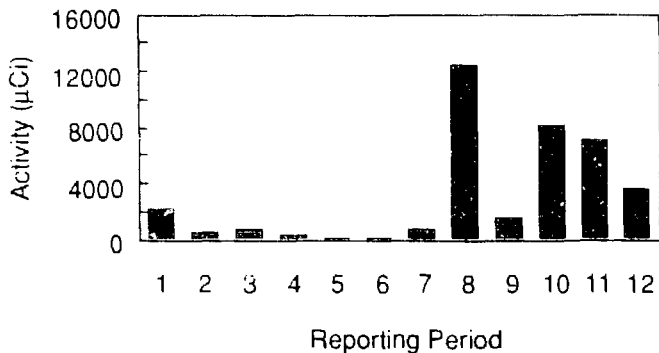


**Figure 55. Gaseous/Mixed Activation Product Emissions at TA-53 In 1990—1992**



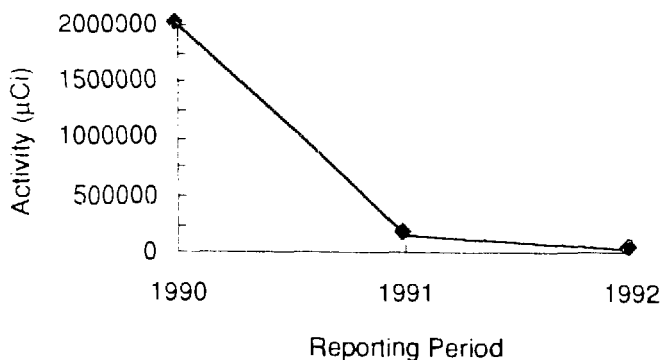
**TA-48 Particulate/Vapor Activation Product Air Emissions**

In 1992, emissions of particulate/vapor activation products from TA-48 stacks peaked in the 8th reporting period. This is shown in Figure 56.



**Figure 56. Particulate/Vapor Activation Products at TA-48 for Each Reporting Period of 1992**

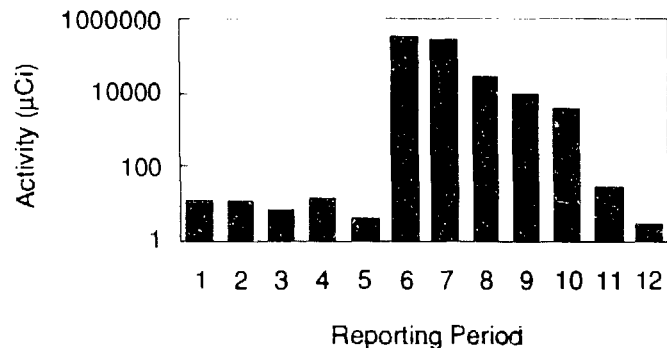
During the 1990—1992 period, the activity of particulate/vapor activation products emitted from TA-48 stacks was greatest in 1990 (2,000,000 µCi). Since 1990, emission of particulate/vapor activation products (then called spallation products) have been decreasing, as displayed in Figure 57.



**Figure 57. Particulate/Vapor Activation Product Emissions at TA-48 in 1990—1992**

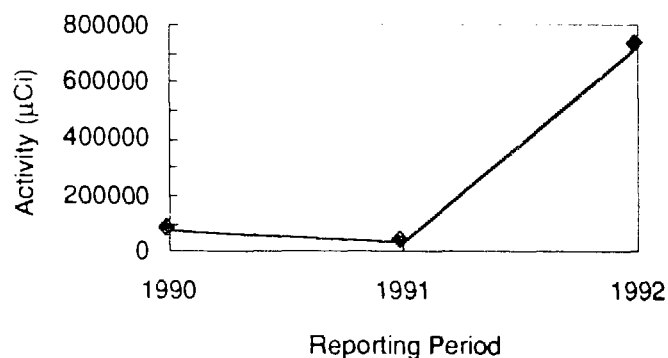
**TA-53 Particulate/Vapor Activation Product Air Emissions**

In June 1992, emissions of particulate/vapor products from TA-53 stacks increased in conjunction with operation of the Los Alamos Meson Physics Facility (LAMPF). As shown in Figure 58, these emissions decreased as operations came to a halt in October 1992.



**Figure 58. Particulate/Vapor Activation Products at TA-53 for Each Reporting Period of 1992**

For the period from 1990—1992, emissions of particulate/vapor activation products from TA-53 stacks are displayed in Figure 59. During this period, the activity of particulate/vapor activation products emitted from TA-53 stacks was greatest in 1992 (approximately 730,000 µCi). These emissions were increased over previous years.



**Figure 59. Particulate/Vapor Activation Product Emissions at TA-53 in 1990—1992**

*Other Radioactive Air Emissions*

## OTHER RADIOACTIVE AIR EMISSIONS

In 1992,  $^{32}\text{P}$  was emitted from stacks at TA-48, the Health Research Laboratory, where radioactivity in humans and animals is measured. The activity of these emissions totaled approximately 10  $\mu\text{Ci}$ , as shown in Table VII. There were also several additional events in 1992 during which radionuclides were released. These additional releases were investigated and their activities are shown in Table VIII. Throughout this section, tritium activities are reported in curies, Ci; all other activities are reported in microcuries,  $\mu\text{Ci}$  (1 million  $\mu\text{Ci}$  equal 1 Ci).

**Table VII.  $^{32}\text{P}$  Emissions in 1992**

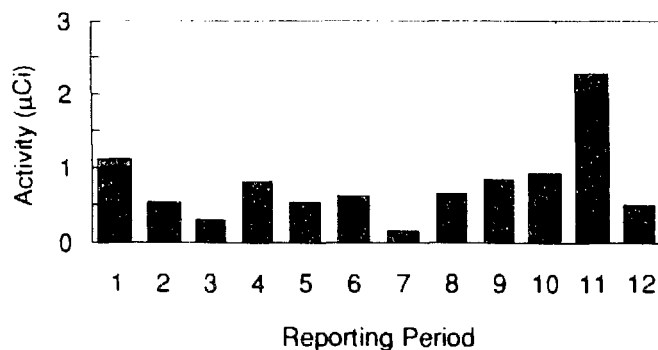
Facility	Stack Number	Activity of $^{32}\text{P}$ Emission ( $\mu\text{Ci}$ )
TA-43-1	FE-9	1.7
	FE-10	2.0
	FE-12	3.8
	FE-34	2.0
Total (rounded)		10

**Table VIII. Additional Releases in 1992**

Facility	Stack Number	Radionuclide	Activity of Emission
TA-3-66	FE-26	$^{232}\text{Th}$	9.9 $\mu\text{Ci}$ (total)
		$^{228}\text{Ac}$	
		$^{212}\text{Pb}$	
		$^{212}\text{Bi}$	
		$^{208}\text{Tl}$	
TA-53-7	FE-2	$^3\text{H}$ (gas)	20 Ci
TA-53-7	FE-2	$^3\text{H}$ (gas)	20 Ci
TA-21-155	FE-5	$^3\text{H}$	0.002 Ci

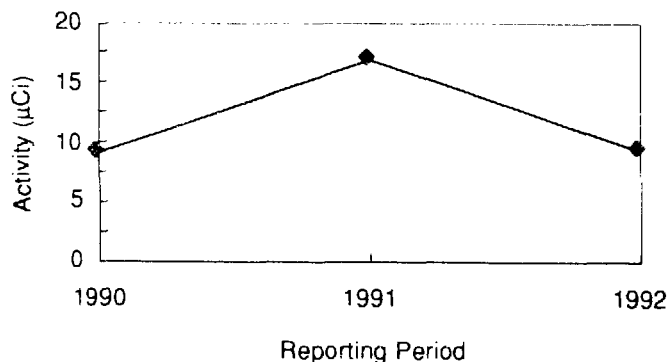
### TA-43 $^{32}\text{P}$ Air Emissions

Emission of  $^{32}\text{P}$  from TA-43 stacks varied during the 12 reporting periods of 1992 (Figure 60).



**Figure 60.  $^{32}\text{P}$  at TA-43 for Each Reporting Period of 1992**

The trend in  $^{32}\text{P}$  air emissions from TA-43 is displayed for 1990—1992 in Figure 61. This figure shows that the total 1992 activity was comparable to the 1990 activity and decreased from the 1991 activity. During the 1990—1992 period, the activity of  $^{32}\text{P}$  emitted from TA-43 stacks was greatest in 1991 (17  $\mu\text{Ci}$ ).



**Figure 61.  $^{32}\text{P}$  Emissions at TA-43 in 1990—1992**

### *Additional Releases*

The following six radioactive releases from Laboratory stacks were not expected based on the usual operations at these facilities and thus are not reported elsewhere in this document. These unplanned releases were investigated and a detailed report was prepared by the Environmental Management Division.

- A release occurred from July 31 to August 7, 1992, at Building 66 at TA-3. The radionuclides emitted were reported to be  $^{232}\text{Th}$  and its daughters,  $^{232}\text{Th}$ ,  $^{228}\text{Ac}$ ,  $^{212}\text{Pb}$ ,  $^{212}\text{Bi}$ , and  $^{208}\text{Tl}$ .
- A release occurred on September 18, 1992, at TA-53. The radionuclide emitted was reported to be tritium gas; 1% was assumed to be converted to tritium water vapor.
- A release occurred on September 24, 1992, at TA-53. As with the release earlier in the month, the radionuclide emitted was reported as tritium gas and 1% was assumed to be converted to tritium water vapor.
- A release occurred on November 13, 1992, from a stack at TA-21. The radionuclide emitted was reported as tritium.