

6. COMPARISON OF DOSES WITH STANDARDS AND GUIDES

DOSES

Calculated radiation doses to offsite populations resulting from SRP emissions are compared in Table III-17 to the Radiation Protection Standards from ERDAM 0524² and to SRP guides. These guides reflect the ERDAM standards, SRP operating experience, and a policy of keeping public exposures in the vicinity of SRP as low as practicable. The guides and their bases are described in Appendix D.

RELEASES

To provide surveillance and control of emission, the releases of radioactivity at SRP are compared monthly to prorated values of annual operating guides. The operating guides are set very close to plant release quantities that reflect the minimum practical levels. SRP policy, as stated in the guides, is that "the plant will confine radioactivity as completely as practical rather than release it to the environment. Release guides are not to be considered desirable discharge quantities."

Because the guides are set close to actual experience, they are occasionally exceeded even on an annual basis; the guides are reviewed at least annually and are revised up or down if production requirements or process improvements cause such a revision to be justified. More frequently, the guides are exceeded only for a short time. These occasions focus attention on problem areas so that corrective action may be taken.

Table III-18 lists the 1975 releases from the various production and laboratory areas compared to the appropriate operating guides for radioactivity release. As noted in the table, only 3 of about 100 guides were exceeded for 1975. The amount of activity in excess of the guides that reached offsite populations contributed 0.1* man-rem to the population dose from atmospheric releases (<1% of the total), and <0.0001 man-rem to the population dose from aqueous releases. The 1976 operating guides are listed in Appendix D.

* 200 Areas guide for stack released tritium was exceeded as result of unusual release of 182,000 Ci on December 31, 1975, most of which was in the gaseous (T₂) form. (See Appendix J.)

TABLE III-17

Individual Dose Commitment Compared to Standards, mrem

<i>Type of Exposure</i>	<i>Doses from 1975 SRP Emissions</i>			<i>SRP Guide</i>	<i>ERDAM 0524^c</i>
	<i>Atmospheric^a</i>	<i>Aqueous^b</i>	<i>Total</i>		
Whole body	0.67	0.5	1.2 ^f	10	500
Gonads	0.67 ^d	0.5 ^e	1.2	10	500
Bone marrow	0.67 ^d	0.5 ^e	1.2	10	500
G.I. tract	0.67 ^d	0.5 ^e	1.2	30	1500
Bone	0.67 ^d	0.5 ^e	1.2	30	1500
Thyroid	1.2 ^d	0.5 ^e	1.7	30	1500
Other organs	0.67 ^d	0.5 ^e	1.2	30	1500

- a.* Atmospheric dose is calculated for an individual living at the plant perimeter.
- b.* Aqueous dose is calculated for an individual drinking untreated river water just downstream from the plant and consuming river fish.
- c.* "Dose to critical individuals at points of maximum probable exposure." Doses from SRP releases are also within the ERDAM 0524 limits for "average dose to a suitable sample of the exposed population," where the 500/1500 mrem standards are reduced to 170/500 mrem.
- d.* Includes 0.67 mrem whole body dose.
- e.* Includes 0.5 mrem whole body dose.
- f.* In a small portion of the offsite swamp immediately below the plant boundary, an individual using the area for fishing, hunting, or boat launching could receive a whole body dose from previously deposited gamma emitters (primarily ¹³⁷Cs, pp. III-13 and III-25) of a few mrem to a few tens of mrem per year.

TABLE III-18

1975 RELEASES COMPARED TO 1975 OPERATING GUIDES
curies

I. To Atmosphere

Nuclide	Separations Areas		Reactor Areas		Heavy Water Area		700-A		CMX-TMX		Raw Materials Area	
	Release	Guide	Release	Guide	Release	Guide	Release	Guide	Release	Guide	Release	Guide
³ H	325,000 ^{a, b}	250,000	159,000	270,000	3,060	9,000	600	1000	-	100	-	1
¹⁴ C	27	50	39	60	-	-	-	-	-	-	-	-
⁴¹ Ar	-	-	65,000	200,000	-	-	-	-	-	-	-	-
⁸⁵ Kr	520,000	950,000	-	-	-	-	-	-	-	-	-	-
^{85, 85m, 87, 88} Kr	-	-	2,400	15,000	-	-	-	-	-	-	-	-
^{131m, 133} Xe	5.8	500	-	-	-	-	-	-	-	-	-	-
^{133, 135} Xe	-	90	1,800	30,000	-	-	-	-	-	-	-	-
¹²⁹ I	0.14	0.25	-	-	-	-	-	-	-	-	-	-
¹³¹ I	0.11	2.0	0.003	0.02	-	-	0.008	0.075	-	-	-	-
⁶⁰ Co	-	Included in "Other β-γ"					0.001	0.005	-	-		
^{89, 90} Sr	0.005	0.02										
⁹⁵ Zr	0.014	0.1										
⁹³ Nb	0.024	0.1										
¹⁰³ Ru	0.002	1.0	Included in "Other β-γ"				Included in "Other β-γ"					
¹⁰⁶ Ru	0.037	1.0										
¹³⁴ Cs	2x10 ⁻⁴	0.001										
¹³⁷ Cs	0.001	0.003										
¹⁴¹ Ce	3x10 ⁻⁴	0.005										
¹⁴⁴ Ce	0.016	0.05										
Other β-γ	2 x 10 ⁻⁴	0.02	0.004	0.005	-	-	3x10 ⁻⁴	0.001	-	-		
U	0.005	0.01	-	-	-	-	-	-	-	-	3x10 ⁻⁶	0.0005
^{238, 239} Pu	0.0025	0.02	-	-	-	-	-	-	-	-	-	-
Gross or Other α	-	0.002	1.4x10 ⁻³	2x10 ⁻³	-	-	3x10 ⁻⁶	0.0002	-	-	7x10 ⁻⁶	0.001

a. Values exceeded their annual guide.
b. Includes 182,000 Ci released 12/31/75.

TABLE III-18 (Continued)

II. To Plant Streams and Earthen Basins

A. To Separations Areas Streams

<i>Nuclide</i>	<i>Release</i>	<i>Guide</i>
^3H	74	200
$^{89,90}\text{Sr}$	0.013	0.05
$^{134,137}\text{Cs}$	0.02	0.1
Other β - γ	0.037	0.3
Alpha	0.007	0.01

B. To Separations Areas Seepage Basins

<i>Nuclide</i>	<u>200-F Area</u>		<u>200-H Area</u>	
	<i>Release</i>	<i>Guide</i>	<i>Release</i>	<i>Guide</i>
^3H	See 200-H		14,000	39,000
			<u>F and H</u>	
^{89}Sr	0.05	0.2	0.35	0.5
^{90}Sr	0.12	0.2	0.68 ^a	0.5
^{95}Zr	0.73	5.0	0.24	1.5
^{95}Nb	0.43	5.0	0.46	2.5
^{103}Ru	0.08	2.0	0.20	2.5
^{106}Ru	4.0	20	2.26	15
$^{124,125}\text{Sb}$	-	Included in "Other β - γ "	0.07	0.3
^{131}I	0.02	1.0	0.20	1.0
^{134}Cs	0.07	0.5	0.41	0.5
^{137}Cs	0.98	5.0	6.23 ^a	4.0
^{141}Ce	0.001	0.1	0.02	1.0
^{144}Ce	0.19	0.5	1.26	2.5
^{147}Pm	0.19	1.0	1.14	1.5
^{51}Cr	-		4.51	15
^{56}Co	-	Included in "Other β - γ "	0.48	1.0
^{60}Co	-		0.41	0.5
^{65}Zn	-		0.57	1.0
Other β - γ	0.014	1.0	0.11	1.0
U	-	Included in "Total α "	-	Included in "Total α "
Pu	-		-	
Total α	0.17	0.5	0.14	0.4

^a. Values exceeded their annual guide.

TABLE III-18 (Continued)

C. To Reactor Areas Streams, Basins, and Cooling Reservoirs

<i>Nuclide</i>	<i>Total to Plant Streams</i>	<i>100-K 50 MGB^a</i>	<i>100-L Oil & Chem Pit</i>	<i>Par Pond Cooling Reservoir</i>	<i>Total Release</i>	<i>Guide</i>
³ H	23,000	15,600	200	5,940	45,000	50,000
⁹⁰ Sr	0.014	0.001	0.002		0.015	0.5
⁹⁰ Sr	0.106	-	0.001		0.107	0.15
⁹¹ Y	0.014	0.002	0.001		0.017	0.5
⁹² Zr-Nb	0.039	0.003	0.004		0.046	1.0
¹⁰³ Ru, ¹⁰⁶ Ru-Rh	0.054	-	0.002		0.056	0.1
^{124,125} Sb	0.001	0.037	-		0.038	0.35
¹³¹ I	-	0.003	-		0.003	0.5
¹³⁴ Cs	0.175	0.007	0.001		0.183	0.3
¹³⁷ Cs	0.440	0.084	0.002		0.526	0.6
¹⁴⁰ Ba- ¹⁴⁰ La	-	-	-		0.0	0.05
^{141,144} Ce	0.039	0.004	0.001		0.044	0.5
¹⁴⁷ Pm	0.034	0.031	-		0.065	0.3
²³⁹ Np	0.008	-	-		0.008	0.04
²³ P	0.002	0.008	-		0.010	0.2
³⁵ S	0.29	0.051	-		0.34	2.8
⁵¹ Cr	0.12	0.058	-		0.18	1.2
^{58,60} Co, ⁵⁹ Fe	0.009	0.001	0.007		0.017	0.1
⁶⁵ Zn	0.002	-	-		0.002	0.06
Gross α	0.010	0.002	-		0.012	0.04
Other β-γ	-	-	-		-	0.04

^a. 50-million-gallon basin.

TABLE III-18 (Continued)

D. To 300-M and 700-A Streams

<i>Nuclide</i>	<i>300-M Release</i>	<i>300-M Guide</i>	<i>700-A Release</i>	<i>700-A Guide</i>
^{235,238} U	0.444	0.4	-	-
Total alpha	-	-	0.002	0.005
Nonvolatile beta	-	-	0.005	0.01

E. To 300-M and 700-A Seepage Basins

<i>Nuclide</i>	<i>300-M Release</i>	<i>300-M Guide</i>	<i>700-A Release</i>	<i>700-A Guide</i>
³ H	-	-	4	50
^{134,137} Cs	-	-	-	0.01
^{89,90} Sr	-	-	0.0007	0.005
^{235,238} U, Pu	0.019	<i>a</i>	0.002	0.01
Other β-γ, total	-	-	0.008	0.05
All other alpha	-	<i>a</i>	0.003	0.1

a. Included with stream of Part D.

F. To 400-D Effluent Streams and Basins

<i>Nuclide</i>	<i>Release</i>	<i>Guide</i>
³ H	1,600	8,500
^{89,90} Sr	0.0005	0.015
^{134,137} Cs	0.003	0.015
Gross α	9x10 ⁻³	0.005
Other β-γ	0.02	0.2

G. To CMX-TNX Seepage Basin

<i>Nuclide</i>	<i>Release</i>	<i>Guide</i>
^{235,238} U	-	0.015
β-γ	-	0.004
Other alpha	-	0.001

CONCENTRATIONS

The standards applicable to concentrations of radionuclides in air and water at SRP are the Concentration Guides given in ERDAM 0524.² These Concentration Guides are based on recommendations of the International Commission on Radiological Protection. Concentration Guides for some significant nuclides are summarized in Table III-19. The complete guides are given in ERDAM 0524.²

Comparisons with the Concentration Guides are made by summing the ratios of annual average concentrations for the various radionuclides to their respective Concentration Guides; the sum of the ratios must be <1. Figures III-9, 10, 11, and 12 show that concentrations in the plant streams that have carried significant quantities of radioactivity (Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs) have always met the ERDAM 0524 standard before their discharge to the Savannah River. The measurements are made at the Road A crossings of the streams (Figure II-2) rather than the stream mouths because of ease of accessibility and consistent flow.

The 0.9 ratio for Four Mile Creek in 1959 occurred prior to routine specific radionuclide analyses for effluent streams and results from comparison to the nonvolatile beta guide. Most of the activity was known qualitatively to be ²³⁹Np and short-lived fission products. When specific analyses were started in 1960, the ratios decreased.

The increased ratios for Steel Creek in 1968 and 1969 reflected the loss of diluent water for P-Area releases when L reactor was shut down and placed in standby condition in February 1968. Subsequent decreases in the ratios signify lower releases resulting from improved fuel storage basin operations in P Area.

Other SRP streams discharging to the Savannah River are Upper Three Runs and Beaver Dam Creek. The major radioactive constituent of Upper Three Runs is alpha activity resulting from 300-Area discharges. Measurements at the Road A crossing since 1954 show that the maximum fraction of the ERDAM 0524² Concentration Guide was 0.08. Beaver Dam Creek is the effluent stream for the 400-Area, and tritium is the only significant nuclide present. Measurements made in the 400-Area discharge since 1964 show that the maximum fraction of the guide was 0.07.

In 1975, the sum of the fractions of the ERDAM 0524 Concentration guides were:

Four Mile Creek	- 0.04	Lower Three Runs	- 0.02
Pen Branch	- 0.05	Beaver Dam Creek	- 0.03
Steel Creek	- 0.04	Upper Three Runs	- 0.02

TABLE III-19

CONCENTRATION GUIDES FOR UNCONTROLLED AREAS
(From ERDAM 0524)

<i>Nuclide</i>	<i>In Water,</i> 10^{-3} $\mu\text{Ci/cc}$	<i>In Air,</i> 10^{-12} $\mu\text{Ci/cc}$
Alpha	30	0.02
Nonvolatile beta	3,000	100
Tritium	3,000,000	200,000
^{14}C	800,000	100,000
^{41}Ar	-	40,000
^{32}P	20,000	2,000
^{33}S	60,000	9,000
^{51}Cr	2,000,000	80,000
^{54}Mn	100,000	1,000
^{60}Co	30,000	300
^{65}Zn	100,000	2,000
$^{85\text{m}}\text{Kr}$	-	100,000
^{85}Kr	-	300,000
^{87}Kr	-	20,000
^{88}Kr	-	20,000
^{89}Sr	3,000	300
^{90}Sr	300	30
$^{89,90}\text{Sr}$	300	30
^{91}Y	30,000	1,000
^{93}Nb	10,000	3,000
^{93}Zr	60,000	1,000
$^{93}\text{Zr-Nb}$	10,000	1,000
^{99}Mo	40,000	7,000
^{103}Ru	80,000	3,000
^{106}Ru	10,000	200
$^{103,106}\text{Ru}$	10,000	200
^{124}Sb	20,000	700
^{125}Sb	100,000	900
$^{124,125}\text{Sb}$	20,000	700
^{129}I	60	20
^{131}I	300	100
$^{131\text{m}}\text{Xe}$	-	400,000
^{133}Xe	-	300,000
^{135}Xe	-	100,000
^{134}Cs	9,000	400
^{137}Cs	20,000	500
$^{140}\text{Ba-La}$	20,000	1,000
^{141}Ce	90,000	5,000
^{144}Ce	10,000	200
$^{141,144}\text{Ce}$	10,000	200
^{147}Pm	200,000	2,000
$^{235,238}\text{U}$	30,000	3
^{238}Pu	5,000	0.07
^{239}Pu	5,000	0.06
^{239}Np	100,000	20,000
^{242}Cm	20,000	4
^{244}Cm	7,000	0.3

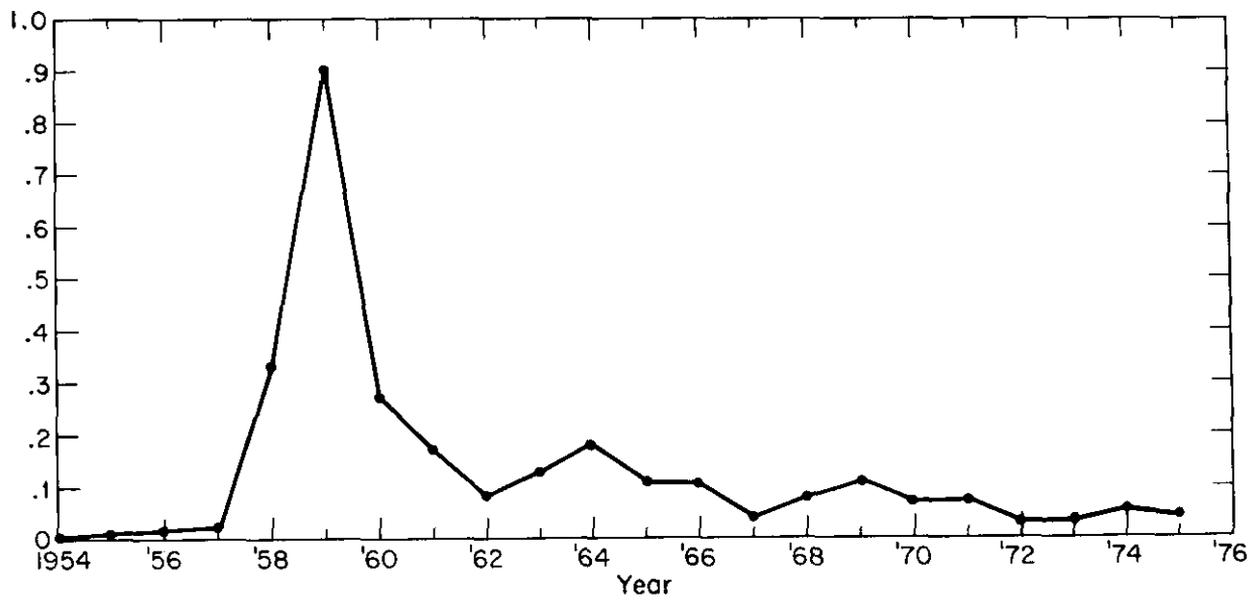


FIGURE III-9. Fraction of ERDAM 0524 Concentration Guides in Four Mile Creek

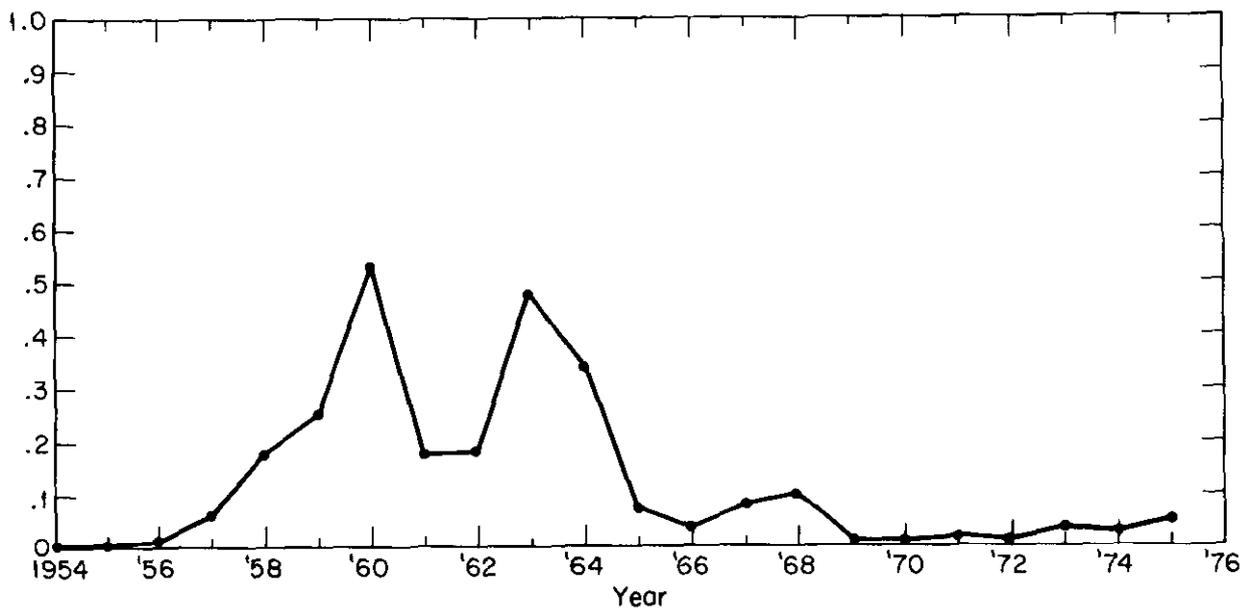


FIGURE III-10. Fraction of ERDAM 0524 Concentration Guides in Pen Branch

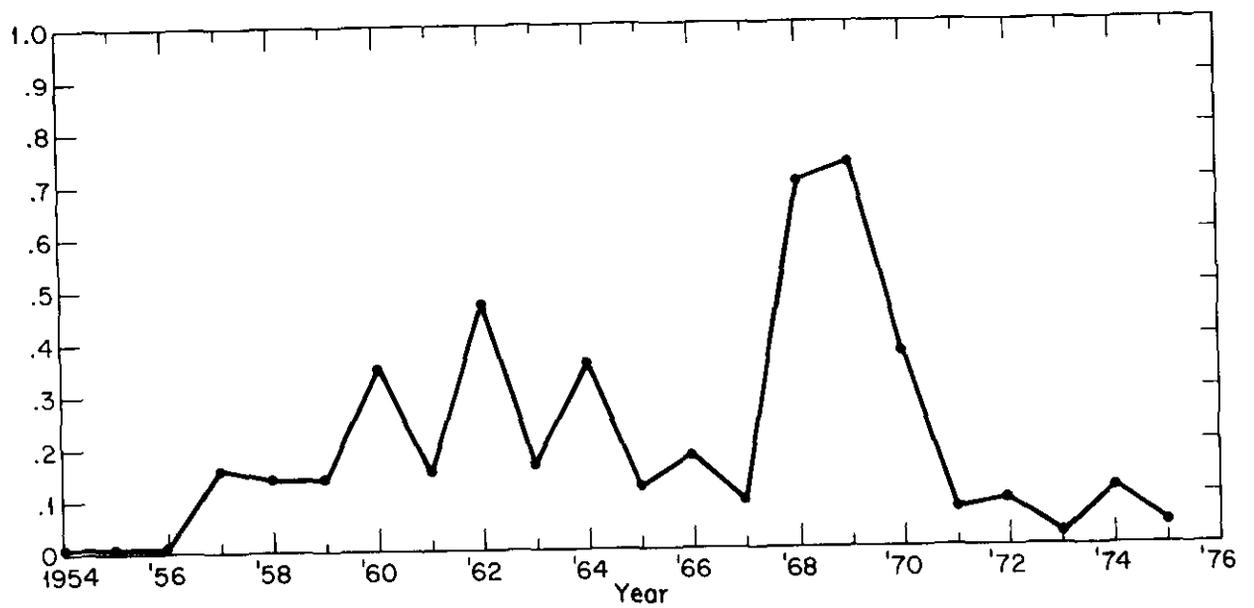


FIGURE III-11. Fraction of ERDAM 0524 Concentration Guides in Steel Creek

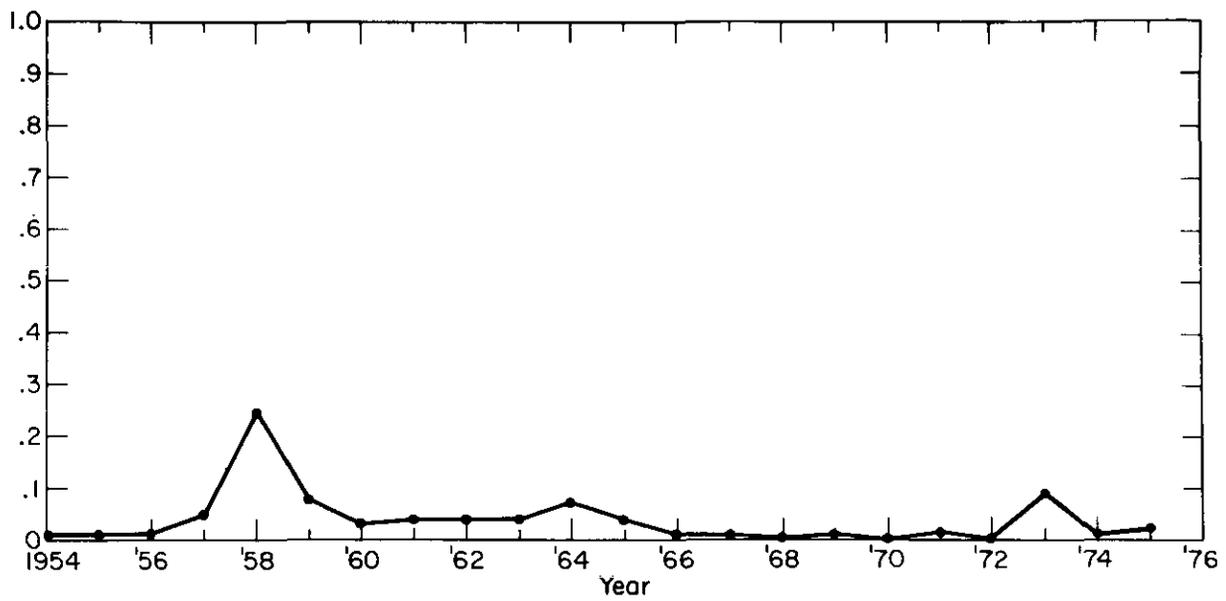


FIGURE III-12. Fraction of ERDAM 0524 Concentration Guides in Lower Three Runs

Similar comparisons to ERDAM 0524² standards for concentrations of atmospheric radionuclides at the plant perimeter show a sum of ratios for the 1975 annual averages of 0.001. Most of these concentrations are calculated from release data; values are given in DPSPU-76-30-1.⁶ For the year of maximum release, the concentration ratios for the significant isotopes were: tritium, 0.003 (1958); ⁴¹Ar, 0.002 (1963); and ¹³¹I, 0.003 (1956).