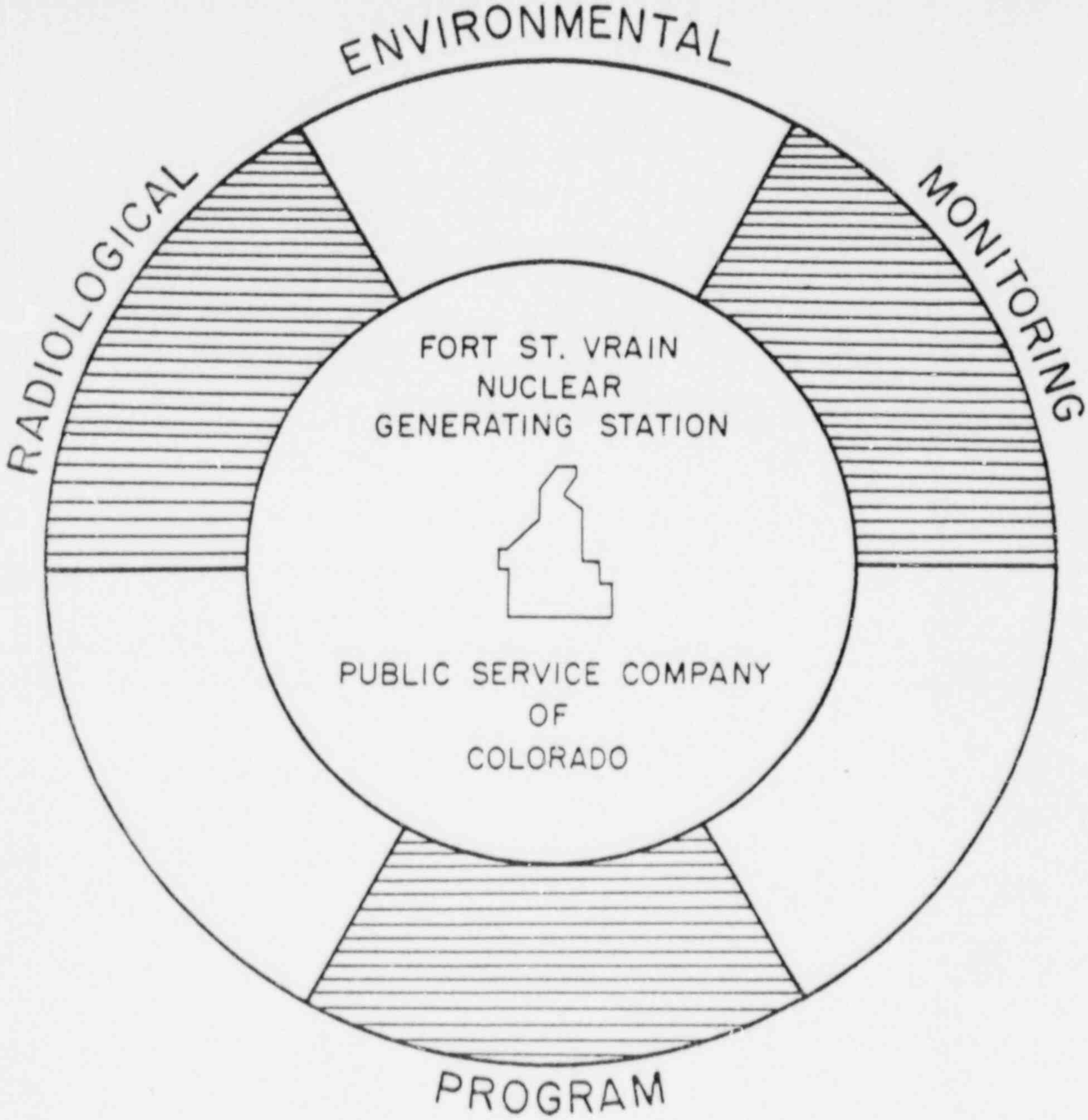

SUMMARY REPORT

1987

COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80523

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Summary Report
for the Period
January 1, 1987 - December 31, 1987

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Acknowledgements

Many persons have contributed to this project during 1987, and it is important to acknowledge their effort. We also wish to thank the citizens from whose farms, homes, and ranches we collect the environmental samples. Without their cooperation the project would not be possible.

The persons working directly on the project have been:

Sheri Chambers	Laboratory Technician
Mark Chapin	Graduate Research Assistant
Sharon Clow	Chemist and Laboratory Coordinator
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I. Introduction to Radiological Environmental Monitoring Data for the Period January 1, 1987 - December 31, 1987

During 1987 the Fort St. Vrain Nuclear Generating Station produced electrical energy as follows:

Month	Dates with Thermal Energy Generation	Gross Thermal Energy Production (MWH)
Jan.-March	0	0
April	17-30	15018.3
May	1-31	164842.3
June	1-12	68393.1
	15-30	80085.6
July	1-29	248206.8
August	0	0
September	12	0.4
	17	43.0
	30	42.7
October	1-3	3860.9
November	0	0
December	11-25	63648.8
	27-31	23793.9
Total for 1987		667934.8

A complete and detailed listing of radioactivity released by all effluent routes may be found in the Public Service Company of Colorado Semi-annual Effluent Release Reports for 1987 to the U.S. Nuclear Regulatory Commission. When possible in this report, any correlation of radioactivity in environmental samples with the effluent release data is discussed. These discussions are presented in the appropriate sample type section and in the summary section, II.H.

Table III.A.2 lists the LLD values achievable by the counting systems used during 1987 on project samples. These values are given for typical sample sizes, counting times and decay times. The LLD is, therefore, an a priori parameter to indicate the capability of the detection system used. The LLD values in Table III.A.2 were calculated as suggested in NUREG-0472.

Throughout the report, however, when a sample result is listed as less than a specified value, that value is the calculated MDC (minimum detectable concentration). This approach is analogous to that of Currie (NUREG/CR-4007): the MDC is the same as S_C, the critical signal, and the LLD is equal to S_D, the detectable signal. The MDC value applies to the actual sample size, counting time and decay time applicable to that individual sample. It is calculated as:

$$MDC = 2.33\ \sigma_B / E\ Y\ V\ E^{-\lambda t}$$

Where: σ_B = Standard deviation of background count rate

E = Counting efficiency, c s^{-1} pCi^{-1}

Y = Chemical yield

V = Sample mass or volume

λ = 0.693/Half-life

t = Decay time between sample collection and analysis

This calculation method assumes that E and Y are constants and makes no allowance for systematic error.

It should be noted that we have not used the notation < MDC for values less than MDC. Rather, we report the result as less than the actual MDC value. Because the MDC is dependent upon variables such as the background count time and sample size, the value will be different for each sample type and even within sample type.

Essentially all radioactivity values measured on this project are near background levels and, more importantly, near the MDC values for each radionuclide and sample type. It has been well-documented that environmental radioactivity values exhibit great inherent variability. This is partly due to sampling and analytical variability, but most importantly due to true environmental or biological variability. As a result, the overall variability of the surveillance data is quite large, and it is necessary to use mean values from a rather large sample population size to make any conclusions about the absolute radioactivity concentrations in any environmental pathway.

Environmental radiation surveillance data also commonly exhibit non-normal frequency distributions. Usually the data can be satisfactorily treated using log-normal statistics. However, when the number of observations is small, i.e., less than 10, log-normal treatment is tentative. The geometric means and geometric standard deviations are calculated for each sample set. If any data point measured resulted in a negative value, the corresponding MDC is used in the calculation of the log-normal statistics. (Negative values are possible due to the statistical nature of radioactivity counting.) In Section II.H. Conclusions and Summary, the geometric means and geometric standard deviations for the reporting period of 1987 are listed in Table II.H.2.

The arithmetic mean for each sample set is also listed in Table II.H.2. All measured values, both positive and negative, are used in the calculations of the arithmetic mean. This is the suggested practice by Gilbert (Health Physics 40:377, 1984) and the NRC (NUREG/CR-4007).

Many sets of data were compared in this report. The statistical test used was either a "t"-test or a paired "t"-test. If data sets are noted to be significantly different or not significantly different, the confidence for the statement is at the 95% level (α = 0.05).

In this report we have footnoted appropriate tables with the maximum permissible concentration applicable to each radionuclide. We have chosen to list the maximum permissible concentrations as found in Appendix B Table II of 10CFR20. This is the concentration in water or air of each radionuclide which if ingested or inhaled continuously would singularly produce the maximum permissible radiation dose rate to a specified individual member of the general public. That value is 500 mrem/year, but must include the dose from all possible sources, and, therefore, cannot be solely due to reactor effluent. As stated in 10CFR20 these are the maximum concentrations above natural background that a licensee may release to an unrestricted area. It is assumed that no direct ingestion or inhalation of effluents can occur at the restricted area boundary and that dilution and dispersion decreases the concentration before it reaches nearby residents. This is certainly the case for the Fort St. Vrain environs.

There is no specified maximum permissible dose rate or dose commitment for residents near the Fort St. Vrain reactor from the reactor effluents. Such limits for water cooled reactors are found in 10CFR50 Appendix I. These are judged as "As Low as Reasonably Achievable" dose rates from such reactor types and, although not directly applicable to the Fort St. Vrain gas cooled reactor, can be used for comparison purposes.

A limit that does apply is the independent maximum permissible dose commitment rate set by the E.P.A. (40CFR190) for any specified member of the general public from any part of the nuclear fuel cycle. This value is 25 mrem/year, the dose rate to the whole body from all contributing radionuclides excluding background and medical radiation dose rate.

Dose commitments are calculated for hypothetical individuals for any mean concentrations noted in unrestricted areas that are significantly above control mean values.

The following is the footnote system used in this report.

a. Sample lost prior to analysis.

b. Sample missing at site.

c. Instrument malfunction.

d. Sample lost during analysis.

e. Insufficient weight or volume for analysis.

f. Sample unavailable.

g. Analysis in progress.

h. Sample not collected (actual reason given).

i. Analytical error (actual reason given).

N.A. Not applicable.

II. Surveillance Data for January Through December 1987 and Interpretation of Results

A. External Gamma-ray Exposure Rates

The average measured gamma-ray exposure rates expressed in mR/day are given in Table II.A.1. The values were determined by CaF_2:Dy (TLD-200) dosimeters at each of 41 locations (see Table III.B.1). Two TLD chips per package are installed at each site and the mean value is reported for that site. The mean calculated total exposure is then divided by the number of days that elapsed between pre-exposure and post-exposure annealing to obtain the average daily exposure rate. The TLD devices are changed quarterly at each location. Fading during field exposure is minimized by the post-annealing readout procedure.

The TLD data indicate that the arithmetic mean measured exposure rate in the facility area for all of 1987 was 0.44 mR/day. The mean exposure rate was 0.44 mR/day for the adjacent area and 0.43 mR/day for the reference area. These mean values were not significantly different from each other.

The exposure rate measured at all sites is due to a combination of exposure from cosmic rays, from natural gamma-ray emitters in the earth's crust and from ground surface deposition of fission products due to previous world-wide fallout. The variation in measured values is due to true variation of the above sources plus the variation due to the measurement method. The purpose of the two TLD rings around the reactor is not to measure gamma-rays generated from the reactor facility itself, but to document the presence or absence of gamma-ray emitters deposited upon the ground from the reactor effluents. Since the inception of power production by the reactor, there has been no detectable increase in the external exposure rate due to reactor releases.

The TLD system was calibrated by exposing chips to a scattered gamma-ray flux produced in a cavity surrounded by uranium mill tailings. This produces a gamma-ray spectrum nearly identical to that from natural background measured in the reactor environs. The quality control program includes calibration before readout of each quarterly batch of TLD devices.

Table II.A.1 Gamma-Ray Exposure Rates. (mR/day) 1987.

Facility Area	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
F-1	0.47	0.41	0.42	0.42
F-2	0.43	0.39	0.45	0.45
F-3	0.46	0.45	0.41	0.50
F-4	0.44	0.36	0.43	0.40
F-5	0.45	0.39	0.42	0.52
F-6	0.45	0.37	0.36	0.45
F-7	0.48	0.48	0.44	0.43
F-8	0.47	0.46	0.47	0.44
F-9	0.45	0.40	0.43	0.44
F-10	0.41	0.39	0.44	0.45
F-11	0.52	0.46	0.48	0.49
F-12	0.47	0.43	0.52	0.45
F-13	0.42	0.41	0.36	0.52
F-14	0.42	0.37	0.43	0.42
F-15	0.43	0.38	0.41	0.43
F-16	0.47	0.38	0.43	0.43
F-17	0.45	0.41	0.46	0.50
F-18	0.47	0.39	0.48	0.49
$\overline{X}$ (1.96σ)	0.45 (0.03)	0.41(0.04)	0.44(0.04)	0.46(0.04)
Adjacent Area				
A-1	0.49	0.39	0.48	0.46
A-2	0.50	0.41	0.49	0.47
A-3	0.46	0.41	0.46	0.45
A-4	0.43	0.37	0.44	0.44
A-5	0.40	0.39	0.40	0.43
A-6	0.43	0.37	0.44	0.39
A-7	0.44	0.41	0.46	0.37
A-8	0.52	0.40	0.53	0.46
A-9	0.50	0.37	0.46	0.50
A-10	0.51	0.48	0.56	0.54
A-11	0.46	0.35	0.48	0.48
A-12	0.43	0.37	0.45	0.42
A-13	0.40	0.37	0.40	0.34
A-14	0.42	0.40	0.32	0.40
A-15	0.45	0.40	0.44	0.42
A-16	0.44	0.44	0.44	0.41
A-17	0.53	0.41	0.48	0.46
A-20	0.49	0.40	0.55	0.49
$\overline{X}$ (1.96σ)	0.46 (0.04)	0.40(0.03)	0.46(0.06)	0.44(0.05)
Reference Area				
R-1	0.44	0.40	0.43	0.39
R-2	0.46	0.37	0.48	0.44
R-3	0.41	0.37	0.40	0.47
R-4	0.47	0.44	0.46	0.49
R-7	0.40	0.34	0.44	0.41
$\overline{X}$ (1.96σ)	0.44 (0.03)	0.38(0.04)	0.44(0.03)	0.44(0.04)

II.B. Ambient Air Concentrations

1. Gross Beta Activity

The air concentrations of long lived particulate gross beta activity measured at the facility and reference sampling sites are listed in Tables II.B.1a-1d for each quarter of 1987. A-19, while technically in the adjacent zone, is only a few meters from the facility boundary and logically should be considered a facility site. It has been termed a facility site since the inception of the monitoring program. The reference sites R-3, R-4, and R-11 are all new locations as of January 1, 1984 and sufficiently distant to be considered reference (control) locations. (See Table III.B.1).

The reported concentrations are listed in units of femtocuries per cubic meter of ambient air, although the measured activity is due to a mixture of radionuclides. It should also be noted that the current technical specifications no longer require measurement of gross alpha activity. All filters, however, are saved indefinitely for later alpha particle analysis if needed.

No statistically significant difference was found in the arithmetic mean values between the facility and reference sites during any quarter of 1987. There was also no difference between quarters as was observed during 1986 due to the Chernobyl fallout.

The gross beta data for 1987 have been added to the plot of air concentrations observed since 1973 (Figure II.B.2). In this figure the half-yearly mean values for the facility sites are plotted with the values from the reference sites. The contribution from Chernobyl is clearly evident in 1986. It can be observed that overall mean values are not significantly different and that world-wide fallout principally due to Chinese atmospheric nuclear weapon tests is the predominant contributor to the measured values.

There has never been a significant difference observed between facility and reference sites. Thus, it can be again concluded that reactor air effluents of particulate fission products or activation products are not a source of dose commitment for the Fort St. Vrain environs population.

Table II.B.1 Concentrations of Long-lived Gross Beta Particulate Activity in Air. (fCi/m^3)

a.) Collection Period: First Quarter, 1987.

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
Jan 3	26 (1.6)*	29 (2.4)	32 (2.1)	26 (2.0)	31 (2.1)	11 (1.1)	24 (1.8)
Jan 10	32 (1.6)	33 (2.1)	30 (2.1)	30 (1.9)	26 (1.9)	29 (1.7)	28 (2.1)
Jan 16	27 (1.8)	27 (2.4)	21 (2.0)	25 (2.4)	24 (2.0)	28 (1.9)	34 (2.4)
Jan 24	39 (2.4)	13 (1.0)	31 (2.3)	c1	17 (1.6)	18 (1.4)	6.9 (1.3)
Jan 31	28 (2.1)	9.8 (1.2)	6.3 (1.3)	35 (4.0)	32 (2.8)	19 (1.5)	18 (1.7)
Feb 7	27 (1.4)	27 (2.0)	26 (1.8)	24 (1.9)	27 (2.1)	24 (1.6)	27 (2.3)
Feb 14	35 (1.8)	35 (2.7)	31 (1.9)	35 (2.8)	38 (2.4)	29 (1.7)	36 (2.8)
Feb 20	18 (1.1)	23 (2.2)	14 (1.5)	16 (2.2)	15 (1.5)	17 (1.2)	16 (2.1)
Feb 28	24 (1.2)	32 (2.3)	31 (1.7)	c2	34 (1.9)	36 (1.6)	20 (1.8)
Mar 6	41 (1.8)	37 (2.4)	33 (2.2)	c2	36 (2.6)	38 (2.1)	47 (2.6)
Mar 14	22 (1.3)	21 (1.8)	21 (1.9)	8.6 (1.1)	27 (1.8)	c3	33 (1.9)
Mar 21	14 (0.90)	16 (1.6)	15 (1.4)	13 (0.91)	15 (1.3)	18 (1.4)	19 (1.5)
Mar 28	13 (1.0)	15 (1.9)	16 (1.4)	10 (1.1)	20 (1.4)	19 (1.1)	22 (1.6)
$\bar{X}$:	27	24	24	22	26	24	25
n:	13	13	13	10	13	12	13
1.96σ:	17	17	17	19	15	16	20
MAX: 41 MIN: 6.3			$\bar{X}$: 24 n: 49 1.96σ: 17		MAX: 47 MIN: 6.9		$\bar{X}$: 25 n: 38 1.96σ: 17

* 1.96σ (due to counting statistics.)

c1 Insufficient deposit on filter.

c2 Pump inoperative. No replacement pump available.

c3 Pump inoperative for major fraction of sampling period.

Table II.B.1 Concentrations of Long-lived Gross Beta Particulate Activity in Air. (fCi/m^3)

b.) Collection Perioa: Second Quarter, 1987.

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Apr 4	16 (1.1)*	19 (1.8)	16 (1.3)	18 (1.1)	19 (1.3)	18 (1.5)	21 (1.5)
Apr 11	20 (1.3)	4.0 (1.5)	20 (1.6)	19 (1.6)	19 (1.5)	15 (1.0)	17 (1.2)
Apr 18	19 (1.2)	21 (1.5)	c1	21 (1.4)	19 (1.7)	18 (1.2)	21 (1.6)
Apr 24	17 (1.4)	20 (1.5)	22 (3.6)	26 (1.9)	22 (1.5)	14 (1.2)	38 (7.6)
May 1	39 (2.0)	27 (1.5)	30 (1.6)	35 (1.9)	29 (2.0)	39 (1.9)	32 (1.8)
May 9	38 (1.7)	29 (1.6)	38 (2.0)	44 (2.3)	28 (1.6)	22 (1.1)	18 (1.1)
May 16	14 (1.1)	19 (1.3)	15 (1.3)	19 (1.3)	20 (1.5)	20 (1.2)	34 (1.8)
May 23	14 (1.2)	15 (1.3)	11 (1.3)	13 (1.5)	13 (1.2)	13 (1.1)	10 (0.87)
May 29	18 (1.2)	17 (1.2)	17 (1.4)	21 (1.7)	17 (1.4)	28 (2.0)	21 (1.5)
Jun 6	22 (1.4)	21 (1.5)	20 (1.6)	19 (1.4)	21 (1.4)	10 (0.87)	21 (1.2)
Jun 12	20 (1.3)	22 (1.5)	21 (1.5)	19 (1.4)	20 (1.6)	19 (1.2)	27 (3.3)
Jun 19	26 (1.7)	26 (1.7)	24 (1.8)	24 (2.0)	24 (1.7)	15 (1.2)	9.1 (1.2)
Jun 26	28 (1.3)	30 (1.7)	33 (1.8)	29 (1.5)	26 (1.9)	25 (1.2)	25 (1.3)
$\bar{X}$:	22	21	22	24	21	20	23
n:	13	13	12	13	13	13	13
1.96 σ:	16	13	15	16	8.8	15	17
MAX: 44 MIN: 4.0			$\bar{X}$: 22 n: 51 1.96 σ: 15		MAX: 39 MIN: 9.1		$\bar{X}$: 21 n: 39 1.96 σ: 14

* 1.96 σ (Due to counting statistics.)
c1 Insufficient deposit on filter.

Table II.B.1 Concentrations of Long-lived Gross Beta Particulate Activity in Air. (fCi/m^3)

c.) Collection period: Third Quarter, 1987.

Collection Date	Facility Sites F-7	Facility Sites F-9	Facility Sites F-16	Facility Sites A-19	Reference Sites R-3	Reference Sites R-4	Reference Sites R-11
Jul 3	24 (1.7)*	22 (1.8)	24 (2.0)	25 (2.0)	27 (2.0)	29 (1.5)	22 (1.5)
Jul 11	31 (1.5)	29 (1.5)	31 (1.6)	29 (1.5)	27 (1.7)	26 (1.3)	27 (1.4)
Jul 17	24 (1.7)	26 (1.7)	22 (1.8)	23 (1.6)	23 (1.8)	40 (2.0)	21 (1.2)
Jul 25	26 (2.7)	18 (1.4)	21 (1.3)	20 (1.2)	16 (1.8)	17 (1.1)	9.7 (1.2)
Aug 1	21 (2.0)	22 (1.9)	13 (1.4)	25 (2.5)	20 (1.7)	18 (1.0)	59 (5.6)
Aug 8	33 (2.1)	30 (2.2)	27 (1.4)	28 (1.6)	20 (2.0)	24 (1.2)	11 (0.88)
Aug 15	20 (2.0)	26 (2.0)	24 (1.7)	23 (1.8)	22 (1.8)	23 (1.2)	21 (1.2)
Aug 22	33 (2.3)	23 (1.6)	23 (1.3)	11 (1.0)	24 (2.2)	23 (1.4)	22 (1.4)
Aug 29	18 (1.9)	17 (1.9)	17 (1.5)	15 (2.0)	23 (1.9)	19 (1.1)	19 (1.1)
Sept 5	32 (2.1)	32 (2.2)	29 (1.5)	33 (2.4)	28 (2.3)	23 (1.2)	20 (1.7)
Sept 12	28 (2.1)	27 (2.1)	25 (1.8)	30 (2.4)	31 (2.3)	13 (1.0)	23 (1.8)
Sept 19	22 (1.9)	25 (2.1)	24 (1.5)	24 (1.9)	28 (2.5)	35 (2.1)	24 (1.5)
Sept 26	44 (2.5)	43 (2.7)	39 (2.2)	49 (3.0)	41 (2.8)	38 (1.6)	35 (2.6)
$\bar{X}$:	27	26	25	26	25	25	24
n:	13	13	13	13	13	13	13
1.96σ:	14	13	13	18	12	16	24
MAX: 49 MIN: 11		$\bar{X}$: 26 n: 52 1.96σ: 14			MAX: 59 MIN: 9.7		$\bar{X}$: 25 n: 39 1.96σ: 18

* 1.96σ (Due to counting statistics.)

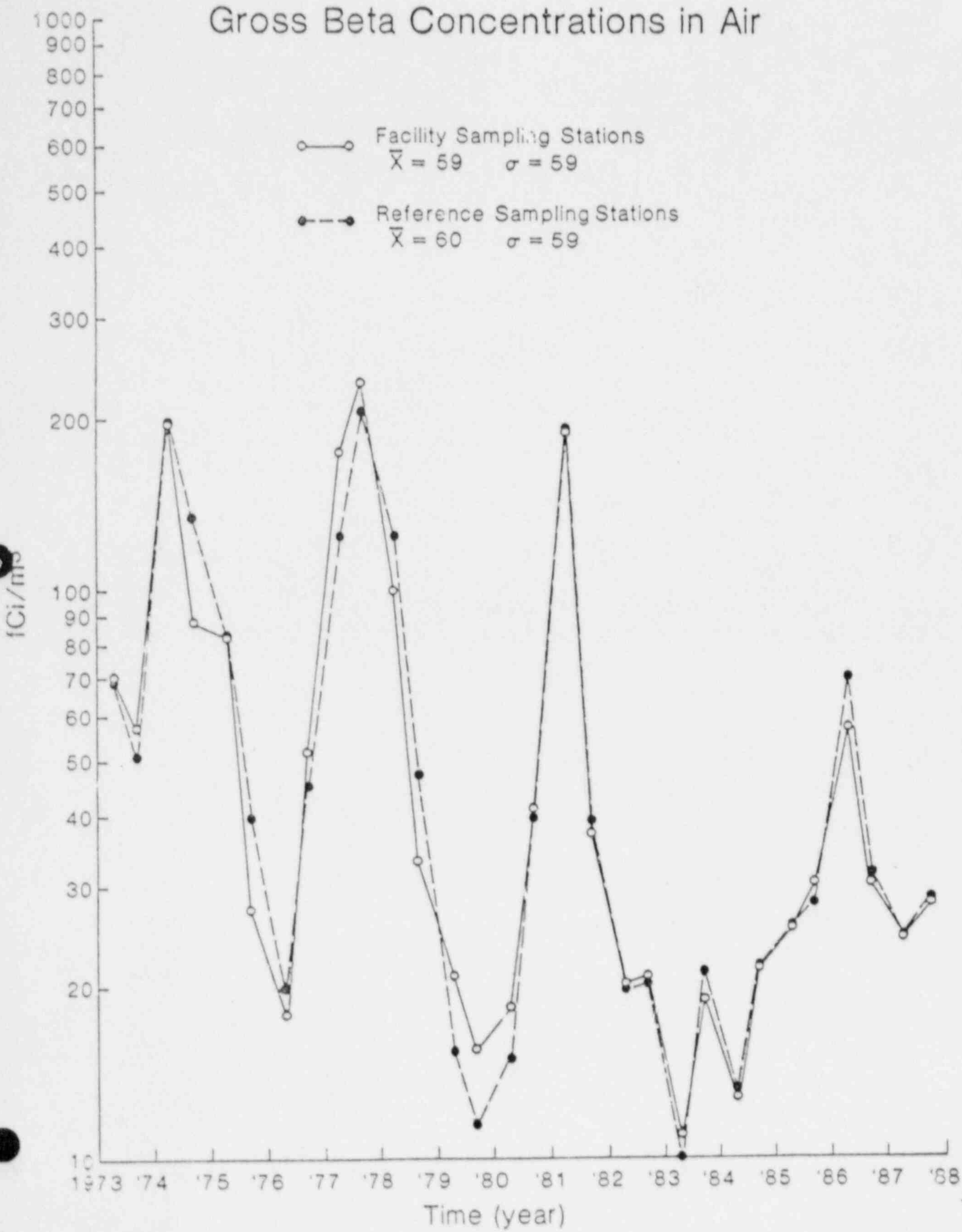
Table II.B.1 Concentrations of Long-lived Gross Beta Particulate Activity in Air. (fCi/m^3)

d.) Collection period: Fourth Quarter, 1987.

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Oct 3	36 (2.2)*	< 2.4	33 (1.6)	36 (2.3)	35 (2.8)	30 (1.5)	32 (1.8)
Oct 10	34 (2.2)	30 (1.5)	33 (1.9)	34 (2.40	32 (2.5)	26 (1.30)	25 (1.3)
Oct 17	33 (2.0)	36 (1.8)	34 (1.7)	37 (2.4)	30 (2.6)	33 (1.6)	c2
Oct 24	34 (2.1)	30 (1.5)	43 (2.2)	34 (2.5)	28 (2.7)	31 (1.4)	27 (1.2)
Oct 31	35 (2.0)	32 (1.6)	33 (1.6)	56 (5.1)	c1	30 (1.5)	35 (1.7)
Nov 7	28 (1.8)	35 (4.5)	27 (1.8)	24 (1.4)	24 (2.9)	27 (1.4)	27 (1.6)
Nov 14	52 (2.2)	c4	51 (2.1)	62 (0.68)	39 (3.5)	39 (1.7)	40 (1.8)
Nov 21	38 (2.0)	33 (1.4)	c3	31 (1.6)	32 (2.2)	25 (1.3)	28 (1.2)
Nov 28	51 (2.1)	27 (1.4)	49 (2.1)	45 (1.7)	45 (1.2)	39 (1.7)	39 (1.7)
Dec 5	42 (2.2)	37 (1.6)	38 (2.1)	24 (1.6)	37 (2.5)	27 (1.4)	35 (1.4)
Dec 12	19 (1.3)	20 (1.4)	18 (1.3)	19 (1.10	14 (1.6)	17 (1.2)	17 (1.2)
Dec 19	27 (1.7)	26 (1.5)	37 (2.1)	30 (1.7)	c2	25 (1.4)	20 (1.1)
Dec 28	23 (1.3)	20 (1.2)	21 (1.3)	25 (1.2)	23 (1.8)	22 (1.2)	18 (1.1)
$\bar{X}$:	35	26	35	35	31	29	29
1.96 σ:	19	27	20	25	17	12	15
MAX: 62 MIN: < 2.4		$\bar{X}$: 33 n: 50 1.96 σ: 23			MAX: 85 MIN: 14		$\bar{X}$: 29 n: 36 1.96 σ: 14

* 1.96 σ (Due to counting statistics.)
c1 Cartridge broken, air filter and charcoal are not representative of the air flow.
c2 Volume was less than 300 m^3.
c3 Pump malfunction.

Figure II.B.1


Gross Beta Concentrations in Air
Facility Sampling Stations
$\overline{X}$ = 59 σ = 59
Reference Sampling Stations
$\overline{X}$ = 60 σ = 59
fCi/m3
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
1973 '74 '75 '76 '77 '78 '79 '80 '81 '82 '83 '84 '85 '86 '87 '88
Time (year)

2. Tritium Activity

Atmospheric water vapor samples are collected continuously by passive absorption on silica gel at all seven air sampling stations (four in the facility area and three in the reference area). The specific activity of tritium in water extracted from these weekly samples for 1987 is listed in Tables II.B.2a-2d. The corresponding tritium concentration in air (pCi/m^3) is calculated from the specific activity data using weekly mean temperatures and dew points measured at the FSV meteorological tower. The measuring point is at a height of 2 m from the surface. The tritium air concentrations are shown in Table II.B.3a-3d.

The principle release mode of tritium from the reactor is batch liquid releases from holding tanks. The tank water is first analyzed and then released with sufficient additional dilution, if necessary, in order not to exceed 10CFR20 concentration limits. The summary of tritium release by all modes is shown in Table II.B.4. The summary indicates that tritium released in 1987 was less than in 1986 for all routes. (See 1986 annual report to the USNRC).

Sampling locations F-16 and A-19 are located near the Goosequill Ditch, which is the principal route for effluent tritium release. Tables II.B.2a-2d indicate a strong correlation of elevated atmospheric tritium concentrations corresponding to the batch release of tritium in water along the ditch. Due to evaporation while in transit, elevated tritium concentrations in air have been observed for these two locations often in past years. The concentrations observed, however, have always been below the limit of regulatory concern. The occasional elevated values at the reference sites are assumed to be statistically false positive values.

The mean value for sites F-16 and A-19 were significantly greater than for all other sites during the year. When all four facility sites are averaged, however, the total mean value is less than the MDC value of 250 pCi/L. Radiation dose commitment estimates are not warranted on the basis of elevated air concentration values alone. Inhalation is not a significant pathway for dose to humans. The milk and food product pathway is the only significant source of radiation dose to humans from environmental tritium.

Since the same relative humidity is assumed for all sites, Table II.B.3 shows the same site dependence on reactor effluent as Table II.B.2.

Table II.B.2 Tritium Concentrations in Atmospheric Water Vapor. (pCi/L)

a.) Collection Period: First Quarter, 1987.

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Jan 3	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Jan 10	< 240	< 240	< 240	< 240	< 240	< 240	< 240
Jan 17	< 240	< 240	< 240	< 240	290 (280)*	< 240	290 (280)
Jan 24	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Jan 31	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Feb 7	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Feb 14	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Feb 21	< 240	< 240	< 240	< 240	< 240	< 240	< 240
Feb 28	370 (290)	300 (280)	< 240	< 240	< 240	< 240	< 240
Mar 6	< 240	< 240	< 240	< 240	< 240	< 240	< 240
Mar 14	< 240	< 240	< 240	< 240	< 240	< 240	< 240
Mar 21	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Mar 28	e	< 230	< 230	< 230	< 230	e	< 230

* 1.96 σ (Due to counting statistics.)
e Insufficient sample volume for analysis.

Table II.B.2 Tritium Concentrations in Atmospheric Water Vapor. (pCi/L)

b.) Collection Period: Second Quarter, 1987.

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
Apr 4	< 240	< 240	< 240	< 240	< 240	< 240	370 (280)*
Apr 11	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Apr 18	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Apr 25	< 240	< 240	< 240	< 240	< 240	< 240	< 240
May 1	< 230	< 230	< 230	< 230	< 230	< 230	< 230
May 9	< 230	< 230	< 230	< 230	< 230	< 230	< 230
May 16	< 230	< 230	250 (270)	< 230	< 230	< 230	230 (270)
May 23	< 230	< 230	870 (280)	< 230	< 230	< 230	< 230
May 29	< 230	< 230	710 (280)	510 (280)	< 230	< 230	< 230
Jun 6	< 230	< 230	580 (290)	620 (290)	< 230	< 230	< 230
Jun 12	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Jun 19	< 230	< 230	e	e	< 230	< 230	< 230
Jun 26	< 230	< 230	< 230	1000 (290)	< 230	< 230	< 230

* 1.96 σ (Due to counting statistics.)

e Insufficient sample volume for analysis.

Table II.B.2 Tritium Concentrations in Atmospheric Water Vapor. (pCi/L)

c.) Collection Period: Third Quarter, 1987.

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Jul 3	< 230	< 230	310 (280)*	360 (280)	< 230	< 230	< 230
Jul 10	< 230	< 230	460 (280)	620 (280)	< 230	< 230	230 (280)
Jul 17	< 230	< 230	250 (280)	< 230	< 230	< 230	< 230
Jul 25	< 230	< 230	440 (280)	< 230	< 230	< 230	< 230
Aug 1	< 230	< 230	480 (280)	270 (280)	< 230	< 230	< 230
Aug 8	< 230	< 230	< 230	290 (280)	< 230	< 230	< 230
Aug 15	< 230	< 230	< 230	< 230	< 230	< 230	e
Aug 22	< 230	< 230	< 230	280 (270)	< 230	360 (270)	< 230
Aug 29	< 230	< 230	< 230	400 (270)	< 230	< 230	< 230
Sept 5	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Sept 12	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Sept 19	< 230	< 230	< 230	< 230	580 (260)	< 230	< 230
Sept 26	< 230	< 230	< 230	< 230	< 230	< 230	< 230

* 1.96 σ (Due to counting statistics.)
e Insufficient sample volume for analysis.

Table II.B.2 Tritium Concentrations in Atmospheric Water Vapor. (pCi/L)

c.) Collection Period: Fourth Quarter, 1987.

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Oct 3	< 240	< 240	< 240	< 240	< 240	< 240	< 240
Oct 10	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Oct 17	< 230	< 230	< 230	540 (280)*	< 230	< 230	340 (270)
Oct 24	< 230	< 230	< 230	< 230	< 230	< 230	350 (280)
Oct 31	< 230	< 230	250 (280)	300 (280)	< 230	< 230	< 230
Nov 7	< 230	< 230	410 (280)	340 (280)	< 230	< 230	440 (280)
Nov 14	< 230	< 230	< 230	< 230	e	< 230	< 230
Nov 21	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Nov 28	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Dec 5	< 250	< 250	< 230	< 230	< 250	< 250	< 230
Dec 12	< 230	< 230	< 230	< 230	310 (280)	< 230	< 230
Dec 19	< 290	< 290	400 (280)	530 (290)	< 290	< 290	< 290
Dec 28	e	< 290	< 290	< 290	e	< 290	< 290

* 1.96 σ (Due to counting statistics.)
e Insufficient volume for analysis.

Table II.B.3 Tritium Concentrations in Atmospheric Water Vapor. (pCi/m^3)

a.) Collection Period: First Quarter, 1987.

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Jan 3	< 0.64	< 0.64	< 0.64	< 0.64	< 0.64	< 0.64	< 0.64
Jan 10	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75
Jan 17	< 0.61	< 0.61	< 0.61	< 0.61	0.74 (0.71)*	< 0.61	0.74 (0.71)
Jan 24	< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	< 0.48	< 0.48
Jan 31	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76
Feb 7	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80
Feb 14	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74
Feb 21	< 0.77	< 0.77	< 0.77	< 0.77	< 0.77	< 0.77	< 0.77
Feb 28	1.1 (0.83)	0.89 (0.83)	< 0.71	< 0.71	< 0.71	< 0.71	< 0.71
Mar 7	< 0.99	< 0.99	< 0.99	< 0.99	< 0.99	< 0.99	< 0.99
Mar 14	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89
Mar 21	< 0.96	< 0.96	< 0.96	< 0.96	< 0.96	< 0.96	< 0.96
Mar 28	e	< 0.67	< 0.67	< 0.67	< 0.67	e	< 0.67

* 1.96 σ (Due to counting statistics.)

e Insufficient sample volume.

^{3}H MPC$_{air}$ = 2x10^5 pCi/m^3 (10CFR20 Appendix B, Column II).

Table II.B.3 Tritium Concentrations in Atmospheric Water Vapor. (pCi/m^3)

a.) Collection Period: Second Quarter, 1987.

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
Apr 4	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75	< 0.75	1.2 (0.87)*
Apr 11	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78
Apr 18	< 0.99	< 0.99	< 0.99	< 0.99	< 0.99	< 0.99	< 0.99
Apr 25	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
May 2	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6
May 9	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
May 16	< 1.8	< 1.8	1.9 (2.1)	< 1.8	< 1.8	< 1.8	1.8 (2.1)
May 23	< 1.9	< 1.9	7.4 (2.4)	< 1.9	< 1.9	< 1.9	< 1.9
May 29	< 1.6	< 1.6	4.9 (1.9)	3.5 (1.9)	< 1.6	< 1.6	< 1.6
Jun 6	< 1.5	< 1.5	3.8 (1.9)	4.0 (1.9)	< 1.5	< 1.5	< 1.5
Jun 12	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Jun 19	< 2.0	< 2.0	e	e	< 2.0	< 2.0	< 2.0
Jun 26	< 1.9	< 1.9	< 1.9	8.2 (2.4)	< 1.9	< 1.9	< 1.9

* 1.96 σ (Due to counting statistics.)

e Insufficient sample volume for analysis.

^3H MPC_{air} = $2x10^5$ pCi/m^3 (10CFR20 Appendix B, Column II).

Table II.B.3 Tritium Concentrations in Atmospheric Water Vapor. (pCi/m^3)

c.) Collection Period: Third Quarter, 1987.

Collection Date	Facility Sites F-7	Facility Sites F-9	Facility Sites F-16	Facility Sites A-19	Reference Sites R-3	Reference Sites R-4	Reference Sites R-11
Jul 3	< 2.3	< 2.3	3.1 (2.8)*	3.6 (2.8)	< 2.3	< 2.3	< 2.3
Jul 10	< 2.1	< 2.1	4.2 (2.5)	5.6 (2.5)	< 2.1	< 2.1	2.1 (2.5)
Jul 17	< 2.1	< 2.1	2.2 (2.5)	2.1 (2.5)	< 2.1	< 2.1	< 2.1
Jul 25	< 1.9	< 1.9	3.6 (2.3)	< 1.9	< 1.9	< 1.9	< 1.9
Aug 1	< 2.5	< 2.5	5.2 (3.0)	3.0 (2.9)	< 2.5	< 2.5	< 2.5
Aug 8	< 2.4	< 2.4	< 2.4	3.0 (2.9)	< 2.4	< 2.4	< 2.4
Aug 15	< 2.3	< 2.3	< 2.3	< 2.3	< 2.3	< 2.3	< 2.3
Aug 22	< 1.9	< 1.9	< 1.9	2.3 (2.3)	< 1.9	3.0 (2.2)	< 1.9
Aug 29	< 2.1	< 2.1	< 2.1	3.7 (2.5)	< 2.1	< 2.1	< 2.1
Sept 5	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1
Sept 12	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
Sept 19	< 1.6	< 1.6	< 1.6	< 1.6	3.9 (1.8)	< 1.6	< 1.6
Sept 26	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4

* 1.96σ (Due to counting statistics.)

^3H $MPC_{air} = 2\times10^5$ pCi/m^3 (10CFR20 Appendix B, Column II).

Table II.B.3 Tritium Concentrations in Atmospheric Water Vapor. (pCi/m^3)

c.) Collection Period: Fourth Quarter, 1987.

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
Oct 3	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
Oct 10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Oct 17	< 1.0	< 1.0	< 1.0	2.4 (1.2)*	< 1.0	< 1.0	1.5 (1.2)
Oct 24	< 0.97	< 0.97	< 0.97	< 0.97	< 0.97	< 0.97	1.3 (1.1)
Oct 31	< 1.1	< 1.1	1.2 (1.3)	1.4 (1.3)	< 1.1	< 1.1	< 1.1
Nov 7	< 1.4	< 1.4	2.5 (1.7)	2.1 (1.7)	< 1.4	< 1.4	2.7 (1.7)
Nov 14	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Nov 21	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78	< 0.78
Nov 28	< 0.77	< 0.77	< 0.77	< 0.77	< 0.77	< 0.77	< 0.77
Dec 5	< 0.91	< 0.91	< 0.91	< 0.91	< 0.91	< 0.91	< 0.91
Dec 12	< 0.69	< 0.69	< 0.69	< 0.69	0.93(0.84)	< 0.69	< 0.69
Dec 19	< 0.58	< 0.58	0.80(0.56)	1.1 (0.58)	< 0.58	< 0.58	< 0.58
Dec 28	< 0.58	< 0.58	< 0.58	< 0.58	< 0.58	< 0.58	< 0.58

* 1.96 σ (Due to counting statistics.)
e Insufficient volume for analysis.
^3H $MPC_{air} = 2x10^5$ pCi/m^3 (10CFR20 Appendix B, Column II).

Table II.B.4 Tritium Released (Ci) in Reactor Effluents, 1987.

TRITIUM RELEASED (CI) IN REACTOR EFFLUENTS, 1987													
MODE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Continuous (Turbine Building Sump)	.0290	.0232	.00862	.00386	.0420	.0788	.159	.0242	.00733	.00258	.0264	.614	1.02
Batch Release (Reactor Building Sump)	.0166	.0124	.0124	.00326	.0343	.0371	.313	.149	.312	.0384	.0129	.0455	.987
Batch Release (System 62)	1.39	.921	2.27	.443	22.6	6.01	7.13	2.64	.767	.400	1.10	8.34	54.0
Gaseous Stack	.000767	.00425	.00809	.0158	.926	.336	.983	.0850	.0500	.108	.00561	.607	3.13
TOTAL	1.44	.961	2.30	.466	23.6	6.46	8.59	2.90	1.14	.549	1.14	9.61	59.1

3. Concentrations of Gamma-ray Emitting Radionuclides in Ambient Air

Tables II.B.5a-5d list the concentrations of I-131 in air as measured by activated charcoal sampling and high resolution gamma-ray spectrum analysis. Each sample from the seven air sampling stations is counted within 96 hours after collection. A 100 minute count is typically required to achieve an MDC of 33 fCi/M^3. Radon daughters and Thoron daughters are trapped on the particulate filter ahead of the charcoal trap. Radon-222 daughter in-growth on the charcoal does not provide interference to the region of interest for I-131 using the Ge(Li) high resolution spectrometry. Any positive I-131 activity is corrected for radioactive decay back to the midpoint of the collection period. Decay correction to the midpoint of the sampling period is appropriate as any I-131 in air would not arrive at the sampling stations at a constant rate, but rather in pulses of short duration compared to the collection period. This is the case whether the I-131 source term would be weapons testing fallout or reactor stack effluent.

There were only occasional positive values very near the MDC value and all are assumed to be false positive. I-131 concentrations due to reactor effluent have never been detected in the Fort St. Vrain environs.

Table II.B.6 lists measured ambient air concentrations of Cs-134 and Cs-137. These values are from gamma-ray spectrum analyses on weekly air filters composited quarterly from each of the seven air sampling stations. The occasional positive Cs-137 concentrations measured are likely due to resuspension of surface soil. The Cs-137 activity is due to Chernobyl (or previous) fallout which is bound by clay minerals on the surface of undisturbed soil. For the entire year, the mean of the facility stations was not different from the mean of the reference stations.

Although only Cs-134 and Cs-137 are reported, each gamma-ray spectrum is scanned for evidence of peaks from other fission products and activation products. Normally only gamma-ray activity due to the naturally occurring background radionuclides are observed. During the second quarter of 1986, however, many other radionuclides were observed due to the Chernobyl accident. Of these only Cs-137 can still be detected.

Table II.B.5 Iodine-131 Concentrations in Air. (fCi/m^3)

a.) Collection Period: First Quarter, 1987.

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
Jan 3	< 19	< 31	< 30	< 18	< 22	< 26	< 21
Jan 10	< 30	< 30	< 18	< 28	< 22	< 28	< 18
Jan 16	< 31	< 18	< 9.7	< 27	< 28	< 8.6	< 29
Jan 24	< 13	< 23	< 28	< 32	< 24	< 29	< 19
Jan 31	< 28	< 34	< 20	< 20	< 12	< 29	< 32
Feb 7	< 15	< 16	< 12	< 32	< 20	< 30	< 14
Feb 14	< 14	< 14	40 (39)*	< 19	< 21	27 (28)	< 27
Feb 20	< 27	< 29	< 13	< 16	< 17	< 30	< 27
Feb 28	< 25	< 34	< 18	c1	< 32	< 13	< 29
Mar 6	< 18	< 14	< 28	c1	< 10	< 16	< 19
Mar 14	< 12	< 32	< 21	< 22	< 14	c2	< 9.5
Mar 21	< 19	< 22	< 18	< 13	< 14	< 19	< 15
Mar 28	< 22	< 34	< 30	< 16	< 13	< 18	< 26

* 1.96σ (Due to counting statistics.)

I-131 MPC = $10^5 fCi/m^3$. (10CFR20, Appendix B, Table II)

c1 Pump inoperative. No replacment pump available.

c2 Pump inoperative for major fraction of sampling period.

Table II.B.5 Iodine-131 concentrations in Air. (fCi/m^3)

b.) Collection Period: Second Quarter, 1987.

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Apr 4	< 21	< 34	< 25	< 15	< 26	< 24	< 22
Apr 11	< 21	< 25	< 18	< 29	< 12	< 16	< 30
Apr 18	< 28	< 17	< 20	< 22	< 27	< 18	< 24
Apr 24	< 31	< 33	< 26	< 7.1	< 19	< 28	c1
May 1	< 15	< 28	< 16	< 20	< 25	< 29	< 20
May 9	< 11	< 27	< 17	< 19	< 21	< 19	< 26
May 16	< 25	< 25	< 30	< 25	< 28	< 17	< 32
May 23	< 29	< 12	< 22	< 32	42 (42)*	< 33	< 21
May 29	< 18	< 14	< 23	< 24	< 30	< 23	< 28
Jun 6	< 9.4	< 25	< 27	< 26	< 29	< 16	< 25
Jun 11	< 29	< 16	< 30	< 34	< 20	< 19	< 33
Jun 19	< 33	< 25	< 34	34 (37)	< 27	< 21	< 11
Jun 27	< 17	< 21	< 15	< 24	< 21	< 12	< 23

* 1.96σ (Due to counting statistics.)
I-131 MPC = 10^5 fCi/m^3. (10CFR20, Appendix B, Table II)
c1 Pump inoperative for major fraction of sampling period.

Table II.B.5 Iodine-131 concentrations in Air. (fCi/m^3)

c.) Collection Period: Third Quarter, 1987.

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Jul 2	< 34	< 29	< 32	< 23	< 18	< 15	< 19
Jul 10	< 12	< 19	< 24	< 8.3	< 6.9	< 14	7.7 (3.6)*
Jul 17	< 25	< 15	< 29	< 18	< 26	< 25	< 14
Jul 25	< 24	< 18	< 11	< 19	< 21	< 17	< 27
Aug 1	< 25	< 16	< 21	< 22	< 16	< 16	< 22
Aug 8	< 18	< 21	< 18	14 (16)	< 25	< 6.7	< 7.8
Aug 15	< 24	< 13	< 15	< 17	< 16	< 12	< 7.0
Aug 22	< 15	< 24	< 18	< 23	< 13	< 15	< 22
Aug 29	< 21	< 28	< 17	< 20	< 21	< 10	< 13
Sept 5	< 20	< 1.4	< 18	< 32	< 34	< 11	< 32
Sept 12	< 13	< 17	< 31	< 3.4	< 31	< 13	< 16
Sept 19	< 19	< 28	< 29	< 35	< 26	< 12	< 21
Sept 26	< 35	< 23	< 19	< 25	< 29	< 17	< 17

* 1.96 σ (Due to counting statistics.)
I-131 MPC = 10^5 fCi/m^3. (10CFR20, Appendix B, Table II)

Table II.B.5 Iodine-131 concentrations in Air. (fCi/m^3)

d.) Collection Period: Fourth Quarter, 1987

Collection Date	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
Oct 3	35 (32)*	< 33	< 11	< 26	< 27	< 9.7	< 13
Oct 10	< 18	< 11	< 19	< 18	< 11	19 (21)	< 21
Oct 17	< 32	< 21	< 16	< 23	< 31	21 (21)	c3
Oct 24	< 30	< 14	< 26	< 11	< 14	< 20	< 18
Oct 31	< 33	< 20	30 (31	< 32	c1	< 29	< 22
Nov 7	< 29	< 20	< 30	< 19	< 16	36 (33)	< 18
Nov 14	< 22	c2	< 31	< 25	< 35	< 27	< 32
Nov 21	< 34	< 23	**< 47	< 32	< 29	< 13	< 17
Nov 28	< 26	< 19	< 16	< 16	< 33	< 14	< 21
Dec 5	< 7.1	< 13	< 8.2	< 6.9	< 20	< 15	< 23
Dec 12	< 31	< 19	< 17	< 15	< 21	< 22	< 21
Dec 19	< 2[illegible]	< 21	< 33	< 10	< 35	< 23	< 23
Dec 28	< 12	< 1.9	< 1.6	< 17	< 35	< 16	< 31

* 1.96 σ (Due to counting statistics.)

** LLD Could not be met due to a low sample volume.

I-131 MPC = 10^5 fCi/m^3. (10CFR20, Appendix B, Table II)

c1 Broken cartridge, air filter and charcoal not representative of air flow

c2 Instrument malfunction- no pump available.

c3 Not enough volume, pump only ran for one day.

Table II.B.6 Radiocesium Concentrations in Ambient Air. (fCi/m^3), 1987.

Collection Period	Radio-nuclide	Facility Sites				Reference Sites		
		F-7	F-9	F-16	A-19	R-3	R-4	R-11
1st Quarter 1987	Cs-134	< 1.4	< 1.8	< 2.4	< 2.7	< 1.7	1.6 (1.9)	< 2.2
	Cs-137	< 1.6	< 2.0	< 2.4	2.8 (3.4)*	< 1.7	< 1.7	< 2.3
2nd Quarter 1987	Cs-134	< 1.8	< 1.6	< 2.6	< 1.9	< 2.3	< 1.7	< 1.6
	Cs-137	3.5 (2.1)	2.2 (2.0)	< 2.8	< 1.9	< 2.4	< 1.7	< 1.7
3rd Quarter 1987	Cs-134	< 2.4	< 2.4	< 1.4	< 1.7	< 1.9	< 1.4	< 1.7
	Cs-137	< 2.5	< 2.5	< 1.6	< 1.9	< 2.0	< 1.4	< 1.8
4th Quarter 1987	Cs-134	< 2.5	< 2.0	< 1.7	< 1.9	< 3.8	< 1.2	< 2.1
	Cs-137	< 2.5	< 2.2	< 1.9	< 2.1	< 3.9	< 1.4	2.9 (2.6)

*1.96 σ (Due to counting statistics.)

Cs-134 MPC = 1 x 10^6 fCi/m^3 , Cs-137 MPC = 2 x 10^6 fCi/m^3 (10CFR20, Appendix B, Table II).

II.C. Radionuclide Concentration in Water

1. Drinking Water

Drinking water is sampled weekly and composited biweekly at two locations. Location R-6 is the well used for drinking water by the town of Gilcrest, Colorado, and R-3 is a water tap located on the CSU dairy farm. The Gilcrest well is the nearest public water supply that could be affected by the reactor effluents. R-3 samples are from the Fort Collins drinking water supply and serve as a reference location since its source is run-off surface water from the Rocky Mountains to the West.

Table II.C.1 shows gross beta concentrations measured in 1987 from each water supply. The mean for the Gilcrest site was again significantly higher than the Reference site in Fort Collins. This is only due to different water treatment practices. The city of Gilcrest does not filter its water and natural radionuclide concentrations are responsible for the higher measured concentrations. As can be observed in Table II.H.2, the mean for the entire year for the Gilcrest site was not greater than in previous years.

Table II.C.2 lists measured tritium concentrations in these same two drinking water sources. The yearly arithmetic mean values for both locations were less than MDC and, therefore, not statistically different from each other. No evidence of the tritium released from the reactor was observed. Figure II.C.1 shows that tritium concentrations in drinking (potable) water sources were less than MDC for 1987.

The two drinking water supplies are also analyzed for fission product and activation product concentrations. A sample of 18 liters is passed through Dowex 1-x8 anion exchange resin and the resin then counted by Ge(Li) spectrometry for I-131. This same method is used for milk samples. A three liter aliquot of the original sample is counted directly for the other gamma-ray emitters.

Inspection of Table II-C.3 reveals occasional positive values of radionuclide concentration, but with the exception of Cs-137, these are interpreted to be random variations. The Cs-137 is the residue from the 1986 Chernobyl accident fallout as well as from past world-wide fallout from nuclear weapon testing.

Table II.C.1
Gross Beta Concentrations in Biweekly Composites of Drinking Water. First Half, 1987. (pCi/L)

Collection Date	Gilcrest City R-6	Fort Collins City R-3 (Reference)
Jan 3, 10	3.2 (2.2)*	0.90 (0.53)
Jan 16, 24	2.2 (2.1)	0.64 (0.54)
Jan 31, Feb 7	3.0 (2.2)	0.79 (0.54)
Feb 14, 21	3.1 (2.2)	0.47 (0.52)
Feb 28, Mar 7	4.1 (2.2)	0.62 (0.53)
Mar 14, 21	5.3 (2.3)	0.57 (0.52)
Mar 28, Apr 4	2.9 (2.2)	1.1 (0.55)
Apr 11, 18	5.2 (2.3)	0.47 (0.52)
Apr 24, May 1	6.2 (2.4)	0.69 (0.53)
May 9, 16	5.8 (2.3)	0.57 (0.52)
May 23, 29	2.6 (2.2)	< 0.45
Jun 6, 12	4.9 (2.2)	0.51 (0.50)
Jun 19, 27	5.2 (2.2)	2.0 (0.56)

*1.96 σ (Due to counting statistics.)

MPC_w = 30 pCi/L Table II, Appendix B limit, 10CFR20 for an unidentified mixture of radionuclides in water if either the identity or the concentration of any radionuclide is not known.

Table II.C.1
Gross Beta Concentrations in Biweekly Composites of Drinking Water. Second Half, 1987. (pCi/L)

Collection Date	Gilcrest City R-6	Fort Collins City R-3 (Reference)
Jul 3, 10	6.1 (2.3)*	0.74 (0.50)
Jul 17, 25	2.5 (2.1)	0.83 (0.52)
Aug 1, 8	5.0 (2.2)	0.88 (0.51)
Aug 15, 22	5.2 (2.2)	0.58 (0.49)
Aug 29, Sept 5	4.1 (2.1)	0.90 (0.50)
Sept 12, 19	6.1 (2.2)	1.4 (0.53)
Sept 26, Oct 3	5.9 (2.3)	0.74 (0.43)
Oct 10, 17	10 (2.4)	0.48 (0.51)
Oct 24, 31	7.6 (2.4)	0.88 (0.52)
Nov 7, 14	5.9 (2.3)	0.70 (0.51)
Nov 21, 28	7.5 (2.3)	1.0 (0.53)
Dec 5,12	5.8 (2.3)	1.1 (0.53)
Dec 19, 28	4.7 (2.2)	1.1 (0.53)

* 1.96σ (Due to counting statistics.)

MPC_w = 30 pCi/L Table II, Appendix B limit, 10CFR20 for an unidentified mixture of radionuclides in water if either the identity or the concentration of any radionuclide is not known.

Table II.C.2
Tritium Concentrations in Biweekly Composites of Drinking Water.
First Half, 1987. (pCi/L)

Collection Date	Gilcrest City R-6	Fort Collins City R-3 (Reference)
Jan 3, 10	430 (280)*	< 240
Jan 16, 24	< 230	< 230
Jan 31, Feb 7	< 230	< 230
Feb 14, 21	430 (280)	450 (280)
Feb 28, Mar 7	< 240	< 240
Mar 14, 21	260 (280)	< 230
Mar 28, Apr 4	< 240	< 240
Apr 11, 18	< 230	< 230
Apr 24, May 1	< 230	< 230
May 9, 16	< 230	< 230
May 23, 29	< 230	< 230
Jun 6, 12	< 230	< 230
Jun 19, 27	< 230	< 230

* 1.96 σ (Due to counting statistics.)

H-3 MPC = 3 X 10^6 pCi/L (10CFR20, Appendix B, Table II)

Table II.C.2
Tritium Concentrations in B ·ekly Composites of Drinking Water.
Second half, 1987. (pCi/L)

Collection Date:	Gilcrest City R-6	Fort Collins City R-3 (Reference)
Jul 3, 10	< 230	250 (280)*
Jul 17, 25	< 230	< 230
Aug 1, 8	< 230	< 230
Aug 15, 22	< 230	< 230
Aug 29, Sept 5	< 230	< 230
Sept 12, 19	< 230	< 230
Sept 26, Oct 3	390 (280)	< 230
Oct 10, 17	610 (280)	< 230
Oct 24, 31	< 230	< 230
Nov 7, 14	< 230	< 230
Nov 21, 28	< 230	< 230
Dec 5, 12	< 230	< 230
Dec 19,26	320 (280)	< 290

* 1.96 σ (Due to counting statistics.)

H-3 MPC = 3 X 10^6 pCi/L (10CFR20, Appendix B, Table II)

Figure II.C.1

Tritium Concentrations in Water 1974–1987

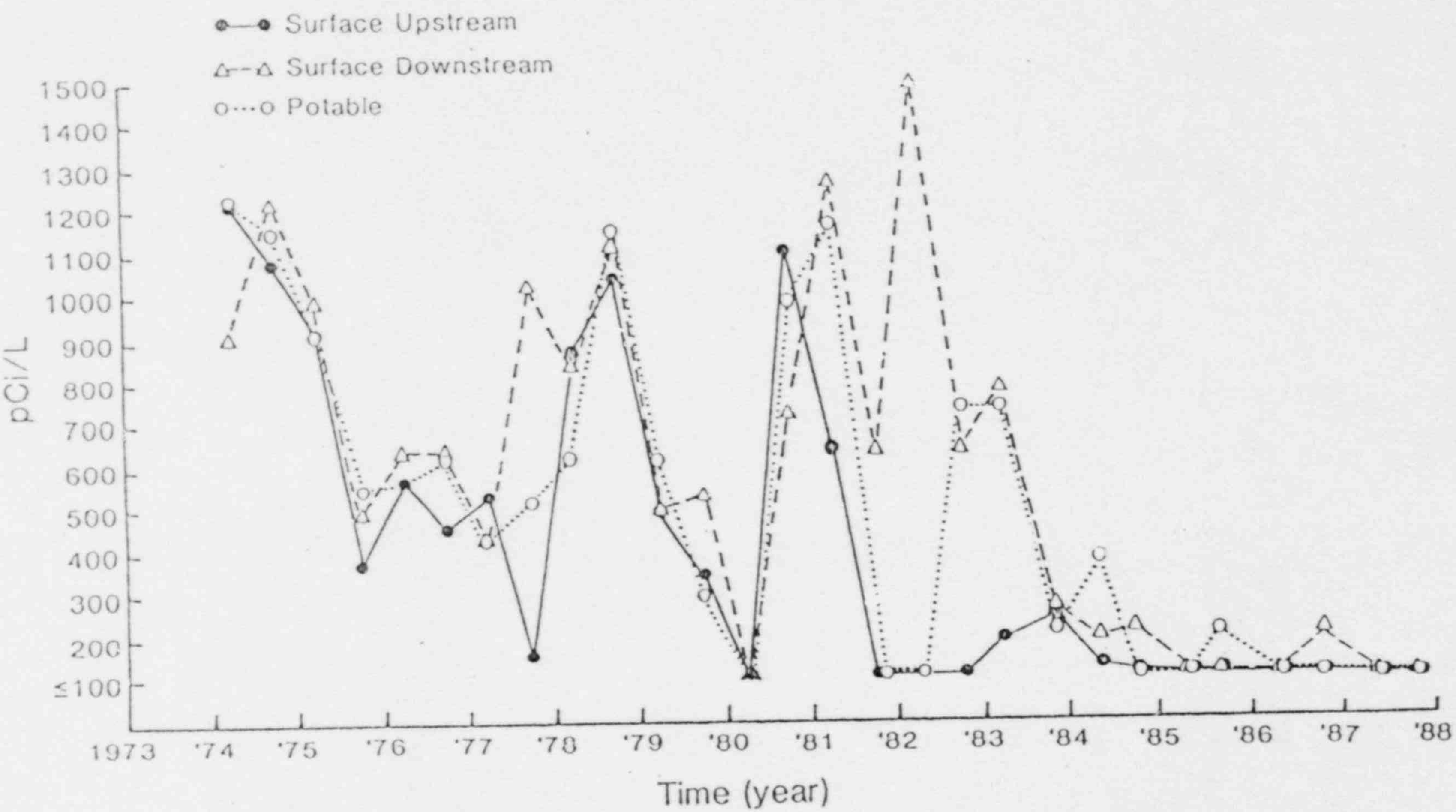


Table II.C.3 Radionuclide Concentrations in Bi-weekly Composite of Drinking Water. (pCi/L)

Collection Date	Jan 3, 10, 1987		Jan 17, 24, 1987		Jan 31, Feb 7, 1987	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	0.51 (0.54)*	< 0.19	< 0.27	< 0.20	< 0.23	< 0.25
Cs-134	< 2.4	< 2.4	< 2.3	< 2.5	< 2.4	< 2.2
Cs-137	< 2.9	< 3.0	5.1 (4.1)	< 3.1	< 2.9	< 3.2
Zr-95	< 5.6	< 5.8	< 5.1	< 5.9	< 5.6	< 4.9
Nb-95	< 2.2	< 2.3	< 2.1	< 2.3	< 2.2	2.9 (2.4)
Co-58	< 2.2	< 2.2	< 2.3	< 2.3	< 2.2	< 2.2
Mn-54	< 2.4	< 2.5	< 2.3	< 2.5	< 2.4	< 2.2
Zn-65	< 5.8	< 5.6	< 5.5	< 5.8	9.0 (6.8)	< 5.1
Fe-59	< 4.4	< 4.8	< 4.2	< 4.7	< 5.7	< 5.3
Co-60	< 2.6	< 2.7	< 2.3	< 2.7	< 2.6	< 2.2
Ba-140	< 3.9	< 5.9	< 3.3	< 4.1	< 5.5	< 3.2
La-140	< 4.5	< 6.8	< 3.8	< 4.7	< 6.3	< 3.7

* 1.96 σ (Due to counting statistics.)

Table II.C.3 Radionuclide Concentrations in Bi-weekly Composite of Drinking Water. (pCi/L)

Collection Date	Feb 14, 20, 1987		Feb 28, Mar 6, 1987		Mar 14, 21, 1987	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.46	< 0.19	< 0.19	< 0.31	< 0.22	< 0.15
Cs-134	< 2.2	< 2.8	< 2.6	< 2.4	< 2.2	< 1.8
Cs-137	< 3.4	< 3.4	< 3.3	< 3.6	5.6 (3.8)	3.8 (3.2)
Zr-95	< 5.5	< 6.6	< 6.2	< 5.3	< 4.7	< 4.4
Nb-95	< 2.1	< 2.5	< 2.3	2.7 (2.7)*	< 1.9	< 1.6
Co-58	< 2.3	< 2.7	< 2.4	< 2.4	< 2.0	< 1.8
Mn-54	< 2.2	< 2.8	< 2.7	< 2.4	< 2.1	< 1.8
Zn-65	< 5.3	< 6.4	< 6.2	9.4 (6.6)	< 5.3	< 4.1
Fe-59	< 5.6	< 6.6	< 6.2	< 5.4	< 4.8	< 4.1
Co-60	< 2.3	< 3.0	< 2.8	< 2.4	< 2.1	< 1.9
Ba-140	< 3.4	< 4.6	< 4.3	< 3.6	< 3.1	< 2.7
La-140	< 3.9	< 5.3	< 5.0	< 4.2	< 3.6	< 3.0

* 1.96 σ (Due to counting statistics.)

Table II.C.3 Radionuclide Concentrations in Bi-weekly Composite of Drinking Water. (pCi/L)

Collection Date	Mar 28, Apr 4, 1987		Apr 11, 18, 1987		Apr 24, May 1, 1987	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.47	< 0.36	< 0.24	0.41 (0.47)	< 0.27	< 0.39
Cs-134	< 2.0	< 2.4	< 2.1	< 2.5	< 1.2	< 2.2
Cs-137	5.0 (3.5)*	< 2.9	< 3.1	< 3.0	< 1.4	4.1 (3.9)
Zr-95	< 4.9	< 5.5	< 5.0	< 6.1	< 2.7	< 5.0
Nb-95	< 1.7	< 2.3	< 1.9	< 2.1	< 1.1	< 2.1
Co-58	< 1.9	< 2.3	< 2.1	< 2.2	< 1.1	< 2.1
Mn-54	< 2.0	< 2.4	< 2.1	< 2.4	< 1.2	< 2.2
Zn-65	< 4.5	< 5.4	< 5.0	< 5.6	< 2.7	6.4 (6.2)
Fe-59	6.7 (6.5)	< 6.1	< 5.2	< 5.8	< 2.7	< 5.0
Co-60	< 2.0	< 2.6	< 2.1	< 2.6	< 1.2	< 2.2
Ba-140	6.9 (6.6)	< 6.1	< 4.4	< 5.6	< 3.2	< 3.3
La-140	7.9 (7.6)	< 7.0	< 5.0	< 6.4	< 3.7	< 3.8

* 1.96σ (Due to counting statistics.)

Table II.C.3 Radionuclide Concentrations in Bi-weekly Composite of Drinking Water. (pCi/L)

Collection Date	May 9, 16, 1987		May 23, 29, 1987		Jun 6, 12, 1987	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.48	< 0.40	< 0.36	< 0.23	< 0.36	< 0.41
Cs-134	< 2.3	< 1.9	< 2.5	< 2.3	< 1.8	< 2.4
Cs-137	< 2.9	< 2.8	< 3.0	< 3.4	2.5 (2.6)	3.2 (3.5)
Zr-95	< 5.4	< 4.3	< 6.0	< 5.0	< 4.2	< 5.8
Nb-95	< 2.1	< 1.7	< 2.3	2.4 (2.4)	< 1.6	< 2.2
Co-58	< 2.1	< 1.8	< 2.3	< 2.3	< 1.6	< 2.2
Mn-54	3.5 (2.8)*	< 1.9	< 2.4	< 2.2	3.3 (2.2)	< 2.5
Zn-65	< 5.4	6.4 (5.3)	< 5.7	< 5.1	< 4.3	< 5.8
Fe-59	< 5.5	< 4.7	< 5.8	< 5.4	< 4.9	< 5.8
Co-60	< 2.5	< 1.9	< 2.6	< 2.2	2.1 (2.4)	< 2.7
Ba-140	< 5.2	< 2.7	< 3.9	< 3.2	< 2.9	< 4.1
La-140	< 6.0	< 3.2	< 4.5	< 3.7	< 3.4	< 4.7

* 1.96 σ (Due to counting statistics.)

Table II.C.3 Radionuclide Concentrations in Bi-weekly Composiete of Drinking Water. (pCi/L)

Collection Date	Jun 19, 26, 1987		Jul 3, 10, 1987		Jul 17, 25, 1987	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.47	< 0.42	< 0.43	< 0.20	< 0.39	< 0.33
Cs-134	< 2.7	< 2.9	< 2.6	< 2.8	< 2.5	2.7 (2.7)
Cs-137	5.7 (4.8)*	< 3.6	6.9 (4.6)	< 3.5	< 3.1	7.0 (4.0)
Zr-95	< 6.2	< 6.8	< 6.2	< 6.5	8.4 (7.5)	< 5.2
Nb-95	< 2.6	2.9 (3.1)	< 2.3	< 2.4	< 2.3	< 2.0
Co-58	< 2.6	< 2.8	< 2.6	< 2.6	< 2.3	4.4 (2.7)
Mn-54	< 2.6	< 2.9	< 2.5	< 2.8	< 2.5	< 2.3
Zn-65	< 6.6	< 6.8	< 6.5	< 6.6	< 5.9	< 5.3
Fe-59	< 6.1	8.4 (9.0)	< 6.6	9.9 (8.4)	< 6.2	< 5.1
Co-60	< 2.8	< 3.2	< 2.6	< 3.1	< 2.7	2.8 (2.7)
Ba-140	< 5.7	< 4.7	7.6 (6.6)	< 4.4	< 5.7	< 4.7
La-140	< 6.6	< 5.4	8.8 (7.5)	< 5.1	< 6.6	< 5.4

* 1.96σ (Due to counting statistics.)

Table II.C.3 Radionuclide Concentrations in Bi-weekly Composite of Drinking Water. (pCi/L)

Collection Date	Aug 1, 8, 1987		Aug 15, 22, 1987		Aug 29, Sep 5, 1987	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.41	< 0.21	< 0.22	< 4.8	< 0.40	< 0.25
Cs-134	< 3.7	< 4.0	< 2.8	2.5 (2.7)	< 2.3	< 1.5
Cs-137	9.5 (6.6)*	< 5.0	< 3.2	< 2.8	3.6 (3.5)	2.0 (2.2)
Zr-95	< 8.2	< 9.9	< 5.0	< 5.5	< 5.9	< 3.5
Nb-95	< 3.2	8.0 (4.4)	< 1.9	3.3 (2.4)	< 2.2	1.8 (1.8)
Co-58	< 3.5	< 3.9	< 2.0	< 2.1	< 2.3	< 1.4
Mn-54	4.3 (4.4)	< 4.0	< 2.1	< 2.2	< 3.1	< 1.5
Zn-65	< 8.8	< 9.5	< 5.2	< 5.5	< 5.6	< 3.9
Fe-59	< 8.2	< 9.5	< 5.0	< 5.6	< 6.0	< 3.8
Co-60	< 3.7	7.1 (5.2)	< 2.1	2.7 (2.9)	< 2.6	< 1.4
Ba-140	< 7.5	< 6.6	< 3.2	< 3.7	< 3.8	< 3.6
La-140	< 8.6**	< 7.5	< 3.7	< 4.3	< 4.4	< 4.1

* 1.96σ (Due to counting statistics.)

** a lab accident caused loss of most of sample so LLD could not be met.

Table II.C.3 Radionuclide Concentrations in Bi-weekly Composite of Drinking Water. (pCi/L)

Collection Date	Sep 12, 19, 1987		Sept 26, Oct 3, 1987		Oct 10, 17, 1987	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.24	0.63 (0.52)	< 3.9	< 0.41	< 0.30	< 0.24
Cs-134	< 2.4	< 2.7	< 2.8	< 2.5	< 2.5	< 2.4
Cs-137	< 3.0	< 3.2	< 3.3	< 3.1	< 3.1	< 2.9
Zr-95	< 5.7	< 6.4	< 6.6	< 5.6	< 5.8	< 5.8
Nb-95	5.3 (2.7)*	< 2.4	< 2.6	< 2.2	< 2.3	< 2.1
Co-58	< 2.4	< 2.5	< 2.6	< 2.3	< 2.3	< 2.3
Mn-54	< 2.4	< 2.6	< 2.7	< 2.5	< 2.5	< 2.4
Zn-65	< 6.1	< 6.5	< 7.1	< 6.0	< 6.3	< 6.0
Fe-59	< 6.3	< 6.2	< 6.5	< 5.9	< 5.7	< 5.6
Co-60	< 2.6	4.5 (3.5)	< 3.0	< 2.6	< 2.7	< 2.7
Ba-140	< 4.0	< 6.0	< 6.5	< 6.2	< 6.3	< 4.0
La-140	< 4.6	< 6.9	< 7.5	< 7.1	< 7.2	< 4.6

*1.96σ (Due to counting statistics.)

Table II.C.3 Radionuclide Concentrations in Bi-weekly Composite of Drinking Water. (pCi/L)

Collection Date	Oct 24, 31, 1987		Nov 7, 14, 1987		Nov 21, 28, 1987	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 2.4	< 0.48	< 0.46	< 0.41	< 0.23	< 0.39
Cs-134	< 2.4	< 1.8	< 1.8	< 1.9	< 1.9	< 2.0
Cs-137	< 3.5	< 2.7	4.9 (3.2)*	2.8 (3.8)	< 2.8	4.0 (3.0)
Zr-95	< 5.4	< 4.2	< 4.3	< 4.2	< 4.6	< 5.3
Nb-95	< 2.4	< 1.7	< 1.6	< 1.8	< 1.7	< 1.9
Co-58	< 2.4	< 1.7	< 1.7	< 1.8	< 1.8	< 2.0
Mn-54	< 2.4	< 1.8	< 1.8	< 1.9	< 1.9	< 2.1
Zn-65	< 6.0	< 4.3	< 4.4	< 4.5	< 4.4	< 4.9
Fe-59	< 5.5	< 4.0	< 4.5	< 4.3	< 4.2	< 4.9
Co-60	< 2.5	< 0.93	< 1.8	< 1.9	< 1.9	< 2.2
Ba-140	< 3.5	< 4.0	< 5.0	< 2.7	< 2.8	< 3.4
La-140	< 4.0	< 4.6	< 4.8	< 3.1	< 3.3	< 3.9

*1.96σ (Due to counting statistics.)

Table II.C.3 Radionuclide Concentrations in Bi-weekly Composite of Drinking Water. (pCi/L)

Collection Date	Dec 5, 12, 1987		Dec 19, 28, 1987			
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.34	< 0.29	< 0.44	< 0.27		
Cs-134	< 2.4	< 2.4	< 2.0	< 2.2		
Cs-137	< 3.6	< 2.9	< 2.4	< 3.2		
Zr-95	< 5.4	< 5.6	< 4.6	< 5.0		
Nb-95	< 2.4	< 2.2	< 1.8	< 2.0		
Co-58	< 2.4	< 2.4	< 1.8	< 2.1		
Mn-54	< 2.4	< 2.4	< 2.0	< 2.2		
Zn-65	< 6.2	< 5.7	6.1 (5.9)*	< 5.5		
Fe-59	< 6.2	< 5.5	< 4.9	< 5.2		
Co-60	< 2.3	< 2.6	< 2.1	< 2.1		
Ba-140	< 4.1	< 6.0	< 4.4	< 4.4		
La-140	< 6.3	< 6.9	< 5.1	< 5.0		

*1.96σ (Due to counting statistics.)

2. Surface Water

Surface water is collected monthly from four sites. Since the reactor water effluent can be directed to either river course, there are upstream and downstream sampling locations on both the St. Vrain Creek and on the South Platte River.

Table II.C.4 shows tritium concentrations measured at the four surface water sites. Most of the values were less than MDC. The arithmetic mean value for the downstream locations in 1987 was not significantly different from the two upstream locations (Table II.H.2). The elevated value observed at R-10 on December 19, 1987 was reanalyzed and confirmed to be correct.

Table II.C.5 shows measurements of fission product and activation product concentrations in surface water samples collected monthly. There were occasional positive values, but the mean of the downstream sites was not significantly different from the mean of the upstream sites during 1987 for any of the gamma-ray emitting radionuclides measured. This has been the case since the inception of reactor operations at the Fort St. Vrain site. The occasional positive values are either fallout Cs-137, which can be expected, or values close to the uncertainty limits and assumed to be false positives.

In addition to the monthly sampling of the South Platte River and St. Vrain Creek, a continuous water sample is collected at station A-25. An aliquot of the farm pond outlet is sampled every 10 minutes and the composite collected weekly. The weekly composites are then combined and analyzed monthly. The results of these samples are shown in Table II.C.6. For every month there was evidence of measurable tritium release. Mean values for the other radionuclides were low and except for Cs-137, less than MDC. The correlation with the effluent release report is high.

Ground water is sampled quarterly at two locations. These are at F-16, a well on the farm immediately north and the closest to the reactor down the hydrological gradient, and at R-5, the Ehrlich feedlot. Table II.C.7 lists the measured concentrations of fission products and activation products in ground water. The Cs-137 results are not surprising due to residue of Chernobyl fallout, and the other results above MDC are assumed to be statistically false positive values.

For comparison purposes, Table II.C.8 lists the Maximum Permissible Concentration values for each of the radionuclides listed in Tables II.C.5-7.

Table II.C.4 Tritium Concentrations in Surface Water. (pCi/L) 1987.

Collection Date	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Jan 10	400 (280)*	< 240	560 (290)	< 240
Feb 14	< 240	< 240	< 240	< 240
Mar 14	< 240	< 240	280 (290)	< 240
Apr 11	< 230	< 230	< 230	< 230
May 16	< 230	< 230	< 230	< 230
Jun 12	< 230	< 230	< 230	< 230
Jul 10	< 230	< 230	< 230	< 230
Aug 8	240 (280)	< 230	< 230	< 230
Sep 12	400 (280)	< 230	190 (300)	< 230
Oct 10	< 230	< 230	< 230	< 230
Nov 14	< 230	< 230	< 230	< 230
Dec 19	< 300	730 (360)	< 300	< 300

* 1.96 σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: January 10, 1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.3	< 3.3	< 2.7	< 3.4
Cs-137	< 3.3	< 4.9	< 4.0	< 4.0
Zr-95	< 5.1	< 7.6	< 6.1	< 7.6
Nb-95	2.5 (2.4)*	< 3.0	2.7 (2.7)	< 3.0
Co-58	< 2.2	< 3.1	< 2.6	< 3.1
Mn-54	< 2.3	< 3.4	< 2.6	< 3.3
Zn-65	< 5.3	< 8.2	< 6.0	< 7.6
Fe-59	< 4.1	7.8 (7.7)	9.2 (5.9)	< 5.6
Co-60	< 2.2	< 3.6	< 2.6	< 3.6
Ba-140	< 3.3	< 5.1	< 3.9	< 5.9
La-140	< 3.8	< 5.8	< 4.5	< 6.8

* 1.96σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: February 14,1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.3	< 3.7	< 3.4	< 3.3
Cs-137	< 3.3	< 4.6	< 4.2	< 4.9
Zr-95	< 5.0	12 (10)	< 7.8	10 (9.2)
Nb-95	< 1.9	< 3.1	< 2.9	< 2.9
Co-58	< 2.2	< 3.4	< 3.2	< 3.1
Mn-54	< 2.2	< 3.6	< 3.4	< 3.3
Zn-65	8.5 (6.0)*	< 8.2	18 (9.2)	8.5 (9.2)
Fe-59	< 5.3	< 8.7	< 8.4	< 7.5
Co-60	< 2.3	< 4.2	< 3.5	< 3.2
Ba-140	< 3.8	< 5.9	< 5.5	6.1 (6.6)
La-140	< 4.4	< 6.8	< 6.3	7.0 (7.6)

* 1.96 σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: March 14, 1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.3	< 2.4	< 1.8	< 2.3
Cs-137	< 3.4	< 3.0	6.1 (3.3)*	< 3.4
Zr-95	< 4.9	< 5.8	< 4.1	< 5.0
Nb-95	< 1.9	< 2.2	< 1.7	< 2.0
Co-58	< 2.1	< 2.3	< 1.8	< 2.2
Mn-54	< 2.2	< 2.5	< 1.8	< 2.2
Zn-65	< 5.1	< 5.6	< 4.1	< 5.2
Fe-59	< 5.2	< 5.8	< 4.5	< 5.1
Co-60	< 2.3	< 2.6	< 1.8	< 2.3
Ba-140	< 4.0	< 4.6	< 2.7	< 3.8
La-140	< 4.6	< 5.3	< 3.1	< 4.4

* 1.96 σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: April 11, 1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 1.8	< 2.2	2.9 (3.0)	< 2.0
Cs-137	3.0 (3.2)*	< 2.8	3.2 (3.6)	< 2.5
Zr-95	< 4.2	< 5.2	< 5.8	< 4.9
Nb-95	< 1.6	< 1.9	< 2.2	< 1.8
Co-58	< 1.7	< 2.1	< 2.3	< 1.9
Mn-54	< 1.8	< 2.3	< 2.4	< 2.0
Zn-65	< 4.2	< 5.1	< 5.8	< 4.7
Fe-59	< 4.3	< 5.3	< 5.9	< 5.1
Co-60	< 1.8	< 2.5	< 2.7	< 2.2
Ba-140	< 2.6	5.1 (5.2)	< 4.4	< 3.3
La-140	< 3.0	5.8 (6.0)	< 5.0	< 3.8

* 1.96 σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: May 16,1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.8	< 3.2	< 2.9	< 2.8
Cs-137	< 4.0	7.4 (5.7)	< 3.5	< 3.4
Zr-95	< 6.0	< 7.1	< 6.9	7.7 (8.1)
Nb-95	4.6 (2.8)*	< 2.8	< 2.5	< 2.4
Co-58	< 2.6	< 3.1	< 2.7	< 2.7
Mn-54	< 2.7	< 3.2	< 2.9	< 2.8
Zn-65	< 6.4	< 7.3	< 6.8	< 6.2
Fe-59	< 6.1	< 8.5	< 6.9	< 6.4
Co-60	< 2.8	< 3.1	< 3.2	< 3.0
Ba-140	< 4.4	< 4.8	< 5.3	< 4.5
La-140	< 5.1	< 5.5	< 6.1	< 5.2

* 1.96σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: June 12, 1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 3.2	< 2.1	< 1.8	< 3.4
Cs-137	< 4.7	4.5 (3.0)	5.5 (3.3)	< 4.1
Zr-95	< 7.4	< 4.8	< 4.2	< 8.4
Nb-95	< 2.8	< 1.9	< 1.6	< 3.1
Co-58	< 3.0	< 1.9	< 1.8	< 3.2
Mn-54	3.6 (3.8)*	< 2.1	< 1.8	< 3.4
Zn-65	< 7.4	7.5 (5.5)	6.3 (5.1)	< 8.0
Fe-59	< 7.4	< 4.8	< 4.6	< 8.2
Co-60	< 3.3	< 2.2	< 1.9	< 3.7
Ba-140	< 4.7	< 4.6	< 2.8	< 5.6
La-140	< 5.4	< 5.3	< 3.2	< 6.4

* 1.96 σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: July 10, 1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.6	< 1.9	< 2.0	2.2 (2.6)
Cs-137	< 3.9	4.2 (3.4)	< 2.5	< 2.7
Zr-95	< 6.0	< 4.4	< 4.8	< 5.1
Nb-95	< 2.3	2.0 (2.1)	3.6 (2.2)	3.8 (2.2)
Co-58	< 2.5	< 1.9	< 1.9	< 2.0
Mn-54	3.5 (3.1)*	< 2.0	< 2.0	< 2.1
Zn-65	< 6.7	< 4.8	< 4.7	< 5.1
Fe-59	< 6.1	< 4.6	< 4.9	< 5.2
Co-60	< 2.6	< 2.0	< 2.2	< 2.3
Ba-140	< 4.5	< 2.9	< 3.3	< 3.5
La-140	< 5.1	< 3.3	< 3.8	< 4.1

* 1.96σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: August 8, 1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.7	< 3.6	< 3.3	< 2.3
Cs-137	< 3.1	6.1 (6.4)*	< 4.8	6.3 (4.0)
Zr-95	< 6.6	< 7.9	< 7.2	< 5.4
Nb-95	< 2.4	< 3.4	< 2.9	< 2.0
Co-58	< 2.4	< 3.3	< 3.3	< 2.2
Mn-54	< 2.6	< 3.6	< 3.1	< 2.2
Zn-65	< 6.5	< 8.2	< 7.7	< 5.5
Fe-59	< 6.1	< 8.5	< 7.7	< 5.2
Co-60	< 2.8	< 3.8	< 3.2	< 2.4
Ba-140	< 4.2	< 5.1	< 4.7	< 3.3
La-140	< 4.8	< 5.9	< 5.4	< 3.8

* 1.96σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: September 12, 1987

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain R-10	S. Platte F-20	St. Vrain A-21	S. Platte F-19
Cs-134	< 3.7	< 2.5	< 2.1	3.9 (4.5)
Cs-137	< 5.6	2.9 (3.5)*	4.0 (3.8)	< 4.7
Zr-95	< 8.6	< 5.8	< 4.8	< 8.9
Nb-95	< 3.5	< 2.2	< 1.9	3.8 (4.1)
Co-58	< 3.5	< 2.3	2.7 (2.5)	4.2 (4.3)
Mn-54	< 3.8	< 2.4	< 2.1	< 3.8
Zn-65	< 10.	< 5.9	< 5.1	< 9.2
Fe-59	< 8.4	< 6.0	< 5.2	< 8.7
Co-60	< 3.8	< 2.7	2.2 (2.1)	< 4.0
Ba-140	< 6.6	< 4.1	< 3.3	< 6.1
La-140	< 7.6	< 4.5	< 3.7	< 7.1

* 1.96σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: October 10, 1987.

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.5	< 1.7	< 3.3	< 2.2
Cs-137	5.3 (3.6)*	< 2.0	7.8 (5.9)	4.3 (3.2)
Zr-95	< 5.8	< 3.5	< 7.6	< 5.0
Nb-95	< 2.3	< 1.6	< 3.2	< 2.1
Co-58	< 2.3	< 1.6	< 3.1	< 2.2
Mn-54	< 2.5	< 1.7	< 3.3	< 2.2
Zn-65	< 5.8	< 4.0	< 8.0	< 5.3
Fe-59	< 6.0	< 4.2	< 8.0	< 5.0
Co-60	< 2.6	< 1.5	< 3.4	< 2.3
Ba-140	< 4.6	< 3.5	< 5.7	< 4.2
La-140	< 5.4	< 4.0	< 6.5	< 4.8

* 1.96 σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: November 14, 1987.

	Downstream Sites		Upstream Sites	
Radionuclide	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.5	< 3.4	< 3.3	< 2.7
Cs-137	< 3.8	< 5.1	< 6.0	3.5 (3.9)
Zr-95	< 5.5	< 7.4	< 7.6	< 6.3
Nb-95	< 2.2	< 3.0	< 3.3	2.7 (3.0)
Co-58	< 2.3	< 3.3	< 3.2	< 2.5
Mn-54	< 2.4	< 3.5	< 3.4	< 2.8
Zn-65	< 6.1	< 8.2	< 8.1	< 6.5
Fe-59	< 5.6	< 7.7	< 7.8	8.5 (7.9)
Co-60	< 2.5	< 3.3	< 3.5	< 3.0
Ba-140	< 4.5	7.2 (7.3)*	7.4 (7.8)	< 5.5
La-140	< 4.1	8.3 (8.4)	8.5 (8.9)	< 6.3

* 1.96σ (Due to counting statistics.)

Table II.C.5 Radionuclide Concentrations in Surface Water. (pCi/L)

Collection Date: December 19, 1987.

Radionuclide	Downstream Sites		Upstream Sites	
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19
Cs-134	< 2.2	< 2.4	< 3.8	< 3.6
Cs-137	4.9 (4.0)*	< 2.9	< 4.6	< 5.4
Zr-95	< 4.9	< 5.6	< 8.9	< 8.0
Nb-95	< 2.1	< 2.2	< 3.4	< 3.3
Co-58	< 2.1	< 2.2	< 3.5	< 3.4
Mn-54	< 2.2	2.9 (2.8)	< 3.7	< 3.5
Zn-65	< 5.6	< 5.8	< 8.8	< 8.7
Fe-59	< 5.1	< 5.4	< 8.8	7.9 (9.6)
Co-60	< 2.2	< 2.5	< 4.0	< 3.7
Ba-140	< 3.2	< 3.9	< 6.1	< 5.3
La-140	< 3.7	< 4.5	< 7.0	< 6.0

* 1.96 σ (Due to counting statistics.)

Table II.C.6. Radionuclide Concentrations in Monthly Composites of Surface Water A-25. (pCi/L).

Collection Year: 1987

Radionuclide	January	February	March	April	May	June
Cs-134	< 2.0	< 2.4	< 2.5	< 2.3	< 1.6	< 2.4
Cs-137	< 2.4	8.0 (3.5)*	< 2.9	< 3.4	< 2.4	< 2.9
Zr-95	< 5.8	< 5.4	< 5.7	< 5.1	< 3.5	< 5.6
Nb-95	< 1.7	< 2.4	< 2.4	3.6 (2.8)	< 1.7	2.7 (3.0)
Co-58	< 1.8	< 2.2	< 2.3	< 2.5	< 1.5	< 2.2
Mn-54	2.5 (2.4)*	< 2.4	< 2.4	< 2.3	< 1.6	4.8 (3.0)
Zn-65	5.3 (5.7)	< 5.5	< 5.6	5.4 (6.6)	9.4 (4.6)	< 5.6
Fe-59	< 4.8	< 5.4	< 5.6	< 6.6	< 5.0	< 5.5
Co-60	< 2.2	< 2.5	< 2.6	< 2.3	< 1.6	< 2.5
Ba-140	< 3.3	< 4.0	< 3.9	< 3.4	< 2.3	< 3.8
La-140	< 3.8	< 4.6	< 4.5	< 3.9	< 2.7	< 4.4
H-3	3700 (320)	3000 (310)	6000 (340)	1500 (290)	18000 (450)	13000 (400)

* 1.96σ (Due to counting statistics.)

Table II.C.6 Radionuclide Concentrations in Monthly Composites of Surface Water, A-25 (pCi/L).

Collection Year: 1987

Radionuclide	July	August	September	October	November	December
Cs-134	< 2.3	< 1.7	< 2.2	< 1.8	< 2.2	< 2.3
Cs-137	3.6 (4.0)*	< 2.1	2.7 (3.2)	2.8 (3.2)	< 2.6	< 2.8
Zr-95	< 5.0	< 4.0	< 5.2	< 4.0	< 5.[illegible]	< 5.2
Nb-95	< 2.2	< 1.7	< 2.0	< 1.6	< 1.9	< 2.0
Co-58	< 2.2	< 1.6	< 2.0	< 1.7	< 2.0	< 2.1
Mn-54	< 2.2	< 1.7	< 2.3	< 1.9	< 2.1	< 2.3
Zn-65	< 5.5	< 4.0	< 5.5	< 4.3	< 5.0	< 5.6
Fe-59	< 5.2	< 4.0	< 6.9	< 5.3	< 6.0	< 6.5
Co-60	< 2.3	< 1.8	< 2.4	< 1.9	< 2.3	< 2.5
Ba-140	< 3.3	< 6.4	< 3.6	< 2.7	< 3.5	< 3.6
La-140	< 3.8	< 7.3	< 4.1	< 3.1	< 4.0	< 4.2
H-3	11,000 (390)	3700 (317)	1300 (300)	2300 (310)	330 (280)	29000 (640)

* 1.96σ (Due to counting statistics.)

Table II.C.7 Radionuclide Concentrations in Ground Water. (pCi/L)
Collection year: 1987

Radio-nuclide	1st Quarter F-16	1st Quarter R-5	2nd Quarter F-16	2nd Quarter R-5	3rd Quarter F-16	3rd Quarter R-5	4th Quarter F-16	4th Quarter R-5
Cs-134	2.6 (2.9)*	< 2.6	< 2.5	< 2.4	< 3.4	< 2.2	< 3.9	< 3.2
Cs-137	4.3 (4.3)	3.9 (3.7)	< 3.1	7.9 (4.2)	< 5.2	< 3.3	8.4 (5.5)	< 3.8
Zr-95	< 5.4	< 6.0	< 6.0	< 5.2	< 7.9	< 5.0	< 9.1	< 7.9
Nb-95	< 2.6	< 2.4	< 2.4	< 2.2	< 3.3	< 2.0	< 3.7	< 2.9
Co-58	< 2.3	< 2.3	< 2.4	< 2.3	< 3.3	< 2.1	< 3.8	< 2.9
Mn-54	< 2.4	< 2.6	< 2.5	< 2.4	< 3.4	< 2.3	< 3.9	< 3.2
Zn-65	< 8.0	< 6.8	< 6.4	9.4 (7.9)	< 9.7	< 5.6	1.0 (1.2)	< 7.7
Fe-59	< 5.7	< 5.9	< 6.1	< 5.5	< 8.1	< 5.1	< 9.3	< 7.6
Co-60	2.7 (2.8)	< 2.8	< 2.8	< 2.4	< 3.6	< 2.1	< 4.1	< 3.4
Ba-140	< 3.7	< 4.6	< 4.9	< 4.2	< 5.3	< 3.6	< 6.1	< 5.2
La-140	< 4.2	< 5.3	< 5.6	< 4.9	< 6.1	< 4.2	< 7.1	< 6.0
H-3	350 (280)	< 230	< 230	< 230	< 230	< 230	< 230	< 300

* 1.96 σ (Due to counting statistics.)

Table II.C.8 Maximum Permissible Concentrations in Drinking Water. (10CFR20, Appendix B, Table II)

H-3	3×10^6 pCi/L
I-131	3×10^2 pCi/L
Cs-134	9×10^3 pCi/L
Cs-137	2×10^4 pCi/L
Zr-95	6×10^4 pCi/L
Nb-95	1×10^5 pCi/L
Co-58	1×10^5 pCi/L
Mn-54	1×10^5 pCi/L
Zn-65	1×10^5 pCi/L
Fe-59	6×10^4 pCi/L
Co-60	5×10^4 pCi/L
Ba-140	3×10^4 pCi/L
La-140	2×10^4 pCi/L

II.C. Milk

The dairy food chain is the critical pathway for possible radiation dose commitment around any nuclear facility. The critical individual would be an infant consuming milk produced from cows grazing local pastures. Milk is the critical pathway for possible dose commitment to humans from environmental contamination of H-3, I-131, Cs-137 and Sr-90. For this reason milk is sampled extensively to document the presence or absence of radioactivity due to reactor operations.

There are no dairies (or personal milk cows) in the facility area, 1.6 km radius. The six dairies in the adjacent area, 1.6-8 km radium, were selected as they are located in the highest X/Q areas (refer to updated FSAR). The description of these locations can be found in Table III.B.1 and Figure III.B.2. The single reference location dairy, R-8, is 22.5 km West of the reactor in the least predominant wind direction. Herd management practices are virtually identical at all dairy locations. The cows are rarely, if ever, out on pasture and under dry-lot management typical of Eastern Colorado.

Table II.D.1 lists the concentrations of all radionuclides that are investigated in milk samples. During 1987, elevated concentrations of I-131 were again consistently observed at site A-22. The source of this I-131 is from nuclear medicine used in the Denver hospitals. The release enters the S. Platte River just North of Denver. A-22 dairy uses irrigation ditch water for its herd rather than well water. The ditch (Independence) receives S. Platte water upstream of FSV. This observation was first made in 1985 and discussed at length in the 1985 REMD summary report.

Figure II.D.1 shows the frequency and magnitude of the I-131 concentrations observed at the A-22 dairy in recent years. The large peak observed in May and June of 1986 is of course due to Chernobyl fallout, but all other peaks are due to hospital use in Denver. Currently, we have initiated a study to investigate this observation in greater detail. A continuous water sampler is in place at the Henderson River gauging station and milk from dairies on the Platte River north of Denver will be sampled when the irrigation season starts.

K-natural, as measured by K-40, is very constant in milk. The mean literature value is 1.5 g/L. K concentrations are homeostatically controlled and independent of K intake. K-nat is measured in all milk samples as a quality control measure for the other radionuclides determined in the same sample by gamma-ray spectrometry, but K-nat concentrations are no longer reported in Table II.D.1.

Elevated tritium concentrations in milk due to reactor effluents have never been observed in the post-operational period of the reactor. This implies the tritium from reactor effluents is not contributing any radiation dose to humans via the milk pathway. Tritium concentrations in milk should respond rapidly to changes in tritium concentrations of the forage water intake or drinking water intake to the cow. This is due to the short biological half-life for water in the cow (about three days for the lactating cow). As noted in previous reports, the reported tritium concentration in milk is the tritium in water extracted from the milk. Contamination of milk samples by any radionuclide due to reactor effluents has never been observed during the operational periods of Fort St. Vrain.

Table II.D.1 Radionuclide Concentrations in Milk. (pCi/L)

Collection Year: 1987

Radionuclide	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	Jan 3	Jan 31	Jan 16	Jan 10	Jan 24	Jan 16	Jan 3
I-131	< 0.21	< 0.38	< 0.36	0.56 (0.53)	< 0.37	< 0.40	< 0.30
Cs-134	< 2.9	< 2.6	< 2.3	< 3.8	3.0 (2.8)	< 2.9	5.0 (3.6)
Cs-137	9.2 (5.2)*	< 3.2	4.8 (3.9)	< 4.4	6.2 (4.2)	7.0 (4.2)	14 (4.4)
Ba-140	< 4.2	< 4.1	< 3.3	< 6.1	< 4.0	< 4.7	< 4.7
La-140	< 4.8	< 4.7	< 3.8	< 7.0	< 4.6	< 5.4	< 5.4
H-3	< 230	< 230	< 240	390 (280)	< 230	< 240	< 230
Collection Date	Feb 7	Feb 28	Feb 28	Feb 14	Feb 20	Feb 28	Feb 7
I-131	< 0.19	< 0.29	< 0.27	< 0.39	< 0.20	< 0.35	< 0.27
Cs-134	< 2.4	< 2.6	2.6 (2.8)	4.2 (3.0)	< 3.1	4.8 (2.9)	< 2.4
Cs-137	4.3 (4.1)	< 3.1	4.3 (4.1)	6.9 (3.8)	< 3.7	18 (4.4)	< 3.5
Ba-140	< 3.7	< 4.1	< 3.9	< 4.2	< 6.4	< 3.8	< 4.5
La-140	< 4.3	< 4.7	< 4.5	< 4.8	< 7.4	< 4.4	< 5.2
H-3	< 230	230 (280)	< 230	< 240	< 230	< 230	< 230
Collection Date	Mar 21	Mar 21	Mar 28	Mar 6	Mar 14	Mar 28	Mar 6
I-131	< 0.36	< 0.34	< 0.40	< 0.41	< 0.30	< 0.29	< 0.50
Cs-134	< 2.3	< 2.6	< 2.0	< 2.3	< 2.6	4.4 (2.9)	< 2.6
Cs-137	4.6 (4.1)	< 3.1	5.4 (3.4)	5.6 (4.2)	< 3.1	12 (4.4)	4.8 (3.7)
Ba-140	< 3.3	< 4.5	< 2.8	< 3.3	< 4.2	< 3.5	< 4.8
La-140	< 3.8	< 5.2	< 3.2	< 3.8	< 4.8	< 4.0	< 5.5
H-3	< 230	290 (280)	< 230	< 2[illegible]0	< 230	< 230	< 230

* 1.96 σ (Due to counting statistics.)

Table II.D.1 Radionuclide Concentrations in Milk. (pCi/L)

Collection Year: 1987

Radionuclide	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	Apr 4	Apr 24	Apr 18	Apr 11	Apr 24	Apr 24	Apr 4
I-131	< 0.28	0.45 (0.35)*	2.1 (0.56)	< 0.39	< 0.22	< 0.29	< 0.18
Cs-134	< 2.5	< 3.0	< 2.3	4.2 (2.9)	< 2.4	3.0 (3.5)	< 2.3
Cs-137	< 3.1	< 3.7	5.9 (4.1)	15 (4.3)	< 3.5	12 (5.3)	5.9 (4.1)
Ba-140	< 4.5	< 4.9	< 3.7	< 3.4	< 3.9	< 4.0	< 3.4
La-140	< 5.2	< 5.7	< 4.3	< 3.9	< 4.5	< 4.6	< 3.9
H-3	< 240	< 240	< 230	< 230	< 240	< 240	< 240
Collection Date	May 9	May 1	May 9	May 9	May 9	May 9	May 1
I-131	0.58 (0.47)	< 0.47	0.68 (0.46)	< 0.36	< 0.27	< 0.22	< 0.41
Cs-134	< 2.8	< 2.6	< 1.5	< 3.0	3.5 (3.5)	3.8 (3.3)	< 2.5
Cs-137	< 3.4	5.2 (3.8)	< 2.3	< 3.6	< 3.6	20 (5.0)	< 3.1
Ba-140	< 4.4	< 4.8	4.5 (3.5)	< 6.9	< 5.6	< 4.3	< 4.0
La-140	< 5.1	< 5.6	5.1 (4.0)	< 7.9	< 6.5	< 5.0	< 4.6
H-3	< 230	< 230	340 (280)	< 230	< 230	< 230	< 230
Collection Date	May 16	May 16	May 23	May 29	May 29	May 23	May 16
I-131	< 0.27	< 0.42	< 0.32	< 0.39	< 0.28	< 0.27	< 0.34
Cs-134	< 2.8	3.7 (4.5)	3.7 (3.7)	< 2.2	< 3.7	6.8 (3.2)	< 2.7
Cs-137	6.1 (4.1)	< 4.5	6.4 (4.5)	5.4 (4.0)	< 4.4	14 (4.0)	9.6 (4.8)
Ba-140	< 4.6	< 5.9	< 5.7	< 4.4	< 5.9	< 5.1	< 3.9
La-140	< 5.4	< 6.8	< 6.5	< 5.1	< 6.8	< 5.8	< 4.4
H-3	< 230	< 230	< 230	< 230	< 230	< 230	< 230

* 1.96 σ (Due to counting statistics.)

Table II.D.1 Radionuclide Concentrations in Milk. (pCi/L)

Collection Year: 1987

Radionuclide	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	Jun 12	Jun 6	Jun 6	Jun 6	Jun 12	Jun 12	Jun 6
I-131	< 0.37	< 0.36	2.4 (0.35)*	< 0.25	< 0.32	< 0.42	< 0.33
Cs-134	< 3.3	< 2.7	< 2.4	4.7 (3.5)	< 3.5	< 2.6	2.9 (2.3)
Cs-137	< 4.8	< 3.9	7.7 (4.1)	9.5 (4.3)	4.9 (5.1)	6.5 (3.8)	< 2.3
Ba-140	< 6.6	< 3.8	< 3.5	< 4.5	< 7.9	< 4.5	< 4.3
La-140	< 7.6	< 4.3	< 4.0	< 5.2	< 9.1	< 5.2	< 5.0
H-3	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Collection Date	Jun 26	Jun 19	Jun 26	Jun 19	Jun 26	Jun 26	Jun 19
I-131	< 0.46	< 0.25	< 0.38	< 0.27	< 0.27	< 0.37	< 0.31
Cs-134	< 3.0	< 2.4	< 2.8	3.4 (3.0)	< 3.1	< 3.9	< 2.4
Cs-137	< 4.4	3.8 (4.2)	< 4.1	< 3.1	< 3.7	6.8 (5.7)	< 2.9
Ba-140	< 6.2	< 3.5	< 4.1	< 4.1	< 4.9	< 6.2	< 5.2
La-140	< 7.1	< 4.0	< 4.8	< 4.7	< 5.7	< 7.2	< 6.0
H-3	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Collection Date	Jul 3	Jul 3	Jul 3	Jul 3	Jul 10	Jul 10	Jul 3
I-131	< 0.33	< 0.20	< 0.44	< 0.40	4.7 (4.2)	< 0.28	< 0.35
Cs-134	< 2.6	< 2.5	< 2.7	< 2.4	< 3.1	< 3.5	2.9 (3.2)
Cs-137	< 3.8	< 3.0	< 3.2	6.2 (4.2)	< 3.7	< 5.1	< 3.3
Ba-140	< 3.7	< 4.9	< 5.5	< 4.9	< 5.0	< 4.8	< 4.2
La-140	< 4.3	< 5.6	< 6.3	< 5.6	< 5.7	< 5.5	< 4.8
H-3	< 230	230 (280)	< 230	< 230	< 230	< 230	380 (280)

* 1.96 σ (Due to counting statistics.)

Table II.D.1 Radionuclide Concentrations in Milk. (pCi/L)

Collection Year: 1987

Radionuclide	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	Jul 17	Jul 17	Jul 17	Jul 17	Jul 25	Jul 25	Jul 25
I-131	< 0.25	< 0.32	5.5 (4.0)	< 0.69	< 0.43	< 0.46	< 0.41
Cs-134	< 2.3	< 2.5	< 2.5	< 2.2	< 2.9	< 3.9	< 2.5
Cs-137	< 3.4	< 3.1	4.6 (4.3)	4.3 (3.9)	< 3.6	< 5.8	4.2 (3.6)
Ba-140	< 4.1	< 4.0	< 4.0	5.9 (5.4)	< 5.2	< 6.6	< 3.9
La-140	< 4.7	< 4.5	< 4.6	6.8 (6.2)	< 5.9	< 7.5	< 4.5
H-3	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Collection Date	Aug 1	Aug 1	Aug 1	Aug 1	Aug 8	Aug 8	Aug 8
I-131	< .34	< 0.21	3.2 (0.35)	< 0.20	< 0.27	< 0.32	< 0.36
Cs-134	< 2.8	< 2.7	< 2.5	< 3.1	< 3.8	< 1.4	< 3.9
Cs-137	< 3.3	< 5.4	6.0 (4.3)	< 3.9	< 4.4	< 3.5	5.2 (5.5)
Ba-140	< 4.4	< 4.1	< 3.7	< 6.2	< 5.8	< 3.1	< 6.3
La-140	< 5.1	< 4.7	< 4.3	< 7.2	< 6.6	< 3.5	< 7.2
H-3	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Collection Date	Aug 15	Aug 15	Aug 15	Aug 15	Aug 22	Aug 22	Aug 22
I-131	< 0.34	< 0.40	0.72 (0.47)*	< 0.22	< 0.3	< 1.7	< 0.28
Cs-134	< 2.6	< 1.6	< 2.3	3.4 (2.6)	< 3.0	< 1.8	< 1.8
Cs-137	< 3.4	< 1.9	< 3.5	< 2.6	3.9 (4.2)	2.2 (2.5)	4.1 (2.6)
Ba-140	< 5.0	< 2.5	< 3.5	< 3.4	< 5.2	< 3.1	< 3.0
La-140	< 5.7	< 2.8	< 4.0	< 3.9	< 6.0	< 3.5	< 3.4
H-3	< 230	< 230	< 230	< 230	< 230	< 230	< 230

* 1.96 σ (Due to counting statistics.)

Table II.D.1 Radionuclide Concentrations in Milk. (pCi/L)

Collection Year: 1987

Radionuclide	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	Sept 12	Sept 5	Sept 12	Sept 5	Sept 12	Sept 12	Sept 12
I-131	< 0.21	< 0.5	< 0.74	< 3.3	< 0.29	0.30 (0.31)	< 4.0
Cs-134	< 1.2	< 2.9	< 2.5	< 4.1	1.7 (1.9)	< 1.7	< 2.[illegible]
Cs-137	2.3 (1.8)*	< 3.2	< 3.0	< 4.9	< 1.9	2.0 (2.3)	5.2 (2.5)
Ba-140	< 2.0	< 5.5	< 4.0	< 6.4	< 3.2	< 3.1	< 3.8
La-140	< 2.3	< 6.3	< 4.5	< 7.3	< 3.7	< 3.6	< 4.3
H-3	< 232	< 228	< 232	< 228	< 230	< 232	< 228
Collection Date	Sept 26	Sept 19	Sept 26	Sept 26	Sept 26	Sept 26	Sept 19
I-131	< .46	< .17	4.2 (0.52)	< 1.9	< 0.23	< 0.27	< .18
Cs-134	< 2.7	< 1.5	< 2.7	< 2.1	< 1.9	< 1.4	< 2.1
Cs-137	< 3.9	3.9 (2.0)	< 3.3	< 2.6	< 2.3	< 1.8	< 2.6
Ba-140	< 4.0	< 2.3	< 4.2	< 4.7	< 3.0	< 2.2	< 3.9
La-140	< 4.6	< 2.6	< 4.9	< 5.4	< 3.5	< 2.5	< 4.5
H-3							
Collection Date							
I-131							
Cs-134							
Cs-137							
Ba-140							
La-140							

* 1.96σ (Due to counting statistics.)

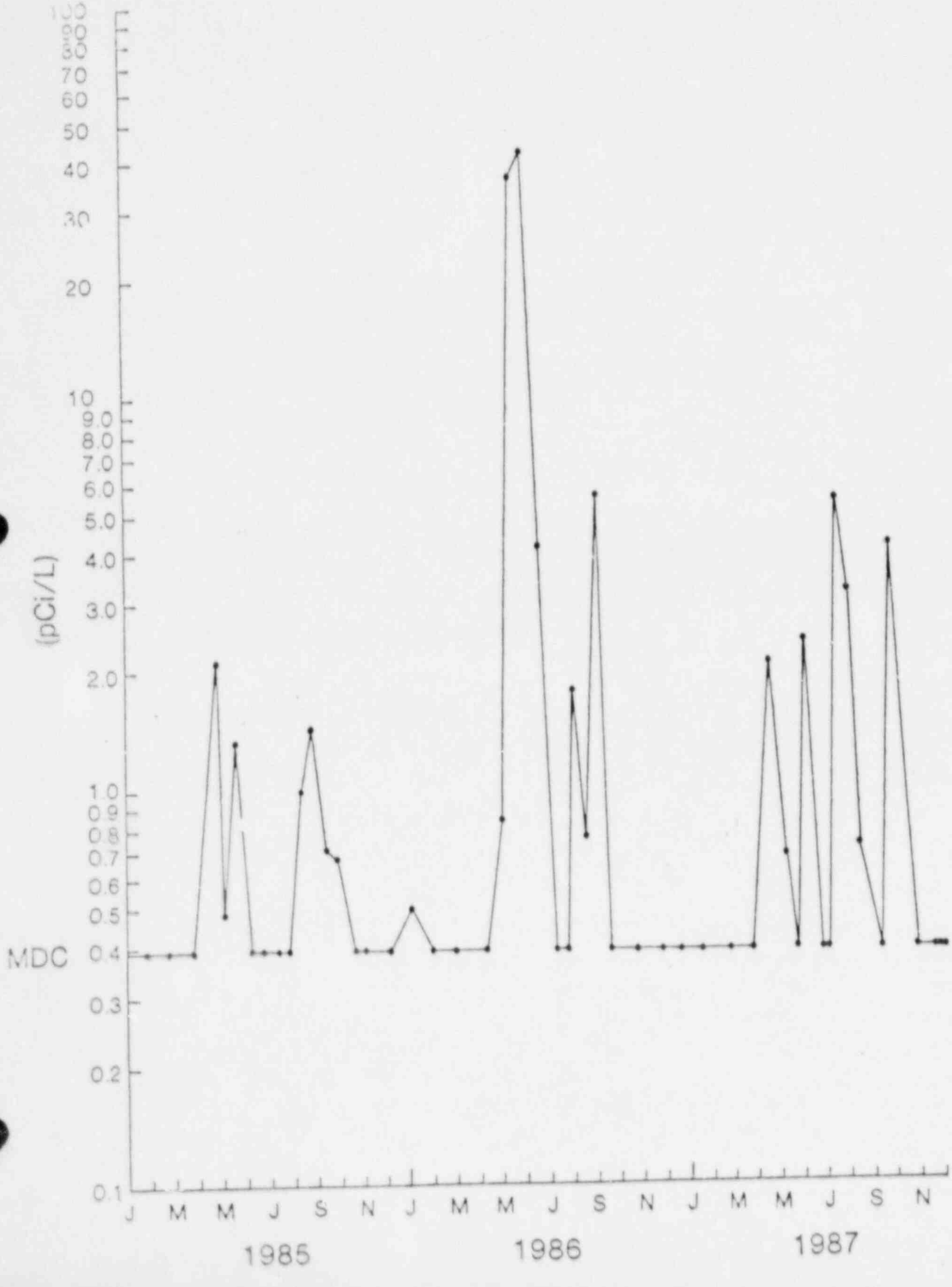
Table II.D.1 Radionuclide Condentrations in Milk. (pCi/L)
Collection Year: 1987.

Radionuclide	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date:	Oct 31	Oct 3	Oct 31	Oct 31	Oct 10	Oct 10	Oct 3
I-131	< 0.32	< 0.33	< 0.35	< 0.30	< 0.23	0.71 (0.42)	< 0.21
Cs-134	< 2.2	< 1.9	< 2.1	< 2.2	< 3.5	< 1.9	< 1.5
Cs-137	< 2.5	< 2.1	2.9 (2.9)*	< 2.5	< 4.9	< 2.1	< 1.8
Ba-140	< 3.3	< 3.2	< 3.1	< 3.3	< 6.1	< 3.5	< 2.5
La-140	< 3.8	< 3.7	< 3.6	< 3.8	< 7.0	< 4.1	< 2.8
H-3	< 230	< 230	< 290	< 240	< 230	250 (270)	< 230
Collection Date:	Nov 6	Nov 21	Nov 21	Nov 21	Nov 14	Nov 14	Nov 21
I-131	< 0.49	< 0.31	< 0.42	< 0.23	< 0.	< 0.39	< 2.6
Cs-134	< 3.3	< 1.4	< 1.7	< 1.8	< 2.	< 2.5	< 1.6
Cs-137	< 4.8	< 1.7	2.36 (2.3)	< 1.9	< 2.	3.1 (3.5)	< 2.0
Ba-140	< 5.1	3.6 (3.9)	< 2.7	< 3.6	< 4.4	< 4.6	< 2.7
La-140	< 5.9	4.2 (4.5)	< 3.1	< 4.2	< 5.1	< 5.2	< 3.1
H-3	< 230	< 230	< 230	< 230	< 230	< 230	< 230
Collection Date:	Dec 12	Dec 5	Dec 5	Dec 5	Dec 12	Dec 12	Dec 5
I-131	< 0.37	< 0.33	< 0.49	< 0.34	< 0.30	< 0.33	< 0.28
Cs-134	< 2.8	< 2.4	< 2.6	< 2.3	< 2.4	< 1.5	< 2.2
Cs-137	4.4 (4.8)	< 3.5	6.5 (3.8)	< 2.7	< 3.5	< 1.8	3.3 (3.2)
Ba-140	6.0 (5.8)	< 3.5	< 4.6	< 4.1	< 3.8	< 2.4	< 4.1
La-140	6.9 (6.7)	< 4.0	< 5.3	< 4.7	< 4.3	< 2.7	< 4.7
H-3	< 290	< 230	< 230	< 230	< 230	< 230	< 230

* 1.96σ (Due to counting statistics.)

Figure II.D.1

I-131 Concentrations in Milk at Site A-22



II.E. Food Products

Food sampling locations were selected from areas possibly irrigated by surface water downstream of the FSV discharge point or by well water from the aquifer most likely to be contaminated by seepage from the farm pond. The locations of these food product collection sites are described in Table III.B.1. One sample of each principal class of food products was collected from these locations. Locations and available produce often change due to owner needs, harvest time, harvest size, etc.

Each sample is homogenized without drying immediately after collection. The sample is then counted by gamma-ray spectroscopy. Table II.E.1 lists the results for the 1987 harvest. No significant activity of any of the principal radionuclides was observed. The gamma-ray spectra were scanned for other radionuclides, but only the naturally occurring were observed, presumably due to surface soil deposits.

Table II.E.1 Radionuclide Concentrations in Food Products (pCi/kg).

Collection Date: September 10, 1987

Location	Food Type	I-131	Cs-134	Cs-137
R-13	Corn	< 2.5	< 2.6	3.3 (3.7)*
R-13	Carrots	< 8.9	< 5.1	6.9 (7.9)
A-30	Zucchini	< 2.9	< 3.1	< 3.5
A-29	Cucumber	< 9.4	< 9.6	< 13
A-27	Zucchini	< 1.1	11 (12)	13 (14)
A-31	Cabbage	< 9.9	< 9.4	< 14
A-31	Brocolli	< 20	< 19	< 22
A-9	Watermelon	< 2.5	< 2.3	4.4 (4.1)
R-13	Tomato	< 2.2	< 2.3	4.5 (3.1)
A-23	Cucumber	< 2.1	< 1.9	2.9 (2.7)
A-31	Cauliflower	3.7 (3.4)	< 2.8	7.9 (4.8)
R-13	Turnips	5.8 (6.3)	< 3.6	<4.5

* 1.96σ (Due to counting statistics.)

II.F. Aquatic Pathways

Table II.F.1 shows radionuclide concentrations measured in fish samples collected at F-19, A-25 and R-10 on two dates in 1987. The fish were collected by netting and the composite sample was homogenized without cleaning and analyzed on a wet weight basis. The occasional positive values are considered to be methodological fluctuation (false positives). During the second half of 1987 fish collection efforts at R-10 were unsuccessful. Repeated sampling was conducted but no fish could be collected before the ice set in. Since no detectable activity was observed in fish at A-25, in the effluent pathway, it can be concluded that no activity could be present further downstream. Collection problems have been remedied for 1988.

Table II.F.2 shows the measured concentrations of both Cs-137 and Cs-134 in surface sediment collected at R-10, the downstream location. There was measurable activity of radiocesium clearly due to the Chernobyl fallout. The cesium ions are bound nearly irreversibly by the clay mineral matrix in the sediment.

Monitoring for Corbicula Fluminea, a species of freshwater clam, was conducted at all fish sampling sites. These monitoring dates coincided with the fish collection dates. Corbicula have been introduced to North America from Asia. The freshwater clams are now found in large river systems in the U.S. from coast to coast. The Colorado Division of Wildlife has stated that Corbicula have been found in Northern Colorado at Boyd Lake, some 30 miles from the Fort St. Vrain Nuclear Generating Station. However, to this date, our samplings have indicated no evidence of Corbicula in any of the sampling sites of the reactor surface water courses.

Table II.F.1 Radionuclide Concentrations in Fish. (pCi/L), 1987.

Collection Date:	First Half			Second Half		
Radionuclide	Upstream F-19	Effluent A-25	Downstream R-10	Upstream F-19	Effluent A-25	Downstream R-10
Cs-134	< 4.2	< 4.3	< 4.8	< 7.4	< 7.0	**
Cs-137	< 5.0	< 5.2	< 5.4	< 8.6	< 8.2	**
Co-58	< 3.9	< 4.0	< 4.2	< 16	< 6.5	**
Mn-54	< 4.2	< 4.2	< 4.6	< 7.3	< 6.7	**
Zn-65	< 11	12 (13)	< 12	< 2.4	< 17	**
Fe-59	< 6.8	13 (13)*	< 7.7	< 13	< 12	**
Co-60	< 4.5	< 4.6	< 5.1	< 8.2	< 7.4	**

* 1.96 σ (Due to counting statistics.)

** Sample unavailable.

Table II.F.2 Radionuclide Concentrations in Sediment from Location R-10. (pCi/L), 1987.

Radionuclide	First Half April 11	Second Half August 29
Cs-134	41 (25)	15 (13)
Cs-137	230 (27)	130 (13)

* 1.96σ (Due to counting statistics.)

II.G. Sample Crosscheck Program

To assure the accuracy and precision of the environmental data obtained from the radiation surveillance program provided for the Fort St. Vrain reactor, Colorado State University participates in a number of interlaboratory and intralaboratory quality assurance programs. The U.S. Environmental Protection Agency (EPA) sponsored laboratory intercomparison studies program is the principal crosscheck. This involves the analysis of a variety of environmental media containing various levels of radionuclides. The media, type of analysis and frequency of analysis for the EPA program are summarized below.

Medium	Analysis (radionuclide)	Frequency
Water	H-3	Triannually
Water	Gross beta, gross alpha	Bimonthly
Water	Co-60, Zn-65, Cs-134, Cs-137	Triannually
Water	I-131	Semiannually
Air particulate filters	Cs-137, gross beta, gross alpha	Semiannually
Milk	I-131, Cs-137	Triannually

For each radionuclide analysis of a particular medium, three independent measurements are performed and all results are reported to the EPA.

Table II.G.1 gives the EPA crosscheck data for 1987. The EPA uses the term, Estimated Laboratory Precision (ELP), calculated as one standard deviation for one determination. The normalized deviation of our mean from the known is calculated as:

$$\frac{\text{CSU mean value - EPA known value}}{\sigma\sqrt{n}}$$

Where: σ = standard ueviation of the mean of all participating laboratory results

n = number of analyses by our laboratory, normally n=3

The control limit is determined by the mean range of all results and three standard deviations of the range. If any result exceeds two standard deviations from the mean (warning level), the result is unacceptable. Whenever our mean value falls outside this limit, the calculations are rechecked and the sample reanalyzed if possible. During 1987 all results except 10 were within the warning level. The results exceeding the warning level have the notation (n) in Table II.G.1. The corrected values are shown in the table. The recheck process and conclusion are given below for these samples.

1. A recalibration resulted in revised counting yields that produced acceptable accuracy.
2. One result of the three determinations was concluded to be an "outlier" (systematic error) and omitted.
3. Dilution procedures were improperly conducted.

Table II.G.2 lists independent results for H-3 in water samples split between this laboratory and the Colorado Department of health, Radiation Control Division and the laboratory at the Fort St. Vrain Generating Station. The comparison between laboratories was acceptable.

Table II.G.3 lists the results of gross beta analyses of the split water samples. Currently, procedural differences between the laboratories are being investigated for the discrepancy.

Table II.G.4 shows results of an intralaboratory crosscheck program. Replicate samples are independently analyzed. The replicate results are not statistically different and imply that the precision of the methods is acceptable.

Table II.G.1 EPA Cross-Check Data Summary. 1987

Date	Radio nuclide	CSU Value	EPA Value	1 E.L.P.*	Normalized Deviation from known**
			WATER TRITIUM		
Feb 13	H-3	3800	4209	421	- 1.40
Jun 12	H-3	2700	2895	357	- 1.10
Oct 16	H-3[1]	4194	4492	449	- 1.15
			WATER		
Jan 23	alpha[1]	13	11	5	+ 0.46
	beta [1]	9	10	5	- 0.34
Mar 20	alpha[2]	7	3	5	+ 1.03
	beta [2]	11	13	5	- 0.86
May 22	alpha	3	11	6	- 2.88
	beta	7	7	5	0.0
Jul 24	alpha	4	5	5	- 0.23
	beta	5	5	5	0.0
Sep 18	alpha	3	4	5	- 0.23
	beta	11	12	5	- 0.35
Nov 20	alpha	5	7	5	- 0.69
	beta	16	19	5	- 0.92
			WATER I-131		
Apr 9	I-131	7.67	7	0.70	+ 1.65
Aug 7	I-131	53	48	6	+ 1.44
Dec 4	I-131	25	26	6	- 0.38
			PERFORMANCE		
Oct 21	alpha	21	28	7	- 1.73
	beta	66	72	5	- 2.19
	Co-60	17	16	5	+ 0.35
	Cs-134	15	16	5	- 0.46
	Cs-137	28	24	5	+ 1.39

* E.L.P. = Expected laboratory precision.

** Normalized deviation = (CSU mean - EPA known)/($\sigma / \sqrt{n}$), if this value falls between upper & lower warning levels, the accuracy is acceptabl^.

Table II.G.1 EPA Cross-Check Data Summary. 1987.

Date	Radio nuclide	CSU Value	EPA Value	1 E.L.P.*	Normalized Deviation from known**
			WATER		
Feb 6	Co-60[3]	395	50	5	
	Zn-65[3]	682	91	5	
	Ru-106[3]	622	100	5	
	Cs-134[3]	429	59	5	
	Cs-137[3]	646	87	5	
Jun 5	Cr-51	39	41	5	- 0.81
	Co-60	63	64	5	- 0.46
	Zn-65	11	10	5	+ 0.23
	Ru-106	71	75	5	- 1.38
	Cs-134	35	40	5	- 1.73
	Cs-137	92	80	5	+ 4.27
Oct 9	Cr-51	63	70	5	- 2.31
	Co-60	14	15	5	- 0.46
	Zn-65	37	46	5	- 3.00
	Ru-106	49	61	5	- 4.27
	Cs-134	23	25	5	- 0.81
	Cs-137	51	51	5	- 0.12
			MILK		
Feb 27	I-131	9	9	0.90	+ 0.00
Jun 26	I-131	62	59	6	+ 0.96
	Cs-137	71	74	5	- 1.15
	K	1653	1525	76	+ 2.92
			AIR FILTER		
Apr 10	Alpha	12	14	5	- 0.58
	Beta	44	43	5	+ 0.46
	Cs-137	10	8	5	+ 0.69
Aug 28	Alpha	8	10	5	- 0.69
	Beta	29	30	5	- 0.35
	Cs-137	13	10	5	+ 1.15

* E.L.P. = Expected laboratory precision.

** Normalized deviation = (CSU mean - EPA known)/($\sigma/\sqrt{n}$), if this value falls between upper & lower warning levels, the accuracy is acceptable.

Table II.G.2
Tritium Crosscheck Analyses on Split Water Samples Determined by Colorado State University, Colorado Department of Health, and Public Service Company. 1987

Collection Date	Sample Location	Tritium Concentrations pCi/L CSU	CDH	PSC
Jan 10	A-25	330 (280)	816 (181)	875 (430)
Jan 10	A-21	< 240	< 350	< 347
Jan 5	E-41	< 240	< 350	< 347
Feb 14	A-25	800 (360)	691 (186)	1450 (423)
Feb 14	A-21	< 240	< 350	596 (410)
Feb 2	E-41	< 240	355 (182)	833 (414)
Mar 14	A-25	8600 (370)	9814 (269)	9510 (544)
Mar 14	A-21	< 230	< 350	< 346
Mar 16	E-41	< 230	< 350	< 346
Apr 11	A-25	2000 (303)	2005 (196)	2590 (443)
Apr 11	A-21	< 240	< 350	< 337
Apr 6	E-41	260 (280)	< 350	< 337
May 16	A-25	7900 (360)	7674 (244)	7970 (522)
May 16	A-21	< 270	< 350	< 337
May 11	E-41	260 (280)	< 350	< 344
Jun 12	A-25	10,000 (380)	*	12,000 (575)
Jun 12	A-21	< 270	*	< 349
Jun 8	E-41	< 270	*	< 349

* Data not received from Colorado Department of Health.

Table II.G.2
Tritium Crosscheck Analyses on Split Water Samples Determined by Colorado State University, Colorado Department of Health, and Public Service Company. 1987

Collection Date	Sample Location	Tritium Concentrations pCi/L CSU	CDH	PSC
Jul 10	A-25	24,000 (500)	18,789 (341)	26,000 (712)
Jul 10	A-21	< 230	154 (178)	508 (409)
Jul 6	E-41	< 230	342 (180)	377 (407)
Aug 8	A-25	5600 (340)	6,226 (229)	5980 (488)
Aug 8	A-21	< 230	234 (167)	< 335
Aug 10	E-41	< 230	192 (166)	< 335
Sep 12	A-25	1100 (290)	828 (175)	1160 (416)
Sep 12	A-21	< 230	313 (169)	< 332
Sep 7	E-41	1200 (290)	1,738 (186)	958 (413)
Oct 10	A-25	4300 (300)	318 (170)	3300 (456)
Oct 10	A-21	< 230	-12 (167)	< 339
Oct 5	E-41	44000 (610)	40,839 (462)	43100 (852)
Nov 14	A-25	390 (280)	537 (172)	985 (419)
Nov 14	A-21	< 230	87 (167)	584 (413)
Nov 2	E-41	< 230	104 (167)	< 346
Dec 19	A-25	21000 (590)	28,208 (393)	29700 (752)
Dec 19	A-21	< 410	303 (170)	< 341
Dec 7	E-41	940 (430)	-43 (166)	< 341

Table II.G.3
Gross Beta Crosscheck Analyses on Split Water Samples Determined by Colorado State University, Colorado Department of Health, and Public Service Company. 1987

Collection Date	Sample Location	Gross beta Concentrations pCi/L CSU	CDH	PSC
Jan 10	A-25	7.4 (5.4)	13 (4)	< [illegible].54
Jan 10	A-21	7.8 (5.4)	7 (4)	10.20 (8.75)
Jan 5	E-41	11 (5.6)	10 (4)	12.90 (8.96)
Feb 14	A-25	8.1 (5.4)	12 (4)	12.00 (9.37)
Feb 14	A-21	1.7 (5.1)	9 (4)	8.92 (9.21)
Feb 2	E-41	19 (5.9)	14 (4)	15.40 (9.76)
Mar 14	A-25	7.0 (5.3)	11 (4)	11.40 (8.33)
Mar 14	A-21	3.5 (5.2)	13 (4)	15.60 (8.84)
Mar 16	E-41	5.6 (5.3)	16 (4)	13.10 (8.58)
Apr 11	A-25	5.1 (5.3)	11 (4)	18.30 (9.61)
Apr 11	A-21	7.9 (5.4)	12 (4)	8.56 (8.79)
Apr 6	E-41	4.0 (5.2)	10 (4)	19.10 (9.68)
May 16	A-25	4.4 (5.2)	12 (4)	8.71 (7.99)
May 16	A-21	5.3 (5.2)	< 5	11.00 (8.13)
May 11	E-41	4.8 (5.2)	7 (4)	9.78 (8.01)
Jun 12	A-25	2.2 (5.0)	*	11.50 (9.37)
Jun 12	A-21	8.2 (5.3)	*	< 6.97
Jun 8	E-41	< 4.1	*	< 6.89

* Data not received from Colorado Department of Health.

Table II.G.3
Gross Beta Crosscheck Analyses on Split Water Samples Determined by Colorado State University, Colorado Department of Health, and Public Service Company. 1987

Collection Date	Sample Location	Gross beta Concentrations pCi/L CSU	CDH	PSC
Jul 10	A-25	3.8 (2.1)	6 (4)	< 6.47
Jul 10	A-21	6.3 (2.2)	11 (4)	16.10 (9.58)
Jul 6	E-41	3.9 (2.1)	15 (5)	13.30 (9.41)
Aug 8	A-25	11 (5.3)	13 (4)	11.60 (8.59)
Aug 8	A-21	12 (5.3)	3 (4)	17.40 (9.30)
Aug 10	E-41	6.0 (5.0)	11 (4)	13.90 (8.93)
Sep 12	A-25	5.7 (5.1)	10 (4)	8.14 (8.21)
Sep 12	A-21	5.3 (4.1)	9 (4)	11.10 (8.57)
Sep 7	E-41	5.6 (5.1)	10 (4)	13.00 (8.63)
Oct 10	A-25	11 (5.0)	14 (4)	10.70 (9.39)
Oct 10	A-21	5.9 (5.1)	15 (4)	12.10 (9.60)
Oct 5	E-41	36 (18)	14 (4)	13.80 (9.81)
Nov 14	A-25	8.5 (5.3)	8 (4)	< 6.39
Nov 14	A-21	7.9 (5.2)	13 (4)	7.66 (8.47)
Nov 2	E-41	11 (5.4)	8 (4)	19.90 (9.70)
Dec 19	A-25	5.8 (5.1)	14 (4)	13.30 (8.84)
Dec 19	A-21	11 (5.3)	10 (4)	11.80 (8.78)
Dec 7	E-41	11 (5.3)	13 (4)	15.30 (9.01)

Table II.G.4 Intralabatory Crosheck Results, (pCi/L) 1987.

Drinking Water (R-6)								
Radio-	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter	
Nuclide	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
Cs-134	< 2.6	2.8 (2.9)	< 2.5	< 2.4	< 2.0	< 2.3	< 1.8	< 2.8
Cs-137	< 3.3	< 3.0	< 3.0	3.7 (3.4)	< 2.4	3.6 (3.5)	4.9 (3.2)	< 3.4
Zr-95	< 6.2	< 6.2	< 6.0	< 5.5	< 5.0	< 5.9	< 4.3	< 6.4
Nb-95	< 2.3	< 2.3	< 2.3	< 2.2	< 1.8	< 2.2	< 1.6	< 2.6
Co-58	< 2.4	< 2.3	< 2.3	< 2.2	< 1.8	< 2.3	< 1.7	< 2.9
Mn-54	< 2.7	< 2.4	< 2.4	< 2.4	< 2.0	3.1 (2.8)	< 1.8	< 2.9
Zn-65	< 6.2	< 5.8	< 5.7	< 5.3	< 4.7	< 5.6	< 4.4	< 6.6
Fe-59	< 6.2	< 6.4	< 5.8	< 5.6	< 5.2	< 6.0	< 4.5	< 6.8
Co-60	< 2.8	< 2.6	< 2.6	< 2.6	< 2.1	< 2.6	< 1.8	< 3.0
Ba-140	< 4.3	< 4.0	< 3.9	< 6.0	< 3.2	< 3.8	< 4.3	< 4.5
La-140	< 5.0	< 4.6	< 4.5	< 6.9	< 3.6	< 4.4	< 5.0	< 5.2
Gross Beta	4.1 (2.2)*	1.0 (2.1)	2.6 (2.2)	3.9 (2.2)	4.1 (2.1)	5.7 (2.1)	5.9 (2.3)	5.1 (2.2)
H-3	< 240	< 230	< 230	< 230	< 230	< 230	< 230	< 230

Milk (A-23)								
	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter	
	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
Cs-134	< 2.4	< 2.3	4.7 (3.5)	< 2.7	< 4.1	< 1.8	< 3.9	< 2.8
Cs-137	6.8 (4.1)*	5.6 (4.2)	9.5 (4.3)	8.6 (3.9)	< 4.9	2.1 (2.6)	< 5.7	< 2.7
Ba-140	< 3.4	< 3.3	< 4.5	6.2 (5.5)	< 6.4	< 2.9	< 6.4	< 4.1
La-140	< 3.9	< 3.8	< 5.2	7.1 (6.3)	< 7.3	< 3.3	< 7.4	< 4.7
H-3	< 240	< 230	< 230	< 230	< 230	< 230	< 230	< 230

* 1.96 σ (Due to counting statistics.)

II.H. Summary and Conclusions

Table II.H.1 summarizes the radiation and environmental radioactivity measurements conducted during 1987 in the environs of the Fort St. Vrain Nuclear Generating Station, owned and operated by Public Service Company of Colorado. The values for each sample type may be compared to pre-operational and operational periods for this reactor, as well as to the values from other U.S. reactor monitoring programs. It must be emphasized, however, that the mean values in Table II.H.1 are only the means of the values greater than MDC, the statistically minimum detectable concentration. The range also is given only for detectable measurements. The mean and range values, therefore, are not the true means or ranges if any of the values in the sample population were less than MDC. The format of Table II.H.1 is a requirement of the NRC.

Inspection of Table II.H.1 reveals that there were no individual measurements except those due to release from Denver hospitals that exceeded the Reporting Level (RL) (see Table III.A.3). The Chernobyl fallout was observable in only a few sample types.

For the category of gross beta concentrations in drinking water, the mean for the Gilcrest well was again significantly greater than for the reference supply located in Fort Collins. This difference cannot be due to reactor effluent activity for the following reasons:

a. None of the individual fission product or activation product radionuclides measured were significantly higher in the Gilcrest drinking water.

b. Tritium concentrations measured at Gilcrest were statistically the same as those in Fort Collins. Tritium is the only significant radionuclide measured in the air or water effluent from FSV. Since it is far more mobile than any of the specific radionuclides, if in the unlikely event that effluent activity were reaching the Gilcrest aquifer, elevated tritium concentrations would be the first and most sensitive indicator.

c. The city of Gilcrest does not filter and treat its water to the same degree as Fort Collins. This has been verified and evidenced by the fact that the gamma-ray spectra of the suspended solids from Gilcrest water samples show elevated natural radionuclides. It has been concluded in previous reports that the elevated gross beta concentrations in Gilcrest water are due to elevated concentrations of the naturally occurring U-238, and Th-232 decay products. The suspended solids are higher in Gilcrest water samples due to less filtration of the water.

For the category of tritium in surface water, as has been the case since reactor operation, elevated concentrations were noted at station A-25, the outlet of the (Goosequill) farm pond. This, of course, is directly in the principal effluent route and should be expected. Elevated concentrations of tritium have never been observed. however, in any human food source in direct or indirect contact with the farm pond water. Downstream surface water concentrations of tritium have occasionally been elevated, but there is significant dilution before any human use of this water. During 1987 elevated tritium concentrations were observed downstream on several occasions but the mean values for the first and second half of 1987 were not significantly greater than in upstream surface water. An historical summary of tritium concentration in upstream, downstream and potable surface water for six month periods from 1974 to 1987 is depicted in Figure II.C.1. The potable water concentrations plotted are those for the Gilcrest city water well.

I-131 was observed again in milk samples from Dairy A-22. Because the reactor did not release any significant fission products during 1987, the source of the I-131 concentrations in milk could not be reactor effluent. It was noted in the 1985 annual report that the source of the I-131 concentrations during that year was not due to the reactor but due to nuclear medicine use and release upstream of the reactor. This was an important observation as I-131 is certainly a critical radionuclide in human dose commitment possibilities, a fact of which the general public is aware. This discovery prompted increased monitoring for I-131. Upstream nuclear medicine releases of I-131 is, therefore, the only likely source of the I-131 observed again in milk samples during 1987.

Cs-137 and Cs-134 and other fission products were also observed in many environmental samples due to the Chernobyl fallout.

Table II.H.2 presents an additional summary of mean values for selected sample types. The sample types and radionuclides were chosen on the basis of their importance in documenting possible radiation dose to humans. Air and surface water would be the predominant environmental transport routes and drinking water and milk would be the predominant sources of radiation dose if significant radioactivity release from FSV occurred. Table II.H.2 also allows comparison to the three most recent years of operation.

The arithmetic means in Table II.H.2 were calculated for all sample results. It should be noted that the tabular data presented in the body of this report contain only positive calculated values. Any calculated values less than zero or less than the minimum detectable concentration (MDC) are listed as less than the actual MDC for that sample analysis. However, the actual result in all cases was used in the calculation for the arithmetic mean values for the period. Therefore, all values, negative as well as positive, were included. This procedure is now generally accepted and gives a proper estimate of the true mean value. Because of this procedure, however, the values listed in Table II.H.2 cannot be calculated directly from the tabular values in the report. It must be emphasized that while it is true that no sample can contain less than zero radioactivity, due to the random nature of radioactive decay, it is statistically possible to obtain sample count rates less than background and hence a negative result. It is equally true that many sample types do in fact have zero concentrations of certain radionuclides. Therefore, to obtain the correct mean value from the distribution of analytical results, all positive results must be averaged with all negative results. If the negative results were omitted, the resulting arithmetic mean would be falsely biased high.

From log-normal analysis of each data set for each 12 month period, the geometric mean and geometric standard deviations are also presented in Table II.H.2. The log-normal probability treatment is to plot all data for each sample type over the year on log-probit coordinates. The samples are ranked by increasing activity concentration and the cumulative percentage of rankings are plotted on the probit abcissa versus the activity concentration of the log ordinate. The geometric mean value, $\bar{X}_g$, is determined directly from the 50th percentile point. The geometric standard deviation is simply the slope of the line which can be calculated from the ratio between 84.1 percentile point and the

50th percentile. In a normal distribution, the arithmetic standard deviation is an additive parameter to the arithmetic mean, i.e. ($\bar{X} \pm \sigma$); whereas, in the log-normal distribution the geometric standard deviation, σ_g, is a multiplicative parameter to the geometric mean ($\bar{X}_g \div \sigma_g$). The area between $\bar{X}_g$ multiplied by σ_g and $\bar{X}_g$ divided by σ_g should contain 68% of the frequency values. With the log-normal analysis, no bias results from using either actual values or less than MDC values in estimating the geometric mean. The geometric mean is identical to the median.

From the values presented in Tables II.H.1 and II.H.2 and the tabular data of the report, the following observations and conclusions may be drawn:

1. Tritium was again the only radionuclide that was detected in significant concentrations in any of the effluent pathways that could be attributed to reactor operation. Since the tritium is released as tritiated water, the dilution by the surrounding hydrosphere is great. Although in 1987 a few elevated levels of tritiated water could be detected in downstream surface water samples, the mean values of downstream surface and Gilcrest drinking water were not statistically greater than upstream concentrations. The tritium concentrations measured in milk produced by the nearest dairy herd were also all less than MDC.
2. Figure II.C.1 is a plot of tritium measured in surface water samples over the period 1974-1987. During the period the predominant source term is that of fallout deposition. There is some delay period in the peaks due to the mean residence

time of tritium in the hydrosphere and input from other areas. Beginning in 1981, an increase can be observed in the downstream locations relative to upstream. This small increase is statistically significant, however, the radiation dose commitment that can be calculated as a result of possible ingestion of this as drinking water was found to be negligible as compared to natural background radiation dose rates. This was discussed in the 1986 annual report.

3. As in every previous report, it was again apparent that for most sample types the variability observed around the mean values was great. This variability is due to counting statistics and methodological variation, but principally due to true environmental variation (often termed sampling error). It must be recognized and accounted for in analysis of any set of environmental data before meaningful conclusions can be drawn.

4. The Chernobyl accident fallout has totally obscured what fission product debris has remained in the FSV environs from the October 1980 Chinese atmospheric nuclear weapon test. The biosphere will contain the Chernobyl fallout for an equally long period. Nuclear weapon test fallout has since the inception of the project been noted to be the predominant source term above natural background. It is the variation in fallout deposition, in addition to the variation in naturally occurring radionuclides, that mandates the large number of environmental samples to detect any possible radioactivity due to reactor effluents. A simple comparison of pre-operational and operational values is of little value for most sample types

because the fallout deposition was considerably greater during the pre-operational period.

5. The prompt and sensitive detection of the Chinese weapon test and Chernobyl fallout in the past assures that the environmental monitoring program is of adequate scope and sensitivity to detect any accidental releases from the FSV reactor operation. It can be concluded from the data collected by the environmental monitoring program that the radiation dose commitments calculated for the closest inhabitants or other parts of the nearby ecosystems due to current reactor effluents are negligible. Natural background radiation and the dose commitment from atmospheric fallout are the only known significant sources of radiation dose to the residents of the area.

TABLE II.H.1 Environmental Radiological Monitoring Program Annual Summary

Fort St. Vrain Nuclear Generating Facility, Platteville, Colorado

Medium or Pathway Sampled (Unit of measurement)	Type and Total Number of Analysis Performed	Facility Locations Mean (f)[b] range	Adjacent Locations Mean (f)[b] range	Locations with Highest Annual Mean: Name, Distance & Direction	Locations with Highest Annual Mean: Mean(f)[b] Range	Reference Locations Mean (f)[b] Range	Number of Nonroutine Reported Measurements
Direct Radiation (mR/day)	TLD (164)	0.43(72/72) (0.36-0.52)	0.44 (72/72) (0.32-0.56)	A-10 old FSV School 7.8 km 215°	0.52 (4/4)	0.43 (20/20) (0.34-0.49)	0
Air, Particulates fCi/m^3	Gross β (354)	26.4(202/206) (4.0-62)	27.0 (49/52) (8.6-62)	F-7 Intersection of CR21 & CR34 1.5 km 170°	28 (52/52)	25.1 (152/156)	0
	Gamma Spectrometry						
	Cs-134 (28)	<2.7 (0/16)		R-4 Longmont Dairy store 20.5 km 250°	1.6 (1/4)	1.6 (1/4)	0
	Cs-137 (28)	2.8 (3/16) (2.2-3.5)		F-7 Farm at intersection of CR21 & CR34 1.5 km 160°	3.5 (1/4)	2.9 (1/4)	0
Air, Atmospheric water vapor (pCi/L)	H-3 (356)	450 (27/48) (1000-250)		A-19 Hunting cabin Goosequill 1.7 km 5°	466 (13/51) (1000-270)	354 (11/152) (230-580)	0
Air, Charcoal (pCi/m^3)	I-131 (357)	31 (5/205) (14-40)		R-3 CSU Dairy W. Drake Rd. FtCollins 45 km 330°	42 (1/62)	24 (6/152) (3.7-42)	0

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Milk	H-3 (119)		301 (7/102) (230-390)	A-23 Leroy Odenbaugh Dairy 4.1 km 90°	390 (1/17)	380 (1/17)	0
	Gamma Spectrometry						
	I-131 (119)		2.0 (13/102) (.45-5.5)	A-22 Percy Odenbaugh Dairy 3.2 km 90°	2.7 (7/17)	<0.40 (0.17) (.68-5.5)	0
	Cs-134 (119)		3.8 (16/102) (1.7-6.8)	A-26 L&F Dairy E.of Rd.13 on Rd. 32 7.8 km 255°	4.6 (5/17) (3.0-6.8)	3.6 (3/17) (2.9-5.0)	0
	Cs-137 (119)		6.5 (45/102) (2.0-20)	A-26 L&F Dairy E.of Rd. 13 on Rd. 32 7.8 km 255°	10.1 (8/17) (2.0-20)	7.1 (6/17) (14-3.3)	0
	Ba-140 (119)		5.0 (4/102) (3.6-6.0)	A-26 Hendrickson Dairy 13278 Rd. 32 7.1 km 115°	6.0 (1/17)	<6.3 (0/17)	0
	La-140 (119)		5.9 (4/102) (4.9-6.9)	A-6 Hendrickson Dairy 13278 Rd. 32 7.1 km 115°	6.9 (1/17)	<7.2 (0/17)	0

TABLE II.H.1 Environmental Radiological Monitoring Program Annual Summary
Fort St. Vrain Nuclear Generating Facility, Platteville, Colorado

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Drinking water (pCi/L)	Gross β (52)	5.0 (26/26) (2.2-10)		R-6 Gilcrest City water 9.3 km 60°	5.0(26/26) (2.2-10)	0.83(25/26) (0.47-2.0)	0
	H-3 (52)	424 (5/26) (260-610)		R-6 Gilcrest City water 9.3 km 60°	424(5/26) (260-610)	350(2/26) (250-450)	0
Gamma Spectrometry							
	I-131 (52)	0.51 (1/26)		R-3 FtCollins City water 45 km 330°	(0.52(2/26) (0.41-0.63)	0.52(2/26) (0.41-0.63)	0
	Cs-134 (52)	< 3.7 (0/26)		R-3 FtCollins City water 45 km 330°	2.6 (2/26) (2.5-2.7)	2.6 (2/26) (2.5-2.7)	0
	Cs-137 (52)	5.4 (9/26) (2.5-9.5)		R-6 Gilcrest City water 9.3 km 60°	6.4 (9/26) (2.5-9.5)	3.8 (7/26) (2.0-7.0)	0
	Zr-95 (52)	8.4 (1/26)		R-6 Gilcrest City water 9.3 km 60°	8.4 (1/26)	<0.9 (0/26)	0
	Nb-95 (52)	5.3 (1/26)		R-6 Gilcrest City water 9.3 km 60°	3.4 (7/26) (1.8-8.0)	3.4 (7/26) (1.8-8.0)	0
	Co-58 (52)	< 3.5 (0/26)		R-3 FtCollins City water 45 km 330°	4.4 (1/26)	4.4 (1/26)	0

TABLE II.H.1 Environmental Radiological Monitoring Program Annual Summary

Fort St. Vrain Nuclear Generating Facility, Platteville, Colorado

Medium or Pathway Sampled (Unit of measurement)	Type and Total Number of Analysis Performed	Facility Locations Mean (f)[b] range	Adjacent Locations Mean (f)[b] range	Locations with Highest Annual Mean: Name, Distance & Direction	Locations with Highest Annual Mean: Mean(f)[b] Range	Reference Locations Mean (f)[b] Range	Number of Nonroutine Reported Measurements
	Mn-54 (52)	3.7 (3/26) (3.3-4.3)		R-6 Gilcrest City water 9.3 km 60°	3.7 (3/26) (3.3-4.3)	<4.0 (0/26)	0
	Zn-65 (52)	7.6 (2/26) (6.1-9.0)		R-6 Gilcrest City water 9.3 km 60°	7.6 (2/26) (6.1-9.0)	7.4 (3/26) (6.4-9.4)	0
	Fe-59 (52)	6.7 (1/26)		R-3 FtCollins City water 9.3 km 330°	9.2 (2/26) (8.4-9.9)	9.2 (2/26) (8.4-9.9)	0
	Co-60 (52)	2.1 (1/26)		R-3 FtCollins City water 9.3 km 330°	4.6 (4/26) (2.7-7.1)	4.6 (4/26) (2.7-7.1)	0
	Ba-140 (52)	7.3 (2/26) (6.9-7.6)		R-6 Gilcrest City water 9.3 km 60°	7.3 (2/26) (6.9-7.6)	<6.6 (0/26)	0
	La-140 (52)	8.4 (2/26) (7.9-8.8)		R-6 Gilcrest City water 9.3 km 60°	8.4 (2/26) (7.9-8.8)	<7.5 (0/26)	0

TABLE II.H.1 Environmental Radiological Monitoring Program Annual Summary

Fort St. Vrain Nuclear Generating Facility, Platteville, Colorado

Medium or Pathway Sampled (Unit of measurement)	Type and Total Number of Analysis Performed	Facility Locations Mean (f)[b] range	Adjacent Locations Mean (f)[b] range	Locations with Highest Annual Mean: Name / Distance & Direction	Locations with Highest Annual Mean: Mean(f)[b] / Range	Reference Locations Mean (f)[b] Range	Number of Nonroutine Reported Measurements
Surface water (pCi/L)	H-3 (60)	5900 (16/36) 240-29,000		A-25 Goosequill 2.2 km 20°	7700(12/12 (330-29,000)	340 (3/24) (190-560)	0
	Gamma Spectrometry						
	Cs-134 (60)	<3.7 (0/36)		--	--	3.0 (3/24) (2.2-3.9)	0
	Cs-137 (60)	4.6 (12/36) (2.7-8.0)		R-10 S.Platte at Co 60 10 km 290°	5.0 (5/12) (2.9-7.4)	5.1 (8/24) (3.2-7.8)	0
	Zr-95 (60)	12 (1/36)		R-10 S.Platte at Co 60 10 km 290°	12 (1/12)	8.9 (2/24) (7.7-10)	0
	Nb-95 (60)	3.1 (5/36) (2.0-4.6)		F-20 St.Vrain 1.5 km 340°	3.6 (2/12) (2.5-4.6)	3.2 (5/24) (2.7-3.8)	0
	Co-58 (60)	<3.5 (0/36)		--	--	3.5 (2/24) (2.7-4.2)	0
	Mn-54 (60)	3.5 (5/36) (2.5-4.8)		A-25 Goosequill 2.2 km 20°	3.7 (2/12) (2.5-4.8)	<3.8 (0/26)	0
	Zn-65 (60)	7.2 (5/36) (5.3-9.4)		F-20 St.Vrain 1.5 km 340°	8.5 (1/12)	5.5 (3/24) (1.8-8.5)	0
	Fe-59 (60)	7.8 (1/36)		R-10 S.Platte at Co 60 10 km 290°	7.8 (1/12)	8.5 (3/24) (7.9-9.2)	0
	Co-60 (60)	<4.2 (0/36)		--	--	2.2 (1/24)	0

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Fort St. Vrain Nuclear Generating Facility, Platteville, Colorado

Medium or Pathway Sampled (Unit of measurement)	Type and Total Number of Analysis Performed	Facility Locations Mean (f)[b] range	Adjacent Locations Mean (f)[b] range	Locations with Highest Annual Mean: Name, Distance & Direction	Locations with Highest Annual Mean: Mean(f)[b] Range	Reference Locations Mean (f)[b] Range	Number of Nonroutine Reported Measurements
	Ba-140 (60)	6.2 (2/36) (5.1-7.2)		R-10 S.Platte at Co 60 10 km 290°	6.2 (2/12) (5.1-7.2)	6.8 (2/24) (6.1-7.4)	0
	La-140 (60)	7.1 (2/36) (5.8-8.3)		R-10 S.Platte at Co 60 10 km 290°	7.1 (2/12) (5.8-8.3)	7.8 (2/24) (7.0-8.5)	0
Fish (pCi/kg,wet)	Gamma Spectrometry						
	Cs-134 (5)	<7.0 (0/3)		--	--	<7.4 (0/2)	0
	Cs-137 (5)	<8.2 (0/3)		--	--	<8.6 (0/2)	0
	Co-58 (5)	<6.5 (0/3)		--	--	<16 (0/2)	0
	Mn-54 (5)	<6.7 (0/3)		--	--	<7.3 (0/2)	0
	Zn-65 (5)	12 (1/3)		A-25 Goosequill Pond 2.2 km 0°	12 (1/3)	<11 (0/2)	0
	Fe-59 (5)	13 (1/3)		A-25 Goosequill Pond 2.2 km 0°	13 (1/3)	<13 (0/2)	0
	Co-60 (5)	<7.4 (0/3)		--	--	<13 (0/2)	0

TABLE II.H.1 Environmental Radiological Monitoring Program Annual Summary
Fort St. Vrain Nuclear Generating Facility, Platteville, Colorado

Medium or Pathway Sampled (Unit of measurement)	Type and Total Number of Analysis Performed	Facility Locations Mean (f)[b] range	Adjacent Locations Mean (f)[b] range	Locations with Highest Annual Mean: Name, Distance & Direction	Locations with Highest Annual Mean: Mean(f)[b] Range	Reference Locations Mean (f)[b] Range	Number of Nonroutine Reported Measurements
Ground water (pCi/L)	H-3 (8)	350 (1/4)		F-16 3 Bar Ranch 1.2 km 0°	350 (1/4)	<300	0
	Gamma Spectrometry						
	Cs-134 (8)	2.6 (1/4)		F-16 3 Bar Ranch 1.2 km 0°	2.6 (1/4)	<3.2 (0/4)	0
	Cs-137 (8)	6.4 (2/4) (4.3-8.4)		F-16 3 Bar Ranch 1.2 km 0°	8.4 (1/4)	5.9 (2/4) (3.9-7.9)	0
	Zr-95 (8)	<9.1 (0/4)		--	--	<7.9 (0/4)	0
	Nb-95 (8)	<3.7 (0/4)		--	--	<2.9 (0/4)	0
	Co-58 (8)	<3.8 (0/4)		--	--	<2.9 (0/4)	0
	Mn-54 (8)	<3.9 (0/4)		--	--	<3.2 (0/4)	0
	Zn-65 (8)	1.0 (1/4)		F-16 3 Bar Ranch 1.2 km 0°	1.0 (1/4)	9.4 (1/4)	0
	Fe-59 (8)	<9.3 (0/4)		--	--	<7.6 (0/4)	0
	Co-60 (8)	2.7 (1/4)		F-16 3 Bar Ranch 1.2 km 0°	2.7 (1/4)	<3.4 (0/4)	0
	Ba-140 (8)	<6.1 (0/4)		--	--	<5.2 (0/4)	0
	La-140 (8)	<7.1 (0/4)		--	--	<6.0 (0/4)	0

TABLE II.H.1 Environmental Radiological Monitoring Program Annual Summary
Fort St. Vrain Nuclear Generating Facility, Platteville, Colorado

Medium or Pathway Sampled (Unit of measurement)	Type and Total Number of Analysis Performed	Facility Locations Mean (f)[b] range	Adjacent Locations Mean (f)[b] range	Locations with Highest Annual Mean: Name, Distance & Direction	Locations with Highest Annual Mean: Mean(f)[b] Range	Reference Locations Mean (f)[b] Range	Number of Nonroutine Reported Measurements
Sediment (pCi/kg,dry)	Gamma Spectrometry						
	Cs-134 (2)			R-10 S.Platte at Co 60 10 km 290°	28 (2/2) (15-41)	28 (2/2) (15-41)	0
	Cs-137 (2)			R-10 S.Platte at Co 60 10 km 290°	180 (2/2) (130-230)	180 (2/2) (130-230)	0
Food Products (pCi/kg,wet)	Gamma Spectrometry						
	I-131 (12)		3.7 (1/12)	A-31 Moran Farm 19801 C.Rd. 25½ 6.9 km 45°	3.7 (1/3)	N/A	0
	Cs-134 (12)		11 (1/12)	A-27 Scottsdale Ranch 18311 Cty. Rd. 23 3.1 km 45°	11 (1/1)	N/A	0
	Cs-137 (12)		6.1 (7/12) (2.9-13)	A-27 Scottsdale Ranch 18311 Cty. Rd. 23 3.1 km 45°	13 (1/1)	N/A	0

Table II.H.2 Summary Table of Geometric Means, Geometric Standard Deviations and Arithmetic Means for Selected Sample Types.

	1984			1985			1986			1987		
	$\bar{X}g$	σ_g	$\bar{X}$	$\bar{X}g$	σ_g	$\bar{X}$	$\bar{X}g$	σ_g	$\bar{X}$	$\bar{X}g$	σ_g	$\bar{X}$
	Drinking Water (pCi/L)											
H-3												
Gilcrest	300	1.6	200	190	1.1	160	130	2.9	<240	150	2.6	75
Ft. Collins	250	2.2	76	180	1.0	<250	210	1.4	<240	210	1.7	<230
Gross Beta												
Gilcrest	7.7	1.4	8.0	4.8	1.0	5.2	3.8	1.4	4.0	4.7	1.5	5.1
Ft. Collins	1.7	2.3	2.3	1.0	1.1	1.2	1.3	1.9	1.6	0.7	1.5	.79
I-131												
Gilcrest	0.4	3.7	0.5	0.2	1.3	0.004	0.2	2.4	0.14	0.2	2.1	.052
Ft. Collins	0.3	4.1	0.5	0.2	1.0	0.077	0.2	1.7	<0.49	0.2	3.5	.071
Cs-137												
Gilcrest	2.5	3.0	1.6	1.8	1.1	1.5	2.6	2.1	1.4	1.8	2.1	2.1
Ft. Collins	4.1	2.3	2.8	1.4	1.1	1.7	2.0	3.3	1.3	1.9	3.1	1.1

Table II.H.2 Summary Table of Geometric Means, Geometric Standard Deviations and Arithmetic Means for Selected Sample Types.

	1984			1985			1986			1987		
	$\bar{X}_g$	σ_g	$\bar{X}$	$\bar{X}_g$	σ_g	$\bar{X}$	$\bar{X}_g$	σ_g	$\bar{X}$	$\bar{X}_g$	σ_g	$\bar{X}$
	Surface Water (pCi/L)											
H-3												
Effluent	8300	4.4	13000	1300	1.3	2700	7800	4.3	15000	4200	3.5	7700
Downstream	340	1.8	220	340	1.8	220	180	3.3	72	170	2.3	21
Upstream	280	2.4	140	140	2.0	<250	230	1.4	<240	160	2.3	<230
Cs-137												
Effluent	3.4	2.5	0.83	2.2	1.2	1.4	2.8	1.6	2.8	1.5	4.5	1.7
Downstream	2.8	2.5	0.57	2.2	1.1	2.1	1.8	2.5	1.7	2.2	2.7	0.01
Upstream	3.2	2.9	1.8	1.9	1.3	1.3	1.9	3.1	1.5	2.3	3.0	0.32
	Milk (pCi/L)											
H-3												
Adjacent	200	2.1	<300	170	1.1	<250	190	1.8	<240	200	1.6	<230
Reference	200	1.7	<300	190	1.1	<250	140	3.6	<240	160	2.5	<230
I-131												
Adjacent	0.75	2.3	<0.50	0.22	1.0	0.02	0.46	12	3.9	0.22	3.1	0.15
Reference	0.60	2.9	<0.50	0.21	1.1	0.47	0.68	5.9	3.8	0.14	5.2	0.02
Cs-137												
Adjacent	1.3	3.6	<9.0	2.1	1.0	1.7	5.8	3.4	11	3.1	2.3	3.2
Reference	1.1	5.3	<9.0	1.9	1.2	1.6	7.6	4.2	13	2.7	3.2	3.6

Table II.H.2 Summary Table of Geometric Means, Geometric Standard Deviations and Arithmetic Means for Selected Sample Types.

	1984			1985			1986			1987		
	$\bar{X}g$	σ_g	$\bar{X}$	$\bar{X}g$	σ_g	$\bar{X}$	$\bar{X}g$	σ_g	$\bar{X}$	$\bar{X}g$	σ_g	$\bar{X}$
	Atmospheric Water Vapor (pCi/L)											
H-3												
Facility	250	2.2	300	200	1.0	<250	220	2.1	<240	190	2.2	<230
Reference	310	2.4	260	190	1.1	<250	180	2.4	<240	190	1.9	<230
	Air (fCi/m)											
Gross Beta												
Facility	15	1.7	17	27	1.0	28	29	2.0	44	24	1.5	26
Reference	16	1.6	18	25	1.0	27	31	2.0	51	24	1.4	25
I-131												
Facility	22	3.7	< 35	11	1.1	< 43	18	2.5	14	12	2.9	1.1
Reference	22	3.4	1.1	13	1.1	< 36	16	5.5	19	12	2.9	1.2
Cs-137												
Facility	6.0	2.6	0.67	1.7	1.3	<4.4	2.5	3.3	4.1	1.3	2.6	0.33
Reference	5.9	3.0	< 30	2.1	2.1	<4.4	2.0	4.7	4.5	1.1	2.6	0.44

III. Radiological Environmental Monitoring Program

A. Sample Collection and Analysis Schedule

Table III.A.1 outlines the sampling design, the collection frequency and the type of analysis for all environmental samples. It should be repeated that this schedule was only adopted January 1, 1984, and while different in certain aspects from the previous schedule, has as its intent the same objective. That objective is to document the radiation and radioactivity levels in the critical pathways of dose to humans. Such data is necessary to prove that reactor radioactivity effluents produce environmental concentrations that are within appropriate environmental protection limits and at the same time are as low as reasonably achievable.

During 1987, R-5 is the only sampling location that was changed. The previous location was one mile South of the present location, which is described in Table III.B.1. The change was required due to the closure of the old site by the feedlot owners. All other sampling locations remained as in 1986.

Table III.B.1 gives the description of each sampling location by number, sector and distance from the reactor. These descriptions were expanded somewhat in this report. Each of these sampling locations (except certain reference locations) can be identified on scale maps (Figures III.B.1 and III.B.2). Topographical maps showing greater detail, as well as photographs of principal sampling sites are on file in the CSU laboratory.

During August of 1987 the land-use census was conducted to determine the locations of the nearest residence, the nearest milk animal, and the nearest garden producing broad leaf vegetation in each of the 16 meteorological sectors around the reactor. These locations by address are shown in Table III.C.1. Figure III.C.1 shows these locations in each sector. From the 1987 census it was verified that the closest permanent residence in Sector 16 is still the critical receptor with regards to mean annual dose commitment.

No resident in the sampling sectors up to a distance of 8 km from the plant has cows or goats used for personal milk consumption. All milk produced is transported to commercial processors. The milk produced [illegible]y is diluted by a large milk shed, processed and distribu[illegible] over a large area for consumption.

Table III.A.2 lists the LLD concentration values for each sample type and radionuclide measured in this report. These LLD values are the actual values pertinent to the samp[illegible]es, counting yields, and counting times used in the project. Typical decay periods were used in the calculations. It should be noted that the LLD values are in all cases equal to or less than those required by the technical specifications.

Table III.A.3 lists the USNRC reporting level for each sample type and radionuclide.

Table III.A.1 OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling Collection Frequency	Type and Frequency of Analysis
AIRBORNE			
Tritium Oxide Radioiodine and Particulates	Samples from seven locations:	Continuous sampler operation with sample collection weekly or as required by dust loading, whichever is more frequent.	Radioiodine Canister: Analyze weekly for I-131 liquid scintillation counting for tritium on water vapor extracted from silica gel on each sample collected.
	Four samples from off-site locations (in different sectors) of the highest calculated annual average ground level D/Q and airborne X/Q.		
	One sample from the vicinity of a community having the highest calculated annual average ground level D/Q.		Particulate Sampler: Gross beta radioactivity following filter change, composite (by location) for gamma isotopic quarterly.[a]
	Two samples from control location 15 to 30 kilometers (10 to 20 miles) distant and in the least prevalent wind direction.		
DIRECT RADIATION	Forty stations with two or more dosimeters or one instrument for measuring and recording dose rate continuously to be placed as follows: 1) an inner ring of stations in the general area of the site boundary and an outer ring in the 4 to 5 mile range from the site with a station in each sector of each ring (16 sectors x 2 rings = 32 stations). The balance of the stations, eight, shall be placed in special interest areas such as population centers, nearby residences, schools, and in two or three areas to serve as control stations.	Quarterly exposure.	Gamma dose quarterly.
WATERBORNE			
Surface	One sample upstream, each stream, one sample downstream.	Samples collected monthly.	Gamma isotopic analysis and tritium monthly.
Surface (Farm Pond)	One sample in immediate area of discharge.	Composite sample over one week period. The weekly composites will be combined for the monthly sample.	Gamma isotopic analysis and composite for tritium monthly.

[a] If gross beta activity in air or water is greater than ten times the yearly mean of control sample for any medium, gamma isotopic analysis should be performed on the individual samples.

Table III.A.1 OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling Collection Frequency	Type and Frequency of Analysis
Ground	Samples from two sources most likely to be affected.	Quarterly	Gamma isotopic and tritium.
Drinking	One sample from the nearest water supply which could be affected by facility's discharge.	Composite sample over two week period.	Composite for tritium, gross beta, and gamma isotopic analyses every two weeks.
	One sample from a control location.		
Sediment from Shoreline	One sample from downstream area with existing or potential recreational value.	Semi-annually	Gamma isotopic analyses semi-annually.
INGESTION			
Milk	Samples from milking animals in all locations, up to a total of three locations, within 5 kilometers.	Semi-monthly when animals are on pasture, monthly at other times.	Gamma isotopic and I-131 analysis semi-monthly when animals are on pasture; monthly at other times.
	One sample from milking animals in each of three areas between 5 to 8 kilometers distant having the highest dose potential. [b]		
	One sample from milking animals at a control location (15 to 30 kilometers) distant and in the least prevalent wind direction).	Semi-monthly when animals are on pasture, monthly at other times.	Gamma isotopic and I-131 analysis semi-monthly when animals are on pasture; monthly at other times.
Aquatic Biota	Sample fish in vicinity of discharge point, upstream and downstream.	Sample semi-annually.	Gamma isotopic analyses.
Food Products	One sample of each principal class of food products from any area which is irrigated by water in which liquid plant wastes have been discharges.	At time of harvest.	Gamma isotopic analyses.

[b] The dose shall be calculated for the maximum organ and age group using the methodology contained in Regulatory Guide 1.109 and the actual parameters particular to the site.

Table III.A.2 Detection Capabilities For Environmental Sample Analysis

Lower Limit of Detection (LLD)*

Analysis	Water (pCi/L)	Airborne Particulate or Gas (fCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/L)	Food Products (pCi/kg, wet)	Sediment (pCi/kg,dry)
Gross Beta	3.86	3.25				
H-3	494					
I-131	0.89	66.4		0.89	56.8	
Cs-134	5.58	8.06	19.5	4.98	44.4	90.6
Cs-137	6.68	7.86	18.5	6.14	44.6	100
Zr-95	10.12					
Nb-95	4.12					
Co-58	4.60		12.8			
Mn-54	4.68		12.7			
Zn-65	10.94		23.6			
Fe-59	8.40		31.4			
Co-60	4.40		14.5			
Ba-140	6.66			8.00		
La-140	7.66			9.16		

* As suggested in NUREG-0472. All values are at or below values listed in Table 8.2-2 of technical specifications.

Table III.A.3 REPORTING LEVELS FOR NONROUTINE OPERATING REPORTS

REPORTING LEVEL (RL)

Analysis	Water (pCi/ℓ)	Airborne Particulate or Gas (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/ℓ)	Broad Leaf Vegetation (pCi/kg, wet)
H-3	2×10^{4} (a)				
Mn-54	1×10^{3}		3×10^{4}		
Fe-59	4×10^{2}		1×10^{4}		
Co-58	1×10^{3}		3×10^{4}		
Co-60	3×10^{2}		1×10^{4}		
Zn-65	3×10^{2}		2×10^{4}		
Nb-95, Zr-95	4×10^{2}				
I-131	2	0.9		3	1×10^{2}
Cs-134	30	10	1×10^{3}	60	1×10^{3}
Cs-137	50	20	2×10^{3}	70	2×10^{3}
Ba-140, La-140	2×10^{2}			3×10^{2}	

[a] For drinking water samples. This is 40CFR Part 141 value.

Table III.B.1 Radiological Environmental Monitoring Program (continued) Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Direct Radiation	F-1	Pole by gate to Goosequill road on dirt extension of CR 21.	1	1.3
	F-2	21st pole N of ditch on dirt extension of CR 21 just before road drops down to river bottom.	2	1.1
	F-3	17th pole N of ditch on dirt extension of CR 21 or first pole N of E-W road.	3	0.7
	F-4	15th pole N of ditch on dirt extension of CR 21, S of pump road, midway between F-3 and F-5.	4	0.7
	F-5	11th pole N of ditch on dirt extension of CR 21, near drive to pump house.	5	0.6
	F-6	8th pole N of ditch on dirt extension of CR 21, by E-W concrete ditch, S of bridge.	6	0.8
	F-7	Old dairy barn, 1st pole N after crossing ditch on dirt extension of CR 21.	7	1.2
	F-8	1st pole W of pump house on N side of road 0.4 km E of CR 19½.	8	1.3
	F-9	Pole E of first shed at intersection of CR 19½ and CR 34.	9	1.5
	F-10	Pole on NW corner of intersection of dirt extension of CR 19 and 34.	10	1.5

Table III.B.1 Radiological Environmental Monitoring Program (continued) Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Direct Radiation	F-11	7th pole N of intersection of dirt extension of CR 19 with CR 34.	11	1.2
	F-12	0.5 km S of FSV Visitor Center take dirt road W across field, go into farmyard of Aristocrat Brangus. (If chain across road enter from CR 36). TLD is located on pole at SE corner of corral across from Aristocrat Brangus office.	12	1.0
	F-13	Take first dirt road S of Visitor Center. Go W across railroad tracks, follow dirt road to metal staircase going down off dike. TLD is taped to railing.	13	0.5
	F-14	2nd pole 0.1 km S intersection CR 36½ & Rd 19.	14	1.5
	F-15	2nd pole 0.7 km S of intersection of CR 38 on CR 19.	15	1.5
	F-16	Pole at NE corner of potato cellar at 3 Bar Ranch (Russell's).	1	1.2
	F-17	Visitor Center, on N end of cross beam over entrance.	13	0.2
	F-18	Pole closest to house on SW corner, 17250 CR 19½. The address of 17250 is taped to the Mountain Bell underground cable warning post.	16	0.8

Table III.B.1 **Radiological Environmental Monitoring Program (continued)**
Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Direct Radiation	A-1	Pole on NW corner of intersection of CR 44 and CR 21.	1	6.7
	A-2	Pole on NE corner intersection of CR 42 and CR 25½.	2	6.8
	A-3	Pole on NE corner of intersection of CR 42 and CO 60.	3	7.5
	A-4	1st pole NE of intersection of CR 29 and CR 38, take CR 29 E out of Gilcrest to CR 38.	4	7.4
	A-5	SE corner of CR 34 and CR 29. Taped to road sign on SW corner of intersection.	5	7.2
	A-6	Pole on S side of CR 32 near drive to dairy 13278 CR 32.	6	7.1
	A-7	Niles Miller dairy. 0.4 km E of US 85 on CR 30. TLD is located on pole at NE corner of house.	7	7.3
	A-8	On CO 66 (CR30) farm on S side of road (address 9476) Pole in front of house.	8	4.7
	A-9	Corner of CO 66 (CR 30) and CR 19, Miller produce stand. Second pole S on CR 19, on E side of road.	9	4.6
	A-10	Pole on SE corner at intersection CR 26½ & CR 15.	10	7.8
	A-11	At intersection of CO 66 and CR 13, 2nd pole N of corner.	11	7.2

Table III.B.1 Radiological Environmental Monitoring Program (continued)
Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Direct Radiation	A-12	On CR 34, pole E of house N of Lake Thomas 2 km from I-25.	12	7.2
	A-13	Pole opposite lake, N of silage pits E side of CR 13 2.9 km N of CR 34.	13	5.8
	A-14	Intersection of CR 13 and CR 40, NW corner.	14	6.9
	A-15	Intersection of CR 42 and CR 15, NW corner.	[illegible]	6.7
	A-16	Intersection of CR 44 and CR 19, SW corner.	16	6.8
	A-17	Platteville school (S edge of town on Main St.) pole on NW corner just outside school intramural field.	6	5.9
	A-20	1st pole N of white picket fence and driveway into turkey farm on S end of building that is parallel with CR 19.	9	2.5

Table III.B.1 Radiological Environmental Monitoring Program (continued)
Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Direct Radiation	R-1	Milliken School, on CR 21½. TLD is located on pole which is located at SE corner of Lola park, across the street from school.		9.3
	R-2	Johnstown School (Letford Elementary), turn left at school crossing on Idaho St. onto Joy Ave. and proceed to school. TLD is located on pole at SE corner of main entrance to school on W side of town.		10.8
	R-3	CSU dairy farm on W Drake, N of Vet Hospital, Ft. Collins, CO. Pole is E of hay barn next to railroad tracks.		45.1
	R-4	Air sampler corner US 287 and CO 66, Longmont Dairy Store. TLD is located on pole directly behind air sampler.		20.5
	R-7	Behind Gilcrest School quonset auditorium, pole on SW end of school property, just before garage.		9.3

Table III.B.1 Radiological Environmental Monitoring Program (continued)
Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Airborne	F-7	Farm at intersection of CR 21 and CR 34. Air sampler is located on west side of shop. Silica gel inside building on N end of workbench.	7	1.5
	F-9	First shed along drive at end of Rd 19½ intersection with Rd 21. Silica gel is located in shed.	9	1.5
	F-16	Potato cellar at 3 Bar Ranch (Russell's). Silica gel in mailbox on tree to S of pump.	16	1.2
	A-19	Hunting cabin between Goosequill ditch and Platte River. Air sampler is on W side of cabin, silica gel is in box on tree north of air sampler.	1	1.7
	R-3	Colorado State University Dairy, W. Drake Rd., Ft. Collins, CO. W side of shed directly N of main dairy building. Silica gel inside mailbox.		45.1
	R-4	Intersection of US 66 and US 287, E side of dairy store, north edge of Longmont. Silica gel in mailbox attached to utility pole.		20.5
	R-11	Air sampler is located in alley behind Johnstown, CO PSC office, 13712 Main St., next to garage. Silica gel is located next to air sampler in mailbox.		10.5

Table III.B.1 Radiological Environmental Monitoring Program (continued)
Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Waterborne Surface	F-19	S. Platte at dam located on dirt road E of pump house #3 directly E of reactor.	4	1.2
	F-20	St. Vrain creek on Rd. 19½ 0.3 km from discharge into St. Vrain creek. Directly N of reactor.	16	1.5
	A-21	St. Vrain creek at bridge on Rd. 34, E of Rd. 19.	11	2.4
	A-25	Goosequill Pond outlet. Continuous sampler located in green box adjacent to the green shed on the N end of the pond.	1	2.2
	R-10	S. Platte river at bridge on CO 60 where highway has just turned and headed South.		10.1
Ground	F-16	Well behind residence at 3 Bar Ranch (Russell's).	1	1.2
	R-5	Erlich feed lot, North side of CO 66 approximately 0.8 km East of WCR 25. Drive north along dirt road approximately 0.27 km to field water spigot on West side of road.		9.0
Drinking	R-3	CSU dairy W Drake Rd., Ft. Collins, CO. N of Vet Hospital. Water sample is taken from hydrant inside the entrance to the milking parlor.		45.1
	R-6	Gilcrest U.S. Post Office located on Birch St. and Rd. 40 off of Hwy 85. Water taken from utility sink inside Post Office.		9.3

Table III.B.1 Radiological Environmental Monitoring Program (continued)
Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Waterborne Sediment from Shoreline	R-10	Sediment from S. Platte River at bridge on CO 60.		10.1
Ingestion Milk	A-6	Hendrickson Dairy, 13278 Rd. 32 (Grand Ave.) 1.6 km E of US 85.	6	7.1
	A-18	Boos Dairy, 11258 W Rd. 40, W of US 85 behind modular home.	2	4.7
	A-22	Percy Odenbaugh Dairy, S on dirt rd from "Percy Odenbaugh Dairy" sign on Rd 36 E of Rd 23.	5	3.2
	A-23	Leroy Odenbaugh Dairy, 11733 Rd 36, W of Rd 25.	4	4.1
	A-24	Marostica Dairy, 20718 Rd 17, 4 miles S of CO 60.	16	6.9
	A-26	L & F Dairy (Fiechtner), E of Rd 13 on Rd 32.	11	7.8
	R-8	Arlo Johnston Farm, located off Exit 255 W of I-25 directly N of Johnson's Corner restaurant.		22.5
Fish	F-19	S. Platte at dam located on dirt Rd E of pump house #3 directly E of reactor.	4	1.1
	A-25	Goosequill pond outlet.	1	2.2
	R-10	S. Platte river at bridge on CO 60.		10.1

Table III.B.1 Radiological Environmental Monitoring Program (continued)
Sampling Site Descriptions

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Food Products	A-9	Miller Store, CR 19 and CO 66.	9	4.6
	A-23	Leroy Odenbaugh Dairy, 11733 CR 36, W of CR 25.	4	4.1
	A-27	Scottsdale Ranch, 18311 CR 23, N of CR 38.	3	3.1
	A-29	19277 CR 25, S of CR 40½.	2	5.8
	A-30	19440 CR 25½.	3	6.5
	A-31	Moran Farm, 19801 CR 25½.	2	6.9
	R-13	Richardson Truck Farm, 21210 CO 60.		9.5

Figure III.B.1

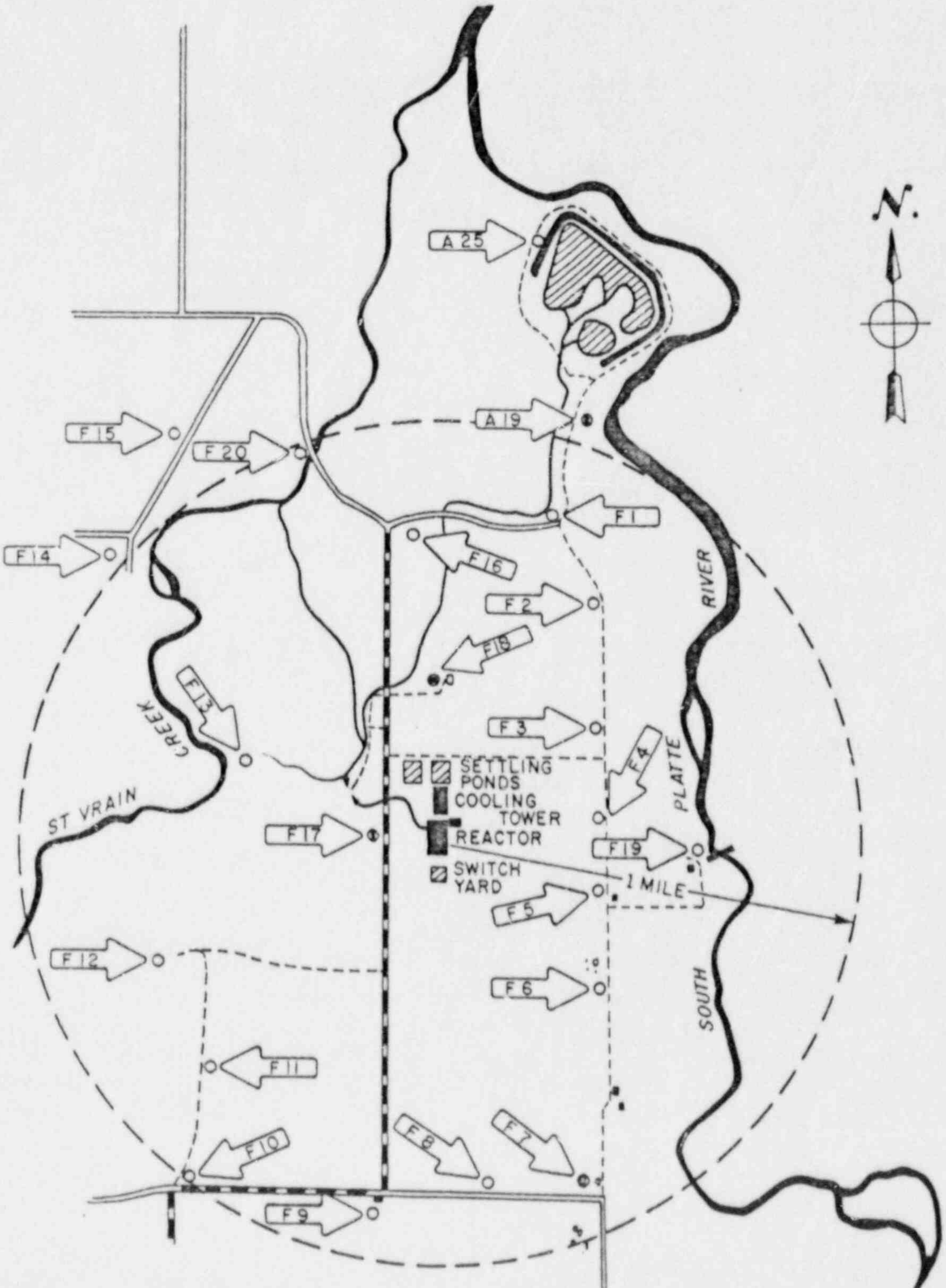


Figure III.B.2

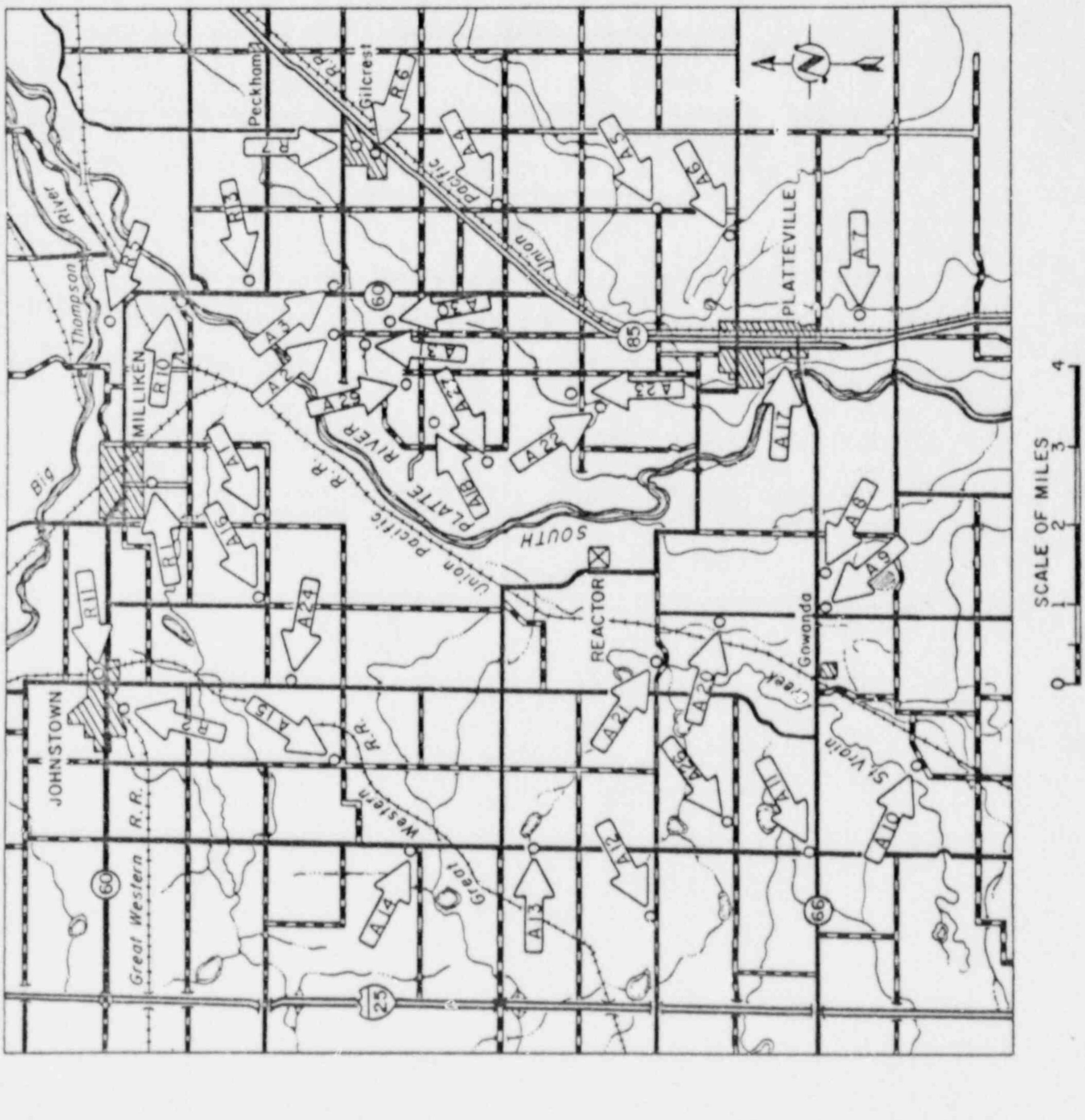


Table III.C.1 1987 Land Use Census*

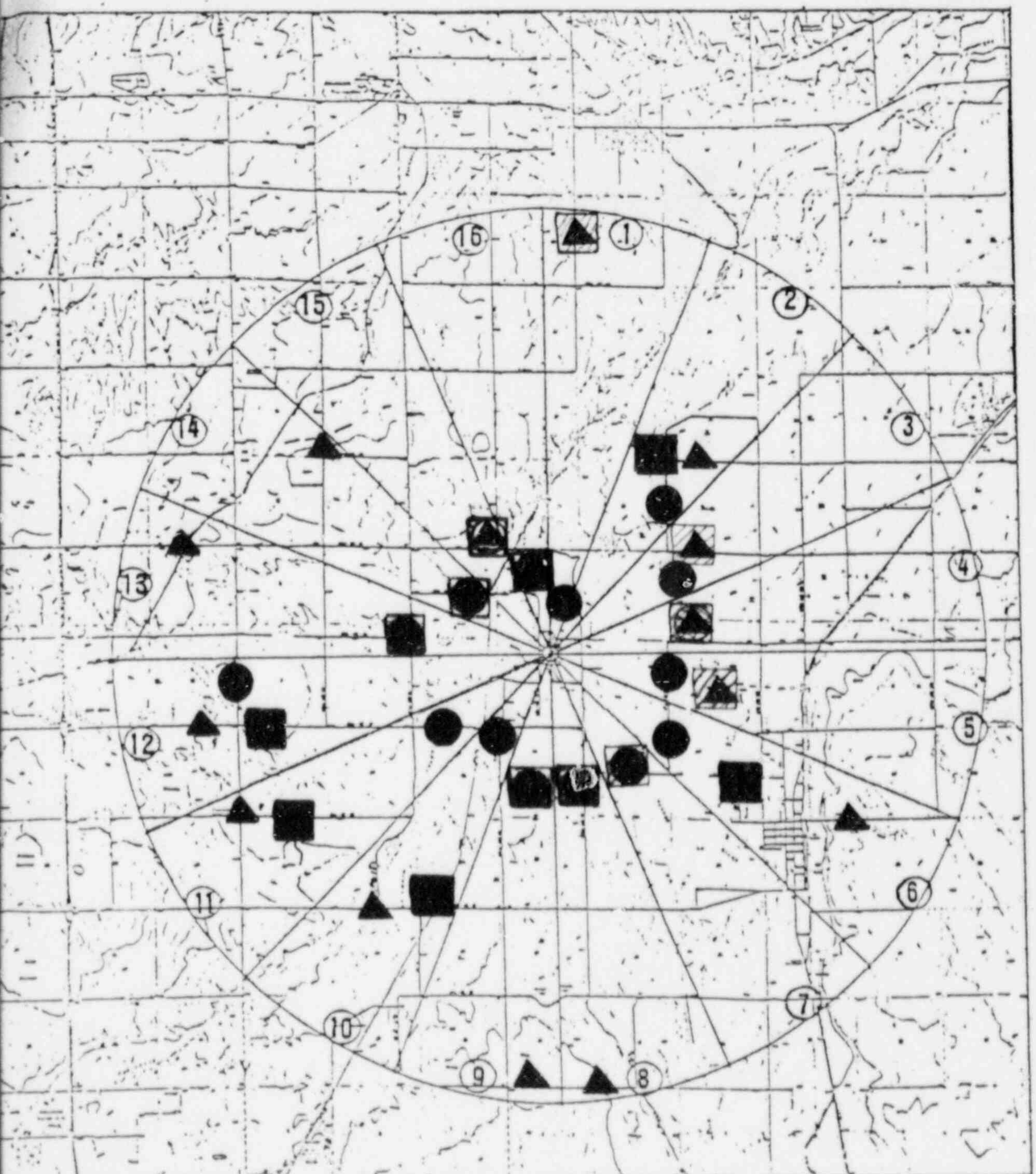
Sector	Nearest Residence	Nearest Garden	Nearest Milk Animal
1	17578 CR 19½	21692 CR 21	21692 CR 21**
2	18311 CR 23	19027 CR 23**	11248 CR 40
3	11250 CR 38	11165 CR 38**	11165 CR 38**
4	11247 CR 36	11247 CR 36**	11247 CR 36**
5	16543 CR 23**	16134 CR 23	16134 CR 23
6	16017 CR 23	11056 CR 32½	13278 CR 32
7	9999 CR 34	9999 CR 34	***
8	15225 CR 21**	15225 CR 21**	9867 CR 26
9	9434 CR 34	9434 CR 34	9033 CR 26
10	9061 CR 34	8416 CO 66**	7388 CO 66
11	8745 CR 34	6165 CR 32	15266 CR 13**
12	16465 CR 17**	5660 CR 34	5492 CR 34
13	17038 CR 17	17038 CR 17**	4709 CR 38
14	8900 CR 36½	8900 CR 36½	18426 CR 15**
15	8903 CR 38	8903 CR 38**	8903 CR 38**
16	17250 CR 19½	17250 CR 19½	***

* Census date: August 4 & 8, 1987

** New location

*** No milk animals

Figure III.C.1 Land Use Census, 1987.

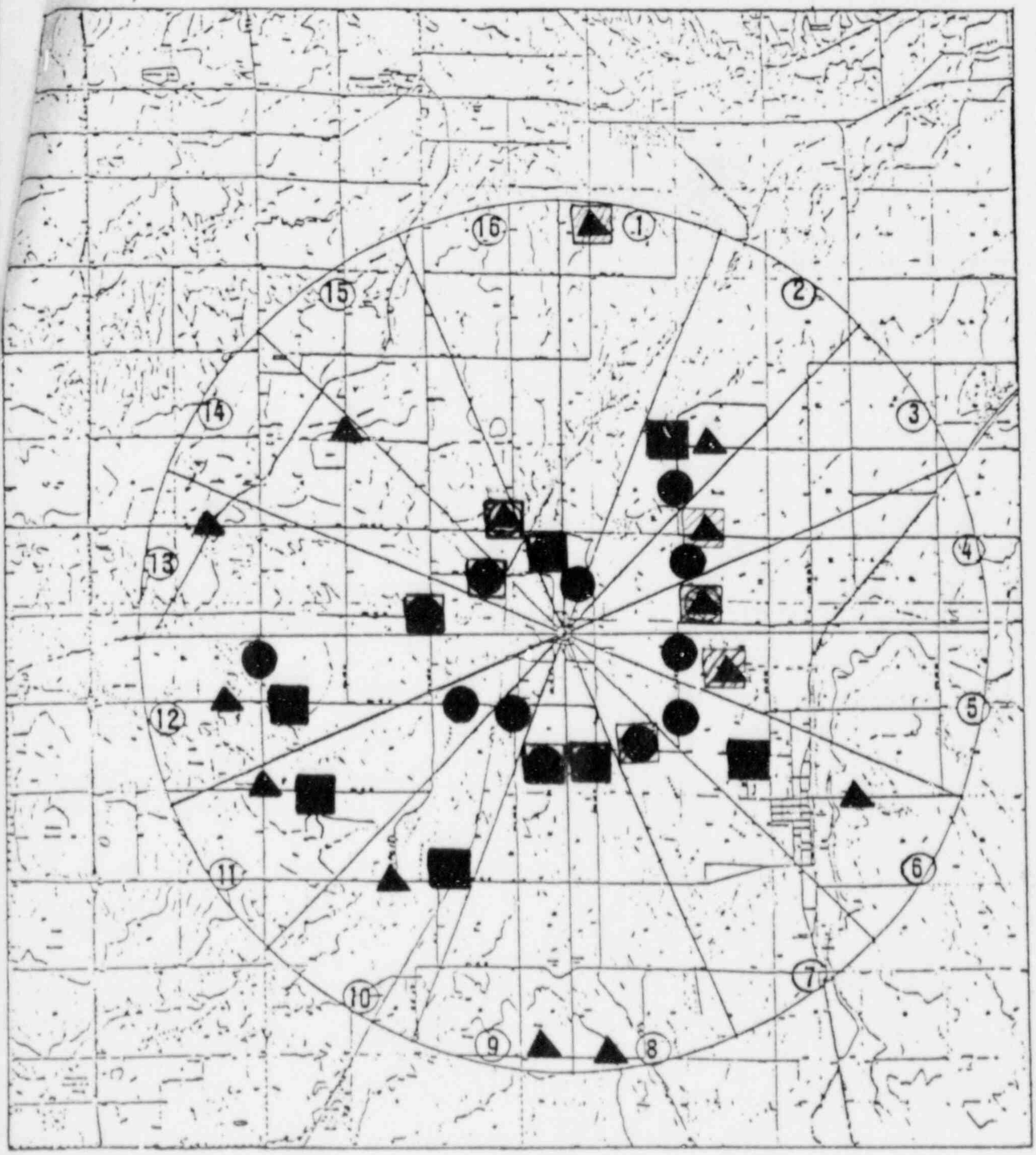


Nearest garden

Nearest residence

Nearest milk animal

ure III.C.1 Land Use Census, 1987.



Nearest garden

Nearest residence

Nearest milk animal