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April 24, 1992
Fort St. Vrain
Unit No. 1
P-92171

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Docket No. 50-267

SUBJECT: ANNUAL PADIOLOGICAL ENVIRONMENTAL MONITORING REPORT

Gentlemen:

Enclosed please find a copy of the Fort St. Vrain Nuclear Generating Station Radiological Environmental Monitoring Program Annual Summary Report for 1991. The report is submitted in accordance with Section 7.3.1.d of the Fort St. Vrain Technical Specifications and 10 CFR 50.4.

Please contact Mr. M. H. Holmes at (303) 620-1701 if you have any questions regarding the report.

Sincerely,

D. W. Warembourg

D. W. Warembou
Manager, Nucle Operations

DWW/lmg

Enclosure

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1/1

cc: Regional Administrator, Region IV

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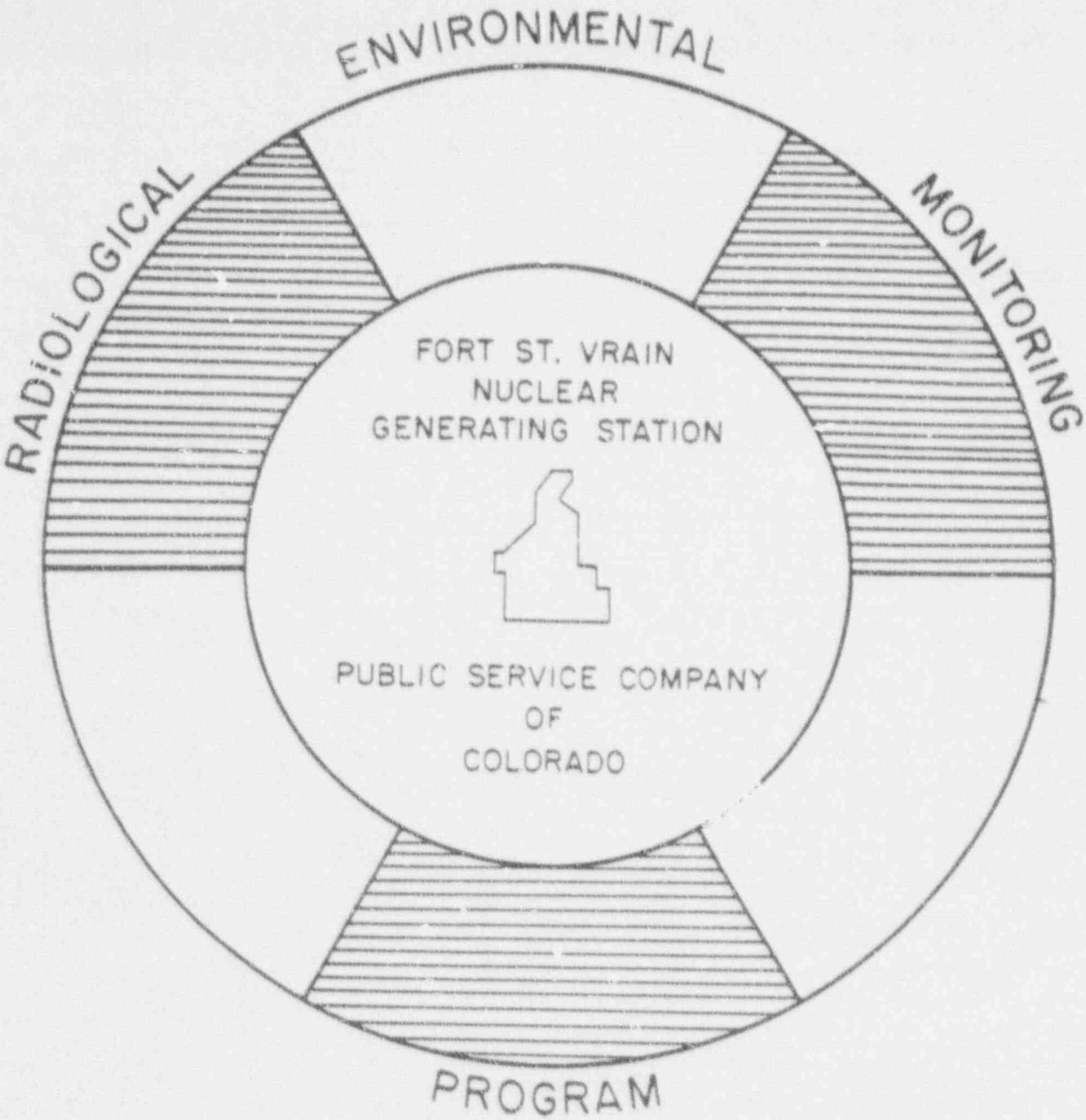

SUMMARY REPORT

1991

COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80523

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

For the Fort St. Vrain Nuclear Generating Station
Operated by the Public Service Co. of Colorado

Summary Report
for the Period
January 1, 1991 - December 31, 1991

Prepared by: James E. Johnson [signature] 4/6/92
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Radiochemistry Supervisor — Date

Approved by: JJBorst [signature] 4/14/92
Radiation Protection Manager — Date

Acknowledgements

Many persons have contributed to this project during 1991, and it is important to acknowledge their effort. We first thank the citizens from whose farms, homes, and ranches we collect the environmental samples. Without their cooperation the project would not be possible.

We also wish to acknowledge and thank Mr. Robert Keiss and his associates as well as the Colorado Division of Wildlife, Fort Collins regional office for assisting with the fish collection. Without their cooperation, equipment and expertise the collection would not be possible.

The persons working directly on the project have been:

Faye Bruno	Chief Laboratory Technician
Norma Frisby	Secretary
Thomas Miller	Student Employee
Steven Ziliak	Student Employee
Charles Sampier	Chief Electronic Technician
Christopher Roelle	Student Employee

James E. Johnson
Professor and Project Director

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During 1991 the Fort St. Vrain Nuclear Generating Station did not operate and is presently in a defueling phase. The operational phase of the reactor ended on August 18, 1989. Fuel removal operations began October 6, 1991.

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 1991 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 1991 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 volume (or mass)

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.

The arithmetic mean for each sample set is 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 ($\alpha = 0.05$) (1.96σ).

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 1991 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 1991 was 0.37 mR/day. The mean exposure rate was 0.39 mR/day for the adjacent area and 0.39 mR/day for the reference area. These latter mean values were not significantly different from each other and identical to the values measured during 1990.

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 having 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 effluent. Since the inception of power production by the reactor, there has been no detectable increase in the external exposure rate due to reactor releases. Fallout deposition, both from the Chinese nuclear weapon tests and from the Chernobyl accident, was detected in the past.

The TLD system is 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.

For comparison purposes, in EPA 520/5 Report #58 lists very similar background external exposure rate values in Denver. There has always been excellent agreement with the results from this program.

Figure II.A.1 shows the measured mean exposure rate in the Facility Area since the inception of the program. The steady decrease in exposure rate over the period is due to the decay and weathering of fission product deposition from previous atmospheric weapon tests.

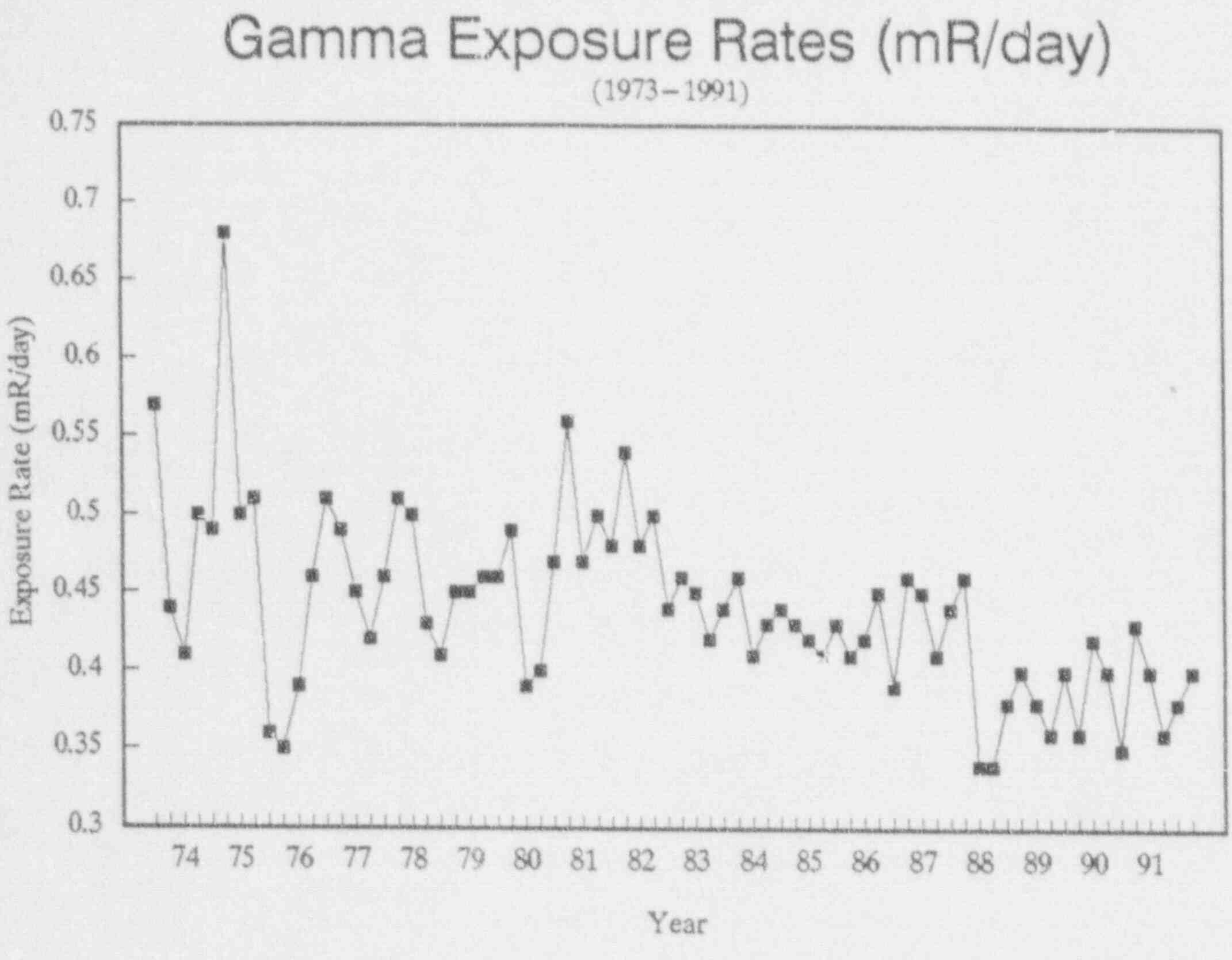
Table II.A.1 Gammma Exposure Rates. (mR/day) 1991

Facility Area	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
F-1	0.39	0.34	0.40	0.39
F-2	0.43	0.35	0.35	0.34
F-3	0.40	0.37	0.33	0.45
F-4	0.39	0.36	0.33	0.32
F-5	0.41	0.39	0.41	0.26
F-6	0.40	0.34	0.39	0.25
F-7	0.43	0.40	0.37	0.26
F-8	0.40	0.36	0.39	0.42
F-9	0.43	0.35	0.36	0.24
F-10	0.43	0.36	0.40	0.36
F-11	0.42	0.36	0.38	0.36
F-12	0.40	0.38	0.27	0.46
F-13	0.39	0.36	0.31	0.44
F-14	0.38	0.39	0.27	0.50
F-15	0.39	0.38	0.37	0.53
F-16	0.40	0.32	0.39	0.26
F-17	0.42	0.35	0.40	0.20
F-18	0.43	0.36	0.38	0.34
$\bar{x}$ (1.96σ)	0.41 (0.03)*	0.36 (0.04)	0.36 (0.08)	0.35 (0.19)
Adjacent Area				
A-1	0.43	0.38	0.41	0.58
A-2	0.41	0.40	0.45	0.57
A-3	0.43	0.34	0.42	0.40
A-4	0.44	0.33	0.38	0.37
A-5	0.39	0.34	0.35	0.43
A-6	0.42	0.37	0.34	0.25
A-7	0.41	0.36	0.40	0.34
A-8	0.39	0.37	0.42	0.35
A-9	0.41	0.38	0.42	0.32
A-10	0.38	b	b	b
A-11	0.36	0.35	0.40	0.27
A-12	0.38	0.39	0.36	0.32
A-13	0.35	0.36	0.33	0.37
A-14	0.37	0.38	0.37	0.58
A-15	0.41	0.38	0.37	0.35
A-16	0.40	0.35	0.37	0.35
A-17	0.42	0.37	0.39	0.57
A-20	0.40	0.38	0.40	b
$\bar{x}$ (1.96σ)	0.40 (0.05)	0.37 (0.04)	0.39 (0.06)	0.4[illegible] (0.22)
Reference Area				
R-2	0.33	0.38	0.38	0.53
R-3	0.40	0.31	0.37	0.35
R-4	0.40	0.35	0.36	0.39
R-5	0.41	0.34	0.42	b
R-7	0.39	b	0.37	0.47
$\bar{x}$ (1.96σ)	0.39 (0.06)	0.35 (0.06)	0.38 (0.05)	0.44 (0.16)

b - sample missing at site

* 1.96σ (Due to Counting Statistics)

Figure II.A.1


Gamma Exposure Rates (mR/day)
(1973-1991)
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
Exposure Rate (mR/day)
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91
Year

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 1991. 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, however, termed a facility site since the inception of the monitoring program. The reference sites R-3, R-4, and R-11 were established on 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 combination of radionuclides almost all of which are naturally occurring. It should be noted that the current technical specifications no longer require measurement of gross alpha activity. All filters, however, are saved indefinitely for later alpha activity analysis if needed.

The mean gross beta concentration in air for all facility stations for all of 1991 was 25 fCi/m^3. For 1990 the mean value was 23 fCi/m^3. The mean concentration for 1990 for all reference stations was 24 fCi/m^3. These measured mean

values were obviously not statistically significant at the 95% confidence level.

The gross beta data for 1991 have been added to the plot of air concentrations observed since 1973 (Figure II.B.1). 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 from each other. World-wide fallout, principally due to past Chinese atmospheric nuclear weapon tests, is the predominant contributor above background to the measured values over the period shown.

There has never been a significant difference observed between facility and reference sites. Thus, it can be concluded that reactor air effluents of particulate fission products or activation products during operation were not a source of dose commitment for the Fort St. Vrain environs population. This is expected to be true as well during the defueling and decommissioning phase.

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

a) First Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
01/05	56 (2.1)*	65 (1.8)	54 (1.8)	66 (2.0)	45 (1.9)	49 (1.9)	40 (1.7)
01/12	69 (2.4)	60 (1.8)	61 (2.0)	69 (1.8)	49 (2.0)	58 (2.0)	58 (2.0)
01/19	19 (1.5)	18 (1.1)	20 (1.3)	19 (1.1)	14 (1.1)	15 (1.2)	18 (1.3)
01/26	23 (1.6)	20 (1.3)	25 (1.5)	24 (1.3)	22 (1.4)	19 (1.3)	23 (1.4)
02/02	31 (1.7)	36 (1.7)	33 (1.7)	39 (1.8)	28 (1.5)	22 (1.4)	29 (1.5)
02/09	32 (1.7)	29 (1.2)	32 (1.5)	33 (1.4)	25 (1.4)	24 (1.4)	29 (1.5)
02/16	31 (1.7)	29 (1.3)	29 (1.5)	29 (1.3)	16 (1.2)	26 (1.6)	28 (1.6)
02/23	19 (1.4)	18 (1.1)	21 (1.4)	20 (1.2)	16 (1.2)	16 (1.3)	20 (1.5)
03/02	22 (1.6)	20 (1.2)	21 (1.3)	21 (1.2)	20 (1.2)	22 (1.5)	21 (1.5)
03/09	13 (1.2)	14 (.94)	15 (1.2)	15 (1.0)	15 (1.2)	13 (1.2)	14 (1.1)
03/16	18 (1.2)	18 (1.1)	17 (1.2)	17 (1.1)	18 (1.2)	17 (1.3)	17 (1.4)
03/23	23 (1.4)	21 (1.2)	22 (1.3)	22 (1.2)	20 (1.2)	22 (1.5)	22 (1.7)
03/30	18 (1.2)	14 (1.0)	16 (1.1)	17 (1.1)	16 (1.1)	17 (1.4)	17 (2.0)
$\bar{x}$ 1.96σ	29 32	28 33	28 28	30 35	23 22	25 26	26 23
MAX: 69 MIN: 13	$\bar{x}$ (1.96σ): 29 (31) n: 52				MAX: 58 $\bar{x}$ (1.96σ): 25 (23) MIN: 13 n: 39		

* 1.96σ (Due to Counting Statistics)

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

b) Second Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
04/06	33 (1.9)*	27 (1.3)	30 (1.5)	31 (2.8)	24 (1.3)	27 (1.7)	25 (1.3)
04/13	16 (1.2)	12 (.89)	14 (1.1)	h	15 (1.1)	16 (1.4)	13 (.92)
04/20	21 (1.3)	20 (1.1)	19 (1.2)	20 (1.2)	22 (1.1)	22 (1.5)	26 (1.5)
04/27	18 (1.2)	20 (1.1)	20 (1.3)	19 (1.2)	19 (1.1)	20 (1.5)	18 (1.0)
05/04	14 (1.1)	13 (1.0)	14 (1.1)	14 (.94)	12 (.92)	19 (1.5)	14 (1.1)
05/11	24 (1.4)	19 (1.2)	24 (1.3)	23 (1.4)	28 (1.5)	23 (1.2)	22 (1.6)
05/18	17 (1.3)	14 (1.1)	17 (1.3)	16 (1.0)	15 (1.1)	20 (2.1)	16 (1.1)
05/25	22 (1.3)	18 (1.0)	21 (1.2)	20 (1.0)	19 (1.3)	32 (2.9)	18 (.98)
06/01	23 (1.1)	24 (1.1)	22 (1.3)	21 (1.0)	24 (1.2)	24 (1.1)	21 (1.1)
06/07	15 (1.2)	14 (1.0)	14 (1.3)	14 (1.2)	12 (1.0)	17 (1.1)	16 (1.1)
06/14	25 (1.3)	25 (1.2)	24 (1.4)	21 (1.2)	24 (1.3)	25 (1.2)	26 (1.3)
06/21	24 (1.3)	19 (3.3)	22 (1.3)	20 (1.1)	21 (1.2)	20 (1.2)	21 (1.2)
06/28	24 (1.3)	29 (1.5)	3.7 (1.8)	19 (1.1)	23 (1.3)	25 (1.3)	23 (1.2)
$\bar{x}$	21	20	19	20	20	22	20
1.96σ	10	11	13	8.8	9.9	8.6	8.7
MAX: 33 MIN: 3.7	$\bar{x}$ (1.96σ): 20 (11) n: 51				MAX: 32 MIN: 12	$\bar{x}$ (1.96σ): 21 (9.1) n: 39	

h - sample not collected (pump not functioning)

* 1.96σ (Due to Counting Statistics)

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

c) Third Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
07/05	20 (1.3)*	23 (1.4)	e	6.1(.78)	23 (1.3)	16 (1.1)	19 (1.1)
07/12	21 (1.3)	21 (1.2)	24 (2.0)	21 (1.2)	23 (1.3)	21 (1.1)	21 (1.2)
07/19	25 (1.3)	24 (1.2)	18 (1.9)	24 (1.2)	30 (1.5)	25 (1.2)	24 (1.2)
07/26	16 (1.1)	17 (1.0)	16 (1.1)	16 (1.0)	15 (1.1)	16 (1.0)	16 (.97)
08/02	30 (1.4)	29 (1.4)	28 (1.4)	27 (1.2)	30 (1.4)	29 (1.3)	27 (1.3)
08/09	23 (1.0)	23 (1.1)	22 (1.0)	21 (.94)	24 (1.1)	24 (1.0)	23 (.98)
08/16	26 (1.2)	26 (1.3)	25 (1.2)	24 (1.2)	24 (1.2)	28 (1.2)	25 (1.2)
08/23	25 (1.3)	25 (1.5)	27 (1.3)	22 (1.2)	25 (2.1)	26 (1.2)	27 (1.3)
08/31	28 (1.3)	29 (1.8)	28 (1.3)	27 (1.2)	26 (2.0)	29 (1.3)	23 (1.1)
09/07	32 (1.4)	20 (3.1)	34 (1.6)	32 (1.4)	34 (2.4)	34 (1.4)	25 (1.3)
09/14	15 (1.1)	17 (1.4)	17 (1.2)	17 (1.0)	20 (2.0)	18 (1.1)	18 (1.1)
09/21	22 (1.3)	25 (1.6)	23 (1.3)	22 (1.2)	24 (2.2)	21 (1.1)	21 (1.2)
09/28	27 (1.5)	26 (1.7)	29 (1.5)	26 (1.3)	27 (2.2)	23 (1.2)	23 (1.3)
$\overline{x}$ 1.96σ	24 9.1	23 7.6	24 11	22 13	25 9.3	24 11	22 6.6
MAX: 34 MIN: 6.1	$\overline{x}$ (1.96σ): 23 (10) n: 51				MAX: 34 MIN: 15	$\overline{x}$ (1.96σ): 24 (9.0) n: 39	

e - insufficient volume for analysis
* 1.96σ (Due to Counting Statistics)

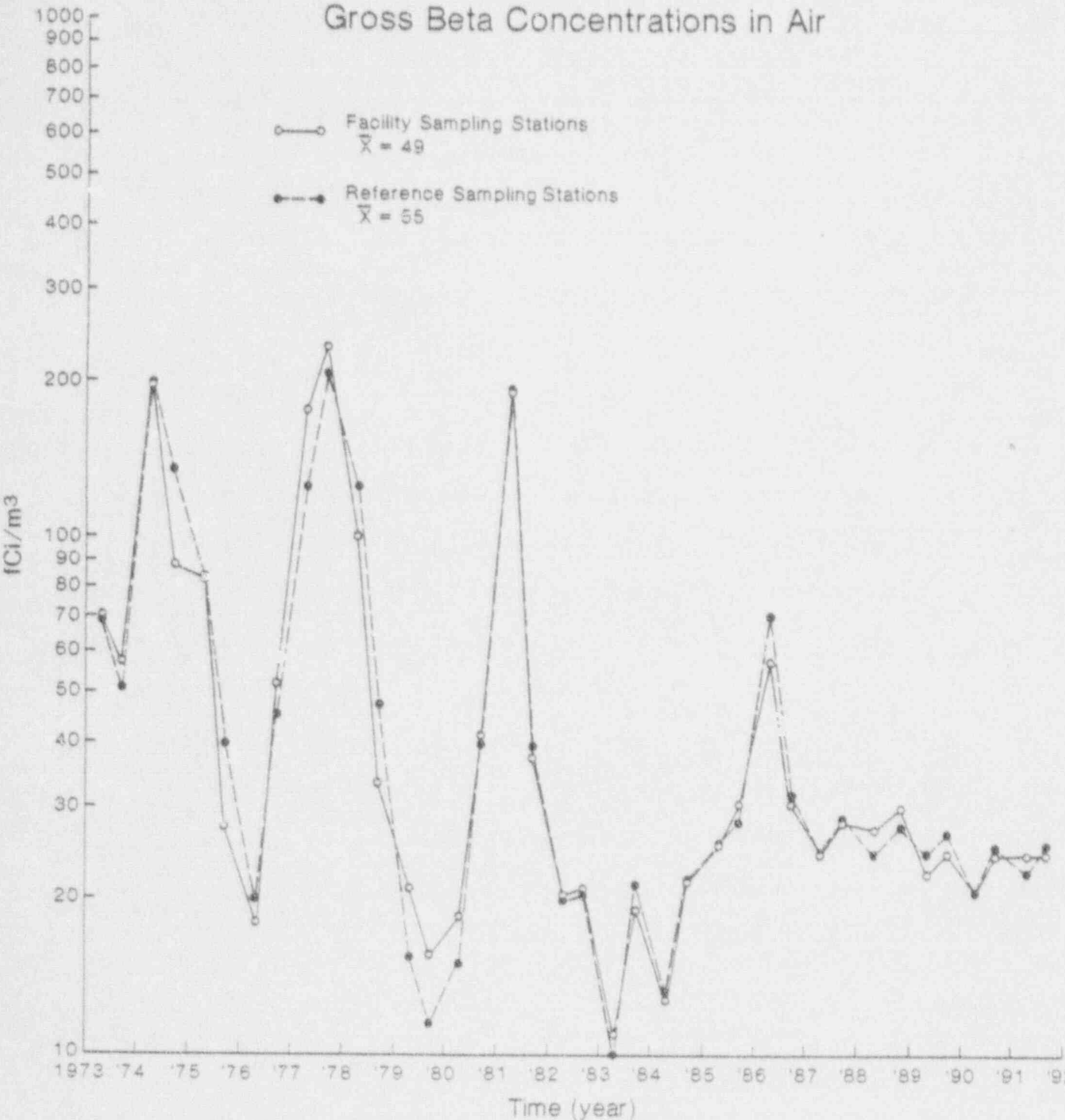
Table II.B.1 Concentrations of Long-lived Gross Beta Particulate Activity in Air. (fCi/m^3)

d) Fourth Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
10/05	28 (1.4)*	28 (1.6)	.60(.68)	27 (1.2)	27 (2.1)	27 (1.3)	29 (1.5)
10/12	4.9(.89)	25 (1.7)	2.0(.66)	1.4(.58)	69 (3.0)	15 (1.1)	15 (1.3)
10/19	27 (1.5)	28 (1.9)	27 (1.5)	25 (1.3)	40 (2.4)	25 (1.3)	27 (1.7)
10/26	30 (1.5)	32 (1.8)	30 (1.5)	29 (1.4)	34 (2.3)	27 (1.3)	30 (1.6)
11/02	31 (1.4)	32 (1.6)	32 (1.4)	33 (1.3)	35 (2.2)	34 (1.3)	64 (3.3)
11/09	39 (1.6)	37 (1.8)	37 (1.6)	38 (1.6)	34 (2.3)	26 (1.3)	34 (1.4)
11/16	23 (1.3)	22 (1.5)	24 (1.5)	23 (1.2)	20 (1.8)	20 (1.2)	21 (1.2)
11/23	14 (1.0)	14 (1.3)	14 (1.2)	15 (.96)	12 (1.7)	13 (.97)	15 (.97)
11/30	20 (1.3)	20 (1.4)	20 (1.2)	20 (1.1)	20 (1.9)	17 (1.0)	22 (1.1)
12/07	24 (1.4)	25 (1.6)	24 (1.3)	23 (1.2)	20 (1.9)	20 (1.2)	22 (1.2)
12/14	33 (1.6)	36 (1.8)	34 (1.5)	35 (1.5)	28 (2.1)	28 (1.3)	32 (1.4)
12/21	37 (1.6)	41 (2.1)	38 (1.6)	24 (1.4)	39 (2.3)	33 (1.5)	31 (1.4)
12/28	45 (1.8)	48 (2.2)	46 (1.8)	46 (1.6)	41 (2.4)	34 (1.4)	39 (1.5)
$\bar{x}$	27	30	25	27	32	25	27
1.96σ	21	18	26	22	28	14	29
MAX: 48 MIN: 0.60	$\bar{x}$ (1.96σ): 27 (21) n: 52				MAX: 69 MIN: 12	$\bar{x}$ (1.96σ): 28 (25) n: 39	

* 1.96σ (Due to Counting Statistics)

Figure II.B.1



Gross Beta Concentrations in Air
Facility Sampling Stations
$\overline{X}$ = 49
Reference Sampling Stations
$\overline{X}$ = 55
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 '89 '90 '91 '92
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 1991 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 was batch liquid releases from holding tanks (system 62). The tank water is first analyzed and then released with sufficient additional dilution, if necessary, to meet 10CFR20 concentration limits. The summary of tritium release by all modes is shown in Table II.B.4. The summary indicates that the total tritium released in 1991 was 3.7X that released in 1990 by all routes. This effluent release was detected at nearly all sampling sites, but principally those close to the Goosequill ditch effluent pathway.

The mean values for sites F-16 and A-19 were statistically the same as for all other sites during the year. In any case, 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. See results for these pathways in sections II.D and II.E.

Since the same weekly relative humidity is assumed for all sites, Table II.B.3 shows the same site dependence on reactor effluent as Table II.B.2. Only the units used to measure tritium in surface air are different.

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

a) First Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
01/05	< 400	< 400	< 400	< 400	< 400	< 400	< 400
01/12	< 400	< 400	< 400	< 400	< 400	< 400	< 400
01/19	< 400	< 400	< 400	< 400	< 400	< 400	< 400
01/26	< 400	< 400	< 400	< 400	< 400	< 400	< 400
02/02	< 400	< 400	< 400	< 400	< 400	< 400	< 400
02/09	< 400	< 400	< 400	< 400	< 400	< 400	< 400
02/16	< 410	< 410	< 410	< 400	< 410	< 410	< 410
02/23	< 400	< 400	< 400	< 400	410(420)*	< 400	< 400
03/02	< 400	< 400	< 400	< 400	< 400	< 400	< 400
03/09	< 390	< 390	530(410)	430(410)	390(400)	< 390	< 390
03/16	< 400	< 400	< 400	< 400	< 400	< 400	< 400
03/23	< 390	< 390	< 390	< 390	< 390	< 390	< 390
03/30	< 400	< 400	< 400	< 400	< 400	< 400	< 400

* 1.96σ (Due to Counting Statistics)

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

b) Second Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
04/06	< 400	< 400	< 400	< 400	< 400	< 400	< 400
04/13	< 400	< 400	< 400	< 400	< 400	< 400	< 400
04/20	< 400	< 400	< 400	< 400	< 400	< 400	< 400
04/27	< 400	< 400	< 400	< 400	< 400	< 400	< 400
05/04	< 400	< 400	< 400	< 400	< 400	< 400	< 400
05/11	< 400	< 400	< 400	< 400	< 400	< 400	< 400
05/18	< [illegible]	< 390	< 390	< 390	< 390	< 390	< 390
05/25	< 400	< 400	< 400	< 400	< 400	< 400	< 400
06/01	< 390	< 390	< 390	< 390	< 390	< 390	< 390
06/07	< 390	< 390	< 390	< 390	< 390	< 390	< 390
06/14	< 390	< 390	< 390	< 390	< 390	< 390	< 390
06/21	< 390	< 390	< 390	< 390	< 390	< 390	< 390
06/28	< 390	< 390	< 390	< 390	< 390	< 390	< 390

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

c) Third Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
07/05	< 380	< 380	< 380	< 380	< 380	< 380	< 380
07/12	< 390	< 390	< 390	< 390	< 390	< 390	< 390
07/19	< 380	< 380	< 380	< 380	< 380	< 380	< 380
07/26	< 390	< 390	< 390	< 390	< 390	< 390	< 390
08/02	< 390	< 390	< 390	< 390	< 390	< 390	< 390
08/09	< 400	< 400	< 400	< 400	< 400	< 400	< 400
08/16	< 390	< 390	< 390	< 390	< 390	< 390	< 390
08/23	< 390	< 390	< 390	< 390	< 390	< 390	< 390
08/31	< 400	< 400	< 400	< 400	< 400	< 400	< 400
09/07	< 400	< 400	< 400	< 400	< 400	< 400	< 400
09/14	730 (410)*	770 (410)	920 (420)	620 (410)	680 (410)	610 (410)	< 390
09/21	650 (370)	< 350	800 (370)	960 (370)	710 (370)	620 (360)	< 350
09/28	640 (370)	610 (360)	460 (360)	550 (360)	730 (370)	< 350	350 (360)

* 1.96σ (Due to Counting Statistics)

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

d) Fourth Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
10/05	< 390	630 (410)*	790 (410)	600 (410)	400 (410)	740 (410)	640 (410)
10/12	< 400	650 (420)	< 400	700 (420)	< 400	< 400	< 400
10/19	< 400	< 400	< 400	430 (420)	< 400	< 400	< 400
10/26	500 (420)	< 400	620 (430)	620 (430)	530 (420)	870 (430)	< 400
11/02	610 (410)	670 (410)	470 (410)	690 (410)	< 390	< 350	730 (420)
11/09	540 (420)	< 400	< 400	560 (420)	< 400	470 (420)	680 (420)
11/16	780 (420)	< 400	< 400	< 400	< 400	< 400	< 400
11/23	< 400	520 (420)	< 400	< 400	< 400	< 400	470 (420)
11/30	< 400	520 (420)	730 (420)	< 400	540 (420)	< 400	< 400
12/07	< 400	< 400	530 (420)	< 400	500(420)	< 400	< 400
12/14	< 400	< 400	650 (420)	< 400	450 (410)	620 (420)	540 (410)
12/21	< 400	520 (420)	440 (420)	< 400	< 400	770 (420)	530 (420)
12/28	< 410	< 410	< 410	550 (430)	< 410	< 410	< 410

* 1.96 σ (Due to Counting Statistics)

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

a) First Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
01/05	< 0.92	< 0.92	< 0.92	< 0.92	< 0.92	< 0.92	< 0.92
01/12	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
01/19	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3
01/26	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79	< 0.79
02/02	< 0.87	< 0.87	< 0.87	< 0.87	< 0.87	< 0.87	< 0.87
02/09	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
02/16	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4
02/23	< 1.2	< 1.2	< 1.2	< 1.2	1.2 (1.2)*	< 1.2	< 1.2
03/02	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03/09	< 1.0	< 1.0	1.4 (1.1)	1.1 (1.1)	1.0 (1.1)	< 1.0	< 1.0
03/16	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
03/23	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
03/30	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2

* 1.96 σ (Due to Counting Statistics)

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

b) Second Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
04/06	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4
04/13	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4
04/20	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8
04/27	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6
05/04	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6
05/11	< 2.2	< 2.2	< 2.2	< 2.2	< 2.2	< 2.2	< 2.2
05/18	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1	< 2.1
05/25	< 2.9	< 2.9	< 2.9	< 2.9	< 2.9	< 2.9	< 2.9
06/01	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
06/07	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1
06/14	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
06/21	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7
06/28	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7

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

c) Third Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
07/05	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7	< 2.7
07/12	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6	< 3.6
07/19	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4
07/26	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4
08/02	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4
08/09	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5
08/16	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5
08/23	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1	< 3.1
08/31	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2
09/07	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
09/14	6.0 (3.4)*	6.3 (3.4)	7.6 (3.4)	5.1 (3.4)	5.6 (3.4)	5.0 (3.4)	< 3.2
09/21	3.8 (2.1)	< 2.0	4.6 (2.1)	5.5 (2.1)	4.1 (2.1)	3.6 (2.1)	< 2.0
09/28	3.2 (1.9)	3.1 (1.8)	2.3 (1.8)	2.8 (1.8)	3.7 (1.9)	< 1.8	1.8 (1.8)

* 1.96σ (Due to Counting Statistics)

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

d) Fourth Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
10/05	< 2.3	3.7 (2.4)*	4.6 (2.4)	3.5 (2.4)	2.3 (2.4)	4.3 (2.4)	3.7 (2.4)
10/12	< 1.9	3.0 (1.9)	< 1.9	3.2 (1.9)	< 1.9	< 1.9	< 1.9
10/19	< 1.5	< 1.5	< 1.5	1.6 (1.6)	< 1.5	< 1.5	< 1.5
10/26	2.0 (1.7)	< 1.6	2.5 (1.7)	2.5 (1.7)	2.1 (1.7)	3.5 (1.7)	< 1.6
11/02	1.3 (.91)	1.5 (.91)	1.0 (.91)	1.5 (.91)	< 0.86	< 0.86	< 0.86
11/09	2.0 (1.6)	< 1.5	< 1.5	2.1 (1.6)	< 1.5	1.8 (1.6)	2.5 (1.6)
11/16	3.3 (1.8)	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
11/23	< 1.3	1.7 (1.4)	< 1.3	< 1.3	< 1.3	< 1.3	1.5 (1.4)
11/30	< 1.4	1.9 (1.5)	2.6 (1.5)	< 1.4	1.9 (1.5)	< 1.4	< 1.4
12/07	< 1.3	< 1.3	1.7 (1.3)	< 1.3	1.6 (1.3)	< 1.3	< 1.3
12/14	< 1.4	< 1.4	2.2 (1.4)	< 1.4	1.5 (1.4)	2.1 (1.4)	1.8 (1.4)
12/21	< 1.4	1.8 (1.4)	1.5 (1.4)	< 1.4	< 1.4	2.6 (1.4)	1.8 (1.4)
12/28	< 1.2	< 1.2	< 1.2	1.6 (1.3)	< 1.2	< 1.2	< 1.2

* 1.96σ (Due to Counting Statistics)

Table II.B.4 Tritium Released (mCi) In Reactor Effluents, 1991

MODE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Continuous (Turbine Building Sump) (1)	0.415	0.492	0.568	0.340	0.524	0.486	0.661	1.29	1.55	1.54	2.05	1.06	10.98
Batch Release (Reactor Building Sump)	0.807	0.614	0.394	0.361	0.173	1.02	0.217	11.8	0.328	0.395	0.307	0.350	16.77
Batch Release (System 62)	1250	2710	202	32.6	3.31	3.75	6.38	1460	648	1400	3280	70.4	11066
Gaseous Stack	11.6	8.53	8.75	10.0	12.6	6.18	12.8	9.51	7.39	3.06	4.76	2.19	97.37
TOTAL	1263	2720	211.7	43.3	16.6	11.4	20.06	1483	657	1405	3287	74.0	11192

(1) Conservative estimate by FSV laboratories. Obtained in many cases by MDA result X volume.

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 Ge(Li) gamma-ray spectrum analysis during 1991. Each sample from the seven air sampling stations is counted within 96 hours after collection. A 100 minute count and a sample volume of 800 m^3 is 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 superior resolution of Ge(Li) spectrometry systems. Any 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 an' 131 in air would not arrive at the sampling stations at a constant rate, but rather randomly in pulses of short duration compared to the collection period. This is the case whether the I-131 source term would be a nuclear accident elsewhere, 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 positives. When a gamma-ray from natural background activity interferes with the region of interest of a measured radionuclide, e.g., Cs-134, Ba-La 140, the number of false positives is higher, implying a systematic error. I-131 concentrations due to reactor

effluent have never been detected in any sample type in the Fort St. Vrain environs. There is essentially no fission product I-131 remaining in any of the fuel elements and, therefore, no possible source term.

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 values are either measurement system false positives or Cs-137 concentrations possibly 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. Only gamma-ray activity due to the naturally occurring background radionuclides are observed. During the second quarter of 1986, however, many other fission product and activation product radionuclides were observed due to the Chernobyl accident. Of these only Cs-137 can still be detected, but at steadily decreasing concentrations.

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

a) First Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
1/02/91	< 20.0	< 24.0	< 19.0	< 19.0	< 20.0	< 23.0	< 29.0
1/09/91	< 30.0	< 25.0	< 21.0	< 22.0	< 35.0	< 24.0	< 34.0
1/16/91	< 34.0	< 12.0	< 16.0	< 17.0	< 26.0	< 33.0	< 24.0
1/23/91	< 7.9	< 21.0	< 35.0	< 34.0	< 20.0	< 32.0	< 33.0
1/30/91	< 26.0	< 18.0	< 25.0	< 20.0	< 19.0	< 33.0	< 22.0
2/06/91	< 11.0	< 13.0	< 16.0	< 17.0	< 26.0	< 19.0	< 34.0
2/13/91	46.0 (33.0)*	< 30.0	< 13.0	< 16.0	< 17.0	< 35.0	< 32.0
2/20/91	< 14.0	< 23.0	< 21.0	< 26.0	< 30.0	< 21.0	< 8.9
2/27/91	< 31.0	< 11.0	< 15.0	20.0 (22.0)	< 19.0	< 21.0	< 21.0
3/06/91	< 32.0	< 16.0	< 18.0	< 23.0	< 18.0	< 26.0	< 23.0
3/13/91	< 20.0	< 21.0	< 23.0	< 17.0	< 35.0	37.0 (38.0)	< 26.0
3/20/91	< 32.0	< 32.0	< 24.0	< 26.0	< 28.0	< 28.0	< 14.0
3/27/91	< 34.0	< 21.0	< 28.0	< 19.0	39.0 (26.0)	< 27.0	< 28.0

* 1.96σ (Due to Counting Statistics)

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

b) Second Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
4/03/91	< 15.0	< 19.0	< 29.0	< 14.0	< 17.0	< 27.0	< 15.0
4/10/91	< 23.0	< 22.0	< 26.0	h	< 24.0	< 14.0	< 19.0
4/17/91	< 7.0	< 9.4	< 32.0	< 14.0	< 12.0	< 32.0	< 26.0
4/24/91	< 25.0	< 24.0	< 28.0	< 27.0	< 18.0	< 14.0	< 15.0
5/01/91	< 23.0	< 24.0	< 31.0	< 16.0	< 20.0	< 23.0	< 19.0
5/08/91	< 16.0	< 7.7	< 16.0	< 13.0	23.0 (22.0)*	< 35.0	< 5.8
5/15/91	< 26.0	< 16.0	< 25.0	< 27.0	< 17.0	< 17.0	< 23.0
5/22/91	< 33.0	< 15.0	< 29.0	< 22.0	< 19.0	< 27.0	< 21.0
5/29/91	< 18.0	41.0 (35.0)	< 23.0	< 12.0	< 17.0	< 16.0	38.0 (40.0)
6/05/91	< 24.0	< 16.0	< 15.0	< 18.0	< 20.0	< 20.0	< 19.0
6/11/91	< 21.0	< 28.0	< 20.0	< 26.0	< 35.0	< 21.0	< 12.0
6/18/91	< 24.0	< 30.0	< 32.0	< 15.0	< 27.0	< 18.0	< 12.0
6/25/91	< 30.0	< 34.0	29.0 (36.0)	< 20.0	< 22.0	< 14.0	< 11.0

* 1.96σ (Due to Counting Statistics)

h - sample not collected (pump not functioning)

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

d) Third Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
7/02/91	< 17.0	< 15.0	< 24.0	32.0 (35.0)*	< 13.0	< 25.0	< 33.0
7/09/91	< 28.0	< 18.0	< 33.0	< 30.0	< 16.0	< 14.0	< 16.0
7/16/91	< 29.0	< 13.0	< 11.0	< 17.0	< 30.0	< 13.0	< 23.0
7/23/91	< 18.0	< 20.0	< 15.0	< 13.0	< 25.0	< 17.0	< 11.0
7/30/91	< 15.0	< 22.0	< 17.0	27.0 (25.0)	< 28.0	< 14.0	< 18.0
8/06/91	< 35.0	< 23.0	< 22.0	< 17.0	< 14.0	< 18.0	< 13.0
8/13/91	< 32.0	< 24.0	< 18.0	< 19.0	< 19.0	< 33.0	< 24.0
8/20/91	< 31.0	< 21.0	< 24.0	< 26.0	< 34.0	< 29.0	< 22.0
8/28/91	< 17.0	< 14.0	< 26.0	< 22.0	< 35.0	< 22.0	< 12.0
9/04/91	< 23.0	< 26.0	< 25.0	< 25.0	< 11.0	< 20.0	< 17.0
9/11/91	< 29.0	< 19.0	< 16.0	< 21.0	< 21.0	< 13.0	< 18.0
9/18/91	< 31.0	< 33.0	< 15.0	< 18.0	< 23.0	< 21.0	< 16.0
9/25/91	< 26.0	< 23.0	< 28.0	< 33.0	< 35.0	< 25.0	< 13.0

* 1.96σ (Due to Counting Statistics)

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

d) Fourth Quarter, 1991

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
10/02/91	< 25.0	< 28.0	< 33.0	< 15.0	< 11.0	< 29.0	< 18.0
10/09/91	< 23.0	< 18.0	< 15.0	32.0 (30.0)*	< 35.0	< 22.0	< 12.0
10/16/91	< 17.0	< 30.0	< 33.0	< 26.0	< 19.0	< 20.0	< 34.0
10/23/91	< 10.0	< 9.0	< 14.0	< 19.0	< 29.0	< 23.0	< 9.5
10/30/91	< 21.0	< 25.0	< 18.0	< 22.0	< 18.0	< 13.0	< 12.0
11/06/91	< 20.0	< 19.0	< 12.0	< 26.0	17.0 (19.0)	< 11.0	< 13.0
11/13/91	< 18.0	< 31.0	< 20.0	< 15.0	< 25.0	< 23.0	25.0 (23.0)
11/20/91	< 23.0	< 16.0	< 15.0	19.0 (24.0)	< 9.8	< 17.0	< 19.0
11/27/91	< 13.0	< 14.0	< 34.0	< 15.0	< 16.0	< 20.0	< 18.0
12/04/91	< 35.0	< 9.1	< 14.0	< 23.0	< 1.8	< 18.0	< 17.0
12/11/91	< 25.0	< 35.0	< 35.0	< 26.0	< 17.0	< 13.0	< 23.0
12/18/91	< 20.0	< 18.0	< 18.0	< 32.0	< 14.0	< 22.0	34.0 (41.0)
12/25/91	< 32.0	< 22.0	< 24.0	< 22.0	< 28.0	< 32.0	< 35.0

* 1.96σ (Due to Counting Statistics)

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

1991 Collection Date	Radionuclide	Facility Sites F-7	F-9	F-16	A-19	Reference Sites R-3	R-4	R-11
1st	Cs-134	< 1.6	< 1.3	< 1.8	< 1.9	3.2 (3.2)	< 2.4	< 3.5
Quarter	Cs-137	< 1.6	1.6 (1.8)*	< 1.9	< 2.0	< 2.8	< 2.9	< 3.3
2nd	Cs-134	< 1.5	< 1.1	< 1.6	< 1.1	< 1.2	2.4 (1.6)	< 1.5
Quarter	Cs-137	< 1.5	< 1.2	< 1.6	< 1.2	< 1.3	1.7 (1.7)	1.5 (1.9)
3rd	Cs-134	< 1.0	< 1.1	< 1.3	< 0.57	< 0.69	< 0.72	< 0.74
Quarter	Cs-137	< 1.1	< 1.1	< 1.3	< 0.57	1.2 (.84)	< 0.71	< 0.77
4th	Cs-134	< 2.3	< 2.4	< 1.2	< 1.7	< 3.4	2.3 (2.5)	< 2.8
Quarter	Cs-137	< 2.4	< 2.3	< 1.3	< 1.8	< 3.2	< 1.6	< 2.2

* 1.96σ (Due to Counting Statistics)

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. Water treatment systems for the two water supplies are very different.

Table II.C.1 shows gross beta concentrations measured in 1991 from each water supply. As in every past year, the mean for the Gilcrest site was significantly higher than the Reference site in Fort Collins. This is only due to the different water treatment practices and the different supply sources. The city of Gilcrest does not completely filter its water and natural radionuclide concentrations due to the suspended solids 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 similar to that observed in previous years.

Table II.C.2 lists measured tritium concentrations in these same two drinking water sources. Concentrations above MDC were detected after the major reactor releases. The yearly arithmetic mean value for the Gilcrest location was 620

pCi/L. Assuming this was the only drinking water intake for Gilcrest residents the resultant dose commitment calculation is as follows:

Assuming 2 L/day intake of drinking water, water from milk of a family milk cow and vegetables from a local garden irrigated with the well water, the yearly intake is 1250 L/year. The adult committed effective dose equivalent is:

$$\frac{1250\,L}{year} \times \frac{620\ pCi}{L} \times 6.3 \times \frac{10^{-8}\ mrem}{pCi} = 0.049\ mrem.$$

This is an insignificant dose commitment. The EPA limit for community drinking water systems is currently 20,000 pCi/L for tritium.

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. 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 about the detection limit. 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. (pCi/L)

Collection Date 1991	Gilcrest City R-6	Fort Collins City R-3 (Reference)
12/29 01/05	6.3 (2.5)*	.84 (0.56)
01/12 01/19	5.1 (2.4)	.67 (0.55)
01/26 02/02	5.1 (2.4)	1.4 (0.59)
02/09 02/16	6.8 (2.5)	1.6 (0.60)
02/23 03/02	5.6 (2.4)	1.5 (0.59)
03/09 03/16	5.1 (2.4)	1.4 (0.59)
03/23 03/30	5.6 (2.4)	1.0 (0.57)
04/06 04/13	4.4 (2.3)	.90 (0.56)
04/20 04/27	4.[illegible] (2.3)	.89 (0.56)
05/04 05/11	8.3 (2.6)	1.0 (0.57)
05/18 05/25	3.3 (2.2)	1.3 (0.58)
06/01 06/07	4.0 (2.3)	.90 (0.57)
06/14 06/21	3.3 (2.3)	.53 (0.55)
06/28 07/12	5.5 (2.4)	.53 (0.55)
07/12 07/19	3.7 (2.3)	.44 (0.54)
07/26 08/02	4.2 (2.3)	.71 (0.56)
08/09 08/16	3.4 (2.3)	.53 (0.54)
08/23 08/30	9.4 (2.7)	.64 (0.55)
09/07 09/14	3.1 (2.3)	.67 (0.56)
09/21 09/28	10 (2.7)	.90 (0.57)
10/07 10/14	5.3 (2.4)	1.4 (0.56)
10/21 10/28	8.7 (2.5)	1.5 (0.60)
11/02 11/09	13 (2.8)	.92 (0.56)
11/16 11/23	6.6 (2.5)	.63 (0.55)
11/30 12/07	5.8 (2.4)	1.1 (0.58)
12/14 12/21	4.6 (2.3)	.91 (0.57)

*1.96σ (Due to Counting Statistics)

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

Collection Date 1991	Gilcrest City R-6	Fort Collins City R-3 (Reference)
12/29 01/05	< 400	< 400
01/12 01/19	< 400	< 400
01/26 02/02	< 400	< 400
02/09 02/16	< 400	< 400
02/23 03/02	< 400	< 400
03/09 03/16	< 400	< 400
03/23 03/30	< 400	< 400
04/06 04/13	< 400	< 400
04/20 04/27	< 400	< 400
05/04 05/11	< 390	< 390
05/18 05/25	< 390	< 390
06/01 06/07	< 390	< 390
06/15 06/22	< 390	< 390
06/29 07/06	< 380	< 380
07/13 07/20	< 390	< 390
07/27 08/03	< 390	< 390
08/10 08/17	< 390	< 390
08/24 08/31	< 400	< 400
09/07 09/14	490 (360)*	< 350
09/21 09/28	640 (420)	< 400
10/05 10/12	< 400	< 400
10/19 10/26	< 400	< 400
11/02 11/09	560 (420)	< 400
11/16 11/23	760 (420)	410 (410)
11/30 12/07	600 (420)	< 400
12/14 12/21	660 (420)	730 (420)

*1.96σ (Due to Counting Statistics)

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

Collection Date	for two weeks ending 02JAN91		for two weeks ending 16JAN91		for two weeks ending 30JAN91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3
I-131	< 0.39	< 0.37	< 0.28	< 0.12	< 0.33	< 0.42
Cs-134	< 2.0	< 3.0	< 2.1	< 2.0	< 1.6	< 2.5
Cs-137	< 2.5	< 3.7	5.4 (3.0)*	< 2.5	< 1.9	< 3.1
Zr-95	< 4.5	< 6.7	< 4.5	< 4.3	< 3.7	< 5.8
Nb-95	< 1.9	< 3.0	< 1.9	< 1.9	< 1.5	< 2.2
Co-58	< 2.0	< 2.9	< 1.9	< 1.8	< 1.4	< 2.3
Mn-54	< 2.1	< 3.0	< 2.1	3.3 (2.4)	< 1.5	< 2.5
Zn-65	< 5.9	< 7.6	< 5.8	< 5.5	< 4.9	< 6.9
Fe-59	< 4.7	< 7.8	< 4.7	< 4.7	< 4.2	< 6.1
Co-60	< 2.1	< 2.9	< 2.0	< 2.0	< 1.5	3.3 (3.2)
Ba-140	< 5.0	< 4.9	< 3.2	< 3.1	< 4.3	< 4.0
La-140	< 5.7	< 5.6	< 3.7	< 3.6	< 4.9	< 4.6

* 1.96 σ (Due to Counting Statistics)

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

Collection Date	for two weeks ending 13FEB91		for two weeks ending 27FEB91		for two weeks ending 13MAR91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3
I-131	< 0.3	< 0.19	< 0.28	< 0.18	< 0.41	< 0.5
Cs-134	< 2.1	< 2.4	< 2.1	< 2.2	< 2.4	< 2.0
Cs-137	3.3 (3.0)*	4.2 (3.5)	< 2.5	< 2.5	2.9 (3.5)	< 2.3
Zr-95	< 4.8	< 5.6	< 5.3	< 4.7	< 6.2	< 4.6
Nb-95	< 1.9	< 2.3	< 1.9	< 2.0	< 2.2	< 1.8
Co-58	< 2.0	< 2.2	< 1.9	< 2.0	< 2.2	< 1.8
Mn-54	< 2.1	< 2.4	< 2.1	< 2.1	< 2.4	< 2.0
Zn-65	< 5.8	< 6.7	< 5.8	< 6.0	< 6.7	< 5.8
Fe-59	9.2 (6.2)	< 6.1	< 5.7	< 4.9	< 6.6	< 4.5
Co-60	< 2.2	< 2.6	< 2.2	< 2.1	< 2.6	< 1.9
Ba-140	< 3.3	< 4.0	< 6.4	< 3.4	< 3.9	< 5.5
La-140	< 3.8	< 4.6	< 7.4	< 3.9	< 4.4	< 6.4

* 1.96 σ (Due to Counting Statistics)

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

Collection Date	for two weeks ending 27MAR91		for two weeks ending 10APR91		for two weeks ending 24APR91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3
I-131	< 0.35	< 0.32	< 0.33	< 0.35	< 0.40	< 0.32
Cs-134	< 2.5	< 2.2	< 1.6	< 1.5	< 2.3	< 1.8
Cs-137	< 3.0	< 2.6	4.4 (2.4)*	< 1.9	< 2.8	< 2.2
Zr-95	< 5.6	< 5.0	< 3.8	< 3.6	< 5.3	< 4.0
Nb-95	< 2.2	< 2.0	< 1.5	< 1.4	< 2.0	< 1.7
Co-58	< 2.3	< 2.0	< 1.5	< 1.5	< 2.1	< 1.7
Mn-54	< 2.5	< 2.1	< 1.6	< 1.5	2.4 (2.7)	< 1.8
Zn-65	< 7.0	< 6.4	< 4.5	< 4.6	< 6.2	< 5.6
Fe-59	< 5.7	< 4.9	< 4.4	< 3.5	< 5.8	< 4.2
Co-60	< 2.6	< 2.1	< 1.8	< 1.5	< 2.5	< 1.8
Ba-140	< 6.1	< 3.4	< 2.6	< 2.4	< 3.7	< 4.1
La-140	< 7.1	< 3.9	< 3.0	< 2.8	< 4.2	< 4.7

* 1.96 σ (Due to Counting Statistics)

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

Collection Date	for two weeks ending 08MAY91		for two weeks ending 22MAY91		for two weeks ending 05JUN91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3
I-131	< 0.35	< 0.49	< 0.37	< 0.39	< 0.24	0.52 (0.5)*
Cs-134	< 2.1	< 1.9	< 3.1	< 2.1	3.4 (2.7)	< 2.4
Cs-137	3.8 (3.2)	< 2.3	< 3.6	< 2.5	< 2.7	< 2.9
Zr-95	< 5.1	4.5 (5.3)	< 6.6	< 4.4	< 5.0	< 5.6
Nb-95	< 2.0	< 1.7	< 2.8	< 1.8	< 2.1	< 2.1
Co-58	< 2.1	< 1.9	< 2.8	< 1.9	< 2.2	< 2.2
Mn-54	< 2.2	2.7 (2.3)	< 3.0	< 2.0	< 2.2	< 2.4
Zn-65	< 5.9	< 5.1	< 8.2	< 5.9	< 6.4	< 6.6
Fe-59	< 5.1	< 4.5	< 6.9	< 5.0	< 5.2	< 5.7
Co-60	< 2.3	< 1.9	< 3.1	< 2.0	< 2.3	< 2.6
Ba-140	< 3.5	< 4.6	< 4.8	< 4.9	< 6.3	< 6.4
La-140	< 4.1	< 5.3	< 5.5	< 5.6	< 7.2	< 7.4

* 1.96σ (Due to Counting Statistics)

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

Collection Date	for two weeks ending 18JUN91		for two weeks ending 03JUL91		for two weeks ending 16JUL91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3
I-131	< 0.19	< 0.3	< 0.37	< 0.33	< 0.48	< 0.38
Cs-134	< 1.2	< 2.1	4.0 (4.2)	2.1 (2.4)	< 1.2	< 0.96
Cs-137	1.7 (1.7)*	< 2.5	4.9 (5.0)	3.8 (2.9)	< 1.4	2.2 (1.4)
Zr-95	< 2.6	< 4.5	< 8.2	< 5.0	< 2.7	< 2.1
Nb-95	< 1.1	< 1.9	< 3.2	< 1.8	< 1.0	< 0.89
Co-58	< 1.2	< 1.9	< 3.1	< 1.8	< 1.1	< 0.97
Mn-54	< 1.2	< 2.0	< 3.4	< 2.0	< 1.2	< 0.96
Zn-65	< 3.3	< 5.5	< 9.1	< 5.4	< 3.1	< 2.6
Fe-59	< 2.8	< 4.8	< 8.8	< 5.0	< 2.6	< 2.2
Co-60	< 1.2	< 2.1	< 3.6	< 2.2	< 1.2	< 0.93
Ba-140	< 3.4	< 5.5	< 7.9	< 4.6	< 1.9	< 1.5
La-140	< 3.9	< 6.3	< 9.1	< 5.3	< 2.1	< 1.7

* 1.96 σ (Due to Counting Statistics)

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

Collection Date	for two weeks ending 26JUL91		for two weeks ending 13AUG91		for two weeks ending 23AUG91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3
I-131	< 0.25	< 0.31	< 0.19	< 0.32	< 0.38	< 0.41
Cs-134	a	< 1.7	< 2.9	< 1.2	2.8 (2.0)	< 2.1
Cs-137	a	3.8 (2.5)*	< 3.4	2.4 (1.7)	< 2.0	3.0 (3.0)
Zr-95	a	< 4.3	< 6.3	< 2.8	< 3.5	< 4.7
Nb-95	a	< 1.7	< 2.7	< 1.1	< 1.5	< 1.9
Co-58	a	< 1.6	< 2.9	< 1.1	1.7 (2.0)	< 1.9
Mn-54	a	< 1.7	< 2.8	< 1.2	< 1.7	< 2.0
Zn-65	a	< 4.8	< 7.9	< 3.2	< 4.6	< 5.4
Fe-59	a	< 3.9	< 6.7	< 2.7	< 4.3	< 4.8
Co-60	a	< 1.7	< 2.9	< 1.1	< 1.6	2.3 (2.4)
Ba-140	a	< 2.7	< 4.6	< 2.1	< 2.6	< 5.0
La-140	a	< 3.1	< 5.3	< 3.6	< 3.0	< 5.7

* 1.96 σ (Due to Counting Statistics)

a - sample lost prior to analysis

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

Collection Date	for two weeks ending 11SEP91		for two weeks ending 25SEP91		for two weeks ending 09OCT91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-[illegible]
I-131	< 0.25	< 0.21	< 0.37	< 0.3	< 0.34	< 0.38
Cs-134	< 1.8	< 1.6	< 1.5	< 2.0	< 1.7	< 1.9
Cs-137	2.4 (2.5)*	< 1.9	< 1.8	< 2.5	< 2.1	3.5 (2.9)
Zr-95	< 4.4	< 3.6	< 3.6	< 4.4	< 3.7	< 5.2
Nb-95	< 1.6	< 1.4	< 1.4	< 2.0	< 1.5	< 1.9
Co-58	< 1.6	< 1.4	< 1.4	< 1.8	< 1.7	< 1.6
Mn-54	1.9 (2.1)	< 1.5	< 1.5	< 2.0	< 1.7	2.7 (2.4)
Zn-65	< 4.9	< 4.2	< 4.2	< 5.6	< 4.6	< 5.5
Fe-59	< 4.0	< 3.6	< 3.5	< 5.6	< 4.5	< 4.7
Co-60	< 1.7	< 1.7	< 1.6	< 2.0	< 1.7	< 2.2
Ba-140	< 5.9	3.4 (3.2)	< 5.2	< 6.5	< 2.6	< 3.3
La-140	< 6.8	3.9 (3.6)	< 6.0	< 7.5	< 3.0	< 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	for two weeks ending 23OCT91		for two weeks ending 06NOV91		for two weeks ending 20NOV91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3
I-131	< 0.21	< 0.37	< 0.46	< 0.39	< 0.4	< 0.36
Cs-134	< 3.3	< 2.1	< 2.1	< 1.7	< 2.2	< 1.8
Cs-137	< 4.1	< 2.5	< 2.5	< 2.1	< 2.6	< 2.2
Zr-95	< 7.2	< 4.4	< 4.6	< 3.7	< 5.1	< 4.0
Nb-95	< 2.8	< 1.9	< 2.0	< 1.6	< 2.0	< 1.6
Co-58	< 3.3	< 1.9	< 1.9	< 1.7	< 2.0	< 1.6
Mn-54	< 3.1	< 2.0	< 2.1	< 1.7	< 2.1	< 1.8
Zn-65	< 9.0	< 5.9	< 5.7	< 4.6	< 6.3	< 5.1
Fe-59	< 7.2	< 5.3	< 4.8	< 4.4	5.3 (6.3)*	< 4.1
Co-60	< 3.0	< 2.0	3.8 (2.6)	< 1.7	< 2.3	< 1.7
Ba-140	< 5.1	< 4.9	< 3.2	< 4.8	< 3.5	< 2.8
La-140	< 5.9	< 5.6	< 3.7	< 5.5	< 4.0	< 3.2

* 1.96 σ (Due to Counting Statistics)

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

Collection Date	for two weeks ending 04DEC91		for two weeks ending 18DEC91	
Radionuclide	Gilcrest R-6	Ft Collins R-3	Gilcrest R-6	Ft Collins R-3
I-131	< 0.24	< 0.34	< 0.35	< 0.50
Cs-134	< 2.3	< 2.6	< 2.3	< 2.4
Cs-137	< 2.8	< 3.2	6.0 (3.3)*	< 2.9
Zr-95	< 6.0	< 6.3	< 5.3	< 7.5
Nb-95	< 2.1	< 2.4	< 2.0	< 2.2
Co-58	< 2.3	< 2.4	< 2.0	< 2.8
Mn-54	3.8 (2.8)	< 2.6	< 2.4	< 2.5
Zn-65	< 6.3	< 7.2	< 6.1	< 6.5
Fe-59	< 5.3	< 6.2	< 5.3	< 5.8
Co-60	< 2.5	< 2.8	< 2.4	< 2.6
Ba-140	< 3.6	< 4.3	< 7.5	< 3.9
La-140	< 4.1	< 4.9	< 7.5	< 4.4

* 1.96 σ (Due to Counting Statistics)

2. Surface Water

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

Table II.C.4 shows tritium concentrations measured during 1991 at the four surface water sites and the effluent route site. The arithmetic mean value for the downstream locations in 1991 was not, however, significantly different from the two upstream locations (Table II.H.2).

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 1991 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 80 minutes and the composite collected weekly. The weekly composites are then combined and analyzed monthly. The results of these samples are also shown in Tables II.C.4 and II.C.5. For January through April and

September and through December there was evidence of measurable tritium release (see Table II.C.4). Mean values for the other radionuclides were less than MDC except for Cs-137. The correlation of the tritium concentrations with the effluent release report is good.

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

	Downstream Sites		Upstream Sites		Effluent
Collection Date	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19	Goosequill A-25
January	< 400	< 400	< 400	< 400	3500 (460)*
February	< 410	< 410	< 410	< 410	2300 (450)
March	< 390	420 (400)	< 390	< 390	1100 (420)
April	< 400	< 400	< 400	< 400	430 (420)
May	< 390	< 390	< 390	< 390	< 400
June	< 390	< 390	< 390	< 390	< 390
July	< 380	< 380	< 380	< 380	< 390
August	< 400	< 400	< 400	< 400	< 400
September	< 350	370 (360)	380 (360)	420 (360)	1300 (430)
October	< 400	< 400	530 (420)	< 400	1000 (430)
November	560 (420)	< 400	< 400	< 400	8300 (510)
December	550 (420)	760 (420)	570 (420)	860 (420)	2000 (450)

* 1.96σ (Due to Counting Statistics)

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

Collection Date: 1/12/91

Radio -nuclide	Downstream Sites St. Vrain F-20	Downstream Sites S. Platte R-10	Upstream Sites St. Vrain A-21	Upstream Sites S. Platte F-19	Effluent Goosequill A-25
Cs-134	< 2.4	< 2.0	< 3.5	< 2.0	< 1.7
Cs-137	4.4 (3.5)*	3.1 (2.9)	< 4.4	< 2.4	< 2.1
Zr-95	< 5.8	5.3 (5.5)	< 8.0	< 4.7	< 4.4
Nb-95	< 2.1	< 1.9	3.6 (3.9)	< 1.8	< 1.6
Co-58	< 2.3	< 1.9	< 3.4	< 1.8	< 1.5
Mn-54	< 2.4	< 2.0	< 3.6	< 2.0	< 1.7
Zn-65	< 6.5	< 5.6	< 10.0	< 5.3	< 4.7
Fe-59	< 5.5	< 4.8	< 8.4	< 4.6	< 5.0
Co-60	< 2.6	< 2.0	< 3.5	< 2.2	< 1.6
Ba-140	< 3.9	< 3.2	< 5.7	< 3.3	6.1 (7.3)
La-140	< 4.4	< 3.7	< 6.5	< 3.7	7.0 (8.4)

*1.96σ (Due to Counting Statistics)

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

Collection Date: 2/09/91

Radio -nuclide	Downstream Sites St. Vrain F-20	Downstream Sites S. Platte R-10	Upstream Sites St. Vrain A-21	Upstream Sites S. Platte F-19	Effluent Goosequill A-25
Cs-134	< 1.5	< 3.0	< 2.1	< 2.0	< 1.0
Cs-137	3.1 (2.2)*	< 3.6	< 2.6	4.1 (2.9)	2.6 (1.5)
Zr-95	< 3.3	< 6.6	< 4.6	< 4.6	< 2.5
Nb-95	< 1.4	< 2.8	< 1.9	< 1.9	< 0.90
Co-58	< 1.4	< 2.8	< 2.1	< 2.0	< 1.1
Mn-54	< 1.5	< 3.0	< 2.1	< 2.0	1.1 (1.2)
Zn-65	< 4.2	< 8.4	< 5.8	< 5.9	< 2.8
Fe-59	< 3.6	< 7.4	< 5.0	< 4.9	< 2.3
Co-60	< 1.5	< 2.9	< 2.1	< 1.9	< 0.98
Ba-140	< 2.4	< 6.6	< 5.2	< 4.5	< 3.5
La-140	< 2.8	< 7.6	< 6.0	< 5.1	< 4.1

*1.96σ (Due to Counting Statistics)

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

Collection Date: 3/09/91

Radio -nuclide	Downstream Sites St. Vrain F-20	Downstream Sites S. Platte R-10	Upstream Sites St. Vrain A-21	Upstream Sites S. Platte F-19	Effluent Goosequill A-25
Cs-134	< 1.2	< 2.2	< 2.6	< 1.3	< 3.3
Cs-137	< 1.5	< 2.7	5.3 (3.7)*	< 1.6	6.6 (4.5)
Zr-95	< 2.9	< 4.8	< 5.5	< 2.8	< 8.3
Nb-95	< 1.1	< 2.2	< 2.5	< 1.2	< 3.0
Co-58	< 1.1	< 2.2	< 2.5	< 1.2	< 3.0
Mn-54	< 1.3	< 2.2	< 2.5	1.5 (1.6)	4.1 (3.8)
Zn-65	< 3.4	< 7.7	< 8.7	< 3.8	< 8.9
Fe-59	< 2.8	< 5.1	8.6 (7.6)	< 4.3	< 7.3
Co-60	< 1.3	< 2.1	< 2.4	< 1.3	< 2.9
Ba-140	7.8 (8.8)	< 3.6	< 6.4	< 2.0	< 4.8
La-140	9.0 (10)	< 4.2	< 7.3	< 2.3	< 5.5

*1.96σ (Due to Counting Statistics)

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

Collection Date: 4/13/91

	Downstream Sites		Upstream Sites		Effluent
Radio -nuclide	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19	Goosequill A-25
Cs-134	< 2.2	< 3.0	< 2.4	< 3.5	< 2.0
Cs-137	< 2.6	< 3.7	< 2.9	< 4.2	< 2.4
Zr-95	< 4.6	< 6.9	< 5.6	< 8.6	< 4.6
Nb-95	< 2.1	< 3.1	< 2.2	< 3.1	< 1.9
Co-58	< 2.0	4.3 (3.5)*	< 2.2	< 3.2	< 1.8
Mn-54	< 2.1	< 3.0	< 2.4	< 3.5	< 2.0
Zn-65	< 6.5	< 9.3	< 6.7	< 9.6	< 5.7
Fe-59	< 5.3	< 7.5	< 5.6	< 8.5	< 4.6
Co-60	< 2.1	< 3.1	< 2.6	< 3.7	< 2.1
Ba-140	< 3.4	< 6.3	< 5.2	< 5.6	< 3.2
La-140	< 3.9	< 7.2	< 5.9	< 6.5	< 3.7

*1.96σ (Due to Counting Statistics)

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

Collection Date: 5/11/91

Radio -nuclide	Downstream Sites St. Vrain F-2C	Downstream Sites S. Platte R-10	Upstream Sites St. Vrain A-21	Upstream Sites S. Platte F-19	Effluent Goosequill A-25
Cs-134	< 2.0	< 1.5	< 2.4	< 1.8	< 1.2
Cs-137	< 2.4	< 1.9	< 2.9	< 2.2	3.4 (1.7)
Zr-95	5.5 (5.6)*	< 3.3	< 5.6	< 4.2	< 2.5
Nb-95	< 1.8	< 1.4	< 2.0	< 1.6	< 1.0
Co-58	< 1.9	< 1.5	< 2.1	< 1.6	< 1.2
Mn-54	< 2.0	< 1.5	< 2.3	< 1.8	< 1.1
Zn-65	< 5.4	< 4.1	< 6.3	< 4.9	< 3.1
Fe-59	< 4.6	< 3.5	< 6.2	< 4.6	< 3.3
Co-60	< 1.9	2.4 (1.8)	< 2.5	< 1.9	< 1.1
Ba-140	< 4.8	< 3.5	< 3.8	< 2.9	5.5 (5.1)
La-140	< 5.5	< 4.0	< 4.4	< 3.4	6.3 (5.9)

*1.96σ (Due to Counting Statistics)

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

Collection Date: 6/07/91

Radio -nuclide	Downstream Sites St. Vrain F-20	Downstream Sites S. Platte R-10	Upstream Sites St. Vrain A-21	Upstream Sites S. Platte F-19	Effluent Goosequill A-25
Cs-134	< 1.7	< 2.5	< 2.0	< 3.0	< 1.7
Cs-137	< 2.1	< 3.0	< 2.5	4.3 (4.4)*	2.6 (2.4)
Zr-95	< 3.7	< 5.4	< 4.7	< 7.0	< 3.6
Nb-95	< 1.6	< 2.3	< 1.8	< 2.7	< 1.5
Co-58	< 1.6	< 2.3	< 2.0	< 3.0	< 1.9
Mn-54	< 1.7	< 2.4	< 2.0	< 3.0	< 1.7
Zn-65	< 4.6	< 6.9	< 5.6	< 7.9	< 4.3
Fe-59	< 3.8	< 6.3	8.5 (6.3)	< 6.9	< 5.3
Co-60	< 1.7	< 2.5	< 2.1	< 3.3	< 1.6
Ba-140	< 2.7	< 6.5	< 3.3	< 4.9	< 2.6
La-140	< 3.1	< 7.4	< 3.8	< 5.6	< 3.0

*1.96σ (Due to Counting Statistics)

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

Collection Date: 7/12/91

Radio -nuclide	Downstream Sites		Upstream Sites		Effluent
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19	Goosequill A-25
Cs-134	< 2.0	< 2.0	< 2.3	< 1.7	< 2.2
Cs-137	< 2.4	< 2.4	< 2.9	2.8 (2.4)*	< 2.6
Zr-95	< 4.6	< 4.3	< 5.3	< 3.7	< 5.0
Nb-95	< 1.8	< 1.7	< 2.1	< 1.5	< 1.9
Co-58	< 1.8	< 1.8	< 2.2	< 1.6	< 2.5
Mn-54	< 2.0	< 1.9	< 2.3	< 1.7	< 2.2
Zn-65	< 5.4	< 5.4	< 6.3	< 4.5	< 5.7
Fe-59	< 4.6	< 4.6	< 5.3	< 3.9	< 4.9
Co-60	< 2.1	< 1.9	2.7 (2.9)	< 1.6	< 2.3
Ba-140	< 3.2	< 3.1	< 5.4	< 2.7	< 3.5
La-140	< 3.7	< 3.5	< 6.2	< 3.1	< 4.0

*1.96σ (Due to Counting Statistics)

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

Collection Date: 8/09/91

Radio -nuclide	Downstream Sites St. Vrain F-20	Downstream Sites S. Platte R-10	Upstream Sites St. Vrain A-21	Upstream Sites S. Platte F-19	Effluent Goosequill A-25
Cs-134	< 1.9	< 2.0	< 2.3	< 2.3	< 2.4
Cs-137	3.0 (2.7)*	< 2.4	4.9 (3.3)	< 2.9	< 2.9
Zr-95	< 4.1	< 4.2	< 5.2	< 5.3	< 6.6
Nb-95	< 1.7	< 1.8	< 2.0	< 2.1	< 2.2
Co-58	< 1.7	< 1.8	< 2.1	< 2.1	< 2.2
Mn-54	< 1.9	< 1.9	3.0 (2.5)	< 2.3	< 2.4
Zn-65	< 5.2	< 5.6	< 5.9	< 6.4	< 6.3
Fe-59	< 4.3	< 4.6	< 5.3	< 5.5	< 5.6
Co-60	< 1.9	< 1.9	< 2.4	< 2.5	< 2.6
Ba-140	< 3.0	< 3.1	< 3.8	5.3 (4.5)	< 3.9
La-140	< 3.4	< 3.5	< 4.4	6.1 (5.2)	< 4.4

*1.96σ (Due to Counting Statistics)

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

Collection Date: 9/14/91

Radio -nuclide	Downstream Sites St. Vrain F-20	Downstream Sites S. Platte R-10	Upstream Sites St. Vrain A-21	Upstream Sites S. Platte F-19	Effluent Goosequill A-25
Cs-134	< 1.9	< 3.1	< 2.0	< 2.1	< 1.2
Cs-137	3.8 (2.7)*	< 3.7	4.5 (2.9)	< 2.5	< 1.4
Zr-95	< 4.1	< 6.6	< 4.7	< 4.5	< 2.5
Nb-95	< 1.7	< 2.7	1.8	< 2.0	< 1.0
Co-58	< 1.7	< 2.8	< 1.9	< 1.9	< 1.1
Mn-54	< 1.9	< 2.9	< 2.0	< 2.0	< 1.2
Zn-65	< 5.0	< 7.4	< 5.4	< 6.0	< 3.1
Fe-59	< 4.3	< 6.9	7.3 (5.8)	< 5.1	< 2.7
Co-60	6.8 (2.4)	< 3.0	< 2.1	< 2.0	< 1.1
Ba-140	< 4.9	< 4.6	< 4.2	< 3.3	< 1.8
La-140	< 5.7	< 5.3	< 4.9	< 3.8	< 2.0

*1.96σ (Due to Counting Statistics)

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

Collection Date: 10/12/91

Radio -nuclide	Downstream Sites St. Vrain F-20	Downstream Sites S. Platte R-10	Upstream Sites St. Vrain A-21	Upstream Sites S. Platte F-19	Effluent Goosequill A-25
Cs-134	2.2 (2.3)*	< 2.0	< 2.4	< 2.2	< 1.1
Cs-137	4.0 (2.7)	< 2.5	< 3.0	< 2.6	< 1.4
Zr-95	< 4.4	< 5.0	< 5.6	< 4.7	< 3.4
Nb-95	< 1.8	< 1.9	< 2.1	< 2.0	< 1.1
Co-58	< 1.8	< 2.0	< 2.4	< 2.0	< 1.3
Mn-54	3.2 (2.3)	< 2.1	< 2.4	< 2.1	1.6 (1.4)
Zn-65	< 5.3	< 5.4	< 6.6	< 5.9	< 3.1
Fe-59	< 4.3	< 4.6	< 5.6	< 5.3	< 3.8
Co-60	< 1.9	< 2.2	3.2 (3.1)	< 2.1	5.0 (1.5)
Ba-140	< 4.5	< 3.3	< 3.9	< 3.3	< 6.5
La-140	< 5.2	< 3.8	< 4.4	< 3.8	< 7.5

*1.96σ (Due to Counting Statistics)

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

Collection Date: 11/09/91

Radio -nuclide	Downstream Sites		Upstream Sites		Effluent
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19	Goosequill A-25
Cs-134	< 1.9	< 2.3	< 2.1	< 2.0	< 2.1
Cs-137	3.3 (2.7)*	< 2.8	2.8 (3.0)	3.4 (2.9)	< 2.6
Zr-95	< 4.4	< 5.8	< 4.6	< 4.7	< 4.9
Nb-95	< 1.7	< 2.2	< 1.9	< 1.8	< 1.9
Co-58	< 1.9	< 2.3	< 2.1	< 1.9	< 1.9
Mn-54	< 1.9	< 2.3	< 2.1	< 1.9	< 2.1
Zn-65	< 4.9	< 6.2	< 5.5	< 5.4	< 5.9
Fe-59	< 4.3	< 6.1	< 4.7	< 5.2	< 6.7
Co-60	4.0 (2.4)	< 2.4	< 2.0	< 1.9	< 2.3
Ba-140	< 5.8	< 3.7	< 3.3	< 5.0	< 3.4
La-140	< 6.6	< 4.3	< 3.8	< 5.3	< 3.9

*1.96σ (Due to Counting Statistics)

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

Collection Date: 12/14/91

Radio-nuclide	Downstream Sites		Upstream Sites		Effluent
	St. Vrain F-20	S. Platte R-10	St. Vrain A-21	S. Platte F-19	Goosequill A-25
Cs-134	< 2.3	< 2.2	< 2.5	< 2.1	< 2.2
Cs-137	2.9 (3.4)*	6.0 (3.1)	< 3.0	< 2.6	< 2.7
Zr-95	< 5.5	< 5.1	< 5.8	< 4.8	< 5.1
Nb-95	< 2.2	< 2.0	< 2.2	< 1.9	< 2.0
Co-58	< 2.6	< 2.4	< 2.3	< 1.9	< 2.0
Mn-54	2.7 (2.9)	< 2.2	3.6 (3.1)	2.7 (2.6)	< 2.2
Zn-65	< 6.4	< 5.9	< 6.8	< 5.7	< 6.0
Fe-59	< 5.4	< 6.8	< 5.7	< 4.8	< 4.9
Co-60	< 2.5	< 2.3	< 2.6	< 2.3	< 2.4
Ba-140	< 3.8	< 3.5	< 4.0	< 3.3	< 3.5
La-140	< 4.4	< 4.1	< 4.6	< 3.8	< 4.1

*1.96σ (Due to Counting Statistics)

3. Ground Water

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, a well at a personal residence in the town of Milliken. Table II.C.6 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.

Table II.C.7 shows tritium concentrations in the same well water samples The results indicate short-lived contamination of the aquifer supplying F-16 well. This well is not used for drinking water purposes and therefore dose commitment calculations are not warranted. Figure II.C.1 shows measured tritium concentrations in the F-16 well since 1984. To test the mean life time of tritium in the aquifer we have initiated weekly sampling of this site beginning early in 1991. The mean lifetime of tritium in the F-16 aquifer appears to be very short. See Figure II.C.2.

For comparison purposes we include Table II.C.8 which lists the Maximum Permissible Concentrations in drinking water from 10CFR20.

Table II.C.6 Radionuclide Concentrations in Ground Water. (pCi/L)

Radio-nuclide	1st Quarter 16 FEB 91		2nd Quarter 11 MAY 91		3rd Quarter 09 AUG 91		4th Quarter 09 NOV 91	
	F-16	R-5	F-16	R-5	F-16	R-5	F-16	R-5
Cs-134	< 3.4	< 2.2	< 1.8	< 2.1	< 2.1	< 2.0	< 2.2	< 2.1
Cs-137	7.7 (4.6)*	6.5 (3.2)	< 2.2	4.1 (3.1)	3.7 (3.1)	< 2.4	< 2.7	< 2.6
Zr-95	< 6.9	< 4.9	< 4.2	< 4.8	< 4.7	< 4.7	< 5.7	< 4.5
Nb-95	< 3.1	< 2.1	< 1.7	< 2.0	< 2.1	< 1.9	< 2.2	< 2.0
Co-58	< 3.1	< 2.0	< 1.7	< 1.9	< 2.0	< 1.9	< 2.2	< 2.1
Mn-54	< 3.1	< 2.2	< 1.8	< 2.1	4.0 (2.6)	< 2.0	< 2.2	< 2.1
Zn-65	< 10.0	< 7.5	< 5.1	< 6.5	< 6.3	< 5.6	< 5.8	< 5.8
Fe-59	< 7.8	< 5.2	< 4.3	< 5.0	< 5.1	< 4.6	< 5.0	< 4.8
Co-60	< 3.0	< 2.2	< 1.7	< 2.2	2.7 (2.4)	< 2.1	3.1 (2.7)	< 2.1
Ba-140	< 6.5	< 4.4	< 2.8	< 3.4	< 3.7	< 3.3	< 6.4	< 3.3
La-140	< 7.5	< 5.0	< 3.3	< 3.9	< 4.2	< 3.7	< 7.4	< 3.8

*1.96σ (Due to Counting Statistics)

Table II.C.7 Tritium in Ground Water 1991 . pCi/L

First Quarter Collected: 02/09		Second Quarter Collected: 05/11		Third Quarter Collected: 08/09		Fourth Quarter Collected: 11/09	
F-16	R-5	F-16	R-5	F-16	R-5	F-16	R-5
<400	<400	<390	<390	2300(430)*	<400	1600(430)	<400

* 1.96 σ (Due to counting statistics.)

Figure II.C.1

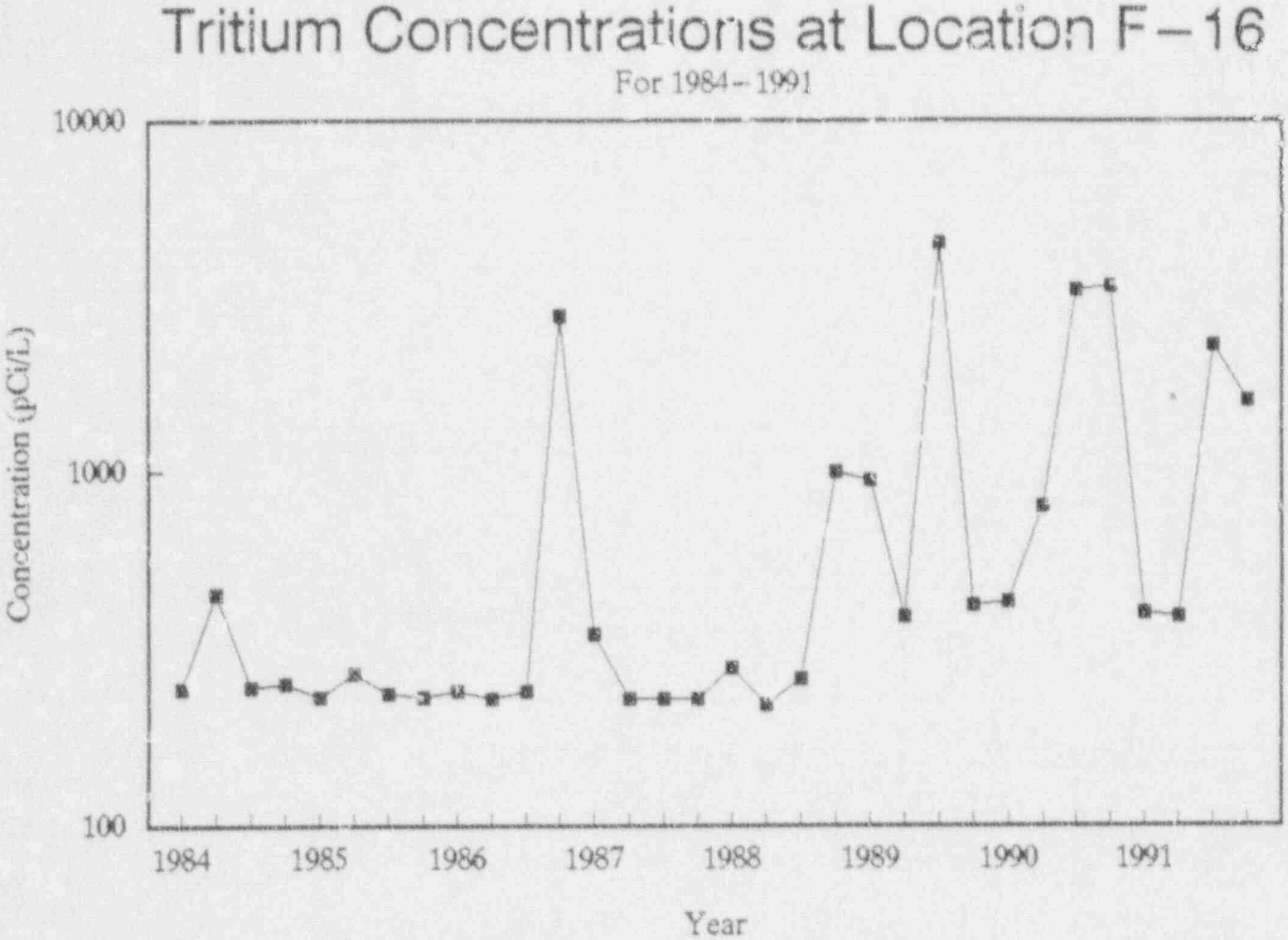

Tritium Concentrations at Location F-16
For 1984-1991
10000
1000
100
Concentration (pCi/L)
1984
1985
1986
1987
1988
1989
1990
1991
Year

Figure II.C.2

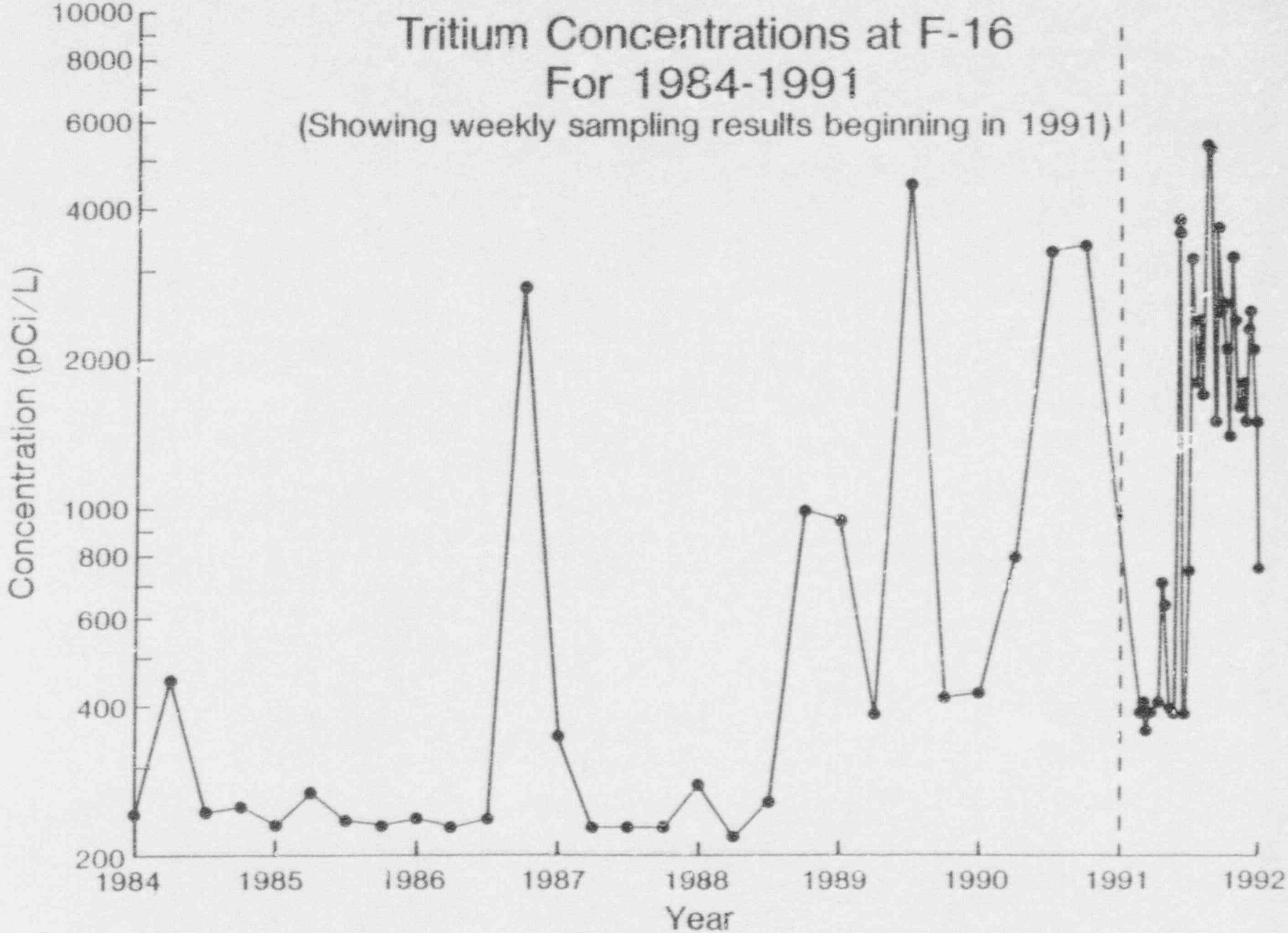

Tritium Concentrations at F-16
For 1984-1991
(Showing weekly sampling results beginning in 1991)
Concentration (pCi/L)
10000
8000
6000
4000
2000
1000
800
600
400
200
1984
1985
1986
1987
1988
1989
1990
1991
1992
Year

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.D. Milk

The dairy food chain is the critical pathway for possible radiation dose commitment around any nuclear facility. This is true for both chronic and acute releases. 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. A three liter milk sample is counted for determination of Cs-137, Cs-134 and Ba-La-140. To measure I-131 at the required LLD of 1.0 pCi/L, an 18 liter sample is concentrated by anion exchange and the resin counted by gamma-ray spectroscopy. The method of treating the milk is modified from that of McCurdy and Mellor, Health Physics 38: 203-213, 1980.

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 radius, 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 in the milking herd are never on pasture but 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 1991, elevated concentrations of I-131 were again consistently observed only at site A-22. The source of this I-131 is from nuclear medicine thyroid therapy practice in the Denver hospitals. The releases enter the S. Platte River just North of Denver. A-22 dairy uses irrigation ditch water for its herd during the summer and fall 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 REMP summary report. A manuscript describing this observation and the magnitude of the I-131 concentrations has been submitted for publication in the Health Physics Journal. Note that A-22 drops out of the sampling program each year in order to meet milk collection system quotas.

K-natural, as measured by K-40, is extremely constant in milk. The mean literature value for cow milk 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.

Table II.D.2 lists measured tritium concentrations in milk. Significant elevated tritium concentrations in milk due to reactor effluents have never been observed during the operational or defueling phase 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 or defueling phases of Fort St. Vrain.

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

LOCATION	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	1/12/91	1/05/91	h	1/05/91	1/12/91	1/12/91	1/12/91
I-131	< 0.49	< 0.29	h	< 0.33	< 0.43	< 0.21	< 0.5
Cs-134	< 2.1	< 2.1	h	< 2.7	< 3.5	< 1.7	< 2.3
Cs-137	< 2.6	< 2.5	h	< 3.2	< 5.1	4.1 (2.9)*	< 3.5
Ba-140	< 3.4	< 4.3	h	< 4.2	< 5.1	< 3.3	< 3.5
La-140	< 3.9	< 4.9	h	< 4.8	< 5.9	< 3.8	< 4.0
Collection Date	2/09/91	2/09/91	h	2/02/91	2/09/91	2/09/91	2/02/91
I-131	< 0.35	< 0.4	h	< 0.25	< 0.44	< 0.23	< 0.17
Cs-134	3.0 (2.8)	< 2.5	h	< 3.4	< 2.3	< 3.7	< 2.4
Cs-137	< 3.5	< 3.1	h	< 4.9	< 3.3	< 4.4	4.2 (4.1)
Ba-140	< 3.4	< 5.1	h	< 4.7	< 4.2	< 5.9	< 4.2
La-140	< 3.9	< 5.9	h	< 5.5	< 4.9	< 6.8	< 4.8
Collection Date	3/02/91	3/09/91	3/02/91	3/02/91	3/09/91	3/09/91	3/02/91
I-131	< 0.31	< 0.46	< 0.27	< 0.4	< 0.5	< 0.41	< 0.48
Cs-134	< 1.5	2.5 (2.8)	< 2.5	< 2.4	< 4.0	< 2.3	< 2.7
Cs-137	2.3 (2.3)	< 3.4	< 3.6	< 3.5	< 5.9	3.6 (4.0)	4.4 (3.9)
Ba-140	< 2.5	< 3.4	< 3.5	9.4 (5.3)	< 5.9	< 4.6	< 4.3
La-140	< 2.8	< 3.9	< 4.1	11.0 (6.1)	< 6.8	< 5.3	< 5.0

h - sample not collected (at dairy owner's request)

* 1.96σ (Due to Counting Statistics)

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

LOCATION	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	4/06/91	4/13/91	4/06/91	4/06/91	4/13/91	4/13/91	4/06/91
I-131	< 0.31	< 0.45	< 0.37	< 0.45	< 0.5	< 0.35	< 0.37
Cs-134	< 2.3	< 2.4	< 2.3	< 2.5	< 2.6	< 2.3	< 2.4
Cs-137	< 3.5	< 3.7	5.9 (4.0)	< 3.1	< 3.2	< 3.5	< 3.5
Ba-140	4.0 (4.7)*	< 4.3	< 4.3	< 4.0	< 4.9	< 4.3	< 4.4
La-140	4.5 (5.4)	< 4.9	< 5.0	< 4.6	< 5.6	< 4.9	< 5.0
Collection Date	5/04/91	5/11/91	5/04/91	5/04/91	5/11/91	5/18/91	5/04/91
I-131	0.48 (0.53)	< 0.28	2.3 (0.65)	< 0.41	< 0.48	< 0.19	< 0.34
Cs-134	< 2.5	< 2.3	2.8 (3.1)	< 2.6	< 2.5	< 2.7	< 2.3
Cs-137	< 3.1	< 3.4	< 3.1	4.2 (3.7)	< 3.1	< 3.2	< 3.5
Ba-140	< 4.1	< 4.2	< 5.3	< 4.1	< 4.0	< 4.3	4.6 (5.3)
La-140	< 4.7	< 4.8	< 6.1	< 4.7	< 4.6	< 4.9	5.3 (6.1)
Collection Date	5/18/91	5/25/91	5/18/91	5/18/91	5/25/91	5/25/91	5/18/91
I-131	< 0.32	< 0.35	< 0.47	< 0.29	< 0.43	< 0.43	< 0.5
Cs-134	< 2.2	< 2.2	2.4 (2.3)	2.2 (2.6)	< 2.4	< 2.4	< 1.8
Cs-137	< 3.2	< 3.2	3.1 (2.7)	< 3.2	< 3.0	< 2.8	2.6 (3.1)
Ba-140	< 4.4	< 3.1	< 3.1	< 3.1	< 4.0	< 3.7	< 3.7
La-140	< 5.0	< 3.6	< 3.5	< 3.6	< 4.5	< 4.3	< 4.2

* 1.96 σ (Due to Counting Statistics.)

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

LOCATION	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	6/01/91	6/07/91	6/01/91	6/01/91	6/07/91	6/07/91	6/08/91
I-131	< 0.3	< 0.3	2.1 (.62)*	< 0.3	< 0.4	< 0.5	0.4 (.43)
Cs-134	< 2.2	< 2.3	< 3.6	< 2.3	< 2.8	< 3.1	< 2.3
Cs-137	< 3.3	< 3.4	< 5.1	< 3.3	5.6 (5.0)	< 3.9	< 3.4
Ba-140	< 3.2	< 4.4	< 6.4	< 3.3	< 4.1	< 5.1	< 4.2
La-140	< 3.6	< 5.0	< 7.4	< 3.8	< 4.8	< 5.9	< 4.8
Collection Date	6/14/91	6/21/91	h	6/14/91	6/21/91	6/21/91	6/21/91
I-131	< 0.35	< 0.49	h	< 0.45	< 0.33	< 0.18	< 0.36
Cs-134	< 2.5	< 2.0	h	< 2.5	< 2.0	< 2.0	< 1.5
Cs-137	< 3.0	< 2.4	h	< 3.0	< 2.9	< 2.9	< 1.8
Ba-140	< 4.1	< 3.1	h	< 5.0	< 6.5	< 2.8	< 3.6
La-140	< 4.8	< 3.6	h	< 5.7	< 7.5	< 3.2	< 4.1
Collection Date	7/12/91	7/12/91	h	7/12/91	7/12/91	7/19/91	7/12/91
I-131	< 0.49	< 0.34	h	< 0.27	< 0.19	< 0.2	< 0.34
Cs-134	< 2.4	< 1.9	h	< 2.1	< 2.5	< 2.5	< 2.7
Cs-137	< 3.6	< 2.8	h	4.9 (3.0)	< 3.1	< 2.9	< 3.3
Ba-140	< 3.5	< 2.7	h	< 3.3	< 4.1	< 3.9	< 4.8
La-140	< 4.1	< 3.2	h	< 3.8	< 4.7	< 4.5	< 5.6

* 1.96σ (Due to Counting Statistics)

h - sample not collected (at dairy owner's request)

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

LOCATION	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	7/19/91	7/26/91	h	7/19/91	7/26/91	7/26/91	7/26/91
I-131	< 0.36	< 0.4	h	< 0.42	< 0.44	< 0.2	< 0.5
Cs-134	< 2.4	< 2.4	h	< 2.3	< 2.3	< 2.3	3.1 (2.7)
Cs-137	4.1 (3.6)*	4.2 (3.5)	h	< 3.3	< 3.3	< 3.4	3.7 (3.8)
Ba-140	< 4.8	< 5.0	h	< 3.7	< 4.5	< 3.4	< 3.2
La-140	< 5.5	< 5.7	h	< 4.2	< 5.2	< 3.9	< 3.6
Collection Date	8/09/91	8/02/91	h	8/09/91	8/09/91	8/09/91	8/02/91
I-131	< 0.47	< 0.41	h	< 0.43	< 0.2	< 0.44	< 0.22
Cs-134	< 2.3	< 2.0	h	< 1.9	< 2.0	< 2.6	< 3.3
Cs-137	3.5 (4.1)	3.7 (2.9)	h	4.1 (3.3)	3.5 (2.9)	< 3.1	5.3 (5.9)
Ba-140	< 3.3	< 3.9	h	< 3.5	< 3.2	< 4.2	< 4.9
La-140	< 3.8	< 4.5	h	< 4.0	< 3.6	< 4.8	< 5.6
Collection Date	8/16/91	8/23/91	h	8/16/91	8/23/91	8/31/91	8/16/91
I-131	< 0.2	< 0.48	h	< 0.29	< 0.22	< 0.16	< 0.18
Cs-134	< 2.0	< 2.3	h	< 2.3	< 2.5	< 2.2	< 2.1
Cs-137	< 2.9	5.6 (4.0)	h	6.4 (4.1)	< 3.1	3.6 (3.2)	< 2.7
Ba-140	< 2.8	< 3.7	h	< 3.4	< 4.4	< 3.5	< 3.6
La-140	< 3.2	< 4.2	h	< 4.0	< 5.1	< 4.0	< 4.2

* 1.96 σ (Due to Counting Statistics.)

h - sample not collected (at dairy owner's request)

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

LOCATION	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	9/07/91	9/14/91	h	9/07/91	9/21/91	9/14/91	9/14/91
I-131	< 0.4	< 0.5	h	< 0.3	< 0.3	< 0.2	0.5 (.49)
Cs-134	< 2.3	< 2.5	h	< 2.0	< 1.1	< 2.3	< 2.3
Cs-137	< 2.9	< 3.0	h	< 2.9	1.6 (1.9)	< 3.4	< 3.3
Ba-140	< 3.7	< 4.0	h	< 3.7	2.2 (2.5)	< 3.4	< 3.4
La-140	< 4.3	< 4.6	h	< 4.3	2.5 (2.9)	< 3.9	< 3.9
Collection Date	9/21/91	9/28/91	h	9/21/91	9/28/91	9/28/91	9/28/91
I-131	< 0.32	< 0.22	h	< 0.44	< 0.5	< 0.48	< 0.48
Cs-134	< 2.4	< 2.4	h	1.2 (1.4)	< 2.4	< 2.6	< 2.4
Cs-137	< 3.5	< 3.5	h	1.9 (1.7)	5.6 (4.1)	< 3.1	3.5 (3.4)
Ba-140	< 4.5	< 3.4	h	< 2.6	< 3.4	< 4.2	< 4.5
La-140	< 5.2	< 3.9	h	< 3.0	< 3.9	< 4.8	< 5.1
Collection Date	10/05/91	10/05/91	h	10/09/91	10/12/91	10/12/91	10/19/91
I-131	< 0.26	< 0.[illegible]	h	< 0.44	< 0.49	< 0.39	< 0.31
Cs-134	< 2.7	< 2.0	h	< 2.5	< 2.6	< 2.7	< 2.0
Cs-137	< 3.2	< 3.0	h	< 3.0	< 3.6	< 3.2	2.9 (3.0)
Ba-140	< 4.3	7.5 (5.3)	h	< 3.9	< 3.7	< 4.2	< 3.3
La-140	< 5.0	8.5 (6.1)	h	< 4.5	< 4.3	< 4.8	< 3.8

* 1.96σ (Due to Counting Statistics)

h - sample not collected (at dairy owner's request)

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

LOCATION	A-6	A-18	A-22	A-23	A-24	A-26	R-8
Collection Date	11/02/91	11/02/91	11/02/91	11/02/91	11/09/91	11/09/91	11/09/91
I-131	0.47 (0.53)*	< 0.39	h	< 0.5	< 0.3	< 0.2	< 0.32
Cs-134	< 2.4	< 2.5	h	< 2.2	< 1.8	< 4.1	< 3.4
Cs-137	< 3.4	< 3.0	h	< 3.3	3.6 (3.1)	< 5.8	< 4.9
Ba-140	< 4.2	< 3.9	h	< 3.2	< 2.6	< 6.0	< 4.9
La-140	< 4.8	< 4.5	h	< 3.7	< 2.9	< 6.9	< 5.7
Collection Date	12/14/91	12/07/91	12/07/91	12/07/91	12/14/91	12/21/91	12/14/91
I-131	< 0.33	< 0.34	h	< 0.34	< 0.46	< 0.44	< 0.33
Cs-134	< 2.5	< 2.4	h	< 2.9	< 2.5	3.1 (3.2)	< 1.5
Cs-137	< 3.0	< 2.9	h	< 3.4	< 3.0	< 3.2	3.2 (2.2)
Ba-140	< 3.9	< 3.9	h	< 4.6	< 4.1	< 4.3	< 2.5
La-140	< 4.5	< 4.5	h	< 5.3	< 4.7	< 4.9	< 2.8

* 1.96 σ (Due to Counting Statistics)

h - sample not collected (at dairy owner's request)

Table II.D.2 Tritium Concentrations in Milk. (pCi/L)

1991

Collection Date	Adjacent Sites						Reference
	A-6	A-18	A-22	A-23	A-24	A-26	R-8
JANUARY	< 400	< 400	h	< 400	< 400	< 400	< 400
FEBRUARY	< 410	< 410	h	< 410	< 410	< 410	< 410
MARCH	< 400	< 400	< 400	< 400	< 400	< 400	< 400
APRIL	< 400	< 400	< 400	< 400	< 400	< 400	< 400
MAY	< 400	< 400	< 400	< 400	< 400	< 400	< 400
MAY	< 400	< 400	< 400	< 400	< 400	< 400	< 400
JUNE	< 390	< 390	< 390	< 390	< 390	< 390	< 390
JUNE	< 390	< 380	< 380	< 390	< 380	< 380	< 380
JULY	< 390	< 390	h	< 390	< 390	< 390	< 390
JULY	< 390	< 390	h	< 390	< 390	< 390	< 390
AUGUST	< 390	< 400	h	< 390	< 390	< 390	< 400
AUGUST	< 390	< 390	h	< 390	< 390	< 400	< 390
SEPTEMBER	< 350	< 350	h	< 350	< 350	410 (360)*	460 (360)
SEPTEMBER	< 350	< 400	h	< 350	470 (410)	< 400	440 (410)

* 1.96σ (Due to Counting Statistics.)

h - sample not collected (at dairy owner's request)

Table II.D.2 Tritium Concentrations in Milk. (pCi/L)

1991

Collection Date	Adjacent Sites						Reference
	A-6	A-18	A-22	A-23	A-24	A-26	R-8
OCTOBER	580 (410)*	830 (420)	h	600 (410)	< 400	< 400	< 400
NOVEMBER	< 400	< 400	h	570 (420)	< 400	< 400	< 400
DECEMBER	570 (420)	< 400	h	< 400	540 (420)	490 (420)	790 (420)

* 1.96σ (Due to Counting Statistics)

h - sample not collected (at dairy owner's request)

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 date of collection and the results for the 1991 harvest. Two of the food samples showed detectable Cs-137 from past Chernobyl fallout deposition and the one result with positive I-131 is assumed to be a false positive, or due to activity released into the S. Platte river from Denver hospitals. It is not possible to determine the actual source, but in any case it could not be due to Fort St. Vrain effluents. I-131 was never observed in any effluent pathway during the operational phase of the reactor and due to decay there was no I-131 in the core inventory at the sample collection time. 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 9/24/91

Location	Food Type	I-131	Cs-134	Cs-137
A-8	CANTALOUPE	< 12.0	< 12.0	< 14.0
A-9	POTATOES	< 17.0	< 6.5	< 7.8
A-27	TOMATOES	17.0 (16.0)*	< 5.5	12.0 (9.6)
A-28	WATERMELLON	< 12.0	17.0 (14.0)	< 17.0
A-29	CHILI PEPPERS	< 6.8	< 6.9	< 10.0
A-30	CORN	< 11.0	< 12.0	31.0 (20.0)
A-31	PEPPERS	< 21.0	< 7.3	< 8.8
R-12	ONIONS	< 6.8	< 6.9	< 10.0

* 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 1991. The fish were collected by shocking and netting and the composite sample was homogenized without cleaning and analyzed on a wet weight basis. The positive values of Cs-137 were assumed to be due to fallout.

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 Cs-137 clearly due to the Chernobyl fallout. The cesium ions are bound nearly irreversibly by the clay mineral matrix in the sediment. The concentrations observed in 1991 were statistically the same as observed in 1990.

Observation for <u>Corbicula fluminea</u>, 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 at any of the sampling sites of the reactor surface water courses.

Table II.F.1
Radionuclide Concentrations in Fish. (pCi/kg)

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	< 5.6	< 4.3	< 5.7	< 5.5	< 6.0	< 6.3
Cs-137	< 6.6	< 5.2	< 6.7	< 6.2	7.2 (8.4)*	16.0 (8.2)
Co-58	< 5.8	< 4.5	< 5.8	< 5.0	< 5.4	< 6.3
Mn-54	< 5.6	< 4.3	< 5.7	< 5.2	< 5.8	< 6.9
Zn-65	< 15.0	< 12.0	< 16.0	< 15.0	< 17.0	< 21.0
Fe-59	< 8.8	< 8.4	< 9.1	< 8.8	< 15.0	< 10.0
Co-60	< 6.1	< 4.4	< 6.0	< 5.7	< 6.2	< 6.5

* 1.96σ (Due to Counting Statistics)

II.F.2
Radionuclide Concentrations in Sediment from location R10. (pCi/kg)

Radionuclide	Collection Date 6/28/91
Cs-134	< 10.0
Cs-137	54.0 (12.0)*
Radionuclide	**Collection Date 10/19/91**
Cs-134	< 11.0
Cs-137	83.0 (13.0)

* 1.96σ (Due to Counting Statistics)

II.G. Sample Crosscheck Program

To assure both 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	Semiannually
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	Annually

For each radionuclide analysis of a particular medium, three independent measurements are performed and all results are reported to the EPA. It should be noted that during 1989, our laboratory became certified by the EPA for drinking water analysis.

Table II.G.1 gives the EPA crosscheck data for 1991. The EPA uses the parameter, 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 deviation 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 1991 all results except 13 were within the warning level. The results exceeding the warning level have the notation (n) in Table II.G.1.

Table II.G.2 lists independent results for H-3 in water samples split between this laboratory and the laboratory at the Fort St. Vrain Generating Station. The comparison between laboratories in general was acceptable.

Table II.G.3 lists the results of gross beta analyses of the split water samples. The procedural differences between the laboratories were previously investigated and minimized. It is concluded that the differences can be attributed only to total analytical uncertainty.

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.

During 1991 approximately 10% of all laboratory calculations that partly involve technician input were recalculated by a different technician. No input or calculation errors were detected. This result gives further credence to the laboratory results which are not solely computer calculated and listed.

Computer calculations are often recalculated by hand and those done during 1991 were all verified to be correct.

Table II.G.1 EPA Cross-Check Data Summary. 1991.

Date	Radio-nuclide	CSU Value	EPA Value	1 E.L.P.*	Normalized Deviation from known**	
			WATER, TRITIUM (pCi/L)			
Feb 22	H-3	4367	4418	442	-0.20	
Jun 21	H-3	12000	12480	1248	-0.67	
Oct 18	H-3	2700	2454	352	1.21	
			WATER, Alpha/Beta (pCi/L)			
Jan 25	alpha	10.33	5.0	5.0	1.83	
	beta	5.67	5.0	5.0	0.23	
May 17	alpha	11.67	24.0	6.0	-3.56	(1)
	beta	29.00	46.0	5.0	-5.89	(2)
Sep 20	alpha	14.00	10.0	5.0	1.39	
	beta	15.00	20.0	5.0	-1.73	
			WATER, I-131 (pCi/L)			
Feb 15	I-131	77.67	75.0	8.0	0.58	
Aug 09	I-131	18.67	20.0	6.0	-0.38	
			WATER, Performance (pCi/L)			
Apr 16	alpha	23.67	54.0	14.0	-3.75	(3)
	beta	102.00	115.0	17.0	-1.32	
	Cs-134	43.33	24.0	5.0	6.70	(4)
	Cs-137	48.33	25.0	5.0	8.08	(5)
Oct 22	alpha	81.00	82.0	21.0	-0.08	
	beta	45.00	65.0	10.0	-3.46	(6)
	Cs-134	10.67	10.0	5.0	0.23	
	Cs-137	15.67	11.0	5.0	1.62	
			WATER, Gamma (pCi/L)			
Feb 8	Co-60	38.33	40.0	5.0	-0.58	
	Zn-65	133.00	149.0	15.0	-1.85	
	Cs-134	4.67	8.0	5.0	-1.15	
	Cs-137	10.67	8.0	5.0	0.92	
	Ba-133	16.33	75.0	8.0	-12.70	(7)
Jun 07	Co-60	9.00	10.0	5.0	-0.35	
	Zn-65	83.00	108.0	11.0	-3.94	(8)
	Cs-134	11.67	15.0	5.0	-1.15	
	Cs-137	15.33	14.0	5.0	0.46	
	Ba-133	16.33	62.0	6.0	-13.1[illegible]	(9)
Oct 4	Co-60	21.33	29.0	5.0	-2.66	
	Zn-65	42.67	73.0	7.0	-7.51	(10)
	Cs-134	7.67	10.0	5.0	-0.81	
	Cs-137	10.00	10.0	5.0	0.00	
	Ba-133	83.67	98.0	10.0	-2.48	

* 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.1 EPA Cross-Check Data Summary, 1991, (continued)

Date	Radio-nuclide	CSU Value	EPA Value	1 E.L.P.*	Normalized Deviation from known**	
			MILK (pCi/L)			
Apr 26	I-131	73.33	60.0	6.0	3.85	(11)
	Cs-137	52.33	49.0	5.0	1.15	
	K-40	1521.67	1650.0	83.0	-2.68	(12)
			AIR FILTERS (pCi/L)			
Mar 29	alpha	22.67	25.0	6.0	-0.67	
	beta	124.00	124.0	6.0	0.00	
	Cs-137	99.00	40.0	5.0	20.44	(13)
Aug 30	alpha	22.67	25.0	5.0	-0.67	
	beta	90.33	92.0	10.0	-0.29	
	Cs-137	30.67	30.0	5.0	0.23	

* 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 and Public Service Company. 1991

Collection Date	Sample Location	Tritium Concentrations pCi/L	
		CSU	PSC
Jan 12	A-25	3500 (460)*	3970 (506)
Jan 12	A-21	<400	<366
Jan 2	E-41	<400	<366
Feb 09	A-25	2300 (450)	2620 (476)
Feb 09	A-21	<410	<358
Feb 13	E-41	<400	<358
Mar 09	A-25	1100 (400)	1620 (456)
Mar 09	A-21	<390	<355
Mar 13	E-41	<390	<355
Apr 13	A-25	690 (400)	1400 (448)
Apr 13	A-21	<400	<352
Apr 03	E-41	<400	523 (432)
May 11	A-25	<400	<352
May 11	A-21	<390	<352
May 08	E-41	<400	<352
Jun 07	A-25	<390	<361
Jun 07	A-21	<390	<361
Jun 05	E-41	<390	<361
Jul 12	A-25	< 390	<347
Jul 12	A-21	< 380	358
Jul 03	E-41	< 380	<347
Aug 09	A-25	< 400	<357
Aug 09	A-21	< 400	<357
Aug 07	E-41	< 400	<357
Sep 14	A-25	1500 (380)	911 (457)
Sep 14	A-21	380 (360)	<368
Sep 04	E-41	< 400	<368
Oct 12	A-25	1400 (430)	838 (446)
Oct 12	A-21	530 (420)	586 (442)
Oct 02	E-41	< 400	392 (438)
Nov 09	A-25	5700 (480)	5900 (525)
Nov 09	A-21	< 400	<357
Nov 06	E-41	450 (410)	<357
Dec 14	A-25	2300 (450)	1730 (459)
Dec 14	A-21	570 (420)	<357
Dec 04	E-41	< 400	<357

* 1.96σ (Due to Counting Statistics.)

Table II.G.3

Gross Beta Crosscheck Analyses on Split Water Samples Determined by Colorado State University and Public Service Company of Colorado. 1991

Collection Date	Sample Location	Gross Beta Concentrations pCi/L CSU	PSC
Jan 12	A-25	14 (5.9)*	24.00 (8.00)
Jan 12	A-21	9.2 (5.7)	14.00 (7.00)
Jan 2	E-41	11 (5.7)	15.00 (8.00)
Feb 09	A-25	19 (6.2)	11.70 (6.96)
Feb 09	A-21	16 (6.0)	8.16 (6.70)
Feb 20	E-41	15 (5.9)	12.00 (6.89)
Mar 09	A-25	18 (6.1)	8.45 (6.61)
Mar 09	A-21	19 (6.2)	12.40 (6.92)
Mar 13	E-41	18 (6.0)	7.49 (6.58)
Apr 13	A-25	22 (6.4)	20.30 (7.15)
Apr 13	A-21	13 (5.9)	12.50 (6.79)
Apr 03	E-41	13 (5.9)	12.10 (6.63)
May 11	A-25	20 (6.2)	16.80 (6.82)
May 11	A-21	12 (5.9)	13.30 (6.75)
May 08	E-41	11 (5.8)	15.30 (6.79)
Jun 07	A-25	11 (5.8)	< 5.46
Jun 07	A-21	9.7 (5.7)	9.09 (7.06)
Jun 05	E-41	5.3 (5.5)	6.13 (6.89)
Jul 12	A-25	19 (6.1)	16.70
Jul 12	A-21	14 (5.9)	7.94
Jul 03	E-41	2.8 (5.4)	11.20
Aug 09	A-25	14 (5.9)	9.36
Aug 09	A-21	12 (5.9)	12.90
Aug 07	E-41	7.9 (5.6)	10.60
Sep 14	A-25	10 (5.8)	19.30 (7.12)
Sep 14	A-21	13 (6.0)	15.50 (7.03)
Sep 04	E-41	9.9 (5.8)	14.50 (6.87)
Oct 12	A-25	10 (5.8)	9.19 (7.30)
Oct 12	A-21	9.6 (5.8)	<5.82
Oct 02	E-41	10 (5.8)	11.00 (7.52)
Nov 09	A-25	17 (6.1)	<5.40
Nov 09	A-21	9.5 (5.8)	8.91 (7.04)
Nov 06	E-41	12 (5.8)	13.70 (7.26)
Dec 14	A-25	9.1 (5.7)	9.85 (6.64)
Dec 14	A-21	9.8 (5.8)	11.90 (6.81)
Dec 04	E-41	11 (5.8)	11.60 (6.71)

* 1.96σ (Due to Counting Statistics.)

Table II.G.4 Intralaboratory Cross-Check Results (pCi/L).
(Replicate Analysis of Same Sample)

Drinking Water

Radio-nuclide	1st Quarter A	1st Quarter B	2nd Quarter A	2nd Quarter B	3rd Quarter A	3rd Quarter B	4th Quarter A	4th Quarter B
Cs-134	<2.1	<2.2	3.4 (2.7)	<2.7	<2.9	<2.1	<1.9	<2.2
Cs-137	<2.5	5.6 (3.1)*	<2.7	<3.3	<3.4	3.7 (2.9)	3.5 (2.9)	<2.7
Zr-95	<5.3	<4.7	<5.0	<7.0	<6.3	<4.4	<5.2	<5.3
Nb-95	<1.9	<2.1	<2.1	<2.4	<2.7	<1.8	<1.9	<2.1
Co-58	<1.9	<2.3	<2.2	<2.8	<2.9	<2.1	<1.8	<2.2
Mn-54	<2.1	<2.3	<2.2	<2.8	<2.8	<2.1	2.7 (2.4)	2.6 (2.7)
Zn-65	<5.8	<6.5	<6.4	<7.2	<7.9	<5.5	<5.5	<5.9
Fe-59	<5.7	<5.0	<5.2	<7.3	<6.7	<4.7	<4.7	<5.3
Co-60	<2.2	<2.1	<2.3	<2.9	<2.9	<2.0	<2.2	<2.4
Ba-140	<6.4	<3.5	<6.3	<4.4	<4.6	<3.1	<3.3	<3.7
La-140	<7.4	<4.1	<7.2	<5.1	<5.3	<3.6	<3.8	<4.2
Gross Beta	5.6 (2.4)	6.0 (2.4)	4.0 (2.3)	5.6 (2.5)	3.4 (2.3)	3.1 (2.3)	13 (2.8)	11 (2.7)
H-3	<400	<400	<400	<400	<390	<390	<400	<400

Milk

Radio-nuclide	1st Quarter A	1st Quarter B	2nd Quarter A	2nd Quarter B	3rd Quarter A	3rd Quarter B	4th Quarter A	4th Quarter B
Cs-134	<2.3	<2.4	<2.5	<2.3	<2.3	<2.3	<2.0	<2.2
Cs-137	5.9 (4.0)	<2.9	<3.0	<3.3	3.5 (4.1)	5.2 (3.3)	2.9 (3.0)	<3.2
Ba-140	<4.3	<3.8	<4.1	<4.2	<3.3	<3.7	<3.3	<3.1
La-140	<5.0	<4.4	<4.8	<4.9	<3.8	<4.3	<3.8	<3.6
H-3	<400	<400	<400	<400	<390	<390	<400	<400

* 1.96σ (Due to Counting Statistics.)

II.H. Summary and Conclusions

Table II.H.1 summarizes the radiation and environmental radioactivity measurements conducted during 1991 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. environmental monitoring programs (e.g., EPA 520). 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 (except for I-131 at site [illegible]-22) there were no individual measurements that exceeded the Reporting Level (RL) (see Table III.A.3). The Chernobyl fallout was still observable in several 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. The following conclusions seem valid.

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, however, statistically greater than those in Fort Collins. This is due to FSV tritium release. However, the resultant dose commitment is insignificant.

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 only elevated concentrations of the 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. A-25 is directly in the principal effluent route and elevated concentrations should be expected, to correlate with release schedules. Downstream surface water concentrations of tritium have occasionally been elevated, but there is

significant dilution before any human use of this water. During 1991 elevated tritium concentrations were not observed downstream and the mean values for the first and second half of 1991 were not significantly different.

I-131 was observed again in milk samples, but again only from Dairy A-22. Because the reactor did not release any significant fission products during 1991, the source of the I-131 concentrations in milk could not be reactor effluent. It was documented 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 1991. Irrigation water samples confirmed this conclusion.

Cs-137 was also observed in many environmental samples due to the Chernobyl fallout.

Tritium concentrations from well water site F-16 do appear to be increasing with time. This could be due to migration to the aquifer from the farm pond drainage. Typically lateral water movement in western soils is approximately 30 m/year. Weekly sampling was initiated in 1991 to observe the movement more closely, but in any case the

well at F-16 is not used for drinking water purposes and elevated tritium concentrations have not been observed in any food chain sample.

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 above the minimum detectable concentration (MDC) levels. 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 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 the reactor. Since the tritium is released as tritiated water, the dilution by the surrounding hydrosphere is great. Although in 1991, tritium could be detected in the effluent pathway, the mean values of downstream surface water were not statistically greater than upstream concentrations.
2. 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.

3. 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, particularly Cs-137, 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.

4. 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 decommissioning. 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.

During the current defueling phase of the reactor it is concluded that this Radiation Environmental Monitoring Program will be more than adequate to detect and quantify any possible routine or accidental release of radioactivity.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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 (158)	0.3[illegible] [illegible]72/72) (0.20-0.53)	0.39 (68/68) (0.25-0.58)	A-2 WCR42 & WCR25½ 6.8 km	0.46 (4/4) (0.40-0.57)	0.[illegible] (18/18) (0.31-0.53)	0
Air, Particulates (fCi/m^3)	Grossβ (363)	25 (207/207) (0.60-69)		F-7 Farm CR21 & CR34 1.5 km 145°	25 (52/52) (4.9-69)	24 (156/156) (12-69)	0
Gamma Spectrometry							
	Cs-134 (28)	< 2.4		R-3 CSU Vet Hosp. 45 km 330°	3.2 (1/4)	2.6 (3/12) (2.3-3.2)	0
	Cs-137 (28)	1.6 (1/16)		R-4 US 66 & US 287 21 km	1.7 (1/4)	1.5 (3/12) (1.2-1.7)	0
Air, Charcoal (pCi/m^3)	I-131 (363)	31 (8/207) (19-46)		F-7 Farm CR21 & CR34 1.5 km 145°	46 (1/52)	30 (7/156) (17-39)	0
Air, Atmospheric Water Vapor (pCi/m^3)	H-3 (364)	621 (37/208) (430-960)		F-7 Farm CR2[illegible] [illegible] CR34 1.5 km 145°	636 (7/52) (540-780)	583 (24/156) (350-870)	0

[b]Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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
Drinking Water (pCi/L)	Grossβ (52)	5.8 (26/26) (3.1-13)		R-6 Gilcrest City Water 9.3 km 60°	5.8 (26/26) (3.1-13)	0.95 (26/26) (0.44-1.6)	0
	H-3 (52)	618 (6/26) (490-760)		R-6 Gilcrest City Water 9.3 km 60°	618 (6/26) (490-760)	570 (2/26) (410-730)	0
Gamma Spectrometry							
	I-131 (52)	< 0.46		R-3 Ft. Collins City Water 45 km 330°	0.52 (1/26)	0.52 (1/26)	0
	Cs-134 (52)	3.4 (3/26) (2.8-4.0)		R-6 Gilcrest City Water 9.3 km 60°	3.4 (3/26) (2.8-4.0)	2.1 (1/26)	0
	Cs-137 (52)	3.9 (9/26) (1.7-6.0)		R-6 Gilcrest City Water 9.3 km 60°	3.9 (9/26) (1.7-6.0)	3.3 (7/26) (2.2-4.2)	0
	Zr-95 (52)	< 7.2		R-3 Ft. Collins City Water 45 km 330°	4.5 (1/26)	4.5 (1/26)	0
	Nb-95 (52)	< 2.8		---	---	< 2.0	0

[b]Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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
Drinking Water	Co-58 (52)	1.7(1/26)		R-6 Gilcrest City Water 9.3 km 60°	1.7 (1/26)	< 2.8	0
	Mn-54 (52)	2.7 (3/26) (1.9-3.8)		R-3 Ft. Collins City Water 45 km 330°	2.9 (3/26) (2.7-3.3)	2.9 (3/26) (2.7-3.3)	0
	Zn-65 (52)	< 9.0		---	---	---	0
	Fe-59 (52)	7.3 (2/26) (5.3-9.2)		R-6 Gilcrest City Water 9.3 km 60°	7.6 (2/26) (5.3-9.2)	< 6.2	0
	Co-60 (52)	3.8 (1/26)		R-6 Gilcrest City Water 9.3 km 60°	3.8 (1/26)	2.87 (2/26) (2.31-3.23)	0
	Ba-140 (52)	< 7.5		R-3 Ft. Collins City Water 45 km 330°	3.4 (1/26)	3.4 (1/26)	0
	La-140 (52)	< 7.5 (4.6-7.3)		R-3 Ft. Collins City Water 45 km 330°	3.9 (1/26)	3.9 (1/26)	0

[b]Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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)	[illegible]47 (12/36) ([illegible]70-8300)		A-25 Goosequill 2.2 km 2[illegible]	2786 (7/12) (1000-8300)	552 (5/24) (380-860)	0
Gamma Spectrometry							
	Cs-134 (60)	2.2 (1/36)		F-20 St. Vrain 1.5 km 345°	2.2 (1/12)	< 3.5	0
	Cs-137 (60)	3.8 (13/36) (2.6-6.6)		R-10 S. Platte at CO 60 10 km 290°	4.6 (2/12) (3.1-6.0)	4.0 (8/24) (2.8-5.3)	0
	Zr-95 (60)	5.4 (2/36) (5.3-5.5)		F-20 St. Vrain 1.5 km 345°	5.5 (1/12)	< 8.6	0
	Nb-95 (60)	< 3.1		A-21 St. Vrain Bridge 2.4 km 220°	3.6 (1/12)	3.6 (1/24)	0
	Co-58 (60)	4.3 (1/36)		R-10 S. Platte at CO 60 10 km 290°	4.3 (1/12)	< 3.4	[illegible]
	Mn-54 (60)	3.0 (6/36) (1.6-4.1)		A-21 St. Vrain Bridge 2.4 km 220°	3.3 (2/12) (3.0-3.6)	2.3(2/24) (1.5-3.0)	0
	Zn-65 (60)	< 9.6		---	---	< 10	0

[b]Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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)	Gamma Spectrometry						
	Fe-59 (60)	< 7.5		A-21 St. Vrain Bridge 2.4 km 220°	8.1 (3/24) (7.3-8.6)	8.1 (3/24) (7.3-8.6)	0
	Co-60 (60)	4.6 (4/36) (2.4-6.8)		F-20 St. Vrain 1.5 km 345°	5.4 (2/12) (4.0-6.8)	3.0 (2/24) (2.7-3.2)	0
	Ba-140 (60)	6.2 (4/36) (5.3-7.8)		F-20 St. Vrain 1.5 km 345°	7.8 (1/12)	< 6.4	0
	La-140 (60)	7.1 (4/36) (6.1-9.0)		F-20 St. Vrain 1.5 km 345°	9.0 (1/12)	< 7.5	0
Ground Water (pCi/L)	H-3 (8)	1950 (2/4) (1600-2300)		F-16 3-Bar Ranch 1.2 km 0°	1950 (2/4) (1600-2300)	< 400	0
	Gamma Spectrometry						
	Cs-134 (8)	< 3.4		---	---	< 2.2	0
	Cs-137 (8)	5.7 (2/4) (3.7-7.7)		F-16 3-Bar Ranch 1.2 km 0°	5.7 (2/4) (3.7-7.7)	5.3 (2/4) (4.1-6.5)	0
	Zr-95 (8)	< 6.9		---	---	< 4.9	0
	Nb-95 (8)	< 3.1		---	---	< 2.1	0

[b] Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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)	Gamma Spectrometry						
	Co-58 (8)	< 3.1		---	---	< 2.1	0
	Mn-54 (8)	4.0 (1/4)		F-16 3-Bar Ranch 1.2 km 0°	4.0 (1/4)	< 2.2	0
	Zn-65 (8)	< 10		---	---	< 7.5	0
	Fe-59 (8)	< 7.8		---	---	< 5.2	0
	Co-60 (8)	2.9 (2/4) (2.7-3.1)		F-16 3-Bar Ranch 1.2 km 0°	2.9 (2/4) (2.7-3.1)	< 2.2	0
	Ba-140 (8)	< 6.5		---	---	< 4.4	0
	La-140 (8)	< 7.5		---	---	< 5.0	0

[b]Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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)	< 11		---	---	---	0
	Cs-137 (2)	69 (2/2) (54-83)		R-10 S. Platte at CO 60 10 km 290°	69 (2/2) (54-83)	---	0
Milk (pCi/L)	H-3 (108)		587 (9/91) (410-830)	A-18 Boos Dairy 4.7 km	830 (1/17)	563 (3/16) (440-790)	0
	Gamma Spectrometry						
	I-131 (108)		1.6 (3/91) (0.47-2.3)	A-22 Percy Odenbaugh Dairy 5 km 90°	2.2 (2/17) (2.1-2.3)	0.45 (2/17) (0.39-0.51)	0
	Cs-134 (108)		2.5 (7/91) (1.2-3.1)	A-26 Docheff Dairy 6.8 km	3.1 (1/17)	3.1 (1/17)	0
	Cs-137 (108)		4.1 (21/91) (1.6-6.4)	A-22 Percy Odenbaugh Dairy 5 km 90°	4.5 (2/17) (3.1-5.9)	3.7 (8/17) (2.6-5.3)	0

[b]Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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
Milk (pCi/L)	<u>Gamma Spectrometry</u>						
	Ba-140 (108)		5.8 (4/91) (2.2-9.4)	A-23 Leroy Odenbaugh Dairy 4.1 km 83°	9.4 (1/17)	4.6 (1/17)	0
	La-140 (108)		6.7 (4/91) (2.5-11)	A-23 Leroy Odenbaugh Dairy 4.1 km 83°	11 (1/17)	5.3 (1/17)	0
Food Products (pCi/kg, wet)	<u>Gamma Spectrometry</u>						
	I-131 (8)		17 (1/8)	R-6 Hernandez Gilcrest 9.6 km 60°	17 (1/6)	---	0
	Cs-134 (9)		17 (1/8)	R-6 Hernandez Gilcrest 9.6 km 60°	17 (1/6)	---	0
	Cs-137 (9)		31 (1/8)	A-27 WCR25 & WCR38 4.3 km	31 (1/2)	---	0

[b]Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses 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
Fish (pCi/kg, wet)	Gamma Spectrometry						
	Cs-134 (6)	< 6.0		---	---	< 6.3	0
	Cs-137 (6)	7.2 (1/4)		R-10 S. Platte at CO 60 10 km 290°	16 (1/2)	16 (1/2)	0
	Co-58 (6)	< 5.8		---	---	< 6.3	0
	Mn-54 (6)	< 5.8		---	---	< 6.0	0
	Zn-65 (6)	< 17		---	---	< 21	0
	Fe-59 (6)	< 15		---	---	< 10	0
	Co-60 (6)	< 6.2		---	---	< 6.9	0

[b]Mean and range based upon detectable measurements only.
Fraction (f) of detectable measurements at specified locations is indicated in parentheses.

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

	1988	1989	1990		1991	
	$\bar{X}$	$\bar{X}$	$\bar{X}$	σ	$\bar{X}$	σ
Atmospheric Water Vapor (pCi/L)						
H-3						
Facility	470	43	<256	285	<9.4	395
Reference	172	<420	<299	288	<80	395
Air (fCi/m^3)						
Gross Beta						
Facility	26	26	23	12	29	31
Reference	24	24	23	12	25	23
I-131						
Facility	1.9	2.2	1.5	3	1.6	13
Reference	<4.5	2.2	1.4	9	0.52	14
Cs-137						
Facility	0.73	0.32	0.55	0.92	0.12	0.69
Reference	1.0	0.46	0.22	0.66	0.98	1.3

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

	1988	1989	1990		1991	
	$\bar{x}$	$\bar{x}$	$\bar{x}$	σ	$\bar{x}$	σ
		Drinking Water (pCi/L)				
H-3						
Gilcrest	370	<390	<238	317	32	465
Ft. Collins	120	<390	<215	288	<48	345
Gross Beta						
Gilcrest	6.8	5.8	4.5	1.8	5.8	2.4
Ft. Collins	1.1	0.98	0.86	0.39	0.95	0.35
I-131						
Gilcrest	0.099	0.068	0.017	0.19	<0.0028	0.16
Ft. Collins	0.083	0.14	0.046	0.24	<0.022	0.20
Cs-137						
Gilcrest	1.7	2.2	1.3	1.4	2.2	1.6
Ft. Collins	1.4	1.8	2.4	1.8	1.7	1.2

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

	1988	1989	1990		1991	
	$\bar{X}$	$\bar{X}$	$\bar{X}$	σ	$\bar{X}$	σ
Surface Water (pCi/L)						
H-3						
Effluent	31000	29000	303	623	1499	2496
Downstream	430	<390	<371	397	6.2	427
Upstream	430	<390	<415	352	20	419
Cs-137						
Effluent	1.9	1.3	1.4	1.9	1.7	2.0
Downstream	2.5	1.8	2.1	1.9	2.3	1.7
Upstream	1.4	2.0	2.2	1.9	2.0	1.9
Milk (pCi/L)						
H-3						
Adjacent	70	<390	<280	330	<133	362
Reference	<220	<390	<290	340	<110	398
I-131						
Adjacent	0.046	0.57	0.53	2.0	0.070	0.39
Reference	<0.17	<0.50	0.0060	0.33	<0.0028	0.24
Cs-137						
Adjacent	2.7	1.5	1.5	2.0	1.9	1.8
Reference	3.3	1.5	16	2.3	2.4	1.9

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 possible 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 1991, there were no changes in the sampling program.

Table III.B.1 gives the description of each sampling location by number, sector and distance from the reactor. 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 September 1991 the land-use census was again 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 are shown in Table III.C.1. Figure III.C.1 shows these locations in each sector. At the time of the 1991 census it was verified that the closest permanent residence in Sector 16 was the critical receptor with regards to mean annual dose commitment and is at the Russell farm F-16.

A few residents in the sampling sectors up to a distance of 8 km from the plant have cows or goats that could be used for personal milk consumption. However, from direct discussion with these persons, this is not a common practice and all cow milk produced is transported to commercial processors. The milk produced locally is diluted by a large milk shed, processed and distributed over a large area for consumption. For this reason the elevated I-131 in milk from A-22 would never be detected in the composited milk supply.

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 sample sizes, 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: 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. Two samples from control location 15 to 30 kilometers (10 to 20 miles) distant and in the least prevalent wind direction.	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 vaper extracted from silica gel on each sample collected. Particulate Sampler: Gross beta radioactivity following filter change, composite (by location) for gamma isotopic quarterly.[a]
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 an 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/m3)	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			494		
I-131	0.890	66.4		0.890	56.8	
Cs-134	5.58	8.06	19.5	5.58	44.4	90.6
Cs-137	5.34	7.86	18.5	5.34	44.6	100
Zr-95	7.96					
Nb-95	4.24					
Co-58	3.66		12.8			
Mn-54	3.64		12.7			
Zn-65	7.92					
Fe-59	8.30		31.4			
Co-60	3.74		14.5			
Ba-140	8.87			8.87		
La-140	10.2			10.2		

* 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 (RL) For Nonroutine Operating Reports

Reporting Level (RL)

Analysis	Water (pCi/L)	Airborne Particulate or Gas (fCi/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	9×10^2		3	1×10^2
Cs-134	30	1×10^4	1×10^3	60	1×10^3
Cs-137	50	2×10^4	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 1.6-8 km. 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 or 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 1.6-8 km. 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 1.6-8 km. 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 12854 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 intersection on E side of CR13.	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 1.6-8 km. 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.	15	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 1.6-8 km. 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 Jay 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
Waterborne Sediment from Shoreline	R-10	Sediment from S. Platte River at bridge on CO 60.		10.1

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

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8 km. 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 34. 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 is in mailbox attached to utility pole.		20.5
	R-11	Air sampler is located in alley behind PSC office, next to garage. Silica gel is located next to air sampler in mailbox and on top of post, 13 1/2 Parish St., Johnston, CO.		10.5

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

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8 km. 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), 17578 WCR 19 1/2.	1	1.2
	R-5	Well at 108 S. Grace, Milliken.		9.5
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 1.6-8 km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
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 "LeRoy & Paul Odenbaugh Dairy" sign. Dairy sign on WCR 36, E of Rd 23. Dairy sign is located next to mailbox of Mike Thomas.	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	Jim Docheff Dairy, east of Road 13 on Rd 32, at 4513 WCR 32.	11	9.4
	R-8	Borba Dairy, 2252 S. CR 7, take the Hwy. 402 exit for Loveland from I-25, travel west 1.6 km to Cty. Rd. 7. Turn south and go to second dairy on left.		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 1.6-8 km. R: Reference Area)

Exposure Pathway	Site No.	Location Description (see map)	Sector	Distance, km
Food Products	A-27	Fields on SE corner of intersection of WCR 25 and WCR 38.	4	4.3
	A-28	Residence 11399 WCR 40½.	2	5.3
	R-6	Hernandez Produce Stand, Highway 85, Gilcrest.		9.6

Figure III.B.1

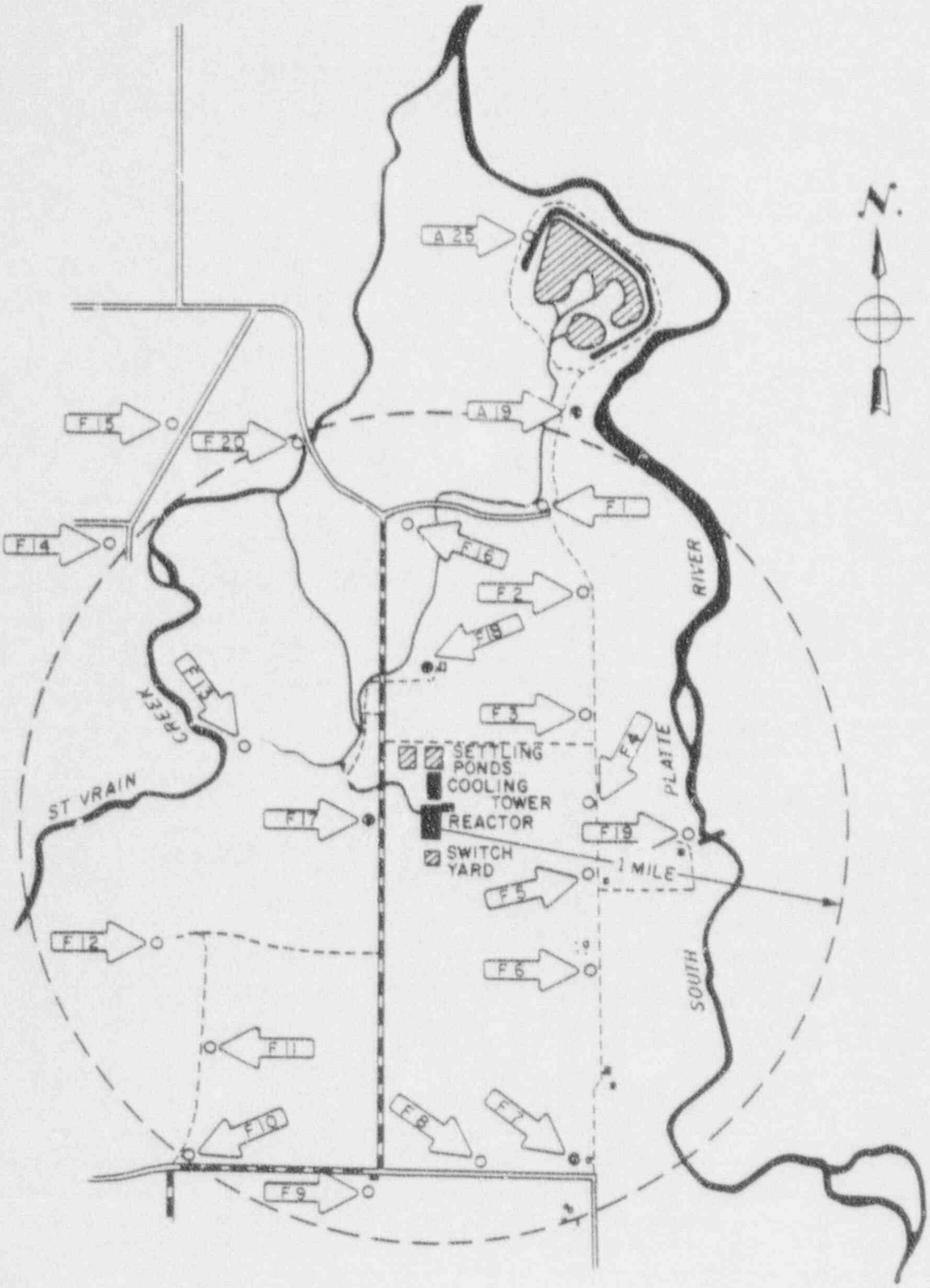


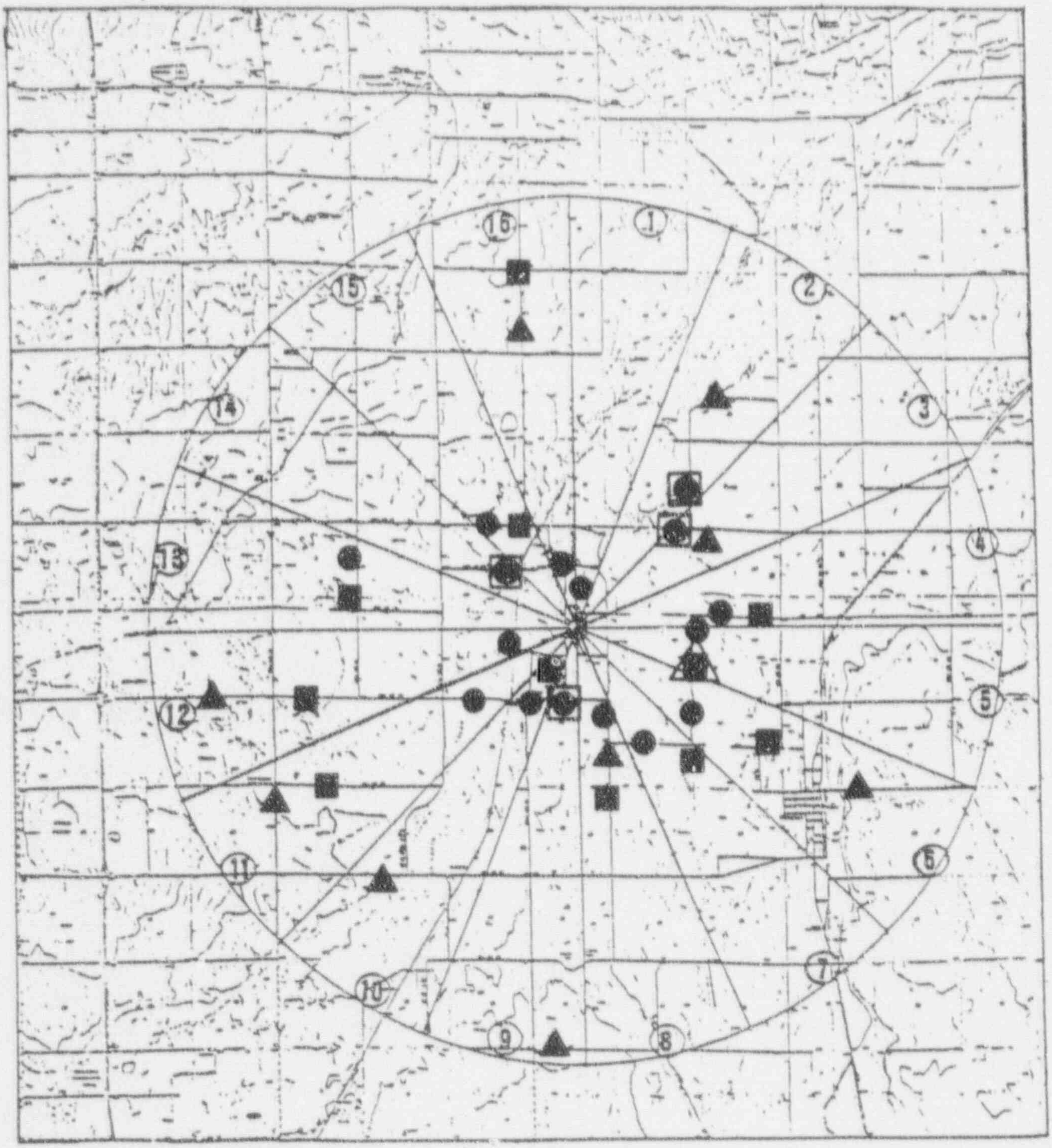
Figure III.B.2 Adjacent and Reference Sampling Locations

Table III.C.1 1991 Land Use Census*

Sector	Nearest Residence	Nearest Garden	Nearest Milk Animal
1	17578 CR 19½	9626 CR 44	***
2	18311 CR 23	18999 CR 23	11283 CR 40½
3	11100 CR 38	11100 CR 38	11165 CR 38
4	11247 CR [illegible]	11777 CR 36	11777 CR 36
5	16543 CR 23	16134 CR 23	16134 CR 23
6	11056 CR 32	11585 CR 32	11585 CR 32
7	9999 CR 34	9999 CR 34	***
8	15883 CR 21	14605 CR 21	15152 CR 21
9	9456 CR 34**	9456 CR 34**	9033 CR 26
10	9061 CR 34	15449 CR 19	7388 CO 66
11	8745 CR 34	6769 CR 32	4513 CR 32
12	Aristocrat Ranch	6519 CR 34	5492 CR 34
13	17038 CR 17	17038 CR 17	***
14	8896 CR 19	8896 CR 19	***
15	9115 CR 38	9115 CR 38	***
16	9239 CR 30	9102 CR 44**	18986 CR 19

* Census Data: Sept. 24, 1991
** New Location
*** No milk animals

Figure III.C.1   Land Use Census, 1991



● Nearest Residence

■ Nearest Garden

▲ Nearest Milk Animal