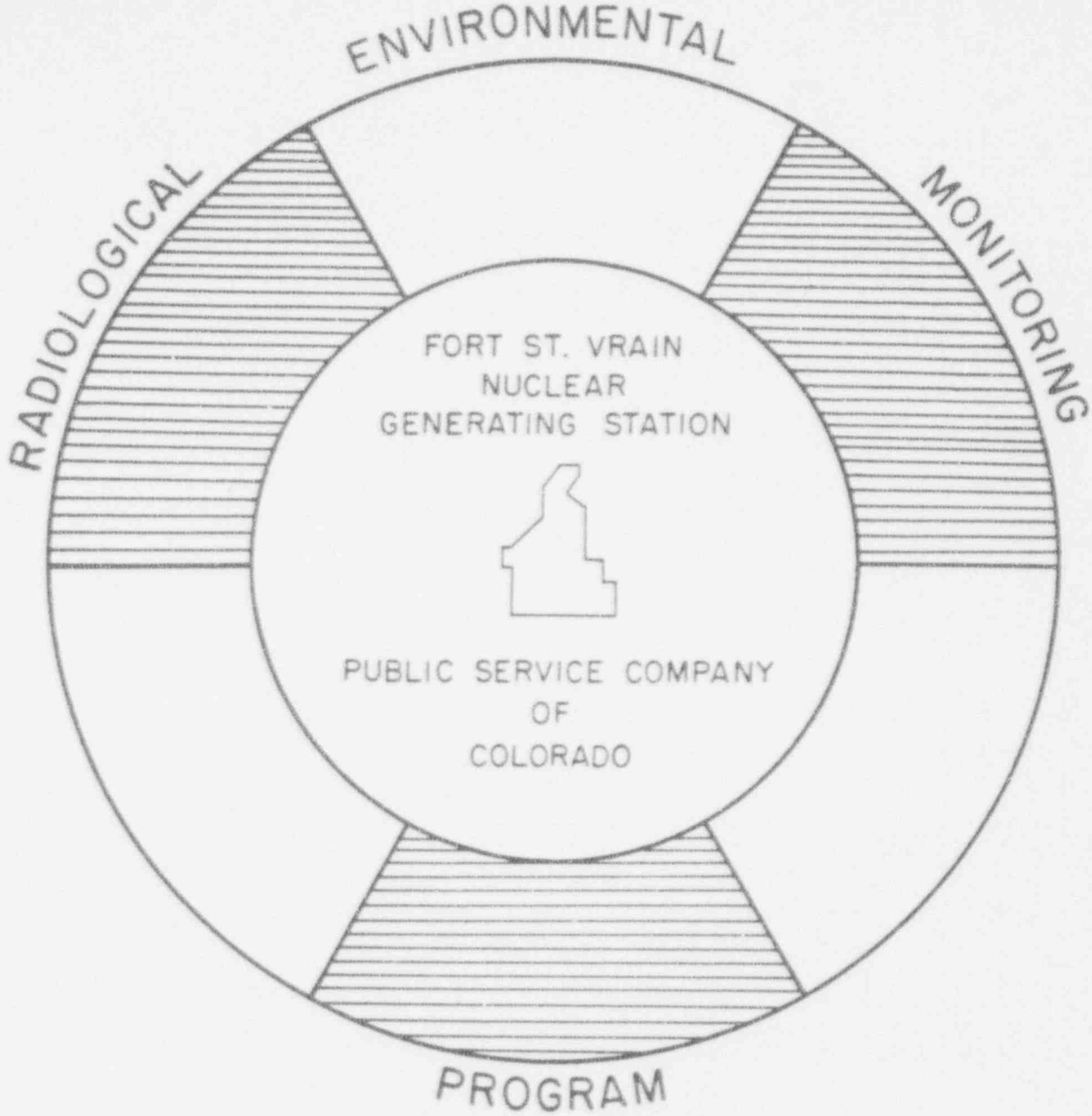

SUMMARY REPORT

1992

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, 1992 December 31, 1992

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Acknowledgements

Many persons have contributed to this project during 1992, 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. Their cooperation, equipment and expertise made the collection possible.

The persons working directly on the project have been:

Thomas Miller	Laboratory Coordinator
Monte McDonald	Laboratory Technician 1B
Robert Marvel	Laboratory Technician
Norma Frisby	Secretary
Charles Sampier	Chief Electronic Technician
Christopher Roelle	Student Employee

James Johnson

James E. Johnson
Professor and Project Director

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I. Introduction to Radiological Environmental Monitoring Program(REMP) Data for the Period January 1, 1992 - December 31, 1992.

During 1992 the Fort St. Vrain Nuclear Generating Station did not operate and is presently in a decommissioning phase. The operational phase of the reactor ended on August 18, 1989. Fuel removal operations were completed by June 10, 1992.

A complete and detailed listing of radioactivity released by all effluent routes may be found in the Public Service Company of Colorado Annual Effluent Release Report for 1992 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 1992 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 minimum detectable concentration (MDC). 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:

$$MDC = \frac{2.33\sigma_B}{EYVe^{-\lambda t}}$$

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 EPA (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 can be 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 1992 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 1992 was 0.41 mR/day. The mean exposure rate was 0.40 mR/day for the adjacent area and 0.40 mR/day for the reference area. These mean values are not significantly different from each other and not different from the mean values measured during 1991.

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, from world-wide fallout, the Chinese nuclear weapon tests, and from the Chernobyl accident, has been 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, EPA 520/5 Environmental Radiation Data 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 Gamma Exposure Rates. (mR/day)

Facility Area	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
F-1	0.52	0.42	0.36	0.32
F-2	0.39	0.35	0.47	0.36
F-3	0.53	0.32	0.38	0.37
F-4	0.55	0.42	0.58	0.43
F-5	0.50	0.46	0.41	0.51
F-6	0.36	0.39	0.48	0.35
F-7	0.39	0.60	0.34	0.42
F-8	0.35	0.44	0.38	0.34
F-9	0.27	0.37	0.35	0.38
F-10	0.36	0.33	0.48	0.44
F-11	0.46	0.42	0.37	0.38
F-12	0.40	0.35	0.39	0.41
F-13	0.31	0.44	0.37	0.36
F-14	0.30	0.37	0.50	0.43
F-15	0.36	0.41	0.32	0.33
F-16	0.36	0.60	0.38	0.40
F-17	0.37	0.43	0.48	0.39
F-18	0.37	0.35	0.35	0.40
$\overline{X}(1.96\sigma)$	0.40(0.16)	0.42(0.15)	0.41(0.13)	0.39(0.10)

Table II.A.1 (cont'd)

Adjacent Area	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
A-1	0.36	0.35	0.35	0.40
A-2	0.41	0.42	0.44	0.41
A-3	0.40	0.32	0.43	0.36
A-4	0.37	0.32	0.38	0.48
A-5	0.31	0.63	0.31	0.35
A-6	0.33	0.29	0.34	0.43
A-7	0.55	0.41	0.36	0.36
A-8	0.37	0.54	0.36	0.40
A-9	0.37	0.32	0.38	0.46
A-10	b	0.61	0.43	0.42
A-11	0.41	0.28	0.57	0.40
A-12	0.46	0.39	b	0.41
A-13	0.30	0.31	0.30	0.39
A-14	0.33	0.32	0.32	0.35
A-15	0.47	0.45	0.33	0.37
A-16	0.37	0.44	0.41	0.41
A-17	0.37	0.49	0.39	0.38
A-20	0.55	0.36	0.39	0.43
$\overline{X}(1.96\sigma)$	0.40(0.14)	0.40(0.20)	0.38(0.12)	0.40(0.08)

b - Sample missing at site

Table II.A.1 (cont'd)

Reference Area	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
R-2	0.39	0.43	0.34	0.36
R-3	0.35	0.40	0.31	0.31
R-4	0.38	0.50	0.36	0.38
R-5	0.40	0.43	b	0.48
R-7	0.60	0.46	0.39	0.41
$\overline{X}(1.96\sigma)$	0.42(0.18)	0.43(0.07)	0.35(0.06)	0.39(0.12)

b - Sample missing at site

Gamma Exposure Rates (mR/day)
1978-1992

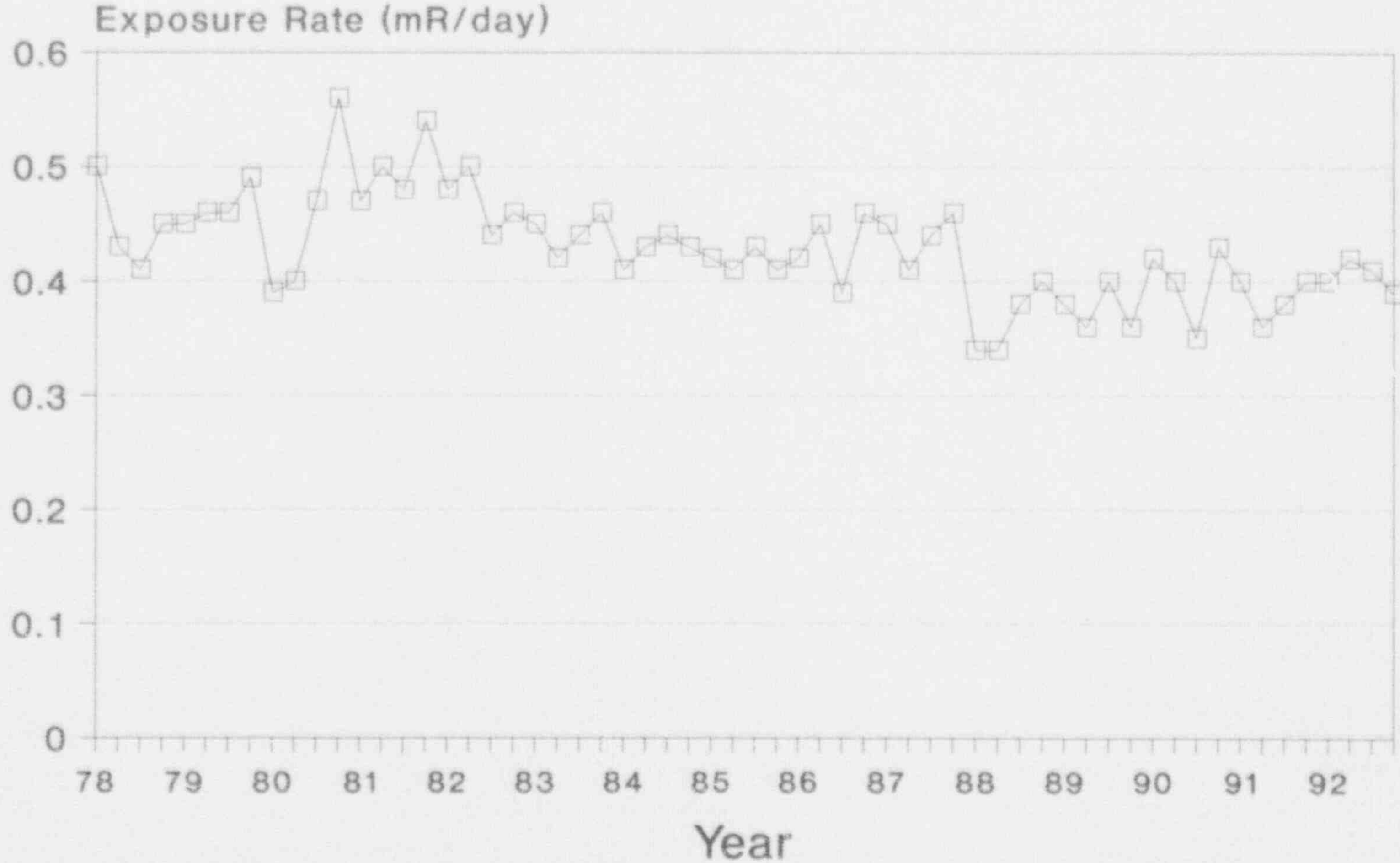


Figure II.A.1

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 1992. 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 are 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 gamma activity.

The mean gross beta concentration in air for all facility stations for all of 1992 was 25 fCi/m^3. For 1991 the mean value was 25 fCi/m^3. The mean concentration for 1992 for all reference stations was 25 fCi/m^3. These measured mean values were obviously not statistically significant at the 95% confidence level.

The gross beta data for 1992 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 the Chernobyl accident is clearly evident in 1986. It can be observed that overall mean values of the facility samplers are not significantly different from the reference samplers. 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 remaining decommissioning phase.

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

1st Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
01/04	41(1.3)*	40(2.1)	44(1.8)	42(1.6)	41(2.4)	32(1.4)	37(1.5)
01/11	36(1.8)	25(1.2)	32(2.3)	41(2.0)	28(2.2)	14(1.1)	29(1.4)
01/18	20(1.3)	18(1.1)	20(1.3)	22(1.3)	18(1.8)	18(1.1)	23(1.3)
01/25	25(1.4)	21(1.1)	27(1.4)	27(1.4)	19(1.7)	21(1.2)	25(1.2)
02/01	20(1.6)	30(1.3)	32(1.6)	31(1.4)	28(2.1)	24(1.3)	32(1.4)
02/08	26(1.4)	25(1.1)	26(1.4)	25(1.2)	25(1.9)	24(1.2)	24(1.2)
02/15	31(1.5)	34(1.3)	33(1.5)	33(1.4)	33(2.1)	33(1.4)	35(1.4)
02/22	16(1.2)	13(0.92)	14(1.1)	14(1.0)	12(0.97)	13(1.0)	13(0.98)
02/29	15(1.2)	15(1.0)	16(1.2)	15(1.1)	14(1.1)	14(1.0)	15(1.0)
03/07	22(1.4)	18(1.1)	22(1.4)	22(1.2)	20(1.3)	17(1.1)	19(1.1)
03/14	21(1.3)	18(1.0)	15(1.3)	26(1.5)	7.2(0.87)	14(0.81)	22(1.2)
03/21	24(1.1)	22(1.0)	25(1.5)	25(1.2)	26(1.3)	33(2.8)	24(1.2)
03/28	28(1.4)	23(1.1)	21(1.4)	25(1.5)	23(1.2)	21(1.1)	27(1.3)
$\overline{X}$	25	23	25	27	23	21	25
1.96σ	7.2	7.4	8.2	8.1	8.7	7.1	6.8
	Max:44 Min:13		**$\overline{X}(1.96\sigma)$: 25(15) n:52**		**Max:41 Min:7.2**	**$\overline{X}(1.96\sigma)$:23(15) n:39**	

* - 1.96σ (Due to counting statistics)

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

2nd Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
04/04	28(1.4)*	22(1.0)	20(3.1)	22(1.1)	21(1.2)	22(1.1)	22(1.1)
04/11	21(1.2)	20(1.1)	26(1.6)	23(1.2)	24(1.3)	22(1.2)	23(1.2)
04/18	29(1.5)	22(1.1)	23(1.5)	22(1.1)	21(1.2)	29(1.7)	24(1.2)
04/25	15(1.0)	12(1.0)	12(1.1)	13(0.9)	10(0.8)	8(1.3)	11(0.8)
05/02	24(1.3)	22(1.2)	26(1.5)	26(1.3)	26(1.5)	36(1.9)	22(1.2)
05/09	29(1.4)	27(1.3)	27(1.5)	28(1.3)	22(1.1)	28(1.4)	25(1.3)
05/16	19(1.1)	24(1.4)	20(1.4)	20(1.1)	21(1.2)	40(2.6)	18(1.1)
05/23	18(1.1)	18(1.0)	19(1.4)	22(1.3)	19(1.4)	19(1.1)	18(1.1)
05/30	17(0.9)	18(1.0)	16(1.3)	17(1.0)	15(1.0)	18(1.0)	16(0.9)
06/06	18(1.0)	21(1.1)	16(1.2)	16(0.9)	16(1.1)	19(1.1)	18(1.0)
06/13	21(1.0)	20(1.0)	21(1.4)	21(1.1)	22(1.2)	24(1.1)	23(1.2)
06/20	23(1.2)	22(1.1)	20(1.4)	20(1.1)	19(1.2)	19(1.1)	18(1.1)
06/27	22(1.1)	30(1.6)	22(1.6)	21(1.1)	22(1.1)	35(1.7)	21(1.2)
$\overline{X}$	23	21	21	21	20	25	20
1.96σ	8.7	8.2	8.2	7.5	7.9	17	7.3
	Max:30 Min:12			**$\overline{X}$(1.96σ):21(8.4) n:52**	**Max:40 Min:8**	**$\overline{X}$(1.96σ):21(12) n:39**	

* - 1.96σ (Due to counting statistics)

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

3rd Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
07/06	20(1.0)*	17(1.1)	14(1.2)	19(0.92)	22(1.0)	20(1.0)	19(1.0)
07/11	19(1.3)	6.2(1.4)	33(2.3)	18(1.3)	18(1.3)	64(4.5)	18(1.4)
07/18	48(2.4)	c	c	c	22(1.3)	39(1.8)	22(0.75)
07/25	23(1.1)	22(1.0)	22(1.1)	21(1.1)	20(1.1)	29(1.5)	21(1.2)
08/01	26(1.2)	25(1.2)	26(1.3)	24(1.2)	28(1.4)	31(1.6)	18(1.3)
08/07	27(1.4)	25(1.3)	26(1.4)	26(1.3)	25(1.3)	29(1.4)	23(1.3)
08/15	32(1.3)	28(1.2)	30(1.3)	29(1.2)	28(1.2)	28(1.2)	24(1.1)
08/22	27(1.3)	25(1.2)	25(1.1)	29(1.3)	37(1.6)	30(1.3)	26(1.2)
08/29	18(1.0)	18(1.0)	19(1.2)	18(1.0)	26(2.5)	18(1.0)	16(1.0)
09/05	27(1.3)	26(1.1)	25(1.2)	24(1.2)	b	23(1.1)	27(1.3)
09/12	25(1.2)	23(1.2)	26(1.3)	25(1.2)	27(1.2)	24(1.2)	23(1.3)
09/18	21(1.3)	20(1.3)	20(1.3)	21(1.3)	25(1.4)	20(1.3)	16(1.2)
09/26	20(1.1)	17(1.0)	20(1.2)	21(1.1)	17(1.0)	18(1.0)	18(1.0)
$\overline{X}$	24	21	24	23	25	29	21
1.96σ	8.0	11	9.7	7.3	10	23	6.9
	Max:33 Min:17		**$\overline{X}(1.96\sigma)$:23(9.4) n:48**		**Max:64 Min:16**	**$\overline{X}(1.96\sigma)$:25(16) n:38**	

* - 1.96σ (Due to counting statistics)

b - sample missing at site; c - instrument malfunction

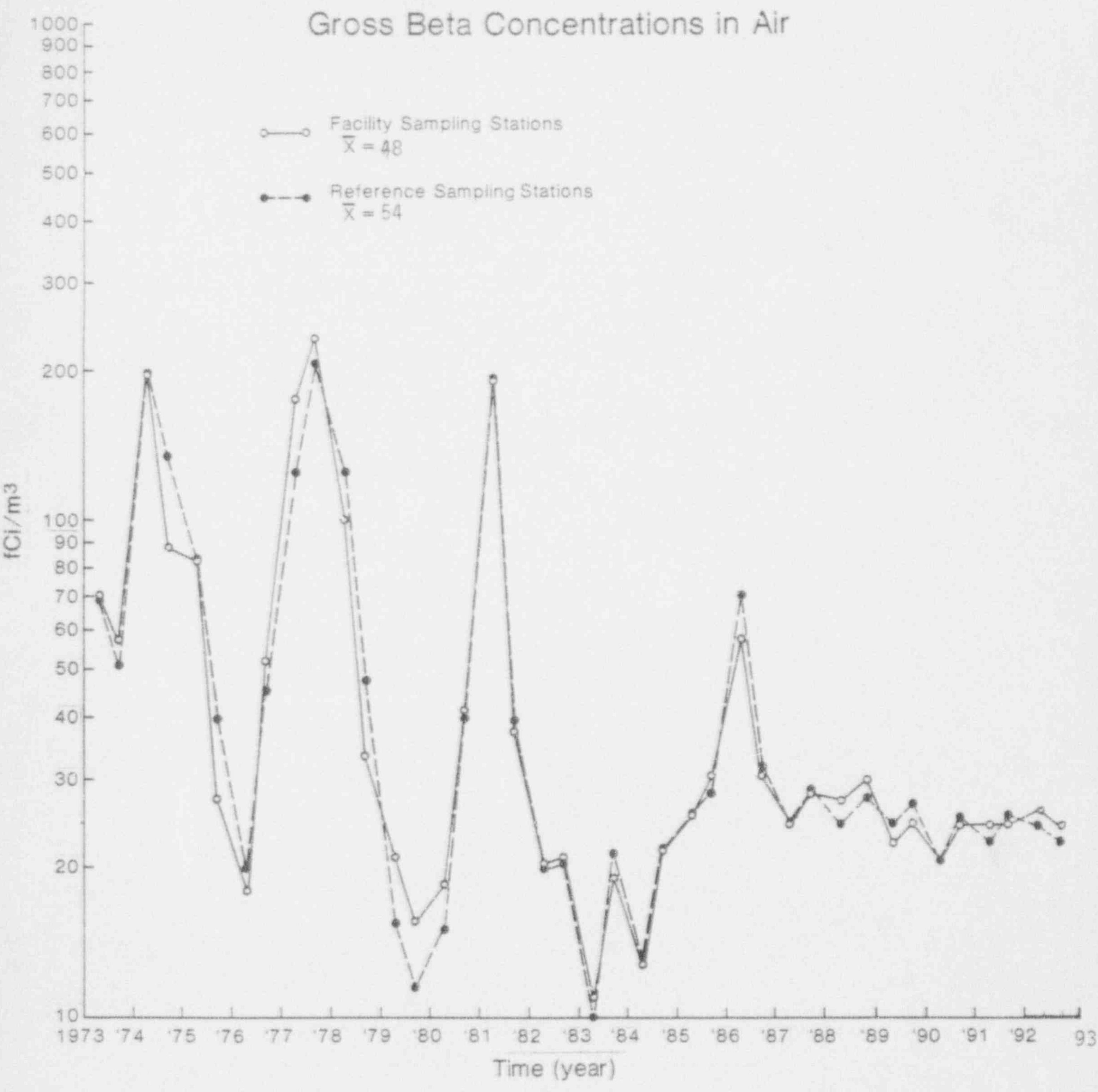
Table II.B.1(d) Concentrations of Long-lived Gross Beta Particulate Activity in Air (fCi/m^3)

4[th] Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
10/03/92	27(1.4)*	26(1.3)	31(1.5)	29(1.3)	28(1.4)	36(1.8)	29(1.4)
10/10/92	24(1.2)	25(1.2)	26(1.4)	28(1.3)	26(1.3)	25(1.2)	25(1.3)
10/17/92	25(1.4)	22(1.2)	28(1.5)	28(1.4)	26(1.3)	22(1.2)	27(1.4)
10/24/92	35(1.6)	38(1.5)	41(1.8)	49(2.0)	42(1.6)	32(1.5)	35(1.6)
10/31/92	31(1.4)	28(1.3)	36(1.6)	32(1.4)	35(1.4)	32(1.4)	34(1.5)
11/07/92	23(1.2)	20(1.1)	21(1.3)	22(1.2)	19(1.1)	18(1.1)	22(1.2)
11/14/92	34(1.4)	34(1.4)	40(1.7)	36(1.4)	30(1.4)	28(1.3)	26(1.2)
11/21/92	37(1.5)	36(1.4)	48(1.9)	43(1.6)	35(1.5)	35(1.4)	33(1.4)
11/29/92	46(1.6)	43(1.5)	45(1.7)	48(1.6)	39(1.6)	33(1.3)	42(1.6)
12/05/92	24(1.4)	22(1.3)	26(1.6)	26(1.5)	21(1.4)	19(1.2)	25(1.5)
12/12/92	31(1.5)	33(1.5)	35(1.7)	b	21(1.3)	29(1.6)	30(1.5)
12/19/92	28(1.6)	22(1.3)	33(1.8)	33(1.6)	25(1.4)	22(1.4)	33(1.6)
12/26/92	31(1.4)	27(1.3)	32(1.7)	29(1.3)	21(1.3)	33(1.7)	23(1.5)
$\overline{X}$	30	29	34	34	28	28	30
1.96σ	12	14	15	16	14	12	5.5
	Max:48 Min:20		**$\overline{X}$(1.96σ):32(15) n:51**		**Max:42 Min:18**	**$\overline{X}$(1.96σ):29(12) n:39**	

* - 1.96σ (Due to counting statistics)

Figure II.B.1



Gross Beta Concentrations in Air
Facility Sampling Stations
X̄ = 48
Reference Sampling Stations
X̄ = 54
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 93
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 1992 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 principal 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 1992 was 2.5 times less than that released in 1991 by all routes. This effluent release was detected at nearly all sampling sites, but principally those close to the Goosequill ditch effluent pathway.

Inspection of Table II.B.2 shows a general increase in tritium activity concentrations during the last quarter of 1992. The concentrations also increased at the reference stations and, in general, along the Goosequill ditch pathway. This increase can be correlated with the effluent release of tritium (see Table II.B.4). Inhalation, however, is not a significant pathway for dose to humans. Therefore, dose commitment calculations due to inhalation are not warranted. The milk and

food pathway is the only significant source of radiation dose to humans from environmental tritium. See results in sections II.D and II.E for these pathways.

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

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

1st Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
01/04	< 420	< 420	< 420	< 420	< 420	< 420	< 420
01/11	< 420	< 420	< 420	< 420	< 420	< 420	< 420
01/18	< 430	< 430	< 430	< 430	< 430	< 430	< 430
01/25	< 410	< 410	< 410	< 410	< 410	< 410	< 410
02/01	< 410	< 410	< 410	< 410	< 410	< 410	< 410
02/08	< 420	< 420	< 420	< 420	< 420	< 420	< 420
02/15	< 410	< 410	< 410	< 410	< 410	< 410	< 410
02/22	< 420	< 420	< 420	< 420	< 420	< 420	< 420
02/29	< 420	< 420	< 420	< 420	< 420	< 420	< 420
03/07	< 410	< 410	< 410	< 410	< 410	< 410	< 410
03/14	< 410	< 410	< 410	< 410	< 410	< 410	< 410
03/21	< 420	< 420	< 420	< 420	< 420	< 420	< 420
03/28	< 430	< 430	< 430	< 430	< 430	< 430	< 430

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

2nd Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
04/04	< 420	< 420	< 420	< 420	< 420	< 420	< 420
04/11	< 430	< 430	< 430	< 430	< 430	< 430	< 430
04/18	< 440	< 440	< 440	< 440	< 440	< 440	< 440
04/25	< 420	< 420	< 420	< 420	< 420	< 420	< 420
05/02	< 420	< 420	< 420	< 420	< 420	< 420	< 420
05/09	< 420	< 420	< 420	< 420	< 420	< 420	420(420)*
05/16	< 420	< 420	< 420	< 420	< 420	< 420	< 420
05/23	710(420)	510(420)	< 420	520(420)	< 420	580(420)	< 420
05/30	< 420	< 420	< 420	< 420	< 420	< 420	< 420
06/06	< 440	< 440	< 440	< 440	< 440	< 440	< 440
06/13	< 450	< 450	< 450	< 450	< 450	< 450	5"0(540)
06/20	< 450	< 450	< 450	< 450	< 450	< 450	< 450
06/27	< 430	< 430	< 430	< 430	< 430	< 430	< 430

* - 1.96σ (Due to counting statistics)

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

3rd Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
07/06	520(420)*	560(420)	640(420)	< 420	< 420	510(420)	< 420
07/11	630(420)	< 420	< 420	< 420	< 420	< 420	< 420
07/18	< 410	< 410	< 410	420(410)	< 410	< 410	< 410
07/25	700(420)	< 420	< 420	< 420	< 420	< 420	< 420
08/01	< 430	< 430	< 430	< 430	< 430	< 430	< 430
08/07	< 420	< 420	< 420	450(420)	< 420	< 420	< 420
08/15	< 420	< 420	< 420	< 420	< 420	< 420	< 420
08/22	< 410	< 410	< 410	440(410)	< 410	< 410	< 410
08/29	< 420	< 420	< 420	< 420	< 420	< 420	< 420
09/05	420(410)	< 420	< 420	520(420)	590(420)	520(420)	< 350
09/12	< 420	< 420	< 420	< 420	< 420	< 420	< 420
09/18	< 420	< 420	< 420	< 420	< 420	< 420	< 420
09/26	< 420	< 420	700(420)	580(420)	< 420	< 420	440(420)

* - 1.96σ (Due to counting statistics)

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

4th Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
10/03/92	< 410	< 410	< 410	< 410	< 410	< 410	570(500)
10/10/92	< 410	< 410	630(480)	< 410	930(490)	< 410	670(490)
10/17/92	< 410	< 410	< 410	< 410	< 410	< 410	< 410
10/24/92	450(500)	< 410	< 410	< 410	430(500)	< 410	< 410
10/31/92	930(510)	880(510)	< 430	< 430	< 430	500(510)	< 430
11/07/92	770(490)	790(490)	530(480)	< 410	< 410	440(430)	650(480)
11/14/92	850(510)	720(510)	< 440	< 440	< 440	480(510)	530(510)
11/21/92	< 410	510(480)	< 410	< 410	< 410	< 410	< 410
11/29/92	< 430	1200(510)	11000(620)	830(510)	< 430	490(506)	2300(530)
12/05/92	< 420	< 420	3900(530)	< 420	< 420	2400(510)	710(490)
12/12/92	< 440	2000(530)	< 440	< 440	1400(520)	450(510)	< 440
12/19/92	< 420	950(490)	< 420	< 420	1300(500)	< 420	< 420
12/26/92	3100(530)	< 410	< 410	< 410	< 410	< 420	790(510)

* - 1.96σ (Due to counting statistics)

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

1st Quarter 1992

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
01/04	< 0.94	< 0.94	< 0.94	< 0.94	< 0.94	< 0.94	< 0.94
01/11	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
01/18	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4
01/25	< 0.81	< 0.81	< 0.81	< 0.81	< 0.81	< 0.81	< 0.81
02/01	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89	< 0.89
02/08	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
02/15	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4
02/22	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
02/29	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
03/07	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
03/14	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
03/21	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	1.3(1.5)*
03/28	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3

* - 1.96σ (Due to Counting Statistics)

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

2nd Quarter 1992

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
04/04	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
04/11	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
04/18	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
04/25	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6	< 1.6
05/02	< 1.6	2.5(2.0)*	< 1.6	2.4(2.0)	< 1.6	< 1.6	2.3(2.0)
05/09	< 2.3	4.0(2.8)	2.6(2.7)	3.4(2.7)	< 2.3	2.9(2.7)	4.0(2.7)
05/16	< 2.2	< 2.2	< 2.2	< 2.2	< 2.2	< 2.2	< 2.2
05/23	2.9(3.1)	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6
05/30	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2
06/06	< 3.4	< 3.4	< 3.4	3.7(4.1)	< 3.4	< 3.4	5.0(4.1)
06/13	< 3.2	< 3.2	3.2(4.0)	< 3.2	< 3.2	4.7(4.0)	3.9(4.0)
06/20	< 3.0	< 3.0	< 3.0	3.5(3.6)	< 3.0	< 3.0	< 3.0
06/27	4.0(2.2)	< 1.8	< 1.8	2.2(2.2)	< 1.8	2.6(2.2)	2.4(2.2)

* - 1.96σ (Due to Counting Statistics)

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

3rd Quarter 1992

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
07/06	3.7(3.6)*	4.0(3.6)	4.5(3.6)	< 3.0	< 3.0	3.6(3.6)	< 3.0
07/11	5.8(4.6)	< 3.9	< 3.9	< 3.9	< 3.9	< 3.9	< 3.9
07/18	< 3.7	< 3.7	< 3.7	3.8(4.4)	< 3.7	< 3.7	< 3.7
07/25	6.0(4.4)	< 3.7	< 3.7	< 3.7	< 3.7	< 3.7	< 3.7
08/01	< 3.7	<3.7	< 3.7	< 3.7	< 3.7	< 3.7	< 3.7
08/07	< 3.7	< 3.7	3.7(4.4)	3.9(4.4)	< 3.7	< 3.7	< 3.7
08/15	< 3.8	< 3.8	< 3.8	< 3.8	< 3.8	< 3.8	< 3.8
08/22	< 3.3	< 3.3	< 3.3	3.5(4.0)	< 3.3	< 3.3	< 3.3
08/29	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4
09/05	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2	< 3.2
09/12	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4
09/18	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5
09/26	< 2.1	< 2.1	3.5(2.6)	2.9(2.6)	< 2.1	< 2.1	2.2(2.6)

* - 1.96σ (Due to Counting Statistics)

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

4th Quarter 1992

Collection Date	Facility Sites				Reference Sites		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
10/03	< 2.4	< 2.4	< 2.4	< 2.4	< 2.4	< 2.4	3.4(2.9)*
10/10	1.4(2.4)	< 2.0	3.0(2.3)	< 2.0	4.4(2.3)	< 2.0	3.2(2.3)
10/17	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
10/24	1.8(2.0)	< 1.6	< 1.6	< 1.6	1.7(2.0)	< 1.6	< 1.6
10/31	2.0(1.1)	1.9(1.1)	< 0.92	< 0.92	< 0.92	1.1(1.1)	< 0.92
11/07	2.9(1.8)	2.9(1.8)	2.0(1.8)	< 1.5	< 1.5	1.6(1.8)	2.4(1.8)
11/14	3.6(2.2)	3.1(2.2)	< 1.9	< 1.9	< 1.9	2.0(2.2)	2.2(2.2)
11/21	< 1.3	1.7(1.6)	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3
11/29	< 1.5	4.2(1.8)	38(2.2)	2.9(1.8)	< 1.5	1.7(1.8)	8.1(1.9)
12/05	< 1.4	< 1.4	13(1.7)	< 1.4	< 1.4	7.8(1.7)	2.3(1.6)
12/12	< 1.5	7.0(1.9)	< 1.5	< 1.5	4.9(1.8)	1.6(1.8)	1.7(1.8)
12/19	< 1.5	3.3(1.7)	< 1.5	< 1.5	4.5(1.8)	< 1.5	< 1.5
12/26	9.1(1.6)	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	2.3(1.5)

* - 1.96σ (Due to Counting Statistics)

Table II.B.4

Tritium Released (mCi) In Reactor Effluents, 1992

MODE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Continuous (Turbine Building Sump) (1)	0.93	0.78	0.82	0.76	0.87	0.58	0.64	1.0	0.70	1.9	0.92	0.093	10
Batch Release (Reactor Building Sump)	0.22	0.38	0.18	0.37	0.23	0.99	0.66	1.7	1.0	0.32	20	22	48
Batch Release (System 62)	1700	870	200	500	440	260	11	68	67	19	0.0	4.6	4100
Gaseous Stack	3.8	8.4	6.2	5.8	3.0	5.6	2.0	2.0	2.6	18	2.6	280	340
Total	1700	880	210	510	440	270	14	73	71	39	24	310	4484.0

(1) Conservative estimates 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 1992. 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 35 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 any I-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. 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 in surface soil is due to Chernobyl or previous world-wide 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(a) Iodine-131 Concentrations in Air (fCi/m^3)

1st Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
01/01	< 21	23(27)*	< 33	< 32	< 28	< 31	< 32
01/08	< 30	< 28	< 23	< 30	< 32	< 32	< 22
01/15	< 23	< 25	< 30	< 20	< 29	< 22	< 21
01/22	< 18	< 19	< 19	< 31	< 28	< 31	< 26
01/29	< 32	< 30	< 33	< 27	< 19	33(31)	< 25
02/05	< 32	< 17	< 23	< 31	< 35	< 31	< 31
02/12	< 23	< 29	< 19	< 28	< 35	< 23	< 24
02/19	< 32	< 25	< 25	< 23	< 24	< 17	< 29
02/26	36(40)	< 17	< 22	< 17	< 35	< 22	< 28
03/04	< 14	< 23	< 30	< 34	< 35	< 21	< 24
03/11	< 24	< 26	< 15	< 19	< 28	< 20	< 28
03/18	42(37)	< 20	< 31	< 18	< 20	< 17	< 22
03/25	< 25	< 21	< 25	< 34	< 23	< 30	< 35

* - 1.96σ (Due to counting statistics)

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

2nd Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
04/04	< 24	30(36)*	< 32	< 29	< 30	< 31	< 31
04/11	< 21	< 30	< 19	< 17	< 23	< 34	< 30
04/18	< 6.2	< 29	< 4.1	< 15	< 28	< 32	< 19
04/25	< 18	< 17	< 17	41(33)	< 27	< 31	13(13)
05/02	< 35	< 22	< 17	< 30	< 19	< 7.3	< 14
05/09	< 24	< 21	< 10	< 21	< 31	< 22	< 17
05/16	< 20	< 13	< 12	< 11	< 9.3	< 17	< 26
05/23	< 23	< 22	< 15	< 25	< 31	< 19	< 14
05/30	< 14	< 10	< 6.3	< 10	< 8.8	< 19	< 19
06/06	< 20	29(29)	< 8.2	< 4.9	< 6.1	< 14.0	32(24)
06/13	< 29	< 9.1	< 13	< 15	< 7.8	< 24	< 13
06/20	< 12	< 14	< 25	< 17	< 2.9	< 22	< 15
06/27	< 17	< 8.0	< 7.5	< 6.1	< 26	< 18	< 9.5

* - 1.96σ (Due to counting statistics)

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

3rd Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
07/06	< 8.4	< 33	< 3.6	< 17	< 6.1	< 2.4	< 19
07/11	< 19	< 16	< 20	< 4.3	< 9.9	< 23	< 25
07/18	< 9.7	< 33	16(17)*	< 10	< 12	< 19	< 9.4
07/25	< 16	< 9.1	< 10	< 12	< 28	21(24)	< 14
08/01	< 16	< 14	< 9.8	< 21	< 6.5	21(25)	< 3.5
08/07	< 18	12(15)	< 24	< 20	< 13	< 26	< 17
08/15	< 16	< 11	< 9.9	< 14	< 6.9	< 20	< 16
08/22	< 9.9	< 9.0	< 29	< 9.4	< 15	< 20	< 13
08/29	< 22	< 15	< 5.6	< 7.6	< 28	< 7.7	< 15
09/05	24(23)	< 19	< 5.2	< 16	b	< 14	< 22
09/12	18(11)	< 12	< 9.1	< 3.1	< 22	< 15	< 9.3
09/18	< 20	< 9.4	< 20	< 32	< 16	< 29	< 33
09/26	< 8.2	< 8.4	17(20)	< 19	< 16	< 16	< 10

* - 1.96σ (Due to counting statistics)

b - Sample missing at site.

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

4th Quarter 1992

Collection Dates	Facility				Reference		
	F-7	F-9	F-16	A-19	R-3	R-4	R-11
10/07/92	< 25	< 18	< 11	< 17	< 12	17(17)*	< 9.9
10/14/92	< 9.2	< 27	< 9.2	< 7.8	< 8.3	< 26	< 30
10/21/92	< 7.6	< 13	< 13	< 26	< 26	< 20	< 29
10/28/92	< 24	< 14	< 18	< 9.7	< 8.6	< 9.3	< 3.1
11/04/92	< 15	< 16	< 17	< 10	< 9.1	< 9.3	< 18
11/11/92	< 9.6	< 17	< 18	< 19	< 10	17(17)	< 22
11/18/92	< 21	< 15	< 31	< 12	< 35	< 16	< 32
11/25/92	< 16	< 7.9	< 17	< 32	< 34	< 19	< 18
12/02/92	< 23	< 3.7	< 26	< 31	22(25)	< 16	< 21
12/09/92	< 26	< 20	< 12	b	< 11	< 4.1	< 18
12/16/92	< 20	< 17	< 30	< 20	< 30	< 27	< 14
12/23/92	< 16	< 20	< 6.4	< 22	31(28)	< 18	< 12
12/30/92	< 28	< 19	< 20	< 41	< 27	< 31	< 17

* - 1.96σ (Due to counting statistics)
b - Sample missing at site.

Table II.B.6 Radiocesium Concentrations in Ambient Air. (fCi/m³)

1992 Collection Dates	Radio-nuclide	Facility				Reference		
		F-7	F-9	F-16	A-19	R-3	R-4	R-11
1st Quarter	Cs-134	< 1.7	< 0.81	1.4(1.1)*	< 0.40	0.63(0.47)	< 0.59	< 0.24
	Cs-137	< 1.6	1.1(0.94)	< 0.84	0.61(0.57)	0.70(0.49)	< 0.62	< 0.23
2nd Quarter	Cs-134	< 0.51	< 1.3	< 0.27	1.5(1.3)	< 0.68	< 1.9	< 0.52
	Cs-137	0.79(0.70)	1.4(1.6)	0.78(0.35)	< 1.1	< 0.62	< 2.0	< 0.53
3rd Quarter	Cs-134	< 0.73	< 1.3	< 1.5	< 1.1	< 1.5	0.81(1.0)	< 0.37
	Cs-137	1.1(1.1)	< 1.3	< 1.5	< 1.2	< 1.5	1.5(1.2)	< 0.46
4th Quarter	Cs-134	3.0(2.4)	< 2.7	< 1.6	< 0.69	1.5(1.5)	0.64(0.75)	< 0.85
	Cs-137	< 2.0	0.83(0.34)	< 1.6	0.94(0.94)	< 1.3	< 0.63	< 0.98

* - 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 1992 from each water supply. As in every past year, the mean for the Gilcrest site was 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 the well supply 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. There is no significant difference in the yearly mean tritium concentrations in the two drinking water supp ies. The EPA limit for community drinking water systems is currently 20,000 pCi/L for tritium.

The two drinking water supplies were also analyzed for fission product and activation product concentrations. A sample of 18 liters was passed through Dowex

1-x8 anion exchange resin and the resin was then counted by Ge(Li) spectrometry for I-131[1]. 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.

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[1] Note: I-131 analysis is no longer required by the technical specifications.

Table II.C.1(a) Gross Beta in Drinking Water (pCi/L)

1st and 2nd Quarter 1992

Collection Dates	Gilcrest R-6	Ft. Collins R-3
01/11 01/18	4.5(2.4)*	1.4(0.60)
01/25 02/01	5.6(2.4)	1.0(0.57)
02/08 02/15	7.7(2.5)	0.79(0.56)
02/22 02/29	9.1(2.6)	1.1(0.58)
03/07 03/14	6.1(2.4)	0.96(0.57)
03/21 03/28	4.7(2.4)	0.88(0.57)
04/04 04/11	9.9(2.7)	0.62(0.55)
04/18 04/25	7.2(2.5)	1.1(0.58)
05/02 05/09	4.9(2.4)	1.0(0.57)
05/16 05/23	1.5(2.2)	0.42(0.54)
05/30 06/06	0.13(2.6)	1.6(0.63)
06/13 06/20	4.7(2.4)	0.88(0.57)

* - 1.96σ (Due to Counting Statistics)

Table II.C.1(b) Gross Beta in Drinking Water (pCi/L)

3rd and 4th Quarter 1992

Collection Dates	Gilcrest R-6	Ft. Collins R-3
06/27 07/06	5.4(3.0)*	0.50(0.55)
07/11 07/18	4.3(2.9)	1.2(0.64)
07/25 08/01	< 2.2	0.60(0.60)
08/07 08/15	3.7(2.9)	0.57(0.55)
08/22 8/29	3.9(2.9)	0.56(0.54)
09/05 09/12	3.1(2.3)	0.57(0.55)
09/18 09/26	3.3(2.9)	0.76(0.59)
10/03 10/10	2.5(2.3)	0.44(0.54)
10/17 10/24	0.83(2.7)	1.4(0.60)
10/31 11/07	4.6(2.4)	1.1(0.58)
11/14 11/21	3.8(2.4)	1.1(0.58)
11/28 12/05	4.2(2.4)	1.1(0.58)
12/12 12/19	3.5(2.4)	0.86(0.57)
12/26 01/02	2.5(2.3)	0.78(0.56)

* - 1.96σ (Due to Counting Statistics)

Table II.C.2(a) Tritium in Drinking Water 1992 (pCi/L)

1st and 2nd Quarter 1992

Collection Dates	Gilcrest R-6	Ft. Collins R-3
12/28 01/04	< 410	< 430
01/11 01/18	< 410	< 410
01/25 02/01	< 410	< 410
02/08 02/15	< 410	< 410
02/22 02/29	< 410	< 410
03/07 03/14	< 430	< 430
03/21 03/28	< 430	< 430
04/04 04/11	< 440	< 440
04/18 04/25	< 420	< 420
05/02 05/09	< 420	< 420
05/16 05/23	< 420	< 420
05/30 06/06	< 440	< 440
06/13 06/20	480(420)*	< 420
06/27 07/06	< 420	< 420

* - 1.96σ (Due to Counting Statistics)

Table II.C.2(b) Tritium in Drinking Water (pCi/L)

3rd and 4th Quarter 1992

Collection Dates	Gilcrest R-6	Ft. Collins R-3
06/27/92 07/06/92	< 420	< 420
07/11/92 07/18/92	440(410)*	< 410
07/25/92 08/01/92	< 430	480(420)
08/07/92 08/15/92	480(420)	< 420
08/22/92 08/29/92	< 420	< 420
09/05/92 09/12/92	< 420	< 420
09/18/92 09/26/92	690(420)	< 420
10/03/92 10/10/92	< 420	< 420
10/17/92 10/24/92	560(510)	570(510)
10/31/92 11/07/92	< 440	< 440
11/14/92 11/21/92	< 430	450(510)
11/28/92 12/05/92	530(490)	< 420
12/12/92 12/19/92	690(490)	< 420
12/26/92 01/02/93	530(500)	< 410

* - 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 01/01/92		for two weeks ending 01/15/92		for two weeks ending 01/29/92	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	d	d	< 0.17	< 0.25	< 0.21	< 0.44
Cs-134	< 2.3	< 2.4	< 2.8	< 2.6	< 1.5	< 2.4
Cs-137	< 2.8	3.0(3.5)*	< 3.4	3.5(3.7)	2.1(2.1)	< 3.0
Zr-95	< 6.3	< 5.6	< 6.6	< 6.0	< 3.4	< 7.0
Nb-95	< 2.0	< 2.1	< 2.5	< 2.3	< 1.3	< 2.2
Co-58	< 2.5	< 2.6	3.4(4.2)	< 2.4	< 1.7	< 2.2
Mn-54	< 2.3	< 2.4	< 2.9	< 2.7	< 1.5	< 2.4
Zn-65	< 6.2	< 6.4	< 7.4	< 6.9	< 4.0	< 6.6
Fe-59	< 6.9	< 5.4	< 6.6	< 10	< 4.8	< 5.6
Co-60	< 2.4	< 2.5	< 3.0	< 2.8	< 1.6	< 2.7
Ba-140	< 9.6	< 10	< 26	< 26	< 2.4	< 3.9
La-140	< 11	< 12	< 30	< 29	< 2.7	< 4.5

* - 1.96σ (Due to counting statistics)

d - LLD not met due to decay, both samples had < 12 pCi/L of ^{131}I

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

Collection Date	for two weeks ending 02/12/92		for two weeks ending 02/26/92		for two weeks ending 03/11/92	
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	< 0.42	d	d	< 0.45	< 0.23
Cs-134	< 0.81	< 3.0	< 0.71	< 0.72	< 0.57	< 0.80
Cs-137	3.3(1.2)*	< 3.8	2.1(1.1)	3.9(1.1)	4.2(0.85)	3.3(1.2)
Zr-95	3.0(2.3)	< 7.3	< 1.5	< 1.6	1.7(1.7)	< 2.0
Nb-95	< 0.77	< 2.8	< 0.81	< 0.67	< 0.59	< 0.80
Co-58	< 0.74	< 3.0	< 0.83	< 0.81	< 0.59	< 0.73
Mn-54	1.0(0.97)	< 3.0	0.92(0.88)	< 0.71	< 0.58	< 0.79
Zn-65	< 2.4	< 8.5	< 1.6	< 1.8	< 1.3	< 1.8
Fe-59	< 2.0	< 7.1	3.1(2.9)	< 2.4	< 1.7	< 2.2
Co-60	3.5(0.98)	< 3.3	< 0.67	< 0.69	< 0.55	< 0.74
Ba-140	3.0(2.9)	< 5.1	< 1.2	< 1.2	< 0.92	2.5(2.9)
La-140	3.5(3.4)	< 5.8	< 1.4	< 1.3	< 1.1	2.9(3.3)

* - 1.96σ (Due to counting statistics)
d - LLD not met due to decay, both samples had < 12 pCi/L of ^{131}I

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

Collection Date	for two weeks ending 03/25/92		for two weeks ending 04/08/92		for two weeks ending 04/22/92	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.45	< 0.25	< 0.46	< 0.23	< 0.29	< 0.5
Cs-134	< 0.57	< 0.74	< 2.0	< 0.72	< 2.3	< 2.5
Cs-137	4.2(0.85)	3.5(1.1)*	< 2.5	2.8(1.1)	4.5(3.5)	< 3.0
Zr-95	1.7(1.7)	< 1.6	< 4.7	< 1.6	< 5.2	< 5.6
Nb-95	< 0.59	< 0.70	< 1.8	< 0.68	< 2.5	< 2.2
Co-58	< 0.59	< 0.81	< 1.8	< 0.72	< 2.1	< 2.3
Mn-54	< 0.58	< 0.76	2.3(2.4)	< 0.74	4.0(2.7)	< 2.4
Zn-65	< 1.3	< 1.8	< 5.4	< 1.7	< 8.1	< 6.9
Fe-59	< 1.7	< 2.4	< 5.4	< 2.0	< 7.2	< 5.8
Co-60	< 0.55	< 0.71	2.6(2.6)	< 0.7	< 2.1	< 2.7
Ba-140	< 0.92	< 3.4	< 5.8	< 1.2	< 4.0	< 4.0
La-140	< 1.1	< 3.9	< 6.6	< 1.4	< 4.6	< 4.6

* - 1.96σ (Due to counting statistics)

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

Collection Date	for two weeks ending 05/05/92		for two weeks ending 05/20/92		for two weeks ending 06/03/92	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.24	< 0.44	< 0.49	< 0.52	< 0.27	< 0.25
Cs-134	< 1.4	< 2.6	< 1.3	< 2.0	< 1.5	< 1.3
Cs-137	1.9(2.1)*	< 3.2	5.8(1.9)	< 2.5	4.5(2.2)	4.5(1.9)
Zr-95	3.6(4.1)	< 6.0	< 3.1	< 4.8	< 3.3	< 3.1
Nb-95	< 1.5	< 2.5	< 1.4	< 1.9	< 1.4	< 1.2
Co-58	< 1.4	< 2.6	< 1.2	< 1.9	< 1.4	< 1.2
Mn-54	< 1.4	< 2.6	< 1.2	< 2.1	< 1.4	< 1.3
Zn-65	< 4.6	< 7.1	< 4.7	< 5.6	< 4.7	< 3.6
Fe-59	< 3.8	< 6.0	< 2.9	< 4.6	< 3.5	< 3.0
Co-60	< 1.3	7.0(3.4)	< 1.2	3.3(2.7)	< 1.4	< 1.4
Ba-140	< 4.3	< 4.2	< 2.1	< 3.3	< 2.4	< 2.1
La-140	< 4.9	< 4.9	< 2.4	< 3.8	< 2.8	< 2.4

* - 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 06/16/92		for two weeks ending 07/01/92		for two weeks ending 07/14/92	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.11	< 0.49	< 0.17	< 0.30	< 0.45	< 0.21
Cs-134	< 1.3	4.0(2.9)	2.7(2.8)	< 1.3	< 2.2	< 1.1
Cs-137	2.7(2.0)*	< 3.0	< 2.9	4.3(1.9)	< 2.6	3.2(1.7)
Zr-95	< 2.8	< 6.4	< 5.6	< 2.9	< 5.0	3.5(3.3)
Nb-95	< 1.4	< 2.5	< 2.8	< 1.2	< 2.0	< 1.1
Co-58	< 1.3	< 2.4	< 2.7	< 1.4	< 1.9	< 1.0
Mn-54	< 1.3	< 2.5	2.5(3.0)	1.8(1.6)	< 2.1	< 1.1
Zn-65	< 4.7	< 6.7	< 6.4	< 3.1	< 5.8	< 2.8
Fe-59	< 3.7	< 5.6	< 5.4	5.4(4.9)	< 4.9	4.6(4.1)
Co-60	< 1.3	< 2.6	< 2.6	< 1.2	< 2.3	< 1.0
Ba-140	< 2.1	< 7.3	< 3.9	7.5(7.0)	< 3.4	< 1.8
La-140	< 2.5	< 8.4	< 4.5	8.6(8.0)	< 3.9	< 2.1

* - 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 07/29/92		for two weeks ending 08/12/92		for two weeks ending 08/26/92	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.45	< 0.24	< 0.075	< 0.29	< 0.054	< 0.28
Cs-134	< 2.1	< 1.2	< 2.5	< 2.3	< 1.2	< 1.2
Cs-137	< 2.6	1.7(1.7)*	5.0(3.6)	< 2.8	3.9(1.8)	1.8(1.9)
Zr-95	< 5.0	< 2.7	< 6.5	< 5.9	< 2.6	< 2.7
Nb-95	< 1.9	< 1.0	< 2.3	< 2.1	< 1.3	< 1.2
Co-58	< 1.9	< 1.1	< 2.3	< 2.1	< 1.1	< 1.2
Mn-54	< 2.1	< 1.2	3.3(3.0)	< 2.3	< 1.2	< 1.3
Zn-65	< 5.8	< 3.2	< 6.7	< 6.2	< 3.0	< 2.9
Fe-59	< 4.9	< 2.7	< 5.9	< 5.3	< 3.1	< 3.1
Co-60	< 2.2	< 1.3	< 2.7	< 2.4	< 1.1	< 1.1
Ba-140	8.1(7.7)	< 1.9	< 4.0	< 3.8	< 2.0	< 3.1
La-140	9.3(8.9)	< 2.2	< 4.6	< 4.3	< 2.3	< 3.5

* - 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 09/09/92		for two weeks ending 09/22/92		for two weeks ending 10/06/92	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.14	< 0.11	< 0.25	< 0.44	< 0.41	< 0.38
Cs-134	< 1.3	< 2.2	< 1.9	< 2.1	< 1.0	< 2.1
Cs-137	2.9(1.9)*	< 2.7	4.1(2.8)	3.0(3.2)	3.2(1.6)	< 2.4
Zr-95	< 2.9	< 5.3	< 5.0	< 4.7	< 2.3	< 4.7
Nb-95	< 1.2	< 2.0	< 1.7	< 2.1	1.3(1.3)	< 1.8
Co-58	< 1.2	< 2.2	< 1.8	< 1.9	< 1.0	< 1.9
Mn-54	< 1.3	< 2.2	< 2.0	< 2.0	< 1.0	< 2.0
Zn-65	< 3.8	< 6.0	< 5.4	< 6.4	< 3.0	< 5.4
Fe-59	< 3.1	< 5.7	< 4.5	< 5.1	< 2.7	< 4.6
Co-60	< 1.2	< 2.4	< 2.1	< 1.8	< 0.98	< 2.2
Ba-140	< 2.8	6.0(6.3)	< 5.3	< 5.6	< 2.8	< 3.2
La-140	< 3.2	6.9(7.3)	< 6.1	< 6.5	< 3.2	< 3.7

* - 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 10/20/92		for two weeks ending 11/04/92		for two weeks ending 11/18/92	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.49	< 0.36	< 0.21	< 0.45	< 0.11	< 0.81
Cs-134	< 0.65	< 1.2	< 1.6	< 0.99	1.9(1.5)	< 2.4
Cs-137	3.2(0.97)*	< 1.5	< 1.9	3.8(1.5)	2.2(1.9)	< 3.0
Zr-95	< 1.5	< 3.2	< 3.7	< 2.2	< 2.9	< 5.6
Nb-95	< 0.67	< 1.1	< 1.4	< 0.95	< 1.4	< 2.3
Co-58	< 0.60	< 1.1	< 1.4	< 0.90	1.8(1.6)	< 2.6
Mn-54	0.75(0.77)	1.3(1.5)	< 1.6	< 0.96	< 1.3	< 2.5
Zn-65	< 1.7	< 3.3	< 4.2	< 2.6	< 3.5	< 6.5
Fe-59	< 1.5	< 3.3	< 3.7	< 2.7	< 4.3	< 5.6
Co-60	0.78(0.73)	< 1.3	< 1.7	< 0.92	< 1.2	< 2.6
Ba-140	< 1.1	< 2.0	< 4.5	< 1.6	< 6.2	< 12.0
La-140	< 1.2	< 2.3	< 5.1	< 1.8	< 7.2	< 13.0

* - 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 12/02/92		for two weeks ending 12/16/92		for two weeks ending 12/30/92	
Radionuclide	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3	Gilcrest R-6	Ft. Collins R-3
I-131	< 0.30	< 0.49	d	< 0.12	h	h
Cs-134	3.9(2.6)*	< 0.67	< 1.6	< 1.0	1.9(1.5)	< 1.1
Cs-137	< 2.5	4.6(0.97)	< 1.9	< 1.3	2.2(1.9)	4.7(1.7)
Zr-95	< 7.0	< 1.9	< 3.7	< 2.4	< 2.9	< 2.4
Nb-95	< 1.8	< 0.81	< 1.4	< 0.94	< 1.4	< 1.1
Co-58	4.2(3.2)	< 0.60	< 1.4	< 0.94	1.8(1.6)	1.1(1.3)
Mn-54	< 2.1	< 0.65	< 1.6	< 1.1	< 1.3	< 1.1
Zn-65	< 5.6	< 1.6	< 4.2	< 2.8	< 3.5	< 2.9
Fe-59	< 4.9	< 2.5	< 3.7	< 3.3	< 4.3	< 2.7
Co-60	< 2.3	< 0.62	< 1.7	< 1.1	< 1.2	< 0.99
Ba-140	< 3.3	< 5.3	< 4.5	< 1.7	< 6.2	< 1.8
La-140	< 3.8	< 6.1	< 5.1	< 1.9	< 7.2	< 2.1

* - 1.96σ (Due to counting statistics)
d - Sample lost during analysis.
h - Iodine sampling no longer required.

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 1992 at the four surface water sites and the effluent route site. The arithmetic mean value for the downstream locations in 1992 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 1992 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 November and December there was evidence of measurable tritium release in downstream water (see Table II.C.4). The correlation of the tritium concentrations with the effluent

release report is good.

Mean values for the other radionuclides were less than MDC except for Cs-137.

Table II.C.4 Tritium in Surface Water 1992 (pCi/L)

Collected Date	Downstreams		Upstream		Effluent
	F-20	R-10	A-21	F-19	A-25
01/11	< 410	< 410	< 410	< 410	< 410
02/08	< 420	< 420	< 420	< 420	< 420
03/07	< 420	< 420	< 420	< 420	520(420)
04/11	< 420	480(440)	< 420	< 420	< 420
05/09	< 420	< 420	< 420	< 420	2200(420)
06/20	< 420	< 420	< 420	< 420	460(430)
07/11	450(410)	< 410	< 410	< 410	< 420
08/07	< 420	< 420	< 420	< 420	< 420
09/12	< 420	< 420	< 420	< 420	440(420)
10/10	< 410	< 410	< 410	< 410	600(510)
11/14	2900(520)	760(490)	640(490)	< 420	730(490)
12/12	700(490)	620(490)	< 420	< 420	440(490)

* - 1.96σ (Due to counting statistics)

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

Collection Date: January 11, 1992**

Radionuclide	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	< 2.4	< 2.0	< 2.8	< 2.5	< 2.5
Cs-137	< 2.8	4.6(2.9)*	< 3.4	< 2.9	< 3.1
Zr-95	< 7.8	< 4.7	< 9.1	< 5.7	9.1(9.8)
Nb-95	< 2.1	< 1.8	< 2.5	< 3.1	< 2.2
Co-58	< 2.1	< 1.8	< 2.5	< 3.0	< 2.3
Mn-54	< 2.3	< 2.0	< 2.9	3.0(3.1)	< 2.5
Zn-65	< 6.2	< 5.4	< 7.3	< 6.8	< 6.7
Fe-59	< 5.2	< 4.6	< 6.3	< 5.6	< 5.8
Co-60	< 2.5	< 2.1	< 2.9	< 2.6	< 2.7
Ba-140	< 3.7	< 15	< 29	21(25)	< 25
La-140	< 4.3	< 18	< 34	25(29)	< 29

* - 1.96σ (Due to counting statistics)
** - A-25 collected January 15, 1992

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

Collection Date: February 8, 1992**

Radionuclide	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	< 2.1	< 2.9	< 1.0	< 0.97	< 2.0
Cs-137	< 2.6	< 3.5	4.1(1.6)	4.6(1.4)	3.4(2.9)
Zr-95	< 5.8	< 7.8	< 2.7	2.7(2.9)	< 4.6
Nb-95	< 1.8	< 2.6	< 1.0	< 0.96	< 1.8
Co-58	< 1.9	< 3.0	< 1.1	< 1.0	< 1.8
Mn-54	< 2.1	< 2.9	< 1.1	< 0.94	< 2.1
Zn-65	< 5.5	< 7.7	< 2.9	< 2.7	< 5.1
Fe-59	7.4(7.5)*	< 6.9	< 2.6	3.9(3.4)	< 7.7
Co-60	< 2.3	< 3.1	< 1.0	< 0.92	< 2.1
Ba-140	< 3.3	< 4.6	< 1.8	< 1.5	< 3.2
La-140	< 3.8	< 5.3	< 2.0	< 1.8	< 3.7

* - 1.96σ (Due to counting statistics)
** - A-25 collected February 15, 1992

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

Collection Date: March 14, 1992**

Radionuclide	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	< 0.90	< 0.77	< 0.64	< 0.77	< 0.98
Cs-137	2.3(1.3)*	4.4(1.1)	2.6(0.95)	5.0(1.2)	1.9(1.5)
Zr-95	< 2.4	< 1.7	< 1.6	< 1.7	5.2(3.3)
Nb-95	1.6(1.1)	0.96(0.91)	< 0.66	< 0.70	1.6(1.3)
Co-58	1.1(1.2)	< 0.79	< 0.57	< 0.70	< 1.1
Mn-54	< 0.90	< 0.74	< 0.63	0.94(0.93)	< 1.0
Zn-65	< 2.3	< 1.8	< 1.5	< 1.9	< 2.5
Fe-59	< 2.1	2.7(2.7)	< 1.9	2.2(2.6)	< 3.4
Co-60	< 0.87	< 0.72	< 0.58	< 0.72	1.9(1.2)
Ba-140	< 3.5	< 2.4	< 1.0	< 2.6	< 1.6
La-140	< 4.0	< 2.8	< 1.2	< 3.0	< 1.8

* - 1.96σ (Due to counting statistics)
** - A-25 collected March 15, 1992

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

Collection Date: April 11, 1992**

Radionuclide	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	< 1.1	< 2.2	< 2.5	< 1.1	< 1.3
Cs-137	3.9(1.5)*	< 2.2	< 3.0	4.3(1.8)	5.7(2.0)
Zr-95	< 2.2	< 5.1	< 5.7	< 2.6	< 2.9
Nb-95	< 1.3	< 1.9	< 2.3	< 1.6	< 1.3
Co-58	< 0.95	2.2(2.6)	< 2.3	< 1.4	< 1.6
Mn-54	< 1.1	< 2.1	< 2.4	< 1.2	< 1.3
Zn-65	< 3.0	< 5.9	< 6.5	< 4.1	< 4.3
Fe-59	4.7(4.3)	< 5.8	6.8(8.1)	< 3.9	< 4.6
Co-60	< 0.98	< 2.3	< 2.6	< 1.1	< 1.3
Ba-140	< 1.7	< 5.8	< 4.0	< 8.8	< 8.7
La-140	< 1.9	< 6.7	< 4.6	< 10.0	< 10.0

* - 1.96σ (Due to counting statistics)
** - A-25 collected April 15, 1992

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

Collection Date: May 9, 1992**

Radionuclide	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	< 1.3	< 2.0	< 1.2	< 1.3
Cs-137	< 2.4	5.6(1.9)	3.5(2.9)	4.3(1.9)	5.7(2.0)
Zr-95	< 4.6	< 2.8	< 4.4	< 3.1	< 2.9
Nb-95	< 1.8	< 1.3	< 2.0	< 1.2	< 1.3
Co-58	< 2.0	< 1.2	< 2.0	< 1.3	< 1.6
Mn-54	< 2.0	< 1.3	< 1.9	2.3(1.6)	< 1.3
Zn-65	< 5.5	< 3.9	< 5.0	< 3.7	< 4.3
Fe-59	< 5.5	< 3.1	< 5.4	< 3.5	< 4.6
Co-60	< 2.2	< 1.2	< 1.7	< 1.2	< 1.3
Ba-140	9.2(7.3)	< 3.8	< 3.2	< 4.0	< 8.7
La-140	11.0(8.4)	< 4.4	< 3.7	< 4.6	< 10.0

* - 1.96σ (Due to counting statistics)
** - A-25 collected May 15, 1992

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

Collection Date: June 20, 1992**

Radionuclide	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	< 1.2	< 2.6	< 3.8	< 2.2	< 1.9
Cs-137	4.5(2.0)	< 3.0	< 4.7	< 2.7	< 2.3
Zr-95	< 2.9	< 5.2	< 9.2	< 5.2	< 4.5
Nb-95	< 1.3	< 2.9	< 3.7	< 2.1	< 1.7
Co-58	< 1.2	< 2.4	< 3.5	< 2.0	< 1.9
Mn-54	1.2(1.5)	< 2.3	< 3.8	< 2.2	< 1.9
Zn-65	< 4.1	< 7.5	< 11.0	< 6.3	< 5.1
Fe-59	4.1(3.9)	< 6.2	< 9.2	< 5.3	< 4.4
Co-60	< 1.2	< 2.5	< 4.3	< 2.4	< 2.1
Ba-140	< 2.2	< 4.5	< 6.3	< 3.7	< 3.1
La-140	< 2.5	< 5.2	< 7.2	< 4.2	< 3.6

* - 1.96σ (Due to counting statistics)
** - A-25 collected June 15, 1992

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

Collection Date: July 11, 1992**

Radionuclide	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	< 2.5	< 1.3	< 3.7	< 2.5	< 2.0
Cs-137	< 3.1	1.6(1.9)*	4.9(5.4)	< 3.1	< 2.4
Zr-95	< 6.2	4.6(3.4)	< 8.5	< 6.2	< 4.6
Nb-95	< 2.3	< 1.1	< 3.3	< 2.2	< 1.8
Co-58	< 2.3	< 1.3	< 3.4	< 2.2	< 1.8
Mn-54	< 2.6	< 1.3	< 3.7	< 2.5	< 2.0
Zn-65	< 6.7	< 2.8	< 9.5	< 6.6	< 5.4
Fe-59	< 5.8	4.2(4.0)	< 8.7	< 5.6	< 4.5
Co-60	< 2.6	< 1.2	< 4.0	< 2.6	< 2.1
Ba-140	< 4.1	< 3.1	< 9.4	< 6.2	< 3.2
La-140	< 4.8	< 3.6	< 11.0	< 7.2	< 3.6

* - 1.96σ (Due to counting statistics)
** - A-25 collected July 15, 1992

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

Collection Date: August 7, 1992[**]

Radionuclide	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	< 2.5	< 2.3	< 2.1	< 2.1	< 1.5
Cs-137	4.6(4.0)[*]	3.2(3.4)	3.2(3.1)	5.1(2.8)	< 1.8
Zr-95	< 5.3	< 5.2	< 5.0	< 4.3	< 3.4
Nb-95	< 2.4	< 2.0	< 2.0	< 1.9	< 1.3
Co-58	< 2.5	< 2.3	< 1.9	< 1.9	< 1.4
Mn-54	< 2.4	< 2.3	2.3(2.6)	< 1.9	< 1.5
Zn-65	< 7.3	< 6.1	< 5.6	< 5.0	< 4.0
Fe-59	< 6.3	< 6.1	< 5.0	< 4.9	< 4.5
Co-60	< 2.3	< 2.5	< 2.2	< 1.8	< 1.6
Ba-140	< 4.0	< 3.6	< 3.5	< 3.2	< 2.4
La-140	< 4.6	< 4.2	< 4.0	< 3.6	< 2.7

* - 1.96σ (Due to counting statistics)
** - A-25 collected August 15, 1992

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

Collection Date: September 12, 1992**

Radionuclide	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	< 1.0	< 1.1	< 2.2	< 2.0
Cs-137	< 2.4	2.8(1.5)*	3.0(1.7)	2.7(3.2)	3.1(2.9)
Zr-95	< 4.5	< 2.2	< 2.5	< 5.1	< 5.4
Nb-95	< 1.8	< 0.93	< 1.0	< 2.0	< 1.9
Co-58	< 1.8	< 0.95	< 1.0	< 2.0	< 1.8
Mn-54	< 1.9	1.4(1.2)	1.3(1.3)	2.9(2.7)	2.0(2.4)
Zn-65	< 5.3	< 2.4	< 2.7	< 6.0	< 5.9
Fe-59	< 4.5	< 2.5	< 2.9	< 5.7	< 6.6
Co-60	< 2.0	1.8(1.2)	< 1.0	< 2.4	< 1.7
Ba-140	< 3.1	< 2.0	< 1.9	< 3.6	13.0(13.0)
La-140	< 3.6	< 2.3	< 2.1	< 4.2	15.0(15.0)

* - 1.96σ (Due to counting statistics)
** - A-25 collected September 15, 1992

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

Collection Date: October 10, 1992**

Radionuclide	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	< 1.0	< 1.3	< 0.63	< 1.1	< 1.2
Cs-137	2.5(1.7)*	2.1(2.1)	3.6(0.95)	2.4(1.5)	2.7(1.9)
Zr-95	< 2.7	< 2.9	< 1.3	< 2.5	< 2.7
Nb-95	< 1.0	1.5(1.8)	< 0.65	< 0.95	< 1.1
Co-58	< 1.1	< 1.4	< 0.57	< 0.98	< 1.1
Mn-54	< 1.1	< 1.3	< 0.63	1.7(1.3)	< 1.2
Zn-65	< 2.7	< 3.6	< 1.7	< 2.9	< 3.0
Fe-59	< 3.0	< 4.0	< 1.8	< 2.5	4.1(4.7)
Co-60	< 1.0	< 1.2	< 0.60	< 1.2	< 1.1
Ba-140	< 1.7	< 5.2	2.2(2.5)	< 3.3	< 5.9
La-140	< 2.0	< 5.9	2.5(2.8)	< 3.8	< 6.8

* - 1.96σ (Due to counting statistics)
** - A-25 collected October 15, 1992

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

Collection Date: November 14, 1992**

Radionuclide	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	< 1.2	< 2.0	< 1.2	< 2.2	< 3.9
Cs-137	2.0(1.7)*	4.7(3.0)	4.3(1.8)	< 2.6	< 4.7
Zr-95	< 2.7	< 4.4	< 2.5	< 5.0	< 9.2
Nb-95	< 1.0	< 2.3	2.3(1.7)	< 1.9	4.5(5.3)
Co-58	< 1.1	< 1.8	< 1.1	< 2.5	< 4.5
Mn-54	< 1.2	2.0(2.4)	1.4(1.5)	< 2.1	< 3.9
Zn-65	< 3.1	6.1(6.3)	< 3.1	< 5.8	< 10
Fe-59	< 2.7	< 4.9	< 3.9	< 5.1	< 9.4
Co-60	< 1.3	< 1.9	< 1.1	< 2.3	< 4.2
Ba-140	< 8.1	< 13	< 7.8	< 3.5	< 25
La-140	< 9.3	< 15	< 9.0	< 4.0	< 28

* - 1.96σ (Due to counting statistics)
** - A-25 collected November 15, 1992

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

Collection Date: December 12, 1992**

Radionuclide	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	< 1.1	< 2.5	1.5(1.3)	< 1.3
Cs-137	< 2.4	4.3(1.7)*	< 3.0	2.8(1.6)	3.0(1.8)
Zr-95	< 4.8	< 2.4	< 5.9	< 2.4	< 2.9
Nb-95	< 1.8	1.2(1.3)	< 2.2	< 0.93	< 1.1
Co-58	< 1.9	< 1.0	< 2.3	1.0(1.2)	< 1.2
Mn-54	< 2.0	< 1.1	< 2.4	< 1.0	< 1.3
Zn-65	< 5.4	< 2.6	< 6.8	< 2.6	< 3.4
Fe-59	< 4.7	< 2.5	< 5.9	< 2.7	< 3.8
Co-60	< 2.1	< 0.99	< 2.6	< 0.97	< 1.4
Ba-140	< 4.0	< 2.3	< 4.0	< 2.0	< 5.2
La-140	< 4.5	< 2.6	< 4.6	< 2.3	< 5.9

* - 1.96σ (Due to counting statistics)
** - A-25 collected December 15, 1992

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. Figure II.C.1 shows measured tritium concentrations in the F-16 well from 1984 through 1991. 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.

This well is not commonly used for drinking water purposes. The resultant dose commitment, if it were used, would be very low. The calculated mean tritium concentration during all of 1992 was 1,100 pCi/L. Assuming an intake of 2 L/day for ingestion and cooking, the calculated dose commitment for 1992 would be as follows[2]:

$$(2L/day)(1100pCi/L)(365days)(6.4E\text{-}8mrem/pCi) = 0.052mrem$$

This is indeed an extremely low dose commitment compared to natural radiation

[2] Note: Dose commitment factor from ICRP-30

background dose rate and the radiation protection standards for the general public.

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		2nd Quarter		3rd Quarter		4th Quarter	
	F-16	R-5	F-16	R-5	F-16	R-5	F-16	R-5
Cs-134	< 0.71	< 2.3	< 2.4	< 1.6	< 1.2	< 1.4	< 1.1	0.66(0.77)
Cs-137	3.8(1.1)*	2.9(3.4)	< 3.0	2.1(2.4)	3.8(1.8)	2.6(2.0)	3.1(1.6)	3.5(0.97)
Zr-95	1.8(2.1)	< 6.4	< 6.1	< 3.5	3.0(1.4)	< 3.2	< 2.6	< 1.4
Nb-95	< 0.70	< 2.1	< 2.3	< 1.7	< 1.1	< 1.2	< 0.99	1.7(0.88)
Co-58	< 0.65	< 2.1	< 2.4	< 1.6	< 1.1	< 1.2	1.3(1.3)	< 0.57
Mn-54	< 0.71	2.9(2.9)	< 2.4	< 1.6	< 1.2	< 1.4	1.4(1.3)	0.71(0.79)
Zn-65	< 2.0	< 6.3	< 6.6	< 5.5	< 3.0	< 3.6	< 2.8	< 1.6
Fe-59	< 2.0	< 6.6	< 5.6	< 4.3	< 2.8	< 3.8	< 3.0	3.6(2.7)
Co-60	< 0.66	< 2.3	< 2.6	1.6(1.7)	< 1.1	4.2(1.7)	1.1(1.3)	0.65(0.7)
Ba-140	< 2.2	< 3.7	< 6.4	< 4.4	< 4.0	< 2.2	< 1.8	< 1.0
La-140	< 2.5	< 4.3	< 7.4	< 5.1	< 4.6	< 2.5	< 2.1	< 1.2

* - 1.96σ (Due to counting statistics)

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

First Quarter 1992 Collected: 2/8/92		Second Quarter 1992 Collected: 5/9/92		Third Quarter 1992 Collected: 8/7/92		Fourth Quarter 1992 Collected: 11/14/92	
F-16	R-5	F-16	R-5	F-16	R-5	F-16	R-5
1900(440)*	< 400	< 420	470(420)	2300(420)	< 430	2000(500)	490(420)

* - 1.96σ (Due to counting statistics)

Figure II.C.1

Tritium Concentration in F-16 Well Water 1984-1991

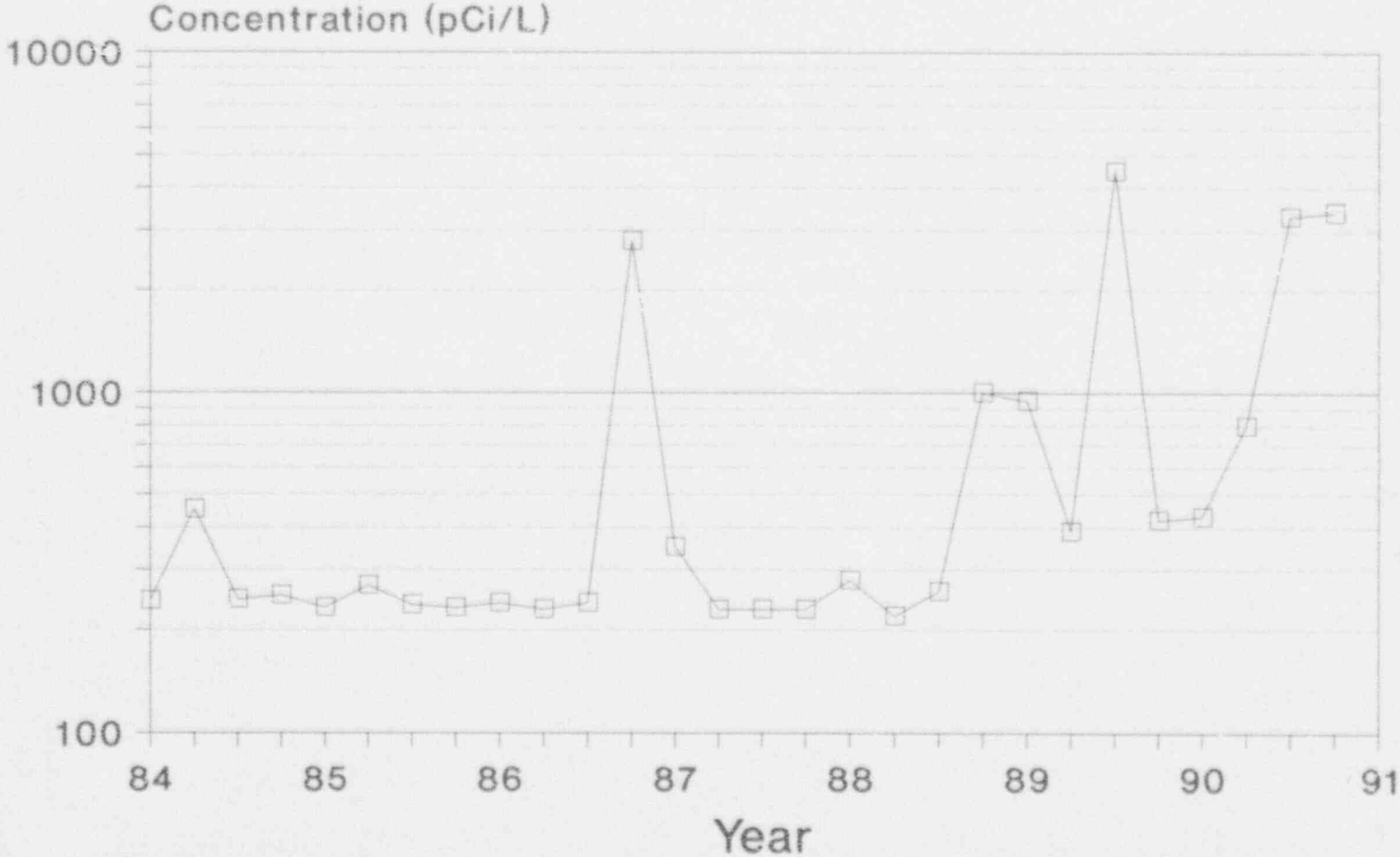

Figure II.C.2

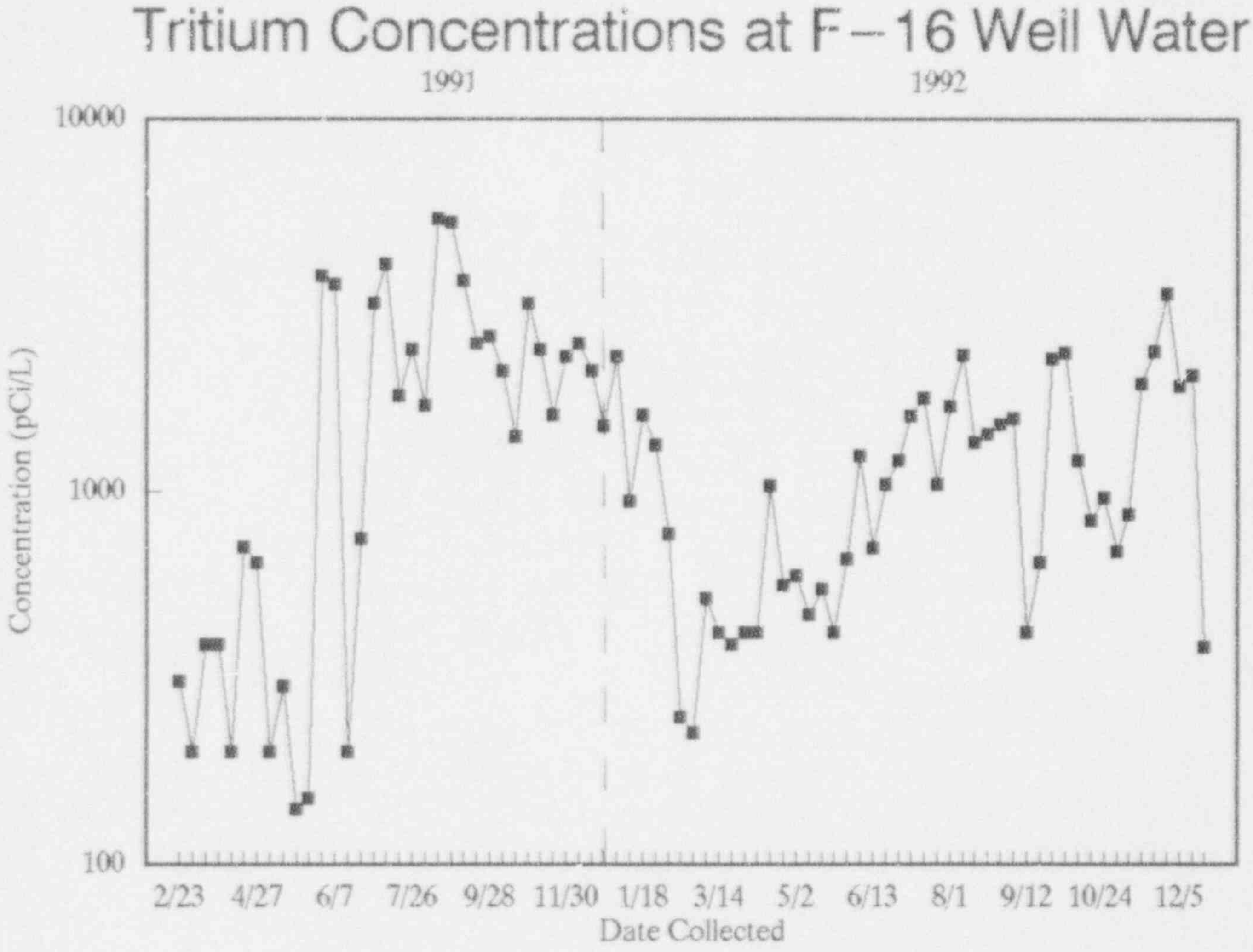
Tritium Concentrations at F-16 Well Water
1991
1992
10000
1000
100
Concentration (pCi/L)
2/23 4/27 6/7 7/26 9/28 11/30 1/18 3/14 5/2 6/13 8/1 9/12 10/24 12/5
Date Collected

Table II.C.8

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

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

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 22.5km West of the reactor in the least predominant wind direction. Herd management practices are similar at all dairy locations. The cows in the milking herd are never on pasture but are managed under dry-lot management which is typical of the Western U.S.

Table II.D.1 lists the concentrations of all radionuclides that are investigated in milk samples. Note that A-22 dropped out of the sampling program this 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 1.5g/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. Elevated tritium concentrations in milk due to reactor effluents were never observed during the operational or defueling phase of the reactor. During 1992, slightly elevated concentrations were observed particularly during the fourth quarter. However, the mean of the 5 adjacent sites was not statistically greater than the reference site. This implies the tritium from reactor effluents is not contributing any significant 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. If there are other more wide-spread source terms, they are unknown at the present time.

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	01/04/92	01/11/92	h	01/04/92	01/11/92	01/11/92	01/08/92
I-131	< 0.34	< 0.51		< 0.47	< 0.50	< 0.81	0.52(0.6)
Cs-134	< 2.4	< 2.1		< 2.7	< 2.6	< 2.6	< 2.5
Cs-137	< 3.0	6.2(3.1)*		< 3.2	< 3.1	< 3.1	< 3.1
Ba-140	< 3.5	< 3.4		< 4.2	< 16	< 4.1	< 14
La-140	< 4.4	< 3.9		< 4.8	< 19	< 4.7	< 16
Collection Date	02/08/92	02/22/92	h	02/22/92	02/29/92	02/29/92	02/22/92
I-131	< 0.33	< 0.49		< 0.50	< 0.38	< 0.23	< 0.40
Cs-134	< 3.2	< 2.4		< 2.6	< 2.6	< 2.5	< 2.4
Cs-137	< 3.9	2.9(3.4)		< 3.1	3.2(3.8)	< 3.1	< 3.0
Ba-140	< 8.0	< 3.7		< 6.5	< 4.1	< 4.1	< 3.9
La-140	< 9.2	< 4.3		< 7.5	< 4.8	< 4.7	< 4.5
Collection Date	03/21/92	03/21/92	h	03/28/92	03/28/92	03/28/92	03/28/92
I-131	< 0.37	< 0.49		< 0.32	< 0.49	< 0.40	< 0.46
Cs-134	< 1.5	< 2.1		< 2.0	< 2.0	< 3.0	< 2.4
Cs-137	2.0(2.2)	3.8(3.1)		< 2.5	< 2.4	< 3.6	3.0(3.5)
Ba-140	< 2.5	< 4.8		7.3(7.4)	< 3.2	< 4.9	< 4.9
La-140	< 2.8	< 5.5		8.5(8.5)	< 3.7	< 5.6	< 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	04/25/92	04/18/92	h	04/11/92	04/25/92	04/25/92	04/18/92
I-131	< 0.22	< 0.35		< 0.33	d	< 0.26	< 0.48
Cs-134	< 1.5	< 2.5		< 2.6	< 2.1	< 2.7	< 2.3
Cs-137	4.6(2.8)	< 3.0		< 3.0	4.5(3.8)	< 3.3	< 2.7
Ba-140	< 4.5	< 6.5		< 4.7	< 6.1	< 7.6	< 6.3
La-140	< 5.2	< 7.5		< 5.4	< 7.1	< 8.7	< 7.3
Collection Date	05/16/92	05/09/92	h	05/16/92	05/09/92	05/09/92	05/02/92
I-131	< 0.30	< 0.17		< 0.31	< 0.16	< 0.38	< 0.17
Cs-134	< 2.0	< 1.5		< 1.3	< 1.5	< 1.6	< 1.4
Cs-137	< 2.5	3.5(2.7)		4.9(2.3)	5.8(2.6)	3.3(2.9)	4.8(2.5)
Ba-140	< 4.4	< 2.3		< 1.8	< 2.7	5.0(3.4)	< 2.1
La-140	< 5.1	< 2.6		< 2.1	< 3.1	5.8(3.9)	< 2.4
Collection Date	06/06/92	05/23/92	h	06/06/92	05/23/92	05/23/92	05/23/92
I-131	< 0.32	< 0.13		< 0.14	< 0.39	< 0.38	< 0.35
Cs-134	< 2.0	< 2.5		< 2.4	< 1.2	< 1.6	< 2.1
Cs-137	< 3.3	< 3.0		5.7(4.4)	6.6(2.3)	7.4(2.9)	5.0(3.0)
Ba-140	< 3.8	< 5.0		< 4.1	< 2.6	< 3.0	< 3.4
La-140	< 2.8	< 5.7		< 4.8	< 3.0	< 3.4	< 3.9

* - 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	06/20/92	06/13/92	h	06/20/92	06/13/92	06/13/92	06/13/92
I-131	< 0.22	< 0.31		< 0.43	< 0.12	< 0.19	< 0.36
Cs-134	< 2.1	< 0.91		< 1.4	< 1.5	< 2.6	< 2.3
Cs-137	4.5(3.9)	5.5(1.7)		8.5(2.5)	6.0(2.8)	< 3.2	4.1(3.9)
Ba-140	< 3.2	< 1.9		< 3.0	< 3.5	< 4.1	< 3.3
La-140	< 3.7	< 2.2		< 3.5	< 4.1	< 4.7	< 3.8
Collection Date	06/27/92	06/20/92	h	06/27/92	06/27/92	06/27/92	06/20/92
I-131	< 0.44	< 0.28		< 0.40	< 0.22	< 0.17	< 0.39
Cs-134	< 1.4	< 12.9		< 1.4	< 2.5	< 0.72	< 1.6
Cs-137	5.3(2.5)	< 3.6		6.1(2.5)	< 3.1	4.3(1.3)	< 2.4
Ba-140	< 2.0	< 4.8		< 2.3	< 4.1	< 1.1	< 3.1
La-140	< 2.4	< 5.6		< 2.7	< 4.7	< 1.2	< 3.5

* - 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	07/09/92	07/11/92	h	07/06/92	07/11/92	07/11/92	07/11/92
I-131	< 0.39	< 0.11		< 0.25	< 0.18	< 0.12	< 0.48
Cs-134	< 3.6	< 1.4		< 1.5	< 2.5	< 1.5	2.5(2.6)
Cs-137	< 4.5	4.7(2.7)		4.7(2.6)	< 3.0	1.9(2.1)	5.0(4.0)
Ba-140	< 5.9	< 2.2		< 2.1	< 5.4	< 3.4	< 3.3
La-140	< 6.8	< 2.5		< 2.4	< 6.2	< 1.3	< 3.8
Collection Date	07/18/92	07/25/92	h	07/18/92	07/25/92	07/25/92	07/25/92
I-131	< 0.37	< 0.24		< 0.30	< 0.24	0.38(0.39)	< 0.43
Cs-134	< 2.0	< 1.5		< 1.5	< 0.92	< 1.2	< 1.2
Cs-137	< 2.4	5.7(2.8)		5.1(2.6)	5.1(1.7)	3.8(2.1)	5.3(2.2)
Ba-140	< 3.1	< 2.8		< 3.3	< 2.0	< 2.3	< 2.3
La-140	< 3.6	< 3.3		< 3.8	< 2.2	< 2.6	< 2.7
Collection Date	08/01/92	08/07/92	h	08/01/92	08/07/92	08/07/92	08/07/92
I-131	< 0.47	< 0.31		< 0.14	< 0.21	< 0.33	< 0.35
Cs-134	< 2.5	< 2.3		< 0.73	< 1.5	< 2.2	< 1.4
Cs-137	< 3.0	4.2(3.4)		3.9(1.3)	5.4(2.6)	< 2.6	5.5(2.4)
Ba-140	< 4.0	< 5.3		< 1.0	< 2.2	< 3.4	< 2.0
La-140	< 4.6	< 2.1		< 1.2	< 2.5	< 3.9	< 2.3

* - 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	08/15/92	08/22/92	h	08/15/92	08/22/92	08/29/92	08/22/92
I-131	< 0.43	< 0.30		< 0.31	< 0.41	< 0.12	< 0.053
Cs-134	< 2.2	1.7(1.9)		< 2.3	< 1.5	< 1.4	< 2.4
Cs-137	4.3(3.9)	2.8(2.9)		< 2.8	< 2.2	3.1(2.5)	< 2.9
Ba-140	< 3.9	< 2.5		< 3.7	< 2.6	< 2.0	< 3.9
La-140	< 4.4	< 2.9		< 4.3	< 2.9	< 2.3	< 4.4
Collection Date	09/05/92	09/12/92	h	09/05/92	09/12/92	09/12/92	09/12/92
I-131	< 0.19	< 0.31		< 0.22	< 0.46	< 0.23	< 0.53
Cs-134	< 1.5	< 2.3		< 1.3	< 2.4	< 0.85	< 1.3
Cs-137	5.9(2.8)	3.1(3.3)		4.8(2.2)	4.3(4.5)	5.1(1.5)	< 1.9
Ba-140	< 2.3	< 3.6		< 1.9	< 4.1	< 1.7	< 1.8
La-140	< 2.6	< 4.1		< 2.1	< 4.7	< 2.0	< 2.1
Collection Date	09/18/92	09/26/92	h	09/18/92	09/26/92	09/26/92	09/26/92
I-131	< 0.37	< 0.54		< 0.23	< 0.12	< 0.25	< 0.30
Cs-134	< 1.5	< 1.4		< 1.3	< 1.3	< 2.3	< 2.5
Cs-137	2.2(2.2)	6.2(2.5)		2.6(2.3)	< 2.0	< 2.8	4.4(3.7)
Ba-140	< 2.4	< 2.1		< 1.9	< 2.0	< 3.6	< 4.9
La-140	< 2.8	< 2.4		< 2.1	< 2.3	< 4.2	< 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	10/10/92	10/03/92	h	10/10/92	10/10/92	10/10/92	10/03/92
I-131	< 0.29	< 0.25	---	< 0.39	< 0.14	< 0.28	< 0.15
Cs-134	2.9(3.1)*	< 4.0	---	< 1.6	< 1.6	< 2.5	< 2.2
Cs-137	< 3.3	< 4.8	---	6.1(2.8)	3.1(2.9)	6.3(3.7)	< 2.8
Ba-140	< 4.3	< 6.5	---	< 2.4	< 2.3	< 4.0	< 4.4
La-140	< 4.9	< 7.4	---	< 2.8	< 2.7	< 4.6	< 5.1
Collection Date	11/11/92	11/07/92	h	11/14/92	11/14/92	11/14/92	11/14/92
I-131	< 0.04	< 0.26	---	< 0.24	< 0.22	d	< 0.50
Cs-134	< 0.88	< 2.4	---	< 2.1	< 1.5	< 2.1	< 0.10
Cs-137	2.5(1.3)	< 3.0	---	4.2(3.1)	5.6(2.8)	< 2.5	4.8(1.8)
Ba-140	< 2.8	< 4.8	---	< 3.4	< 2.9	< 3.4	< 2.1
La-140	< 3.2	< 5.6	---	< 3.9	< 3.4	< 3.9	< 2.4
Collection Date	12/19/92	12/19/92	h	12/26/92	12/14/92	a	12/26/92
I-131	< 0.28	< 0.27	---	< 0.38	< 0.12	---	< 0.38
Cs-134	< 2.4	< 1.5	---	< 2.3	< 0.77	---	< 1.2
Cs-137	< 2.9	4.7(2.8)	---	< 2.8	5.4(1.4)	---	4.4(2.3)
Ba-140	< 3.7	6.0(4.7)	---	< 6.1	< 1.4	---	< 1.9
La-140	< 4.3	6.9(5.3)	---	< 7.0	< 1.6	---	< 2.2

* - 1.96σ (Due to counting statistics)
a - Sample lost prior to analysis.
d - Sample lost during analysis.
h - Sample not collected at dairy owner's request.

Table II.D.2 Tritium in Milk 1992. (pCi/L)

Collection Period	Adjacent						Reference
	A-6	A-18	A-22	A-23	A-24	A-26	R-8
January	< 410	< 410	h	< 410	< 410	< 410	< 410
February	< 410	< 410	h	< 410	< 410	< 410	< 410
March	< 420	< 420	h	< 420	< 420	< 420	< 420
April	830(500)	490(490)	h	580(490)	< 410	< 410	690(500)
May	530(490)	< 410	h	< 410	780(500)	< 410	660(490)
	450(420)	< 420	h	< 420	< 420	< 420	580(420)
June	< 430	< 430	h	620(520)	670(530)	620(530)	< 430
	1090(500)	600(500)	h	730(500)	< 410	530(500)	670(500)

* - 1.96σ (Due to Counting Statistics)
h - Sample not collected at dairy owner's request.

Table II.D.2 Tritium in Milk 1992. (pCi/L)

Collection Period	Adjacent						Reference
	A-6	A-18	A-22	A-23	A-24	A-26	R-8
July	< 430	< 430	h	< 430	< 430	< 430	< 430
	< 420	< 420	h	< 420	< 420	< 420	< 420
August	< 420	660(420)*	h	< 420	430(420)	540(420)	< 420
	< 410	< 410	h	< 410	< 410	< 420	< 410
September	< 420	440(420)	h	< 420	< 420	< 420	< 420
	< 420	420(420)	h	< 420	530(420)	< 420	< 420
October	720(490)	< 410	h	630(480)	< 410	580(480)	440(500)
November	3400(520)	< 420	h	< 430	< 412	< 440	590(500)
December	< 420	< 410	h	< 420	1400(500)	< 410	480(510)

* - 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 1992 harvest. Four of the food samples showed detectable Cs-137 from past Chernobyl world-wide fallout deposition. The gamma-ray spectra were scanned for other radionuclides, but only the naturally occurring radionuclides were observed, presumably due to surface soil deposits.

To provide background information on environmental radioactivity prior to decommissioning, tissues were obtained from a heifer that had grazed the pasture area that is irrigated by the Goosequill ditch. The ditch is also a drinking water source for cattle grazing the pasture.

The heifer was removed from the pasture on October 20, 1992 and trucked to a holding pen at the CSU meat laboratory. The heifer was slaughtered on October 21, 1992 by CSU meat laboratory staff. The thyroid gland and surrounding tissue was removed to determine whether there was any I-131 present. The carcass

was aged, according to general practice, for one week in a cooler.

The carcass was cut into retail cuts, wrapped and frozen on October 28, 1992. Ground meat samples representing the total carcass were mixed and ten random 1kg samples of ground beef were packed into 1L Marinelli beakers for γ-ray spectroscopy. Subsamples of each were taken for tritium analysis.

The radionuclide concentration results are given in Table II.E.2

Table II.E.1

Radionuclide Concentrations in Food Products (pCi/kg)
Collection Date: October 20, 1992

Location	Food Type	I-131	Cs-134	Cs-137
R-6	Red Peppers	< 8.6	< 8.7	25(15)*
R-6	Jalapeños	< 14	< 14	< 17
R-6	Watermelons	< 22	< 4.3	14(7.9)
R-6	Tomatoes	< 13	< 3.2	22(5.9)
R-6	Red Chilies	< 25	< 14	21(20)
R-6	Cantaloupe	< 21	< 5.2	< 6.3

* 1.96σ (Due to Counting Statistics.)

Table II.E.2 Radionuclide Concentrations in Beef Samples Collected on 10/21/92

Radionuclide concentrations in Beef			
Beef Sample #	K-nat mg/L	Cs-137 pCi/kg	H-3 pCi/L
1	1.0	< 6.0	< 410
2	2.1	7.4	< 410
3	2.0	11	< 410
4	2.0	10	< 410
5	2.0	11	610(500)
6	1.7	4.0	2000(520)
7	1.3	7.3	< 410
7b	8.0	7.3	< 410
8	1.1	< 8.7	< 410
9	1.2	13	< 410
10	1.8	9.2	510(510)
$\overline{X}(1.96\sigma)$	2.2(3.7)	8.2(5.5)	480(510)

Notes:

1. Cow slaughtered 10/21/92. Cow donated by Ben Houston. Animal grazed on pasture north of FSV, and had access to Goosequill Ditch.
2. Thyroid sample was counted separately for I-131 and yielded < 230pCi/kg.

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 1992. 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. The Fe-59 values for the second half of 1992 are close to the uncertainty confidence limits.

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 due to the Chernobyl fallout. The cesium ions are bound nearly irreversibly by the clay mineral matrix in the sediment. The concentrations observed in 1992 were statistically the same as observed in 1991.

Observation for Corbicula fluminea, a species of freshwater clam, had previously been conducted at all fish sampling sites. Our past samplings have indicated no evidence of Corbicula at any of the sampling sites of the reactor surface water courses. This monitoring has been terminated.

Table II.F.1

Radionuclide Concentrations in Fish. (pCi/kg)

Collection Date	First Half '92			Second Half '92		
Radionuclide	Upstream F-19	Effluent A-25	Downstream R-10	Upstream F-19	Effluent A-25	Downstream R-10
Cs-134	< 1.8	< 3.6	< 4.3	< 4.7	< 4.4	< 2.6
Cs-137	7.9(2.5)*	< 4.1	< 4.7	8.4(6.3)	7.7(5.7)	13(2.5)
Co-58	< 1.6	< 3.2	7.0(6.6)	< 4.2	< 8.8	< 2.2
Mn-54	1.9(2.2)	< 3.8	< 4.4	< 4.5	< 3.5	< 3.0
Zn-65	< 6.5	< 10	< 12	< 13	< 12	< 9.1
Fe-59	< 5.5	< 11	< 6.7	< 7.4	43(39)	20(24)
Co-60	< 2.0	< 3.9	< 4.6	< 5.0	< 4.4	< 2.7

*-1.96σ (Due to Counting Statistics.)

Table II.F.2

Radionuclide Concentrations in Sediment from location R-10. (pCi/kg)

Radionuclide	Concentration
Collection Date: June 6, 1992	
Cs-134	17(11)*
Cs-137	71(11)
Collection Date: October 31, 1992	
Cs-134	< 9.5
Cs-137	69(11)

* - 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 β, Gross alpha	Semiannually
Water	Co-60, Zn-65, Cs-134, Cs-137	Triannually
Water	I-131	Semiannually
Air particulate	Cs-137, Gross β, 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 1992. 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 three 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 1992 all results except 11 were within the warning level. The results exceeding the warning level have the notation (n) in Table II.G.1. The explanation for the incorrect result is given 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 1992 approximately 15% 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 1992 were all verified to be correct.

Table II.G.1 EPA Cross-Check Data Summary. 1992.

Date	Radio-nuclide	CSU Value	EPA Value	1 E.L.P.*	Normalized Deviation from known**
		WATER, TRITIUM (pCi/L)			
Feb 21	H-3	8500	7904	790	1.31
Jun 19	H-3	2300	2125	347	0.99
Jun 23	H-3	5667	5962	596	-0.96
		WATER, Alpha/Beta (pCi/L)			
May 15	alpha	13.0	15.0	5.0	-0.69 (1)
	beta	22.30	44.0	5.0	-7.09 (2)
Sep 18	alpha	59.33	45.0	11.0	3.60 (3)
	beta	35.00	50.0	5.0	-4.71 (4)
		WATER, I-131 (pCi/L)			
Feb 07	I-131	69.33	59.0	6.0	2.98
Aug 07	I-131	49.33	45.0	6.0	1.25
		WATER, Performance (pCi/L)			
Apr 14	beta	85.33	140.0	21.0	-4.51 (5)
	Cs-134	26.33	24.0	5.0	0.81
	Cs-137	25.67	22.0	5.0	1.27
Oct 20	alpha	29.33	29.0	7.0	0.08
	beta	42.67	53.0	10.0	-1.79
	Cs-134	5.33	5.0	5.0	0.12
	Cs-137	10.67	8.0	5.0	0.92
		WATER, Gamma (pCi/L)			
Feb 14	Co-60	40.00	40.0	5.0	0.00
	Zn-65	125.00	148.0	15.0	-2.66
	Cs-134	25.67	31.0	5.0	-1.85
	Cs-137	46.00	49.0	5.0	-1.04
	Ba-133	12.00	76.0	8.0	-13.86 (6)
Jun 05	Co-60	16.00	20.0	5.0	-1.15
	Zn-65	74.30	99.0	10.0	-3.70
	Cs-134	15.00	15.0	5.0	0.00
	Cs-137	20.00	15.0	5.0	1.85

WATER, Gamma (pCi/L) (cont.)

Oct 09	Co-60	15.33	10.0	5.0	1.85
	Zn-65	270.0	148.0	15.0	14.09 (7)
	Cs-134	13.00	8.0	5.0	1.73
	Cs-137	18.00	8.0	5.0	3.46 (8)

MILK (pCi/L)

Apr 24	I-131	88.67	78.0	8.0	2.31
	Cs-137	34.33	39.0	5.0	-1.62
	K-40	2563.33	1710.0	86.0	17.19 (9)
Sep 25	I-131	113.33	100.0	10.0	2.31
	Cs-137	16.67	15.0	5.0	0.58
	K-40	3240.00	1750.0	88.0	29.33 (10)

AIR FILTERS (pCi/F)

Mar 27	alpha	5.00	7.0	5.0	-0.69
	beta	13.00	41.0	5.0	-9.7 (11)
	Cs-137	10.67	10.0	5.0	0.23
Aug 28	alpha	26.67	30.0	8.0	-0.79
	beta	71.33	69.0	10.0	0.46

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* 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.

(1) Error on original submission to EPA
(2,3,4,5) No apparent reason for error in result
(6,7) Interference due to Bi-214 was incorrectly calculated
(8) No apparent reason for incorrect result
(9,10) K-40 calibration was in error. Calibration has been corrected
(11) No apparent reason for error in result

Table II.G.2

Tritium Crosscheck Analyses on Split Water Samples Determined by Colorado State University and Public Service Company. 1992

a) 1st and 2nd Quarters

Collection Date	Sample Location	Tritium Concetrations (pCi/L)	
		CSU	PSC
Jan 11	A-25	< 410	< 360
Jan 11	A-21	< 410	< 360
Jan 22	E-41	< 410	< 360
Feb 8	A-25	860(510)*	728(448)
Feb 8	A-21	< 410	< 360
Feb 5	E-41	< 410	< 360
Mar 14	A-25	990(500)	1190(448)
Mar 14	A-21	< 410	< 360
Mar 18	E-41	< 410	< 360
Apr 11	A-25	580(490)	< 360
Apr 11	A-21	< 410	< 360
Apr 01	E-41	< 410	< 360
May 16	A-25	1490(530)	1620(442)
May 09	A-21	< 420	< 360
May 13	E-41	< 420	< 360
Jun 20	A-25	810(520)	624(428)
Jun 20	A-21	< 410	< 360
Jun 03	E-41	460(520)	< 360

* - 1.96σ (Due to Counting Statistics)

Table II.G.2

Tritium Crosscheck Analyses on Split Water Samples Determined by Colorado State University and Public Service Company. 1992

b) 3rd and 4th Quarters

Collection Date	Sample Location	Tritium Concetrations (pCi/L)	
		CSU	PSC
Jul 11	A-25	< 420	509(427)
Jul 11	A-21	< 420	363(425)
Jul 08	E-41	< 420	< 360
Aug 07	A-25	< 420	< 349
Aug 07	A-21	< 420	< 349
Aug 05	E-41	< 430	< 349
Sep 12	A-25	440(500)*	765(429)
Sep 12	A-21	< 420	< 346
Sep 09	E-41	< 420	< 346
Oct 10	A-25	560(510)	600(428)
Oct 10	A-21	< 410	994(436)
Oct 14	E-41	< 420	< 348
Nov 14	A-25	730(490)	< 363
Nov 14	A-21	640(490)	< 363
Nov 05	E-41	4090(520)	3590(496)
Dec 12	A-25	440(420)	< 358
Dec 12	A-21	640(490)	419(413)
Dec 02	E-41	510(490)	< 358

* - 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. 1992

a) 1st and 2nd Quarters

Collection Date	Sample Location	Gross Beta (pCi/L)	
		CSU	PSC
Jan 11	A-25	12(5.8)*	14.4(7.49)
Jan 11	A-21	10(6.0)	11.9(7.44)
Jan 22	E-41	8.4(5.8)	5.97(7.01)
Feb 8	A-25	15(6.0)	12.1(7.01)
Feb 8	A-21	9.7(5.8)	16.6(7.34)
Feb 5	E-41	11(5.8)	13.8(7.15)
Mar 14	A-25	12(5.9)	11.6(7.20)
Mar 14	A-21	24(6.4)	23.6(8.07)
Mar 18	E-41	11(5.8)	10.3(7.17)
Apr 11	A-25	15(6.1)	11.5(7.58)
Apr 11	A-21	14(5.9)	9.67(7.49)
Apr 01	E-41	11(5.9)	11.1(7.61)
May 16	A-25	13(5.9)	16.3(7.29)
May 09	A-21	5.3(5.5)	< 5.39
May 13	E-41	11(5.8)	9.5(7.00)
Jun 20	A-25	8.5(5.7)	16.3(7.29)
Jun 20	A-21	5.1(5.5)	< 5.39
Jun 03	E-41	8.8(5.7)	9.5(7.00)

* - 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. 1992

b) 3rd and 4th Quarters

Collection Date	Sample Location	Gross Beta Concetrations (pCi/L)	
		CSU	PSC
Jul 11	A-25	7.4(5.6)*	11.8(6.86)
Jul 11	A-21	< 5.3	10.3(6.94)
Jul 08	E-41	< 5.4	11.7(6.93)
Aug 07	A-25	< 5.5	11.1(7.57)
Aug 07	A-21	< 5.7	< 6.02
Aug 05	E-41	< 5.5	12.2(7.76)
Sep 12	A-25	< 5.5	10.5(7.39)
Sep 12	A-21	8.0(5.8)	10.2(7.54)
Sep 09	E-41	< 5.5	8.09(7.41)
Oct 10	A-25	10(2.7)	22.3(7.98)
Oct 10	A-21	5.9(2.5)	17.7(7.70)
Oct 14	E-41	4.4(2.4)	7.39(7.21)
Nov 14	A-25	10(6.0)	19.7(8.62)
Nov 14	A-21	7.7(5.8)	13.0(8.29)
Nov 05	E-41	5.8(5.7)	14.1(8.31)
Dec 12	A-25	9.5(5.9)	17.4(9.05)
Dec 12	A-21	14(6.1)	12.4(8.16)
Dec 02	E-41	6.8(5.7)	15.2(8.61)

* - 1.96σ (Due to Counting Statistics)

Table II.G.4

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

Radionuclide	Drinking Water							
	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter	
	A	B	A	B	A	B	A	B
Cs-134	< 6.7	< 10	< 1.3	< 1.8	< 1.3	< 1.9	1.9(1.5)	3.6(2.4)
Cs-137	2.7(2.7)	< 2.2	5.8(1.9)	3.5(2.3)	2.9(1.9)	4.1(2.8)	2.2(1.9)	< 2.2
Zr-95	< 1.8	< 2.1	< 3.1	3.7(3.7)	< 2.9	< 5.0	< 2.9	< 3.1
Nb-95	< 0.97	< 1.6	< 1.4	< 1.8	< 1.2	< 1.7	< 1.4	< 1.8
Co-58	< 0.82	< 1.8	< 1.2	< 1.9	< 1.2	< 1.8	1.8(1.6)	3.2(3.5)
Mn-54	< 0.91	< 1.9	< 1.2	< 2.6	< 1.3	< 2.0	< 1.3	< 2.4
Zn-65	< 2.2	< 5.2	< 4.7	< 5.0	< 3.8	< 5.4	< 3.5	< 3.6
Fe-59	< 2.6	< 3.6	< 2.9	< 4.2	< 3.1	< 4.5	< 4.3	< 4.9
Co-60	50(1.8)	< 2.5	< 1.2	< 3.3	< 1.2	< 2.1	< 1.2	< 3.3
Ba-140	< 5.2	< 4.6	< 2.1	< 4.3	< 2.8	< 5.3	< 6.2	< 4.6
La-140	< 6.0	< 5.1	< 2.4	< 5.0	< 3.2	< 6.1	< 7.2	< 6.4
Gross Beta	5.6(2.4)	7.1(2.5)	5.0(2.4)	2.5(2.3)	3.7(2.9)	2.2(2.8)	3.7(2.4)	5.2(2.5)
H-3	< 410	< 410	< 420	< 420	< 420	< 420	< 440	< 440

Radionuclide	Milk							
	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter	
	A	B	A	B	A	B	A	B
Cs-134	< 3.2	< 2.4	< 2.0	< 2.0	< 1.5	< 1.5	2.9(3.1)	< 2.4
Cs-137	< 3.9	< 3.0	< 2.5	< 2.5	5.9(2.8)	2.2(2.2)	< 3.3	< 2.9
Ba-140	< 8.0	< 3.8	< 4.4	< 3.3	< 2.3	< 2.4	< 4.3	< 3.7
La-140	< 9.2	< 4.4	< 5.1	< 3.8	< 2.6	< 2.8	< 4.9	< 4.3
H-3	< 410	< 410	< 430	< 430	< 420	< 420	690(490)	< 420

II.H. Summary and Conclusions

Table II.H.1 summarizes the radiation and environmental radioactivity measurements conducted during 1992 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 there were no individual measurements that exceeded the Reporting Level (RL) (see Table III.A.3). The Chernobyl world-wide fallout was still observable as Cs-137 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, not

statistically greater than those in Fort Collins.

c. The city of Gilcrest does not filter and treat its well 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 and should 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 1992 elevated tritium concentrations were not observed downstream and the mean values for the first and second half of 1992 were not significantly different.

Cs-137 was also observed in many environmental samples due to the Chernobyl world-wide 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. Residents at the F-16 Russell Ranch purchase bottled water for their primary consumption.

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 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 1992, 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 partly 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 analyses of any set of environmental data before meaningful conclusions can be drawn.

3. The Chernobyl world-wide 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 due to world-wide fallout.

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 human 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 decommissioning 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 Radiological Environmental Monitoring Program Annual Summary
Fort St. Vrain Nuclear Generating Station, Platteville, Colorado

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses Performed	Facility Locations Mean (f)[1] Range and Direction	Adjacent Locations Mean (f)[1] Range and Direction	Locations with Highest Annual Mean Name	Mean	Reference Locations Mean (f)[1] Range	Number of Nonroutine Reported Measurements
Direct Radiation (Mr/day)	TLD (161)	0.41(72/72) (0.27-0.60)	0.40(70/72) (0.28-0.63)	F-4 North WCR21 0.7 km	0.50(4/4) 0.42-0.58	0.40(20/20) (0.31-0.60)	0
Air, Particulates (Fci/m^3)	Gross β (359)	23(202/206) (12-48)		F-16 3-Bar Ranch 1.2 km 0°	25(52/52) (12-48)	23(155/156) (7.2-64)	0
Gamma Spectrometry							
	Cs-134 (28)	2.0(3/16) (0.61-3.0)		F-16 3-Bar Ranch 1.2 km 0°	1.1(2/4)	< 0.85	0
	Cs-137 (28)	0.94(8/16) (0.61-1.4)		F-9 Farm CR19½ [illegible]CR34 1.5 k[illegible] [illegible]45°	1.1(3/4)	< 0.92	0
Air, Charcoal (Pci/m^3)	I-131 (362)	26(11/207) (12-42)		F-7 Farm CR21 & CR34 1.5 km 145°	30(4/52) (18-42)	23(9/155) (13-33)	0
Air, Atmospheric Water Vapor (Pci/m^3)	H-3 (362)	880(31/202)		F-16 3-Bar Ranch 1.2 km 0°	2900(6/52)	< 780	0
Drinking Water (Pci/L)	Gross β (52)	4.4(26/26) (0.13-9.9)		R-6 Gilcrest City Water 9.3 km 60°	4.4(26/26) (0.13-9.9)	0.90(26/26) (0.42-1.4)	0
	H-3 (52)	< 550(8/26)		R-6 Gilcrest City Water 9.3 km 60°	500(3/26)	500(3/26)	0

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses Performed	Facility Locations Mean (f)[1] Range and Direction	Adjacent Locations Mean (f)[1] Range and Direction	Locations with Highest Annual Mean Name	Mean	Reference Locations Mean (f)[1] Range	Number of Nonroutine Reported Measurements
Gamma Spectrometry							
	I-131 (52)	-----		-----	-----	-----	0
	Cs-134 (52)	2.3(2/26) (1.9-2.7)		R-3 Ft. Collins City Water 45 km 330°	4.0(1/26)	4.0	0
	Cs-137 (52)	3.5(21/26) (1.9-5.8)		R-6 Gilcrest City Water 9.3 km 60°	3.5(15/26) (1.9-5.8)	3.5(15/26) (1.7-4.7)	0
	Zr-95 (52)	2.7(5/26)		R-6 Gilcrest City Water 9.3 km 60°	3.5(1/26)	3.5(1/26)	0
	Nb-95 (52)	1.3(1/26)		R-6 Gilcrest City Water 9.3 km 60°	1.3(1/26)	------	0
	Co-58 (52)	2.8(4/26)		R-6 Gilcrest City Water 9.3 km 60°	1.5(1/26)	< 2.5	0
	Mn-54 (52)	2.1(7/26)		R-3 Ft. Collins City Water 45 km 330°	2.1(7/26) (1.2-2.8)	1.8(1/26)	0
	Zn-65 (52)	-----		-----	-----	-----	0
	Fe-59 (52)	3.1(1/26)		R-6 Gilcrest City Water 9.3 km 60°	3.1(1/26)	-----	0
	Co-60 (52)	2.3(3/26) (0.78-3.5)		R-3 Ft. Collins City Water 45 km 330°	5.2(4/26) (2.6-7.0)	5.2(4/26) (2.6-7.0)	0

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses Performed	Facility Locations Mean (f)[1] Range and Direction	Adjacent Locations Mean (f)[1] Range and Direction	Locations with Highest Annual Mean Name	Mean	Reference Locations Mean (f)[1] Range	Number of Nonroutine Reported Measurements
	Ba-140 (52)	5.6(2/26) (3.0-8.1)		R-6 Gilcrest City Water 9.3 km 60°	5.6(2/26) (3.0-8.1)	5.3(3/26) (3.0-8.1)	0
	La-140 (52)	6.4(2/26) (3.5-9.3)		R-6 Gilcrest City Water 9.3 km 60°	6.4(2/26) (3.5-9.3)	-----	0
Surface Water (Pci/L)	H-3	850(14/36) (450-2900)		A-25 Goosequill 2.2 km 20°	770(7/12) (460-2200)	640(1/12)	0
				<u>**Gamma Spectrometry**</u>			
	Cs-134 (60)	1.5(1/36)		F-19 S. Platte 1.2 km 90°	1.5(1/12)	-----	0
	Cs-137 (60)	3.5(15/36) (1.6-5.6)		R-10 S. Platte at CO 60 10 km 290°	3.8(16/36) (2.6-5.1)	3.6(7/24) (1.9-5.7)	0
	Zr-95 (60)	4.6(1/36)		A-25 Goosequill 2.2 km 20°	7.2(2/12) (5.2-9.1)	2.7(1/24)	0
	Nb-95 (60)	1.5(5/36) (0.96-2.3)		A-25 Goosequill 2.2 km 20°	3.1(2/12) (1.6-4.5)	2.3(1/24)	0
	Co-58 (60)	1.4(3/36) (1.0-2.2)		R-10 S. Platte at CO 60 10 km 290°	2.2(1/12)	2.2(1/24)	0
	Mn-54 (60)	2.0(6/36) (0.94-3.0)		F-19 S. Platte 1.2 km 90°	2.0(5/12) (0.94-3.0)	1.7(2/24) (1.4-2.0)	0
	Zn-65 (60)	< 10		R-10 S. Platte at CO 60 10 km 290°	6.1(1/12)	< 10	0

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses Performed	Facility Locations Mean (f)[1] Range and Direction	Adjacent Locations Mean (f)[1] Range and Direction	Locations with Highest Annual Mean Name	Mean	Reference Locations Mean (f)[1] Range	Number of Nonroutine Reported Measurements
	Fe-59 (60)	4.5(5/36) (2.2-7.4)		F-20 S. Platte 1.5 km 345°	4.5(5/36) (2.2-7.4)	3.5(2/24) (2.7-4.2)	0
	Co-60 (60)	-----		A-25 Goosequill 2.2 km 20°	1.9(1/12)	1.8(1/24)	0
	Ba-140 (60)	15(2/36) (9.2-21)		F-19 S. Platte 1.2 km 90°	21(1/12)	-----	0
	La-140 (60)	18(2/36) (11-25)		F-19 S. Platte 1.2 km 90°	25(1/12)	-----	0
Ground Water (Pci/L)	H-3 (8)	2100(3/4) (1900-2300)		F-16 3-Bar Ranch 1.2 km 0°	2100(3/4) (1900-2300)	480(2/4) (470-490)	0
				Gamma Spectrometry			
	Cs-134 (8)	< 2.4		R-5 Milliken 9.5 km 11°	0.66(1/4)	0.66(1/4)	0
	Cs-137 (8)	3.6(3/4) (3.1-3.8)		R-5 Milliken 9.5 km 11°	3.6(3/4) (3.1-3.8)	2.8(4/4) (2.1-3.5)	0
	Zr-95 (8)	2.4(2/4) (1.8-3.0)		F-16 3-Bar Ranch 1.2 km 0°	-----	< 6.2	0
	Nb-95 (8)	< 2.3		R-5 Milliken 9.5 km 11°	1.7(1/4)	1.7(1/4)	0
	Co-58 (8)	1.3(1/4)		F-16 3-Bar Ranch 1.2 km 0°	1.3(1/4)	< 1.7	0
	Mn-54 (8)	1.4(1/4)		R-5 Milliken 9.5 km 11°	1.8(2/4) (0.71-2.9)	1.8(2/4) (0.71-2.9)	0
	Zn-65 (8)	< 6.6		-----	-----	< 6.3	0

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses Performed	Facility Locations Mean (f)[1] Range and Direction	Adjacent Locations Mean (f)[1] Range and Direction	Locations with Highest Annual Mean Name	Mean	Reference Locations Mean (f)[1] Range	Number of Nonroutine Reported Measurements
	Fe-59 (8)	< 5.6		R-5 Milliken 9.5 km 11°	3.6(1/4)	3.6(1/4)	0
	Co-60 (8)	1.1(1/4)		R-5 Milliken 9.5 km 11°	2.2(3/4) (0.65-4.2)	2.2(3/4) (0.65-4.2)	0
	Ba-140 (8)	< 6.4		-----	-----	< 4.4	0
	La-140 (8)	< 7.4		-----	-----	< 5.1	0
Sediment (Pci/kg.dry)							
			Gamma Spectrometry				
	Cs-134 (2)	17(1/2)		R-10 S. Platte at CO 60 10 km 290°	17(1/2)	-----	0
	Cs-137 (2)	70(2/2) (96-71)		R-10 S. Platte at CO 60 10 km 290°	70(2/2) (69-71)	-----	0
Milk (Pci/L)	H-3 (116)	760(24/99) (420-3400)		A-6 Henrickson Dairy 7.1 km 315°	760(24/99) (420-3400)	590(7/16) (440-690)	0
			Gamma Spectrometry				
	I-131 (116)		0.38(1/99)	A-26 Docheff Dairy 9.4 km 180°	0.52(1/17)	0.52(1/17)	0
	Cs-134 (116)		2.3(2/99) (1.7-2.9)	R-8 Gorzeman Dairy 23 km	2.5(1/17)	2.5(1/17)	0

Medium or Pathway Samples (Unit of measurement)	Type and Total Number of Analyses Performed	Facility Locations Mean (f)[1] Range and Direction	Adjacent Locations Mean (f)[1] Range and Direction	Locations with Highest Annual Mean Name	Mean	Reference Locations Mean (f)[1] Range	Number of Nonroutine Reported Measurements
	Cs-137 (116)		4.6(50/99) (1.9-7.4)	R-8 Gorzeman Dairy 23 km	4.6(10/16) (3.0-5.5)	4.6(10-16) (3.0-5.5)	0
	Ba-140 (116)		6.7(2/99) (6.0-7.3)	A-23 Leroy Odenbaugh Dairy 4.1 km 83°	7.3(1/17)	-----	0
	La-140 (116)		7.0(3/99) (5.8-8.5)	A-23 Leroy Odenbaugh Dairy 4.1 km 83°	7.0(3/17) (5.8-8.5)	-----	0
Food Products (Pci/kg, wet)							
<u>**Gamma Spectrometry**</u>							
	I-131 (6)		-----	R-6 Hernandez Gilcrest 9.6 km 60°	< 25	< 25	0
	Cs-134 (6)		-----	R-6 Hernandez Gilcrest 9.6 km 60°	< 14	< 14	0
	Cs-137 (6)		-----	R-6 Hernandez Gilcrest 9.6 km 60°	21(4/9) (14-25)	21(4/9) (14-25)	0

1. 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.

	1989		1990		1991		1992	
	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ
H-3	Atmospheric Water Vapor (pCi/L)							
Facility	43		< 260	290	< 9.4	400	980	830
Reference	< 420		< 300	290	< 80	400	780	530
Gross Beta	Air (fCi/m^3)							
Facility	26		23	12	29	31	25	15
Reference	24		23	12	25	23	25	12
I-131								
Facility	2.2		1.5	3	1.6	13	25	9.0
Reference	2.2		1.4	9	0.52	14	23	6.9
Cs-137								
Facility	0.32		0.55	0.92	0.12	0.69	1.0	0.22
Reference	0.46		0.22	0.66	0.98	1.3	1.1	0.40
H-3	Drinking Water (pCi/L)							
Gilcrest	< 390		< 240	320	32	410	550	90
Ft. Collins	< 390		< 220	290	< 48	350	500	51
Gross Beta								
Gilcrest	5.8		4.5	1.8	5.8	2.4	4.5	2.3

	1989		1990		1991		1992	
	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ
Ft. Collins	0.98		0.86	0.39	0.95	0.35	0.90	0.31
I-131								
Gilcrest	0.068		0.017	0.19	< 0.0028	0.16	0.29	0.14
Ft. Collins	0.14		0.046	0.24	< 0.022	0.20	0.35	0.15
Cs-137								
Gilcrest	2.2		1.3	1.4	2.2	1.6	3.4	1.1
Ft. Collins	1.8		2.4	1.8	1.7	1.2	3.4	0.88
H-3	**Surface Water (pCi/L)**							
Effluent	29000		300	620	1500	2500	770	590
Downstream	< 390		< 370	400	6.2	430	990	860
Upstream	< 390		< 420	350	20	420	640	0
Cs-137								
Effluent	1.3		1.4	1.9	1.7	2.0	3.6	1.4
Downstream	1.8		2.1	1.9	2.3	1.7	3.5	1.2
Upstream	2.0		2.2	1.9	2.0	1.9	3.8	0.89
H-3	**Milk (pCi/L)**							
Adjacent	< 390		< 280	330	< 130	360	760	590
Reference	< 390		< 290	340	< 110	400	590	89
I-131								

	1989		1990		1991		1992	
	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ	$\overline{X}$	σ
Adjacent	0.57		0.53	2.0	0.070	0.39	< 0.32	0.13
Reference	< 0.50		0.0060	0.33	< 0.0028	0.24	< 0.37	0.13
Cs-137								
Adjacent	1.5		1.5	2.0	1.9	1.8	5.0	1.5
Reference	1.5		16	2.3	2.4	1.9	4.6	0.68

Special Table II.J.1 Tritium Concentrations in F-16 Well Water

Date Collected	Concentration (pCi/L)
1/04/92	940
1/11/92	g
1/18/92	1600
1/25/92	g
2/08/92	1300
2/15/92	770
2/22/92	< 420
2/29/92	< 420
3/07/92	520
3/14/92	< 420
3/21/92	< 420
4/04/92	< 420
4/11/92	< 420
4/18/92	1000
4/25/92	560
5/02/92	600
5/09/92	470
5/16/92	550
5/23/92	< 420
5/30/92	660
6/06/92	1200
6/13/92	710
6/20/92	1000
6/27/92	1200
7/06/92	1600
7/18/92	1800

Date Collected	Concentration (pCi/L)
7/25/92	1000
8/01/92	1700
8/07/92	2300
8/15/92	1400
8/22/92	1400
8/29/92	1500
9/05/92	1600
9/12/92	< 420
9/18/92	650
9/26/92	2300
10/03/92	2400
10/10/92	1200
10/17/92	840
10/24/92	960
10/31/92	690
11/07/92	870
11/14/92	1900
11/21/92	2400
11/29/92	3400
12/05/92	1900
12/12/92	2000
12/19/92	g
12/26/92	< 420

g - analysis in progress

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.

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. During 1992, there were no changes in the sampling program, however changes in Iodine-131 analysis occured in December 1992, for the 1993 project.

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 October 1992 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 1992 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.

Table III.A.1 Operational Radiological Environmental Monitoring Program

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

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

Table III.A.1. OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (continued)

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. One sample from a control location.	Composite sample over two week period.	Composite for tritium, gross beta, and gamma isotopic analyses every two weeks.
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. One sample from milking animals in each of three areas between 5 to 8 kilometers distant having the highest dose potential. h	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 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.

h 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					
I-131	0.89	66.4		0.89	56.8	
Cs-134	5.58	8.06	19.5	4.98	44.4	90.6
Cs-137	6.68	7.86	18.5	6.14	44.6	100
Zr-95	10.12					
Nb-95	4.12					
Co-58	4.60		12.0			
Mn-54	4.68		12.7			
Zn-65	10.94		23.6			
Fe-59	8.40		31.4			
Co-60	4.40		14.5			
Ba-140	6.66			8.00		
La-140	7.66			9.16		

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

Table III.A.3 Reporting Levels for Nonroutine Operating Reports

REPORTING LEVELS FOR NONROUTINE OPERATING REPORTS

REPORTING LEVEL (RL)

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

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

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

(F: Facility Area 0-1.6 km. A: Adjacent Area 1.6-8 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 on N side of road 0.4 km E of CR 19½.	8	1.3
	F-9	Pole E of first shed at intersection of CR 19½ and CR 34.	9	1.5
	F-10	Pole on NW corner of intersection of dirt extension of CR 19 and 34.	10	1.5

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

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

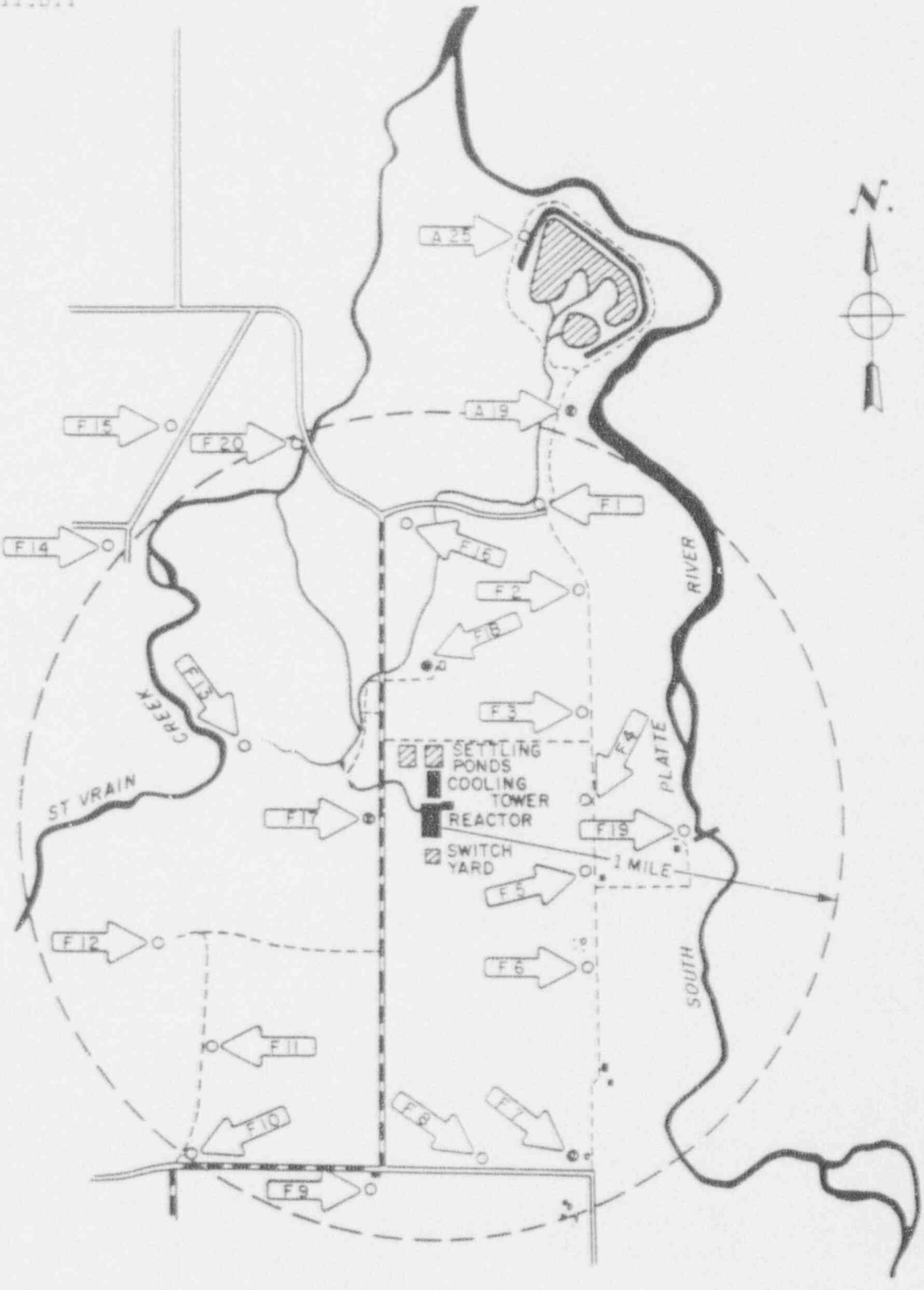


Figure III.B.2

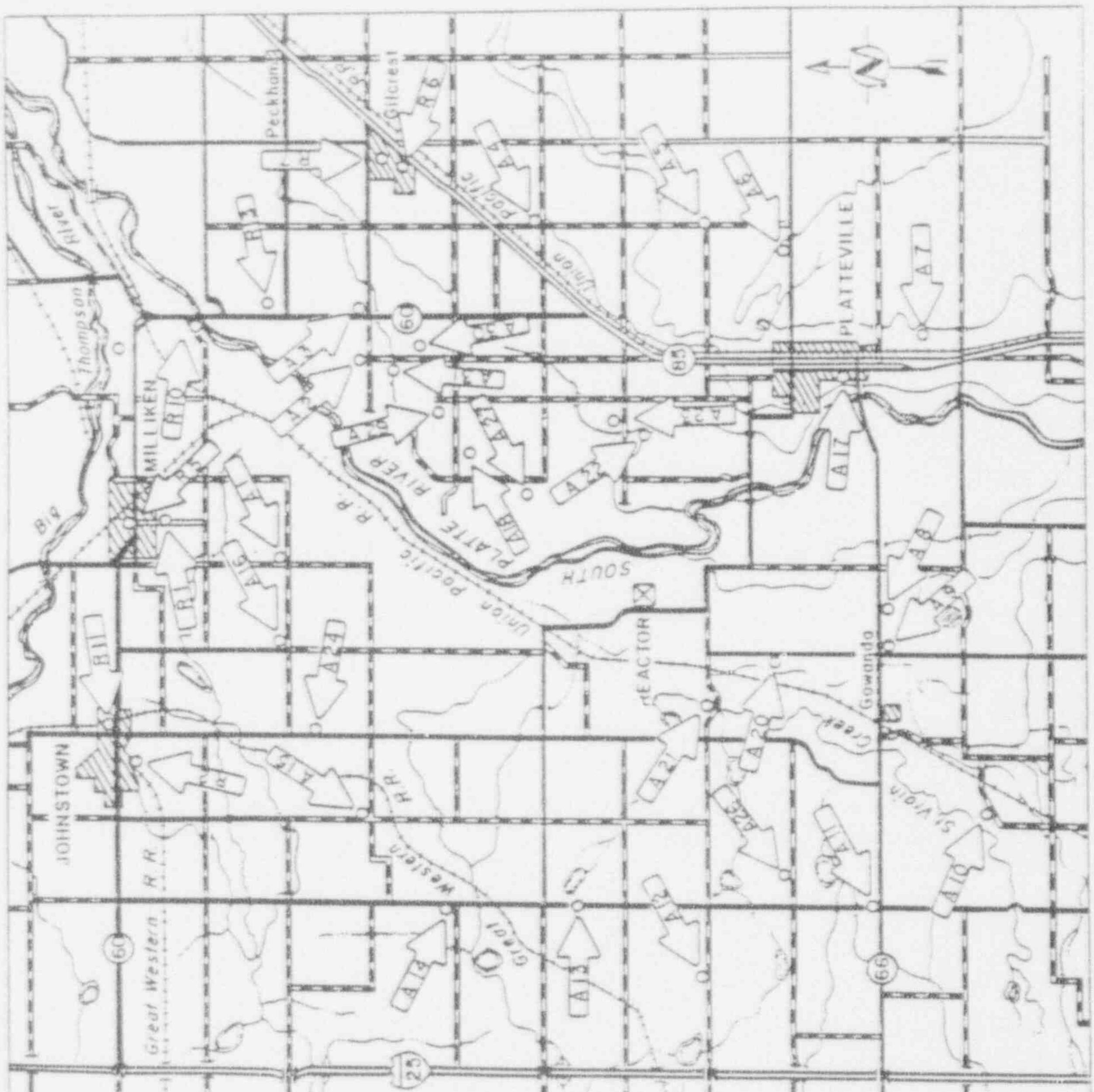
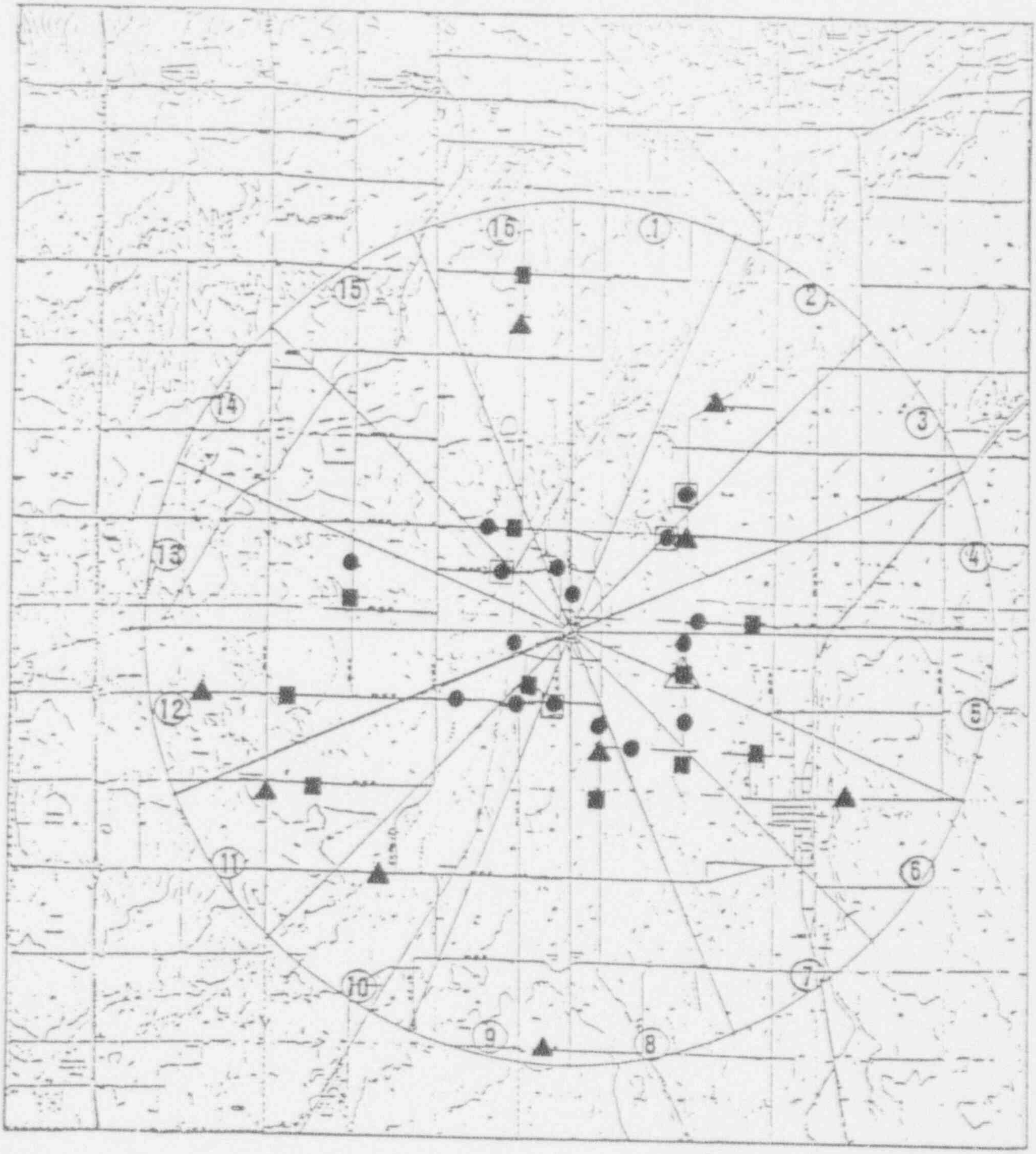


Table III.C.1 1992 Land Use Census*

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 36	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 Date: October, 1992
** New Location
*** No milk animals

Figure III.C.1 Land Use Census 1992



● Nearest Residence

■ Nearest Garden

▲ Nearest Milk Animal