SHIELD SOURCE INCORPORATED

2003
ENVIRONMENTAL MONITORING PROGRAM
ANNUAL COMPLIANCE REPORT

CNSC LICENCE NSPFOL-12.01/2004

Shield Source Incorporated
CNSC Licence NSPFOL-12.01/2004

Environmental Monitoring Program
Annual Compliance Report

Year 2003

Submitted to:

Canadian Nuclear Safety Commission
280 Slater Street, Ottawa, ON K1P 5S9

Prepared by:

Peggy Hirst
Radiation Safety Officer

Approved By:

Susanne J. Tanney
General Manager

Date: March 30, 2004

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Licence No:	NSPFOL-12.01/2004
Owner:	Shield Source Incorporated
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1. INTRODUCTION

1.1 Purpose

This Environmental Monitoring report is to be the environmental monitoring portion of Shield Source Incorporated (SSI) 2003 Annual Report. This report contains a summary of the environmental monitoring results including stack emissions, air, water, milk and vegetation monitoring data. Stack emissions have been compared with the environmental monitoring data and dose to the receptor group has been calculated.

1.2 Background Information

In 1997, Twin Oaks Consulting (Twin Oaks) was retained by SSI to develop and implement an environmental monitoring program (EMP) and to calculate Derived Release Limits (DRL). Golder Associates reviewed the EMP developed by Twin Oaks and produced a revised EMP including new DRLs. SSI, Golder and CNSC worked together to attain a quality program. The revised EMP was approved in August 2003 and the DRLs in April 2003.

1.3 Land Use Within the Monitoring Program Area

On January 30, 2001, [redacted] of Golder Associates' Whitby Office accompanied by the Production Supervisor of SSI, conducted a land use survey within the monitoring program area. Specifically, the land use survey was conducted in the eastern end of North Monaghan Township, adjacent to the SSI facility, and in the western end of Otonabee Township, within a 10 km radius of the SSI facility. The portions of the two townships included in the survey are located in the prevailing down-wind direction from the SSI facility. The description of the land use within the monitoring area was given in SSI's report entitled "2000 Annual Report On Environmental Monitoring Program" submitted by Golder in April 2001.

SSI conducted additional surveys in November 2001, December 2002 and December 2003 finding no changes from the initial survey.

1.4 Environmental Monitoring Locations

The sampling locations and distances from the stack are summarized in Table 1. Although the final EMP was not approved by CNSC until August 2003, SSI began implementing the new sampling locations and methods in February 2003.

Table 1: SSI EMP Sampling Locations

Sampling Location Numbers	Location	Approximate Distance from Stack (m)	Direction from Stack
A1	Airport Beacon Tower	74	NE
W1	Well Water at SSI	120	NE
A2	Fence at Environment Canada weather station	240	SE
W2	Water from washroom tap at airport	240	SE
A3	Sign across from airport entrance	210	SE
W3	Pond just to the north-east of the sign	170	SE
A4	Along Airport Road at creek north of Mel O'Brien Way	250	N
W4	Along Airport Road at creek north of Mel O'Brien Way	250	N
A5	Tree at house opposite SSI	220	NE
W5	Pond at house opposite SSI	220	NE
V5	Apple tree near pond and residence east of SSI	220	NE
A6	Tree at wetland west of SSI	210	SW
W6	Wetland at tree line west of SSI	210	SW
A7	Mel O'Brien Rd. at end of chain fence	200	NW
W7	Mel O'Brien Rd. at end of chain fence	200	NW
A8	Pond/creek at west side of Airport Rd just prior to bend	870	SE
W8	Pond/creek at west side of Airport Rd just prior to bend	870	SE
A9	Cavan Creek	1500	SW
W9	Cavan Creek	1500	SW
A10	Culvert at Beardsmore Road	1500	N
W10	Culvert at Beardsmore Road	1500	N
V10	End of Mervin Line (at Otonabee River)	1625	NE
A11	Marshy area east of SSI adjacent to Otonabee River	1200	E
W11	Standing Water	1200	E
A12	Airport Road near tributary to Otonabee River	1000	NW
W12	Pond adjacent to Airport Road	1000	NWW
A13	Mervin Line, swampy area	1000	W
W13	Mervin Line, swampy area	1000	W
A14	Adjacent to main runway, at pond	1000	SW
W14	Adjacent to main runway, at pond	1000	SW
A15	Fraserville access to Otonabee River	2500	S
W15	Fraserville access to Otonabee River	2500	S
V15	Fraserville access to Otonabee River	2500	S
M16	[redacted] Dairy Farm east of Stewart Hall and North of Crystal Springs	2860	SE
A17	Background sample 16 km NE of stack	16000	NE
W17	Background sample 16 km NE of stack	16000	NE

2. SUMMARY OF ENVIRONMENTAL MONITORING RESULTS

2.1 Samples

Ambient Air, Water and Milk samples were collected monthly by SSI staff and sent to Monserco Laboratories for analysis. Vegetation Samples were collected during harvest time (September through to November). Stack emissions were measured continuously from the SSI facility. Precipitation samples were not collected in 2003, however collections have begun in January 2004 as per EMP protocol.

The 2003 sampling program consists of 5 types of samples collected - stack emissions, ambient air samples, ambient water samples, milk and vegetation samples. The sampling results are described below.

2.2 Stack Emissions

SSI monitors both Tritium Gas (HT) and Tritium Oxide (HTO) continuously. Total (HT+HTO) stack emissions are recorded daily and HTO activity readings are measured on the last day of a seven-day interval. The weekly, monthly and yearly stack emissions are then calculated. The Derived Release Limits (DRLs) originally calculated by Twin Oaks Consulting (TOC) have been revised by Golder Associates and approved by CNSC in August 2003. Therefore, HTO and HT emission are compared to both the TOC DRL values and the Golder DRL values in this report.

2.2.1 Stack Emission Results

Monthly tritium stack emissions for the period between environmental monitoring sampling dates are presented in Table 2.

Table 2: Monthly Tritium Stack Emissions

Date		HTO Released Bq	HT Released Bq	Total Activity Bq
From	To			
19-Dec	23-Jan	1.2E+12	1.0E+13	1.2E+13
23-Jan	19-Feb	9.1E+11	9.2E+12	1.0E+13
19-Feb	19-Mar	8.8E+11	9.9E+12	1.1E+13
19-Mar	23-Apr	1.5E+12	8.5E+12	1.0E+13
23-Apr	3-Jun	2.4E+12	6.2E+12	8.6E+12
3-Jun	25-Jun	8.5E+11	4.5E+12	5.3E+12
25-Jun	22-Jul	1.9E+12	2.0E+12	3.9E+12
22-Jul	19-Aug	2.2E+12	1.9E+12	4.1E+12
19-Aug	23-Sep	4.0E+12	5.9E+12	9.9E+12
23-Sep	21-Oct	2.2E+12	4.2E+12	6.4E+12
21-Oct	25-Nov	2.2E+12	4.1E+12	6.2E+12
25-Nov	17-Dec	1.0E+12	3.2E+12	4.2E+12
	Total	2.1E+13	7.0E+13	9.1E+13
	Average	1.8E+12	5.8E+12	7.6E+12
	Maximum	4.0E+12	1.0E+13	1.2E+13

Minimum	8.5E+11	1.9E+12	3.9E+12

The maximum release of HTO occurred during the sampling period of August 19 to September 23, 2003, when an activity of 4.00 TBq was recorded. This corresponds with the maximum monthly average of tritium in ambient air and ambient water samples.

The maximum release of HT and consequently the maximum total activity released occurred during the sampling period of December 19, 2002 to January 23, 2003, when an activity of 10.33 TBq (HT) and 11.56 TBq (Total Activity) was recorded. Below average tritium results in ambient air and ambient water occurred at this time.

The minimum stack emission for HTO was found during the sampling period of June 3 to June 25, 2003 (0.85 TBq). This corresponds with average levels of tritium in ambient water and slightly below average levels of tritium in air monitoring data.

The minimum stack emission for HT was found during the sampling period of July 22, 2003 to August 19, 2003 (1.88 TBq). This corresponds with slightly below average levels of tritium in ambient air monitoring data and below average levels of tritium in water monitoring data.

No discernable variation with season was observed in the data.

2.2.2 DRL and AL

SSI's current licence requires that if the stack emissions exceed 1% of the DRLs per year or 0.02% of the DRLs per week as calculated by Twin Oaks Consulting (TOC 1997), the CNSC is to be notified. The Weekly and Yearly TOC DRLs and Action Levels (AL) are given in Table 3.

Table 3: Weekly and Yearly TOC DRL and AL Values

Description	TOC DRL (Bq)	AL (Bq)
HTO/Week	9.9E+13	9.9E+11
HT/Week	5.7E+15	5.7E+13
HTO/Year	5.2E+15	5.2E+13
HT/Year	3.0E+17	3.0E+15

SSI has proposed new Quarterly and Yearly Action Levels (AL) based on the new approved DRLs (Golder). If an AL is reached SSI must take specific actions and notify the CNSC. The Quarterly and Yearly HTO and HT DRL values calculated by Golder and the proposed ALs are summarized in Table 4.

Table 4: Quarterly and Yearly Golder DRL And Proposed AL Values

Description	Golder DRL (Bq)	Action Level (AL) (Bq)
HTO/Quarter	2.5E+13	2.0E+13
HT/Quarter	8.5E+18	6.8E+13

HTO/Year	1.0E+14	5.0E+13
HT/Year	3.4E+19	3.4E+14

2.2.3 Exceedences of DRL and AL

2.2.3.1 Yearly Stack Emissions

The total HTO and HT stack emissions for 2003 did not exceed the yearly DRLs or ALs calculated by TOC and Golder. (Table 5)

Table 5: Annual Stack Emission Compared with DRL and AL

YEAR	TRITIUM OXIDE (HTO) PER YEAR (Bq)					TRITIUM GAS (HT) PER YEAR (Bq)				
	STACK EMISSION	TWIN OAKS		GOLDER		STACK EMISSION	TWIN OAKS		GOLDER	
		DRL 5.2E+15	AL 5.2E+13	DRL 1.0E+14	Proposed AL 5.0E+13		DRL 3.0E+17	AL 3.0E+15	DRL 3.4E+19	Proposed AL 3.4E+14
		Exceedance of DRL or AL (% Exceeded By)					Exceedance of DRL or AL (% Exceeded By)			
2003	2.2E+13	--	--	--	--	7.0E+13	--	--	--	--

2.2.3.2 Weekly Stack Emissions

The weekly HTO and HT stack emissions for 2003 did not exceed the weekly DRLs calculated by TOC. However the HTO emission for the week of September 16, 2003 to September 23, 2003 did exceed the weekly Action Limit of 0.02% of the TOC DRL. The release occurred during a routine oil change on one of the fill rigs. It was determined that a storage can containing the spent oil was not sealed tightly. It was stored in a vented cabinet and was exhausting into the stack. Once the can was sealed properly the emissions dropped. The incident was reported in accordance with the licence requirements and CNSC staff was satisfied with SSI’s response.

The weekly Stack Emissions are compared to the TOC DRL and AL in Table 6.

Table 6: Weekly Stack Emissions Compared with DRL and AL

DATE	TRITIUM OXIDE (HTO) PER 7(1) DAYS (Bq)			TRITIUM GAS (HT) PER 7(1) DAYS (Bq)		
	STACK EMISSION	TWIN OAKS DRL 9.9E+13	ACTION LEVEL 9.9E+11	STACK EMISSION	TWIN OAKS DRL 5.7E+15	ACTION LEVEL 5.7E+13
		Exceedance of DRL or AL (% Exceeded By)			Exceedance of DRL or AL (% Exceeded By)	
7-Jan	1.8E+11	--	--	2.0E+12	--	--
14-Jan	2.2E+11	--	--	1.9E+12	--	--
21-Jan	1.9E+11	--	--	2.2E+12	--	--
28-Jan	1.6E+11	--	--	2.2E+12	--	--
4-Feb	2.5E+11	--	--	2.3E+12	--	--
11-Feb	2.3E+11	--	--	2.8E+12	--	--
18-Feb	2.8E+11	--	--	2.2E+12	--	--
25-Feb	2.3E+11	--	--	2.2E+12	--	--
4-Mar	2.0E+11	--	--	2.6E+12	--	--
11-Mar	3.0E+11	--	--	2.7E+12	--	--
18-Mar	1.6E+11	--	--	2.4E+12	--	--
25-Mar	1.5E+11	--	--	2.4E+12	--	--
1-Apr	1.3E+11	--	--	1.8E+12	--	--
8-Apr	2.9E+11	--	--	1.9E+12	--	--
15-Apr	4.5E+11	--	--	1.6E+12	--	--
22-Apr	4.4E+11	--	--	1.1E+12	--	--
29-Apr	5.0E+11	--	--	1.5E+12	--	--
6-May	2.5E+11	--	--	1.4E+12	--	--
13-May	4.5E+11	--	--	1.3E+12	--	--
20-May	1.5E+11	--	--	1.2E+12	--	--
27-May	4.7E+11	--	--	1.2E+12	--	--
3-Jun	9.8E+11	--	--	9.0E+11	--	--
10-Jun	2.6E+11	--	--	1.3E+12	--	--
17-Jun	2.2E+11	--	--	1.7E+12	--	--
24-Jun	3.1E+11	--	--	1.2E+12	--	--
1-Jul	3.9E+11	--	--	1.2E+12	--	--
8-Jul	6.3E+11	--	--	7.2E+11	--	--
15-Jul	5.5E+11	--	--	6.1E+11	--	--
22-Jul	7.0E+11	--	--	5.0E+11	--	--
29-Jul	5.5E+11	--	--	7.3E+11	--	--
5-Aug	4.8E+11	--	--	7.6E+11	--	--
12-Aug	6.3E+11	--	--	2.9E+11	--	--
19-Aug	5.3E+11	--	--	1.0E+11	--	--
26-Aug	3.9E+11	--	--	1.1E+12	--	--
2-Sep	4.3E+11	--	--	1.6E+12	--	--
9-Sep	6.0E+11	--	--	1.1E+12	--	--
16-Sep	5.9E+11	--	--	9.3E+11	--	--
23-Sep	2.0E+12	--	100	1.1E+12	--	--
30-Sep	4.4E+11	--	--	1.3E+12	--	--

Table 6: Weekly Stack Emissions Compared with DRL and AL (continued)

DATE	TRITIUM OXIDE (HTO) PER 7(1) DAYS (Bq)			TRITIUM GAS (HT) PER 7(1) DAYS (Bq)		
	STACK EMISSION	TWIN OAKS DRL 9.9E+13	ACTION LEVEL 9.9E+11	STACK EMISSION	TWIN OAKS DRL 5.7E+15	ACTION LEVEL 5.7E+13
		Exceedance of DRL or AL (% Exceeded By)			Exceedance of DRL or AL (% Exceeded By)	
7-Oct	4.7E+11	--	--	9.8E+11	--	--
14-Oct	8.2E+11	--	--	5.9E+11	--	--
21-Oct	4.7E+11	--	--	1.3E+12	--	--
28-Oct	5.2E+11	--	--	7.9E+11	--	--
4-Nov	4.6E+11	--	--	5.3E+11	--	--
11-Nov	3.4E+11	--	--	8.8E+11	--	--
18-Nov	3.7E+11	--	--	9.4E+11	--	--
25-Nov	4.6E+11	--	--	9.4E+11	--	--
2-Dec	4.6E+11	--	--	1.1E+12	--	--
9-Dec	2.6E+11	--	--	1.0E+12	--	--
16-Dec	2.6E+11	--	--	9.1E+11	--	--
23-Dec	3.3E+11	--	--	1.2E+12	--	--
31-Dec	2.7E+11	--	--	3.3E+11	--	--

2.2.3.3 Quarterly Emissions

The Quarterly stack emissions did not exceed the Quarterly DRLs calculated by Golder or the proposed Quarterly AL. (Table 7)

Table 7: Quarterly Stack Emission Compared with Golder DRLs and Proposed ALs

QUARTER	TRITIUM OXIDE (HTO) PER QUARTER (Bq)			TRITIUM GAS (HT) PER QUARTER (Bq)		
	STACK EMISSION	Golder DRL 2.5E+13	AL 2.0E+13	STACK EMISSION	Golder DRL 8.5E+18	AL 6.8E+13
		Exceedance of DRL or AL (% Exceeded By)			Exceedance of DRL or AL (% Exceeded By)	
1ST	2.7E+12	--	--	2.9E+13	--	--
2ND	5.2E+12	--	--	1.8E+13	--	--
3RD	8.5E+12	--	--	1.1E+13	--	--
4TH	5.5E+12	--	--	1.1E+13	--	--

2.2.4 Data Trends

Stack emission data did not show an identifiable correlation with seasonal change. A comparison of monthly HTO and HT stack emission values in 2003 with those from 2002, 2001 and 2000 shows no observable repetition of annual trends (Table 8).

Table 8: Yearly HTO & HT Comparison

MONTH	HTO EMISSIONS (Bq)				HT EMISSIONS (Bq)			
	2003	2002	2001	2000	2003	2002	2001	2000
January	8.6E+11	1.2E+12	2.2E+12	2.3E+12	9.3E+12	4.3E+12	1.5E+13	1.3E+12
February	9.6E+11	1.4E+12	2.4E+12	2.3E+12	9.6E+12	1.0E+13	1.1E+13	6.6E+12
March	8.6E+11	1.3E+12	2.1E+12	1.8E+12	1.1E+13	1.1E+13	6.1E+12	2.1E+12
April	1.7E+12	1.9E+12	2.6E+12	3.4E+12	6.4E+12	1.2E+13	1.1E+13	7.8E+12
May	1.9E+12	1.5E+12	3.0E+12	2.8E+12	5.4E+12	8.8E+12	1.1E+13	5.8E+12
June	1.6E+12	2.0E+12	1.9E+12	3.8E+12	5.9E+12	7.9E+12	8.0E+12	3.5E+12
July	2.6E+12	1.6E+12	3.0E+12	2.5E+12	2.8E+12	6.4E+12	1.2E+13	2.7E+12
August	2.2E+12	2.6E+12	2.2E+12	4.0E+12	3.2E+12	1.3E+13	6.0E+12	1.9E+12
September	3.7E+12	2.3E+12	2.3E+12	3.1E+12	5.0E+12	8.3E+12	1.0E+13	9.3E+12
October	2.5E+12	2.3E+12	1.9E+12	2.3E+12	3.9E+12	1.2E+13	8.8E+12	1.1E+13
November	1.8E+12	2.2E+12	1.7E+12	2.0E+12	3.8E+12	9.4E+12	4.5E+12	1.3E+13
December	1.3E+12	2.9E+12	1.7E+12	1.3E+12	3.7E+12	9.9E+12	6.0E+12	1.7E+13

Total	2.2E+13	2.3E+13	2.7E+13	3.2E+13	7.0E+13	1.1E+14	1.1E+14	8.2E+13
Average	1.8E+12	1.9E+12	2.3E+12	2.6E+12	5.8E+12	9.4E+12	9.1E+12	6.8E+12
Max	3.7E+12	2.9E+12	3.0E+12	4.0E+12	1.1E+13	1.3E+13	1.5E+13	1.7E+13
Min	8.6E+11	1.2E+12	1.7E+12	1.3E+12	2.8E+12	4.3E+12	4.5E+12	1.3E+12

2.3 Ambient Air Data

2.3.1 Sampling Method

Passive air monitors were used to assess tritium activity in air. The samplers consist of scintillation vials filled with distilled water and capped with a diffusion cap (designed by Ontario Hydro Technologies). Tritium oxide and tritium gas diffuse into the vial and dissolve in the distilled water. Ethylene glycol is added to the distilled water during the winter months to prevent freezing. The samplers are deployed one meter above the ground by attaching them to an available surface (post, tree). The sampler is attached so that it always faces the SSI facility. A small plastic plant pot is suspended in the inverted position over the sampler to protect it. The sampler is left for a one-month period and then retrieved for analysis. The sampling liquid is analyzed by scintillation counting.

The passive air monitoring data must be converted from Bq/L in sampling liquid to Bq/m^3 in air. There is no standardized and accepted calculation for this conversion. Numerous assumptions must be made in order to estimate the volume of air sampled by a passive device. The conversion calculation and the assumptions made are presented in Appendix I.

2.3.2 Sample Availability

There were 175 planned ambient air sample collections in 2003 and 160 actual collections performed. Therefore 91% of valid ambient air sample collection was achieved compared to planned collection.

2.3.3 Results

The ambient air monitoring data collected from January 2003 to December 2003 is provided in Table 9.

Based on the assumptions used to convert the passive sampling data from Bq/L in sampling liquid to Bq/m^3 in air, tritium activity in air averaged over the sampling period, was estimated to be less than 1 Bq/m^3 at all sample locations.

The highest annual average tritium activities were 1.49 Bq/m^3 and 1.54 Bq/m^3, collected from sample locations A4 and A5, respectively. Sample locations A4 and A5 are located 250 meters north and 220 meters northeast of the SSI stack, respectively.

The maximum monthly average occurred from August 19, 2003 to September 23, 2002 with an average activity of 1.25Bq/m^3. This corresponds with the maximum monthly tritium oxide emission (4.0E+12 Bq) and maximum monthly average ambient water monitoring results (863 Bq/L).

There is moderate variability among the monthly average measurements with exception to the September 23, 2003 collection. During the period of September 16 to September 23, 2003 a release of HTO of 2.0E+12 Bq occurred. This release was reflected in the environmental samples collected on September 23, 2003.

There does not appear to be a monthly tritium activity trend among these locations.

New sampling locations were incorporated in the monitoring program in February 2003 therefore comparison to previous years results is not available.

In general the tritium activity estimates in air decrease with progressive distance from the SSI stack.

Table 9: Ambient Air Monitoring Data (Bq/m^3)

DATE	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A17	TRIP BLANK	FIELD BLANK	AVERG/ MONTH
Jan 21, 03	--	0.27	0.40	--	0.59	0.80	0.58	--	--	--	--	--	--	--	0.27	0.27	0.27	0.27	0.42
Feb 19, 03	0.81	0.46	0.75	0.35	0.90	0.58	0.61	0.47	0.31	--	0.39	0.31	0.65	0.51	0.38	0.33	0.31	0.31	0.50
Mar 19, 03	1.72	0.40	0.47	0.56	0.50	0.53	0.44	0.32	0.32	0.32	0.32	0.34	0.32	0.32	0.32	0.32	0.32	0.32	0.45
Apr 23, 03	1.38	0.48	0.66	0.74	0.68	1.53	0.47	0.31	0.45	--	--	0.42	--	0.43	0.48	1.08	0.26	0.26	0.64
Jun 03, 03	--	0.52	0.60	1.65	1.62	0.62	0.50	0.22	--	0.22	0.28	0.22	--	0.22	--	0.22	0.22	0.22	0.52
Jun 25, 03	--	0.73	0.94	1.34	1.31	1.03	0.80	0.43	0.60	0.41	0.41	0.60	--	0.41	0.90	0.41	0.41	0.64	0.71
Jul 22, 03	--	0.96	1.68	2.04	3.57	1.25	1.00	0.74	0.51	1.00	0.53	0.49	0.39	0.34	0.64	0.34	0.34	0.34	0.95
Aug 19, 03	--	1.40	1.26	1.90	1.75	1.19	--	0.32	0.32	0.49	0.32	0.32	0.32	0.32	0.62	0.32	0.32	0.32	0.72
Sep 23, 03	--	0.85	1.44	3.33	2.23	2.73	4.18	0.36	--	0.66	0.86	0.38	--	0.48	0.26	0.42	0.26	0.31	1.25
Oct 21, 03	--	0.81	1.16	3.38	3.50	0.80	1.42	0.32	--	0.68	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.92
Nov 25, 03	--	0.64	0.82	0.46	0.91	0.96	0.43	0.26	0.28	0.26	--	0.26	0.26	--	0.26	0.26	0.26	0.26	0.44
Dec 17, 03	--	0.41	0.78	0.59	0.94	0.93	0.59	0.41	0.41	0.41	--	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.52
Average	**1.30**	**0.66**	**0.91**	**1.49**	**1.54**	**1.08**	**1.00**	**0.38**	**0.40**	**0.50**	**0.43**	**0.37**	**0.38**	**0.38**	**0.44**	**0.39**	**0.31**	**0.33**	**0.67**
Maximum	**1.72**	**1.40**	**1.68**	**3.38**	**3.57**	**2.73**	**4.18**	**0.74**	**0.60**	**1.00**	**0.86**	**0.60**	**0.65**	**0.51**	**0.90**	**1.08**	**0.41**	**0.64**	**1.25**
Distance	**120**	**240**	**210**	**250**	**220**	**210**	**200**	**870**	**1500**	**1500**	**1200**	**1000**	**1000**	**1000**	**2500**	**16000**			
Direction	**NE**	**SE**	**SE**	**N**	**NE**	**SW**	**NW**	**SE**	**SW**	**N**	**E**	**NW**	**W**	**SW**	**S**	**NE**			

Note: "-" no sample collected or analyzed

2.4 Ambient Water Monitoring

2.4.1 Sampling Method

Water samples were collected and analyzed on a monthly basis. Water samples were collected in suitable bottles and triple rinsed with the sample water. The water samples were analyzed by scintillation counting.

2.4.2 Sample Availability

There were 181 planned water sample collections scheduled for 2003 with 132 actual collections performed. Therefore 73% of valid water sample collections were achieved compared to planned collection.

2.4.3 Results

The ambient water monitoring data collected from January 2003 to December 2003 is provided in Table 10.

The highest annual average tritium activities detected in ambient water samples were from locations 4 and 5. Sample locations 4 and 5 are located 250 meters north and 220 meters northeast of the SSI stack, respectively. The monthly measurements for ambient water from locations 4 and 5 tend to be greater than at other stations. A monthly well water sample was also taken at location 5 with results below detection limit.

The maximum monthly average tritium activity occurred from August 19, 2003 to September 23, 2003 with an average activity of 863 Bq/L. This corresponds with maximum monthly HTO emissions (4.0E+12 Bq/L) and maximum monthly average ambient air monitoring results (1.25 Bq/m^3).

There is moderate variability among the monthly average measurements with exception to the September 23, 2003 collection. During the period of September 16 to September 23, 2003 a release of HTO of 2.0E+12 Bq occurred. This release was reflected in the environmental samples collected on September 23, 2003.

Collection of ambient water samples during the winter months is considerably reduced due to the formation ice over most water sampling sources. Collections are also reduced during the summer months due to peak temperatures causing drought.

There does not appear to be a monthly tritium activity trend among these locations.

New sampling locations were incorporated in the monitoring program in February 2003 therefore comparison to previous years results is not available.

Overall there is a distinct trend of decreasing activity in water with distance from the SSI stack.

Table 10: Ambient Water Monitoring Data (Bq/L)

DATE	W1	W2	W3	W4	Well 5	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W17	TRIP BLANK	FIELD BLANK	AVERG/ MONTH
Jan 23, 03	49	49	-	-	49	-	-	-	-	-	-	-	-	-	-	-	-	49	49	49
Feb 19, 03	49	49	-	-	49	-	-	-	-	-	-	-	-	-	-	-	49	49	49	49
Mar 19, 03	49	49	-	-	49	-	-	-	-	49	-	-	-	-	-	-	49	49	49	49
Apr 23, 03	-	49	792	719		1691	763	600	148	92	100	49	49	88	83	49	49	49	49	319
Jun 3, 03	-	49	826	964	49	1636	573	553	168		94	49	126	57	69	-	53	49	49	335
Jun 25, 03	-	49	847	772	49	1553	572	576	157	49	80	49	49	88	145	49	68	49	49	292
Jul 22, 03	-	49	1155	-	53	1549	-	-	128	79	59	49	78	49	49	49	49	67	49	234
Aug 19, 03	-	49	-	-	49	1549	-	-	49	49	49	49	49	49	49	49	49	49	49	156
Sep 23, 03	-	49	711	9803	49	1695	-	-	88	49	102	49	80	-	63	52	49	64	49	863
Oct 21, 03	-	52	923	1691	49	1658	-	-	83	49	,50	49	121	77	108	49	49	49	49	337
Nov 25, 03	-	49	671	716	-	1875	610	1340	128	49	90	49	49	52	-	49	49	49	49	367
Dec 17, 03	-	49	697	-	49	-	-	-	156	78	-	-	49	-	73	49	49	49	49	122
Average	**49**	**49**	**828**	**2444**	**49**	**1651**	**630**	**768**	**123**	**60**	**82**	**49**	**72**	**66**	**80**	**49**	**51**	**52**	**49**	**264**
Maximum	**49**	**52**	**1155**	**9803**	**53**	**1875**	**763**	**1340**	**168**	**92**	**102**	**49**	**126**	**88**	**145**	**52**	**68**	**67**	**49**	**863**
Distance From Stack	**120**	**240**	**170**	**250**	**100**	**220**	**210**	**200**	**870**	**1500**	**1500**	**1200**	**1000**	**1000**	**1000**	**2500**	**16000**			
Direction	**NE**	**SE**	**SE**	**N**	**NE**	**NE**	**SW**	**NW**	**SE**	**SW**	**N**	**E**	**NW**	**W**	**SW**	**S**	**NE**			

Note: "-" no sample collected or analyzed

2.5 Milk Samples

2.5.1 Sampling Method

Milk samples are collected from an area dairy farm in the prevailing wind direction and at locations closest to the SSI facility. Milk samples were collected in suitable sample bottles and analyzed for tritium by liquid scintillation counting.

2.5.2 Results

The milk monitoring data collected is provided in Table 11.

A survey of the surrounding area indicated that the closest dairy farm in the easterly wind direction is over 2800 m from the SSI stack. Tritium activity was below the detection limit.

Table 11: Milk Monitoring Data (Bq/L)

DATE	M16
Feb 19, 03	<200
Mar 19, 03	<200
Apr 23, 03	<200
Jun 3, 03	<200
Jun 25, 03	<200
Jul 22, 03	<200
Aug 19, 03	<200
Sep 23, 03	<200
Oct 21, 03	<200
Nov 25, 03	<200
Dec 17, 03	<200
Distance	2860
Direction	NE

2.6 Vegetation Samples

2.6.1 Sampling Method

Vegetation samples such as wild grapes and berries were collected. Samples were sealed in freezer bags and analyzed for tritium by liquid scintillation counting.

2.6.2 Results

The vegetation monitoring data collected is provided in Table 12.

The highest tritium activities were detected in samples from locations V4 and V7. Locations V4 and V7 are located 250 meters north and 200 meters northwest of the SSI stack respectively. This corresponds with maximum average ambient air monitoring results for these locations. This corresponds with the highest and third highest maximum average ambient water monitoring results for these locations.

Table 12: Vegetation Monitoring Data (Bq/L)

DATE	V4 Grapes	V5 Grapes	V7 Grapes	V9 Grapes	V10 Grapes	V13	V15 Berries
Sep 23, 03	6040	1240	6190	<200	360		<200
Oct 21, 03	3100				230		<200
Nov 25, 03	660					<200	
Distance	250	220	200	1500	1625	1000	2500
Direction	N	NE	NW	SW	NE	W	S

3. CALCULATED DOSES TO THE CRITICAL RECEPTOR

The model used to estimate doses to the critical receptor is presented in the Shield Source Inc. Derived Release Limits for Tritium Based on Air Dispersion and Environmental Pathway Modeling (Golder 2002). This model was submitted to REPD for review in May 2000, and was updated based on feedback from Mr. Michael James of the CNSC on July 16, 2002.

Historically, the dose to the critical receptor has been reported based on either maximum or average monitoring results obtained at the nearest residence (Station 5) which coincided with areas of maximum monitored activity. In 2003, the area of maximum monitored activity was not at the closest residence, but at different locations (Stations 7 and 4). In order to provide a basis for comparison between years, the dose to the critical receptor was calculated based on the nearest residence. However, since the nearest residence no longer coincided with the maximum monitored activity, dose to the critical receptor was also calculated based on Stations 7 and 4 (with the highest tritium activity in air and water, respectively).

The methodology for calculating doses to the critical receptor is outlined in Appendix II.

The average and maximum measured activities in air and water at Station 5 (the nearest residence) and at stations 7 and 4 (the sites with maximum activity) are presented in Tables 13 and 14.

Table 13: Average Activities of Tritium in Air and Water Measured During the 2003 Monitoring Program

Location	Form of Tritium	Activity in Water (Bq/L)	Activity in Air (Bq/m^3)	Monitoring Sample Locations
Maximum Activity	HTO	2,444	0.3 [(a)]	W4, A7
	HT	-	0.7 [(a)]	
Closest Residence	HTO	1,651	0.4 [(b)]	W5, A5
	HT	-	1.1 [(b)]	

a) based on total activity of 1.00 Bq/m^3 using 27% HTO and 73% HT based on average stack emissions
b) based on total activity of 1.54 Bq/m^3 using 27% HTO and 73% HT based on average stack emissions

Table 14: Maximum Activities of Tritium in Air and Water Measured During the 2003 Monitoring Program

Location	Form of Tritium	Activity in Water (Bq/L)	Activity in Air (Bq/m3)	Monitoring Sample Locations
Maximum Activity	HTO	9,803	1.1 (a)	W4, A7
	HT	-	3.1 (a)	
Closest Residence	HTO	1,875	1.0 (b)	W5, A5
	HT	-	2.6 (b)	

a) based on total activity of 4.18 Bq/m^3 using 27% HTO and 73% HT based on maximum stack emissions
b) based on total activity of 3.57 Bq/m^3 using 27% HTO and 73% HT based on maximum stack emissions

The calculated long-term doses to the critical receptor do not exceed the annual public dose limit of 1 mSv per year (Tables 17 and 18). Potential exposure to tritium through the consumption of local vegetation and animal produce is based on uptake modeling using the average or maximum observed activities in air and water.

Estimated doses of tritium, tritium oxide and organically bound tritium were derived using average or maximum concentrations of tritium in air and water measured at the site with the highest activity (Station 7 and 4, respectively) and at the closest residence to the source (Station 5).

Table 15: Estimated Doses of Tritium Oxide (HTO), Tritium (HT) and Organically Bound Tritium (OBT) to the Critical Receptor Based on Average Monitored Activity in Air and Water at the Location with the Highest Concentrations (Stations 7 and 4, respectively) and at the Closest Residence (Station 5)

Location	Form of Tritium	Total Water Dose (mSv/yr)	Total Air Dose (mSv/yr)	Total Vegetation Dose (mSv/yr)	Total Animal Dose (mSv/yr)	Assumptions
Maximum Activity	HTO	4.3E-02	6.0E-05	3.3E-03	1.1E-02	50% of vegetables and animal produce from vicinity of site
	HT	-	1.7E-08	-	-	
	OBT	-	-	4.6E-03	2.4E-02	
Closest Residence	HTO	2.9E-02	9.2E-05	2.3E-03	7.1E-03	
	HT	-	2.6E-08	-	-	
	OBT	-	-	3.1E-03	1.6E-02	

Table 16: Estimated Doses of Tritium Oxide (HTO), Tritium (HT) and Organically Bound Tritium (OBT) to the Critical Receptor Based on Maximum Monitored Activity in Air and Water at the Location with the Highest Concentrations (Stations 7 and 4, respectively) and at the Closest Residence (Station 5)

Location	Form of Tritium	Total Water Dose (mSv/yr)	Total Air Dose (mSv/yr)	Total Vegetation Dose (mSv/yr)	Total Animal Dose (mSv/yr)	Assumptions
Maximum Activity	HTO	1.7E-01	2.5E-04	1.3E-02	4.2E-02	50% of vegetables and animal produce from vicinity of site
	HT	-	7.0E-08	-	-	
	OBT	-	-	1.8E-02	9.5E-02	
Closest Residence	HTO	3.3E-02	2.1E-04	2.6E-03	8.1E-03	
	HT		5.9E-08	-	-	
	OBT		-	3.6E-03	1.8E-02	

A survey of the monitoring area indicated that at no time have a vegetable garden or livestock been observed at the nearest residence. The vegetation samples collected from this location were grapes. Although the estimated doses in Tables 15 and 16 indicate that consumption of vegetation would not result in unacceptable exposure, residents of this property have confirmed that vegetation from the property are not consumed.

The contribution of each exposure pathway to total dose to the critical receptor is presented in Tables 17 and 18. As expected, the majority of the dose is contributed by ingestion of food and water. The inhalation pathway contributes a very small proportion (<0.3%) of the total dose.

Table 17: Total Tritium Dose (All Forms) using Average Concentrations to the Critical Receptor Resulting from Each Exposure Pathway: Air, Water, Vegetation and Animal

Location	Annual Dose Limit (mSv/yr)	Total Dose to Child (mSv/yr)	Dose from Water		Dose from Air		Dose from Vegetation		Dose from Animal	
			(mSv/yr)	% of Total	(mSv/yr)	% of Total	(mSv/yr)	% of Total	(mSv/yr)	% of Total
Maximum Activity	1	0.08	0.04	50.1	0.00006	0.07	0.008	9.3	0.03	40.5
Closest Residence	1	0.06	0.03	50.0	0.00009	0.2	0.005	9.4	0.02	40.4

Table 18: Total Tritium Dose (All Forms) using Maximum Concentrations to the Critical Receptor Resulting from Each Exposure Pathway: Air, Water, Vegetation and Animal

Location	Annual Dose Limit (mSv/yr)	Total Dose to Child (mSv/yr)	Dose from Water		Dose from Air		Dose from Vegetation		Dose from Animal	
			(mSv/yr)	% of Total	(mSv/yr)	% of Total	(mSv/yr)	% of Total	(mSv/yr)	% of Total
Maximum Activity	1	0.3	0.2	50.1	0.0002	0.07	0.03	9.4	0.1	40.6
Closest Residence	1	0.07	0.03	49.8	0.0002	0.3	0.01	9.5	0.03	40.4

A comparison of modeled average and maximum tritium activities in milk with measured activities in milk shows that the model overestimated milk activities (Tables 20 and 21). This comparison shows that the model predictions are conservative and that doses are not underestimated.

Monitored activity in vegetation (grapes) was higher than modeled activity in 2003 in all cases except when maximum activity levels from the area of maximum activity were used in the model. The elevated activity in grape samples coincides with higher stack emissions at the time of collection than in other months. By contrast, vegetation (grape) samples collected during 2002 had lower activity levels than what was predicted by modeling, and stack emissions during the collection period were lower during sample collection than in 2003. Consequently, stack emission variations during sampling periods may have a direct link to resulting monitored activities in vegetation, particularly in items such as grapes, which would be expected to accumulate some HTO via air deposition or rainfall on the surface of the fruit.

The maximum activity level in vegetation was observed at V7 located 200 m northwest of the stack. When the dose modeling is re-run using monitored data for grapes, the estimated dose from vegetation to a child receptor from the area of maximum activity either remained unchanged or increased by 0.02 mSv/yr above modeled results (Table 21). The estimated dose at the closest proximity site increased between 0.02 and 0.03 mSv/yr above modeled results (Table 21). The estimated dose to a child receptor using monitored or modeled activity in vegetation are both lower than the annual dose limit of 1 mSv/yr.

Table 19: Comparison of Modeled Average Tritium Activity in Milk and Vegetation versus Measured Average Tritium Activity in Milk and Vegetation

Location	Measured (Mean, Bq/L or Bq/kg)		Modeled (Total HTO and OBT, Bq/L or Bq/kg)	
Closest Proximity	Milk	<200	Milk	2,008
	Grapes	6,190	“Vegetation”	1,357
Maximum Activity	Milk	<200	Milk	2,970
	Grapes	6,190	“Vegetation”	1,992

Table 20: Comparison of Modeled Maximum Tritium Activity in Milk and Vegetation versus Measured Maximum Tritium Activity in Milk and Vegetation

Location	Measured (Mean, Bq/L or Bq/kg)		Modeled (Total HTO and OBT, Bq/L or Bq/kg)	
Closest Proximity	Milk	<200	Milk	2,286
	Grapes	6,190	“Vegetation”	1,566
Maximum Activity	Milk	<200	Milk	11,907
	Grapes	6,190	“Vegetation”	7,992

Table 21: Comparison of Estimated Dose Using Modeled Versus Monitored Activity in Vegetation

Location		Annual Dose Limit (mSv/yr)	Total Dose to Child Using Modeled Vegetation Activity(mSv/yr)	Total Dose to Child Using Monitored Acitvity in Grapes(mSv/yr)
Average	Maximum Activity	1	0.08	0.10
	Closest Residence	1	0.06	0.09
Maximum	Maximum Activity	1	0.30	0.30
	Closest Residence	1	0.07	0.09

4. SSI QA/QC

SSI's Quality Assurance (QA) program refers to a detailed protocol used to collect high quality environmental monitoring samples. Quality Control refers to the process by which this protocol is tested to ensure that the final samples are of the specified quality. SSI included field blanks, travel blanks and replicate samples in their sampling program in order to meet the requirements of the QA/QC program.

4.1 Field Blanks

Fields blanks are used to detect incidental or accidental contamination of a sample during sample preparation, sampling, handling, storage, transport and analysis. A water sample field blank is prepared using the same sampling sink matrix used for collection of the environmental samples. At one randomly selected sampling location, the field blank is opened and transferred to an empty sampling container, sealed, placed in a plastic bag and placed in the transport carrier.

4.1.1 Results

Table 22 shows the Field Blank results for 2003.

Table 22: Field Blank Data (Bq/L)

DATE	AMBIENT AIR	AMBIENT WATER	MILK
	Field Blank	Field Blank	Field Blank
Jan 23, 03	<50	<50	<50
Feb 19, 03	<50	<50	<50
Mar 19, 03	<50	<50	<50
Apr 23, 03	<50	<50	<50
Jun 3, 03	<50	<50	<50
Jun 25, 03	77	<50	<50
Jul 22, 03	<50	<50	<50
Aug 19, 03	<50	<50	<50
Sep 23, 03	58	<50	50
Oct 21, 03	<50	<50	<50
Nov 25, 03	<50	<50	<50
Dec 17, 03	<50	<50	<50

Tritium activity was below the detection limit with the exception of the ambient air samples collected on June 25, 2003 and the ambient air and ambient water samples collected on September 23, 2003, indicating that some contamination may have occurred during storage and transport of these samples. The higher value does not appear to correspond to elevated ambient air or water monitoring data for these sampling sessions. However, data collected on June 25 and September 23, 2003 should be interpreted with caution as the results may be biased upwards by contamination.

4.2 Trip Blanks

Trip blanks detect sample contamination during storage and transport. Travel blanks consist of bottles provided by a laboratory equipment supplier and filled by SSI off-site. They accompany empty sample bottles to the field site, where they are left intact and unopened inside the shipping container. The unopened travel blanks are then returned to the analytical laboratory to be analyzed along with the collected samples.

4.2.1 Results

Table 23 shows the Travel Blank results for 2003.

Table 23: Trip Blanks Data (Bq/L)

DATE	AMBIENT AIR	AMBIENT WATER
	Trip Blank	Trip Blank
Jan 23, 03	<50	<50
Feb 19, 03	<50	<50
Mar 19, 03	<50	<50
Apr 23, 03	<50	<50
Jun 3, 03	<50	<50
Jun 25, 03	<50	<50
Jul 22, 03	<50	67
Aug 19, 03	<50	<50
Sep 23, 03	<50	64
Oct 21, 03	<50	<50
Nov 25, 03	<50	<50
Dec 17, 03	<50	<50

Tritium activity was below detection limits for ambient air. Ambient water trip blanks were below detection limits with the exception of July 22, 2003 and September 23, 2003. The higher value detected July 22, 2003 does not appear to correspond to elevated ambient water monitoring data. The higher value detected September 23, 2003 does appear to correspond to elevated results in ambient water monitoring data for that sampling session. These results indicate some contamination may have occurred during storage and transport. Consequently, data interpreted from these collection periods should be interpreted with caution as the results may have been upwardly biased by contamination.

4.3 Replicate Samples

Replicate samples are used to measure precision variation throughout the sampling and analysis process. Replicate samples are collected by filling multiple containers at a single site. They are labeled individually and are submitted separately to the analytical laboratory.

4.3.1 Results

Table 24 shows the Replicate Sample results for ambient air monitoring data and Table 25 shows the Replicate Sample results for ambient water monitoring data.

Table 24: Ambient Air Replicate Sample Data (Bq/m^3)

DATE	LOCATION	REPLICATE 1	REPLICATE 2	REPLICATE 3	Mean	Standard Deviation	Coefficient of Variation (%)
21-Jan-03	A7	1.12	0.27	0.27	0.6	0.4	72.4
19-Feb-03	A7	0.60	0.45	0.79	0.6	0.1	22.7
19-Mar-03	A7	0.36	0.38	0.57	0.4	0.1	21.7
23-Apr-03	A7	0.39	0.72	0.29	0.5	0.2	39.4
03-Jun-03	A7	0.65	0.55	0.29	0.5	0.2	30.5
25-Jun-03	A7	0.79	0.74	0.88	0.8	0.1	7.2
22-Jul-03	A7	1.35	1.08	0.54	1.0	0.3	34.0
19-Aug-03	A7	-	-	-	-	-	-
23-Sep-03	A7	5.54	4.04	2.96	4.2	1.1	25.3
21-Oct-03	A7	1.39	1.50	1.38	1.4	0.1	3.8
25-Nov-03	A7	-	0.58	0.29	-	-	-
17-Dec-03	A7	0.90	0.46	0.41	0.6	0.2	37.3

Table 25: Ambient Water Replicate Sample Data (Bq/L)

DATE	LOCATION	REPLICATE 1	REPLICATE 2	REPLICATE 3	Mean	Standard Deviation	Coefficient of Variation (%)
21-Jan-03	W3	<50	<50	<50			
19-Feb-03	W1	<50	<50	<50			
19-Mar-03	W1	<50	<50	<50			
23-Apr-03	WG5	1828.3	1776.7	1467.5	1690.8	159.3	9.4
3-Jun-03	W4	994.2	961.7	936.7	964.2	23.5	2.4
25-Jun-03	W4	764.6	772.5	779.2	772.1	6.0	0.8
22-Jul-03	W10	<50	80	<50			
19-Aug-03	W12	<50	<50	<50			
23-Sep-03	W15	<50	59.2	<50			
21-Oct-03	W9	<50	<50	<50			
25-Nov-03	W8	136.7	145.4	102.9	128.3	18.3	14.3
17-Dec-03	W2	<50	<50	<50			

The replicate air samples reflect within-site variability plus laboratory precision. Variation between replicates was noted during four sampling occasions (corresponding to activity that was greater than the detection limit): January 21, 2003, September 23, 2003, November 25, 2003 and December 17, 2003. The sampling session in September corresponds with higher stack emissions while the January, November and December within-site variability does not appear to correspond with higher stack emissions.

The replicate air samples show a coefficient of variation between 3.8% and 72.4%. this range of variability is not unexpected for passive air sampling results as minute variations in location and direction of samplers, degree of exposure of samplers and other factors can significantly affect air flow through the samplers.

The coefficient of variation for water samples ranged from 0.8% and 14.3%. This is within-site variability and laboratory precision appear reasonable. The replicate data lend additional confidence to the interpretation of field-collected data.

5. LABORATORY QA/QC

Monserco Limited has indicated that the laboratory QA/QC data is within their upper and lower confidence limits, and that their interlaboratory comparison results are within acceptable limits. The laboratory QA/QC data will be provided as an addendum to this annual report.

6. INCIDENTS

The HTO emission for the week of September 16, 2003 to September 23, 2003 did exceed the weekly Action Limit of 0.02% of the TOC DRL. The release occurred during a routine oil change on one of the fill rigs. It was determined that a storage can containing the spent oil was not sealed tightly. It was stored in a vented cabinet and was exhausting into the stack. Once the can was sealed properly the emissions dropped. The incident was reported in accordance with the licence requirements and CNSC staff was satisfied with SSI's response. (See Section 2.2.3.2).

Environmental Monitoring results collected September 23, 2003 show elevated activity levels in both ambient air and ambient water samples.

7. SUMMARY

Overall there is a trend of decreasing activity in all types of samples with distance from the SSI stack. Tritium activity in most ambient air and ambient water samples collected from locations greater than 900 meters from the SSI stack was less than the detection limit.

The estimated dose to the critical receptor (infant) living at the nearest residential dwelling based on the average and maximum measured activities in air and water was 0.06 mSv/year and 0.07 mSv/year, respectively. Both estimated doses are below the annual dose limit to the general public of 1 mSv/year. A comparison of modeled and measured tritium activities in milk and vegetation showed that the model overestimates milk activities and underestimated vegetation activities for this sampling year. However, when the model was re-run using monitored activity in vegetation (grapes), the resulting estimated dose was either the same or increased by 0.02 mSv/y at the area of maximum activity and increased between 0.02 and 0.03 mSv/yr at the nearest residence. Estimated doses using modeled or monitored activity levels in vegetation were all lower than the annual dose limit of 1.0 mSv/yr. Higher stack emissions at the time of vegetation sampling may be responsible for higher monitored vegetation activities than observed in previous years.

APPENDIX I

CONVERSION CALCULATIONS

CONVERSION FROM BQ/L TO BQ/M3 IN PASSIVE SAMPLERS

The laboratory analysis results for the air monitoring stations have been provided to SSI on the basis of the tritium activity in the liquid from the collection vials. However, these results must be converted to concentration activities before they can be used. The method used for the conversion has been derived from the approach provided to SSI by Ontario Power Generation (OPG),

To illustrate how the conversion would be applied to SSI, it has been applied to a worked example. In the example, a sample collected over a period of 15 days was found to have a tritium level of 150.2 Bq/L in the sample vial liquid.

The conversion includes several steps, the first of which is the conversion of the laboratory disintegrations per minute per millilitre (ml), as follows:

$$150.2\ {}^{Bq}/_{L} \times 0.001\ {}^{L}/_{mL} \times 60\ {}^{dpm}/_{Bq} = 9.012\ {}^{dpm}/_{mL}$$

This activity level was then converted to an activity per unit of time by incorporating the duration of the sampling in the following manner.

$$\frac{9.012\ {}^{dpm}/_{mL}}{15\text{days} \times 24\ {}^{hr}/_{day}} = 0.025\ \frac{\text{dpm}}{\text{hr x mL}}$$

Based on the OPG methodology, the sampling vials should pick up tritium activity at a rate of:

$$5000\ \frac{\text{dpm}}{\text{DAC x hr x mL}}$$

The derived air concentration (DAC) to which the vial was exposed can be calculated by taking the ratio of the activity in the vial and the OPG reference level:

$$\frac{0.025\ {}^{dpm}/_{(hr\ x\ mL)}}{5000\ {}^{dpm}/_{(DAC\ x\ hr\ x\ mL)}} = 5.00 \times 10^{-6}\ \text{DAC}$$

According to the OPG memorandum, each DAC unit is equal to 10 uCi/m3. By substituting this value into the above formulae and converting to Becquerels, the airborne concentration was calculated as:

$$5.00 \times 10^{-6}\ \text{DAC} \times 10\ \frac{{}^{uCi}/_{m3}}{\text{DAC}} \times 37000\ {}^{Bq}/_{uCi} = 1.852\ \frac{\text{Bq}}{m^3}$$

This conversion was applied to all the laboratory results from the SSI air monitoring stations. The results from these calculations are presented in Table 2.

APPENDIX II

DOSE CALCULATION METHOD

MODEL METHODOLOGY

Three forms of tritium were evaluated: HTO, HT and OBT (organically-bound tritium). The dose conversion factors used in the calculations were:

HTO: 5.8×10^{-11} (CAN/CSA 1987)

HT: 1.2×10^{-14} (CAN/CSA 1987)

OBT: 1.2×10^{-10} (ICRP 1995)

The pathways evaluated were as follows:

1. HTO inhalation and immersion:
    - air-to-receptor
2. HT inhalation:
    - air-to-receptor
3. HTO ingestion via drinking water:
    - water-to-receptor

    NOTE: Air-to-water was not modeled; rather, the maximum water activity from the monitoring data was used.
4. HTO ingestion via consumption of plants and animals:
    - air-to-plant, water-to-plant, plant-to-receptor;
    - air-to-animal; water-to-animal, plant-to-animal; animal-to-receptor

    NOTE: Air-to-soil was not estimated because uptake by plants from the soil surface is not applicable to tritium (CAN/CSA 1987). Soil water activity was assumed to be equal to groundwater activity.
5. OBT ingestion via consumption of plants and animals:
    - HTO-to-OBT in plant, OBT in plant-to-receptor
    - OBT in plant-to-animal, HTO-to-OBT in animal, total OBT in animal-to-receptor

The input parameters and results of the calculations for each of the above pathways are presented in the Appendix II tables.

HTO Inhalation and Immersion; HT Inhalation

The critical receptor (infant in the critical group) was assumed to have a total air volume intake of 1900 m^3 per year (CNSC 2000). A 100% occupancy factor was assumed (i.e. the infant would spend 100% of the time in the immediate vicinity of the SSI facility).

Dose from immersion was estimated by multiplying the dose from inhalation by 2. This accounts for skin exposure due to immersion in airborne HTO.

HTO Ingestion via Drinking Water

The total yearly water intake by the critical receptor was assumed to be 300L/yr (CAN/CSA 1987). It was assumed that 100% of drinking water was obtained from the immediate vicinity of the SSI facility.

HTO Ingestion from Consumption of Plants and Animals

(1) Plants: Two pathways leading to plants were evaluated: HTO deposition onto plants from the atmosphere and HTO uptake into plants from soil water. Uptake of tritium from the soil surface was not estimated, since tritium is rapidly incorporated into soil water.

The deposition of HTO onto plants was estimated using the specific activity approach given in CAN/CSA (1987):

$$\text{Transfer parameter (air-to-plant)} = \frac{f_v}{H_a}$$

Where f_v = ratio of specific activity of HTO in soil water to that in air moisture
H_a = absolute humidity of air (kg/m^3).

The resulting transfer parameter used was 50 m^3/kg. Therefore, plant tissue concentration from air-to-plant was:

Bq/kg in plant tissue from air uptake (P_a) = air concentration (Bq/m^3) x 50 (kg/m^3).

The uptake of HTO from soil water into plants was estimated using the specific activity approach given in CAN/CSA (1987):

$$\text{Bq/kg in plant tissue } (P_w) = \frac{\text{Water concentration (Bq/L)}}{G_w \text{ (kg/L)}} \times f_v$$

Where f_v = ratio of specific activity of HTO in vegetation water to that in soil water

G_w = distribution factor for tritium in vegetation (Bq/L of water per Bq/kg fresh weight of vegetation)

Total activity in plants = $P_a + P_w$

(2) Animals: Three pathways leading to animals were evaluated: air-to animal; water-to-animal; and, plant-to-animal.

Transfer parameters for air-to-animal from CAN/CSA (1987) were used. These transfer parameters in m^3/kg are:

Milk:	3.9	Eggs:	3.5
Beef:	1.4	Poultry:	6.7
Pork:	2.2		

Therefore, animal HTO concentration (Bq/kg) from air (A_a) = air concentration x transfer parameter.

Transfer parameters for water-to-animal from CAN/CSA (1987) were used. These transfer parameters in L/kg are:

Milk	1.1	Eggs:	0.66
Beef:	0.9	Poultry:	1.1
Pork:	0.52		

Therefore, animal HTO concentration (Bq/kg) from water (A_w) = water concentration x transfer parameter.

Transfer parameters for plant-to-animal from CAN/CSA (1987) were used. These transfer parameters in kg/kg are:

Milk	0.14	Eggs:	0.22
Beef:	0.18	Poultry:	0.35
Pork:	0.22		

Therefore, animal HTO concentration (Bq/kg) from plant uptake (A_p) = plant concentration x transfer parameter.

Total HTO activity in animals = $A_a + A_w + A_p$

(3) Ingestion of plants and animals by the critical receptor

An intake rate of 96 kg/yr was assumed for intake of plants by the infant critical receptor (CAN/CSA 1987). It was assumed that 50% of plant produce consumed by the critical receptor would be from the immediate vicinity of the SSI facility.

Intake rates for animal products from CAN/CSA (1987) are as follows:

Milk: 220 kg/yr
Meat: 24 kg/yr
Eggs: 5 kg/yr
Poultry: 10 kg/yr

It was assumed that 50% of animal produce consumed by the critical receptor would be from the immediate vicinity of the SSI facility.

<u>OBT Ingestion from Consumption of Plants and Animals</u>

The conversion of HTO to OBT in plant tissues was estimated by using a ratio of OBT/HTO of 0.4 (Brown 1995). Therefore, 40% of the total HTO taken in by the plant was assumed to be converted to OBT. The same intake plant intake rate as that used for HTO (96 kg/yr) was used to estimate OBT intake by the critical receptor.

The activity of OBT in animals was estimated by applying the same transfer parameters for plant-to-animal as used for HTO (see above) and multiplying these transfer parameters by the concentration of OBT in plants. In addition, 50% of HTO taken in via air and water by animals was assumed to be converted to OBT (Okada and Momoshina 1993). Therefore, total OBT in animals was the sum of OBT uptake from plants plus 50% of the HTO uptake from air and from water.

The same ingestion rates for plants and animals as those used for HTO were used to estimate OBT uptake by the critical receptor.

Total Estimated Dose to the Critical Receptor

Total estimated dose to the infant critical receptor was the sum of the doses from HTO and HT inhalation, HTO immersion, HTO in drinking water, consumption of HTO and OBT in plant produce and consumption of HTO and OBT in animal products.

See Attached Appendix II Tables prepared by Golder Associates for data.

References

Brown, R.M. 1995. The measurement of tritium in Canadian food items. AECB Project No. 3.135.1; INFO-0499. Atomic Energy Control Board, Ottawa, ON.

CSA 1987. Canadian Standards Association. Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities.

ICRP. 1995. Age-dependent doses to members of the public from inhalation of radionuclides: Part 5 Compilation of ingestion and inhalation dose coefficients. International Commission on Radiological Protection, Publication 72, Pergamon Press, New York.

Okada, S. and N. Momoshima 1993. Overview of tritium: characteristics, sources and problems. Health Physics 65(6): 595-609.

REPD 2000. SSI's Proposed EMP and DRLs. REPD No. 52083. October 17, 2000.