2.3.3.12 PUBLIC DOSE FOR 2012

The calculation method used to determine the dose to the 'Critical Group' as defined in the SRB Environment Monitoring Program[32] is described in the EMP document using the effective dose coefficients found in CSA Guideline N288.1-08. The dose assessed for the Critical Group is a summation of:

- Tritium uptake from inhalation and absorption through skin at the place of residence and/or the place of work, ($P_{(i)19}$ and $P_{(e)19}$), and
- Tritium uptake due to consumption of well water (P_{29}), and
- Tritium uptake due to consumption of produce (P_{49}), and
- Tritium uptake due to consumption of dairy products (P_{59}).

Dose due to inhalation

The closest residence to Passive Air Sampler NW250 is located at the intersection of Boundary Road and International Drive at approximately 240 meters from the point of release. The 2012 average concentration of tritium oxide in air at Passive Air Sampler NW250 has been determined to be 2.34 Bq/m^3.

Three passive air samplers are located close to the SRB facility and represent the tritium oxide in air ($P_{(i)19}$ and $P_{(e)19}$) concentrations for the critical group member (adult worker) at samplers 1, 2, and 13. The sampler indicating the highest tritium oxide in air concentration is used to calculate the P19 dose values while at work. The highest average result for 2012 for PAS # 1, PAS # 2, and PAS # 13 is 5.20 Bq/m^3 at PAS # 13.

$P_{(i)19}$: Adult worker dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined critical group equals 2.34 Bq/m^3.

$P_{(i)19r}$ = [H-3_{air}] (Bq/m^3) x Time (h/a) x Breathing Rate (m^3/h) x DCF_{H3} (μSv/Bq)
= 2.34 Bq/m^3 x 6,680 h/a x 1.2 m^3/h x 2.0E-05 μSv/Bq
= 0.375 μSv/a

$P_{(i)19}$: Adult worker dose due to HTO inhaled at work

Taking the highest concentration between Passive Air Samplers #1, #2, and #13 is Passive Air Samplers #13 at 5.20 Bq/m^3.

$P_{(i)19w}$ = [H-3_{air}] (Bq/m^3) x Time (h/a) x Breathing Rate (m^3/h) x DCF_{H3} (μSv/Bq)
= 5.20 Bq/m^3 x 2,080 h/a x 1.2 m^3/h x 2.0E-05 μSv/Bq
= 0.260 μSv/a.

$P_{(i)19}$: Adult resident dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined critical group equals 2.34 Bq/m^3:

$P_{(i)19}$ = $[H\text{-}3_{air}]$ (Bq/m^3) x Time (h/a) x Breathing Rate (m^3/h) x DCF_{H3} (μSv/Bq)
= 2.34 Bq/m^3 x 8,760 h/a x 1.2 m^3/h x 2.0E-05 μSv/Bq
= 0.492 μSv/a

$P_{(i)19}$: Infant resident dose due to HTO inhaled at residence

The average value for tritium oxide in air for the sampler representing the place of residence for the defined critical group equals 2.34 Bq/m^3:

$P_{(i)19}$ = $[H\text{-}3_{air}]$ (Bq/m^3) Breathing Rate (m^3/a) x DCF_{H3} (μSv/Bq)
= 2.34 Bq/m^3 x 2,740 m^3/a x 5.3E-05 μSv/Bq
= 0.340 μSv/a

Dose due to skin absorption

$P_{(e)19}$: Adult worker dose due to skin absorption of HTO at residence

The dose due to skin absorption is equal to the dose due to inhalation.

$P_{(e)19r}$ = 0.375 μSv/a

$P_{(e)19}$: Adult worker dose due to skin absorption of HTO at work

The dose due to skin absorption is equal to the dose due to inhalation.

$P_{(e)19w}$ = 0.260 μSv/a

$P_{(e)19}$: Adult resident dose due to skin absorption of HTO at residence

The dose due to skin absorption is equal to the dose due to inhalation.

$P_{(e)19}$ = 0.492 μSv/a

$P_{(e)19}$: Infant resident dose due to skin absorption of HTO at residence

The dose due to skin absorption is equal to the dose due to inhalation.

$P_{(e)19}$ = 0.340 μSv/a

Dose due to consumption of well water

The tritium uptake due to consumption of well water is calculated by taking the average tritium concentration of the water sampled.

The annual consumption rate for well water is assumed to be 840 L/a (2.3 L/d) for adults and 358 L/a (0.98 L/d) for infants.

The highest concentration in a residential well used as the sole source of the drinking water is found in RW-9 at 210 Bq/L and will therefore be used in the calculation of the public dose.

P_{29}: Adult dose due to consumption of well water

$$
\begin{aligned}
P_{29} &= [H\text{-}3]_{well} \times M \times 2.0E\text{-}05\ \mu Sv/Bq; \\
&= [210\ Bq/L] \times 840\ L/a \times 2.0E\text{-}05\ \mu Sv/Bq \\
&= 3.528\ \mu Sv/a
\end{aligned}
$$

P_{29}: Infant dose due to consumption of well water

$$
\begin{aligned}
P_{29} &= [H\text{-}3]_{well} \times M \times 5.3E\text{-}05\ \mu Sv/Bq; \\
&= [210\ Bq/L] \times 358\ L/a \times 5.3E\text{-}05\ \mu Sv/Bq \\
&= 3.985\ \mu Sv/a
\end{aligned}
$$

Dose due to consumption of produce

The tritium uptake due to consumption of produce, both locally purchased and home grown is calculated by taking the average tritium concentration of produce purchased from the local market and consuming 70% of the annual total and by taking the average tritium concentration from local gardens and consuming 30% of the annual total.

The annual consumption rate for produce is assumed to be 200 kg/a for adults and 84 kg/a for infants.

If we assume the average concentration in produce purchased from a market to be 14.5 Bq/L and if we assume the average concentration in produce from the local gardens with the highest average concentration of 58 Bq/L at 416 Boundary Road. Historically the average concentration of all produce in all gardens was used but it was determined that using the garden with the highest average concentrations would be more conservative, i.e. In 2012 using 58 B/L (for 416 Boundary Road only) rather than 48 Bq/L (for all gardens).

P_{49}: Adult dose due to consumption of produce (HTO)

$$
\begin{aligned}
P_{49HTO} &= [[H_{prod,market}] + [H_{prod,res}]] \times 2.0E\text{-}05\ \mu Sv/Bq \\
&= [[H\text{-}3_{veg}]\ (Bq/kg) \times (kg) \times 0.7] + [H\text{-}3_{veg}]\ (Bq/kg) \times (kg) \times 0.3]] \times 2.0E\text{-}5\ \mu Sv/Bq \\
&= [[14.5\ Bq/kg \times 200\ kg/a \times 0.7] + [58\ Bq/kg \times 200\ kg/a \times 0.3]] \times 2.0E\text{-}05\ \mu Sv/Bq \\
&= [[2{,}030\ Bq/a] + [3{,}480\ Bq/a]] \times 2.0E\text{-}05\ \mu Sv/Bq \\
&= 0.110\ \mu Sv/a
\end{aligned}
$$

P_{49}: Infant dose due to consumption of produce (HTO)

P_{49HTO} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 5.3E-05 µSv/Bq
= [[H-3_{veg}] (Bq/kg) x (kg) x 0.7] + [H-3_{veg}] (Bq/kg) x (kg) x 0.3]] x 5.3E-5 µSv/Bq
= [[14.5 Bq/kg x 84 kg/a x 0.7] + [58 Bq/kg x 84 kg/a x 0.3]] x 5.3E-05 µSv/Bq
= [[852.6 Bq/a] + [1,461.6 Bq/a]] x 5.3E-05 µSv/Bq
= 0.123 µSv/a

For OBT, the same equations are applied, using the same ingestion rates and fractions. Since measures of OBT are not available, the measured HTO amount can be used to estimate the OBT. The transfer parameter from HTO in air to HTO in the plant (on a fresh weight basis) is given by:

$P_{14HTO} = RF_p \cdot [1 - DW_p] / H_a$

The transfer parameter from HTO in air to OBT in a plant (fresh weight basis) is:

$P_{14HTO\text{-}OBT} = RF_p \cdot DW_p \cdot ID_p \cdot WE_p / H_a$

Where: RF_p = Reduction factor – default is 0.68

DW_p = Dry weight of plant – default value of 0.1 for generic fruit and vegetables

ID_p = Isotopic discrimination factor for plant metabolism (unitless) - default is 0.8

WE_p = Water equivalent of the plant dry matter (L water • kg^{-1} dry plant) – default value for all plants is 0.56

H_a = Atmospheric absolute humidity - a generic default value of 0.011 L/m^3 can be used.

In using the default values and combining the equations, the amount of OBT in a plant (fresh weight basis) can be determined by multiplying the HTO measure for plants for the same location by 0.05.

If we assume the average concentration in produce purchased from a market to be 14.5 Bq/L and if we assume the average concentration in produce from the local gardens with the highest average concentration of 58 Bq/L at 416 Boundary Road.

Then the values for OBT will be 0.725 Bq/L produce purchased from a market and 2.9 Bq/L in produce from local gardens:

P_{49}: Adult dose due to consumption of produce (OBT)

P_{49OBT} = [[$H_{prod,market}$] + [$H_{prod,res}$]] x 4.6E-05 µSv/Bq
= [[H-3_{veg}] (Bq/kg) x (kg) x 0.7] + [H-3_{veg}] (Bq/kg) x (kg) x 0.3]] x 4.6E-5 µSv/Bq
= [[0.725 Bq/kg x 200 kg/a x 0.7] + [2.9 Bq/kg x 200 kg/a x 0.3]] x 4.6E-05 µSv/Bq
= [[101.5 Bq/a] + [174 Bq/a]] x 4.6E-05 µSv/Bq
= 0.013 µSv/a

P_{49}: Infant dose due to consumption of produce (OBT)

P_{49OBT} = $[[H_{prod,market}] + [H_{prod,res}]]$ x 1.3E-4 μSv/Bq
= $[[H\text{-}3_{veg}]$ (Bq/kg) x (kg) x 0.7] + $[H\text{-}3_{veg}]$ (Bq/kg) x (kg) x 0.3]] x 1.3E-4 μSv/Bq
= [[0.725 Bq/kg x 84 kg/a x 0.7] + [2.9 Bq/kg x 84 kg/a x 0.3]] x 1.3E-4 μSv/Bq
= [[42.63 Bq/a] + [73.08 Bq/a]] x 1.3E-4 μSv/Bq
= 0.015 μSv/a

P_{49}: Adult dose due to consumption of produce (HTO + OBT)

P_{49} = P_{49HTO} + P_{49OBT}
= 0.110 μSv/a + 0.013 μSv/a
= 0.123 μSv/a

P_{49}: Infant dose due to consumption of produce (HTO + OBT)

P_{49} = P_{49HTO} + P_{49OBT}
= 0.123 μSv/a + 0.015 μSv/a
= 0.138 μSv/a

Dose due to consumption of local milk

The tritium uptake due to consumption of milk, from a local producer and distributor is calculated by taking the average tritium concentration of the milk sampled.

The annual consumption rate for milk is assumed to be 265 kg/a (727 g/d) for adults and 371 kg/a (1,016 g/d) for infants.

The average concentration in milk being 5.5 Bq/L but adjusting for the density of milk 5.5 Bq/L x 0.97 L/kg = 5.335 Bq/kg:

P_{59}: Adult dose due to consumption of milk

P_{59} = $[H\text{-}3]_{dairy}$ x M x 2.0E-05 μSv/Bq;
= [5.335 Bq/kg] x 265 kg/a x 2.0E-05 μSv/Bq
= 0.028 μSv/a

P_{59}: Infant dose due to consumption of milk

P_{59} = $[H\text{-}3]_{dairy}$ x M x 5.3E-05 μSv/Bq;
= [5.335 Bq/kg] x 371 kg/a x 5.3E-05 μSv/Bq
= 0.105 μSv/a

Critical group annual dose due to tritium uptake

Based on the Environmental Monitoring Program[43] results the annual dose (P_{total}) due to tritium uptake from inhalation and skin absorption, consumption of local produce, local milk and well water equates to a maximum of 4.949 µSv/A for an adult worker of the critical group in 2012, this is slightly lower than the dose in 2011 of 5.031 µSv/A.

TABLE 11: 2012 CRITICAL GROUP ANNUAL DOSE DUE TO TRITIUM UPTAKE

DOSE CONTRIBUTOR		ADULT WORKER ANNUAL DOSE (µSv/A)	ADULT RESIDENT ANNUAL DOSE (µSv/A)	INFANT RESIDENT ANNUAL DOSE (µSv/A)
DOSE DUE TO INHALATION AT WORK	$P_{(I)19}$	0.260	N/A	N/A
DOSE DUE TO SKIN ABSORPTION AT WORK	$P_{(E)19}$	0.260	N/A	N/A
DOSE DUE TO INHALATION AT RESIDENCE	$P_{(I)19}$	0.375	0.492	0.340
DOSE DUE TO SKIN ABSORPTION AT RESIDENCE	$P_{(E)19}$	0.375	0.492	0.340
DOSE DUE TO CONSUMPTION OF WELL WATER	P_{29}	3.528	3.528	3.985
DOSE DUE TO CONSUMPTION OF PRODUCE	P_{49}	0.123	0.123	0.138
DOSE DUE TO CONSUMPTION OF MILK	P_{59}	0.028	0.028	0.105
TOTAL DOSE DUE TO TRITIUM UPTAKE	P_{TOTAL}	4.949	4.663	4.908