



Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

3.8.2 High Pressure Turbines

The data of Table 3-12 for the high pressure turbines is used as input for MicroShield®. The data input into MicroSkyshine® is given in Table 3-13.

Table 3-12: HPT MicroShield® Input

Parameter	Description	Value	Reference
L	Source length	21 ft (6.4 m)	Reference 6, Section 4.17
T1	Source radius	5 ft (1.53 m)	Reference 6, Section 5.2.5
T2	Outer shell	3 in (0.0762 m) steel	Reference 6, Section 4.17
T3	Air space between source and west shield wall	15.98 ft (487 cm)	Reference 6, Section 5.2.5
T4	Concrete shield thickness	3 ft (91 cm)	Reference 6, Section 5.2.5
	Source density	0.15 lb/in ³ (4.17 g/cm ³) water	Reference 6, Table 5-1
	Source activity	36 Ci (1.33E+12 Bq) N-16	Reference 2, Table 3-1

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Table 3-13: HPT MicroSkyshine® Input

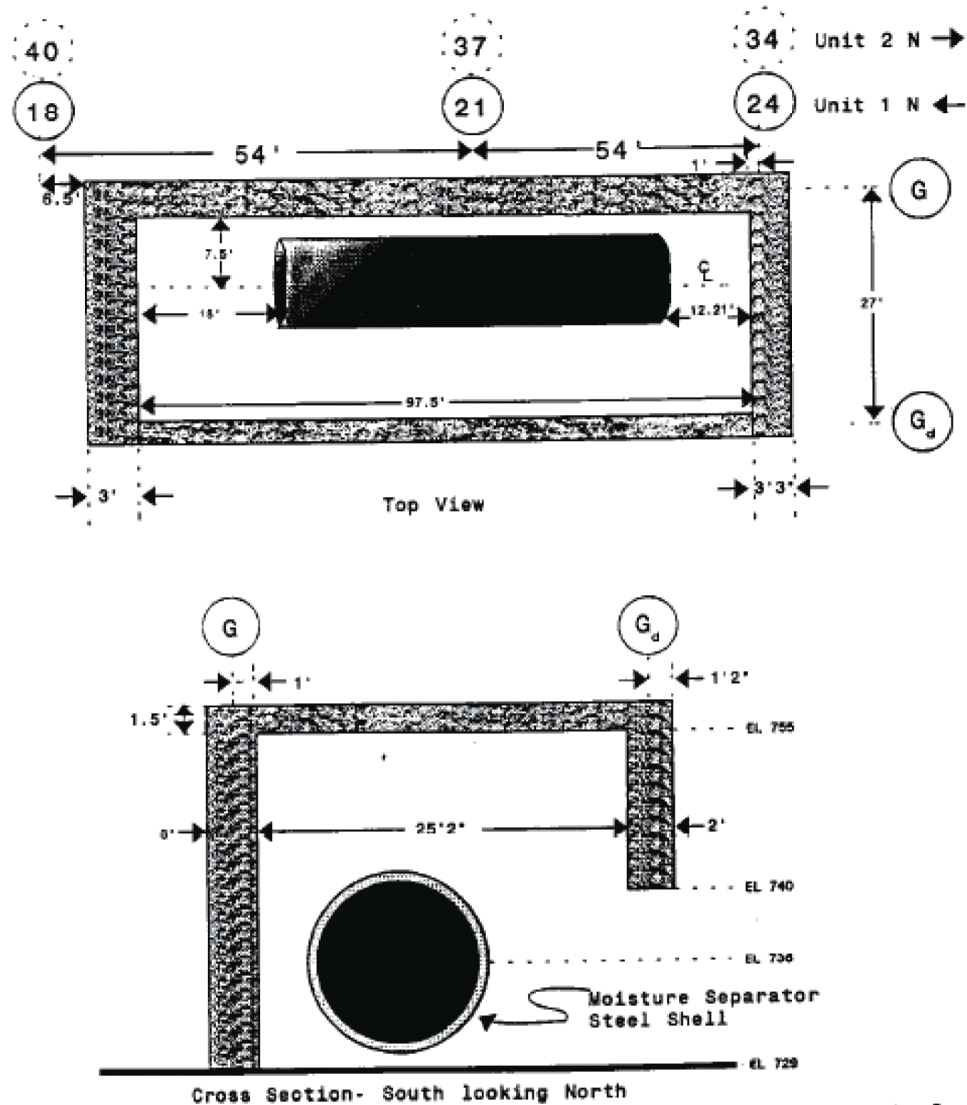
Parameter	Description	Value	Reference
L	Source length	21 ft (6.4 m)	Reference 6, Section 4.17
W	Radius	5 ft (1.53 m)	Reference 6, Section 5.2.5
T1	Cover slab	0	Reference 6, Section 5.2.5
T2	Outer shell	3 in (0.0762 m) steel	Reference 6, Section 4.17
Y		20 ft (6.1 m)	Reference 6, Section 5.2.5
R1	Distance between source and turbine building wall	14.8 ft (4.5 m)	Reference 6, Section 5.3.1.5
R2	Distance between near source edge and turbine building wall	24.8 ft (7.56 m)	Reference 6, Section 5.3.1.5
Z	North to South distance to SW corner of turbine building from Unit 1 HPT	= distance from HPT edge to column 19 + 19 to 21 + 21 to 23 + 23 to 35 + 35 to 37 + 37 to 39 + 39 to 41 + 41 to 46 + distance from 46 to outer turbine building wall = (36 ft – (21 ft/2) – 3.6 ft) + 36 ft + 234 ft + 36 ft + 36 ft + 36 ft + 90 ft + 9 in = 490.65 ft (150 m)	Figure 3-5 and Figure 3-7
	North to South distance to SW corner of turbine building from Unit 2 piping	= distance from HPT edge to column 41 + 41 to 46 + distance from 46 to outer turbine building wall = (3.6 ft + (21 ft /2)) + 90 ft + 9 in = 104.85 ft (32 m)	
X	East to West distance to SW corner of turbine building from Units 1 and 2 HPT	= distance from face of inner turbine building wall to column G _d + G _d to G + G to outer turbine building wall = (21 ft – 19 ft 10.5 in) + 27 ft + 3 ft 9 in = 32 ft (9.75 m)	Figure 3-6 and Figure 3-7
	Elevation of top of shield wall	754 ft (230 m)	
H	Vertical distance from top of shield wall to dose receiver point	754 ft – 700 ft + 6 ft = 60 ft (18 m)	Figure 3-7 Calculated
	Source density	0.15 lb/in ³ (4.17 g/cm ³) water	Reference 6, Table 5-1
	Source activity	36 Ci (1.33E+12 Bq) N-16	Reference 2, Table 3-1

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3.8.3 Moisture Separators

The input data of Table 3-14 is used for MicroShield[®] and the data of Table 3-15 is used for MicroSkyshine[®]. In calculating the direct dose, only the west moisture separators are considered because the east moisture separators are shielded by the turbines.

Figure 3-8: Moisture Separator
[Reference 4, Figure 3]





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Table 3-14: Moisture Separator MicroShield® Inputs

Parameter	Description	Value	Reference
L	Source length	67.29 ft (20.51 m)	Reference 6, Section 5.2.1
T1	Radius	5.35 ft (1.63 m)	Reference 6, Section 5.2.1
T2	Shell thickness	1.25 inches (0.0318 m) iron	Reference 6, Section 5.2.1
T3	Distance between source and shield	2.15 ft (0.66 m) air	Reference 6, Section 5.2.1
T4	Concrete shield	3 ft 3 in (99 cm)	Reference 6, Section 5.2.1
Z	North to South distance to SW corner of turbine building from Unit 1 east and west moisture separators	= distance from source face to inside turbine building wall + distance from inner turbine building wall to column 24 + distance from column 24 to 34 + 34 to 40 + 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 12.21 ft + 1 ft + 198 ft + 108 ft + 36 ft + 72 ft + 9 in = 427.96 ft (130.44 m)	Figure 3-5 and Figure 3-8
	North to South distance to SW corner of turbine building from Unit 2 east and west moisture separator	= distance from source face to inside turbine building wall + distance from inner turbine building wall to column 40 + distance from column 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 18 ft + 3 ft + 6.5 ft + 36 ft + 72 ft + 9 in = 136.25 ft (41.53 m)	Figure 3-5 and Figure 3-8
	Source density	27.5 lb/ft ³ (0.44 g/cm ³)	Reference 6, Section 5.2.1
	Source activity	278 Ci (1.03E+13 Bq) N-16	Reference 2, Table 3-1

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Table 3-15: Moisture Separator MicroSkyshine® Inputs

Parameter	Description	Value	Reference
W	Radius	5.35 ft (1.63 m)	Reference 6, Section 5.2.1
L	Source length	67.29 ft (20.51 m)	Reference 6, Section 5.2.1
T1	Cover slab	1.5 ft (0.457 m) concrete	Reference 6, Section 5.2.1
T2	Shell thickness	1.25 inches (0.0318 m) iron	Reference 6, Section 5.2.1
T3	Shield thickness	3 ft (91 cm) concrete	Reference 6, Section 5.2.1
R1 [†]	Distance between near source edge and turbine building wall (Unit 1 and 2 east moisture separators)	17.2 ft (5.23 m)	Reference 2, Section 4.2.1.2
	Distance between near source edge and turbine building wall (Unit 1 and 2 west moisture separators)	2.15 ft (0.66 m)	Reference 2, Section 4.2.1.2
R2 [*]	Distance between far source edge and turbine building wall (Unit 1 and 2 east moisture separators)	27.9 ft (8.51 m)	Reference 2, Section 4.2.1.3
	Distance between far source edge and turbine building wall (Unit 1 and 2 west moisture separators)	12.85 ft (3.92 m)	Reference 2, Section 4.2.1.3
Z	North to South distance to SW corner of turbine building from Unit 1 east and west moisture separators	= distance from source face to inside turbine building wall + distance from inner turbine building wall to column 24 + distance from column 24 to 34 + 34 to 40 + 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 12.21 ft + 1 ft + 198 ft + 108 ft + 36 ft + 72 ft + 9 in = 427.96 ft (130.44 m)	Figure 3-5 and Figure 3-8
	North to South distance to SW corner of turbine building from Unit 2 east and west moisture separator	= distance from source face to inside turbine building wall + distance from inner turbine building wall to column 40 + distance from column 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 18 ft + 3 ft + 6.5 ft + 36 ft + 72 ft + 9 in = 136.25 ft (41.53 m)	Figure 3-5 and Figure 3-8

[†] R1 and R2 are determined with reference to shield walls on the west side of the moisture separators since construction workers will spend the majority of their time west of Units 1 and 2.

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Parameter	Description	Value	Reference
X	East to West distance to SW corner of turbine building (Unit 1 and 2 east moisture separators)	= distance from inner turbine building wall to column J + distance from J to Gd + Gd to G + G to outer turbine building wall = (2 ft - 1 ft 2 in) + (21 ft + 21 ft) + 27 ft + 3 ft 9 in = 73.58 ft (22.43 m)	Figure 3-5 and Figure 3-8
	East to West distance to SW corner of turbine building (Unit 1 and 2 west moisture separators)	= distance from inner turbine building wall to column G + distance from G to outer turbine building wall = 1 ft + 3 ft 9 in = 4.75 ft (1.45 m)	
	Elevation of bottom of concrete slab	755 ft (230 m)	Reference 2, Section 3.5.1
H	Vertical distance from top of shield wall to dose receiver point	755 ft – 700 ft + 6 ft = 61 ft (18.59 m)	
Y	Depth of source behind wall	19 ft (5.79 m)	Reference 6, Section 5.2.1
	Source density	27.5 lb/ft ³ (0.44 g/cm ³) water	Reference 6, Section 5.2.1
	Source activity	278 Ci (1.03E+13 Bq)N-16	Reference 2, Table 3-1

Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

3.8.4 Low Pressure Turbines

The LPT shielding configuration is shown in Figure 3-9. The data for the low pressure turbines (LPTs) in Table 3-16 is used as input for MicroShield[®]. The data of Table 3-17 is use as input for MicroSkyshine[®]. The middle LPT in each unit is considered representative of the three LPTs.

Figure 3-9: Turbine Shielding

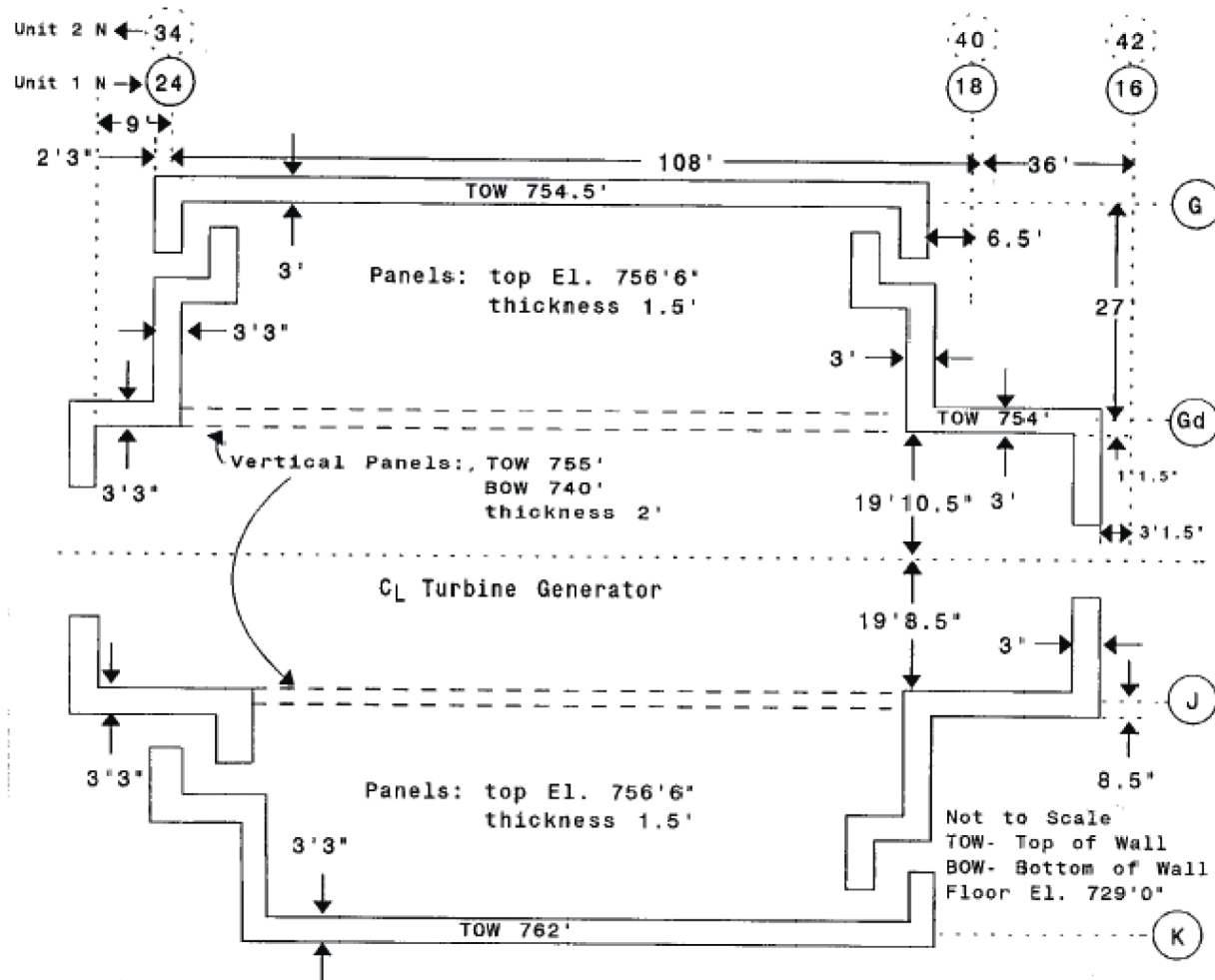


Table 3-16: LPT MicroShield® Inputs

Parameter	Description	Value	Reference
R	Radius	11.8 ft (3.6 m)	Reference 6, Section 5.2.6
T1	Source length	28.5 ft (8.68 m)	Reference 6, Section 4.18
T2	Shell thickness	1.25 inches (0.0318 m) iron	Reference 6, Section 4.18
T3		3 ft 3 inches (99 cm) concrete	Figure 3-9
	Source density	125 lb/ft ³ (2.0 g/cm ³)	Reference 6, Table 5-2
	Source activity	21.8 Ci (8.07E+11 Bq) N-16	Reference 2, Table 3-1

Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

Table 3-17: LPT MicroSkyshine® Inputs

Parameter	Description	Value	Reference
W	Radius	11.8 ft (3.6 m)	Reference 6, Section 5.2.6
L	Source length	28.5 ft (8.68 m)	Reference 6, Section 4.18
T1	Cover slab	0	Reference 6, Section 5.2.6
T2	Shell thickness	1.25 inches (0.0318 m) iron	Reference 6, Section 5.2.6
Y		15.5 ft (4.7 m)	Reference 6, Section 5.2.6
R1	Distance between source and turbine building wall	8.2 ft (2.5 m)	Reference 2, Section 3.5.6
R2	Distance between near source edge and turbine building wall	31.8 ft (9.7 m)	Reference 2, Section 3.5.6
Z	North to South distance to SW corner of turbine building from Unit 1 LPTs	$= \text{distance from face of LPT to column 23} + \text{column 23 to 35} + 35 \text{ to } 37 + 37 \text{ to } 39 + 39 \text{ to } 41 + 41 \text{ to } 46 + \text{distance from } 46 \text{ to outer turbine building wall}$ $= (36 \text{ ft} - (28.5 \text{ ft} / 2)) + 234 \text{ ft} + 36 \text{ ft} + 36 \text{ ft} + 90 \text{ ft} + 9 \text{ in}$ $= 454.5 \text{ ft (139 m)}$	Figure 3-5 and Figure 3-7
	North to South distance to SW corner of turbine building from Unit 2 LPTs	$= \text{distance from face of LPT to column 39} + 39 \text{ to } 41 + 41 \text{ to } 46 + \text{distance from } 46 \text{ to outer turbine building wall}$ $= (36 \text{ ft} - (28.5 \text{ ft} / 2)) + 36 \text{ ft} + 90 \text{ ft} + 9 \text{ in}$ $= 148.5 \text{ ft (45 m)}$	Figure 3-5 and Figure 3-7
X	East to West distance to SW corner of turbine building from Units 1 and 2 LPTs	$= \text{distance from face of inner turbine building wall to column } G_d + G_d \text{ to } G + G \text{ to outer turbine building wall}$ $= (21 \text{ ft} - 19 \text{ ft } 10.5 \text{ in}) + 27 \text{ ft} + 3 \text{ ft } 9 \text{ in}$ $= 32 \text{ ft (9.75 m)}$	Figure 3-6 and Figure 3-7
	Elevation of bottom of concrete slab	754 ft (230 m)	Figure 3-5
H	Vertical distance from top of shield wall to dose receiver point	754 ft – 700 ft + 6 ft = 60 ft (18 m)	Calculated
	Source density	125 lb/ft ³ (2.0 g/cm ³) water	Reference 6, Table 5-2
	Source activity	21.8 Ci (8.07E+11 Bq)N-16	Reference 2, Table 3-1

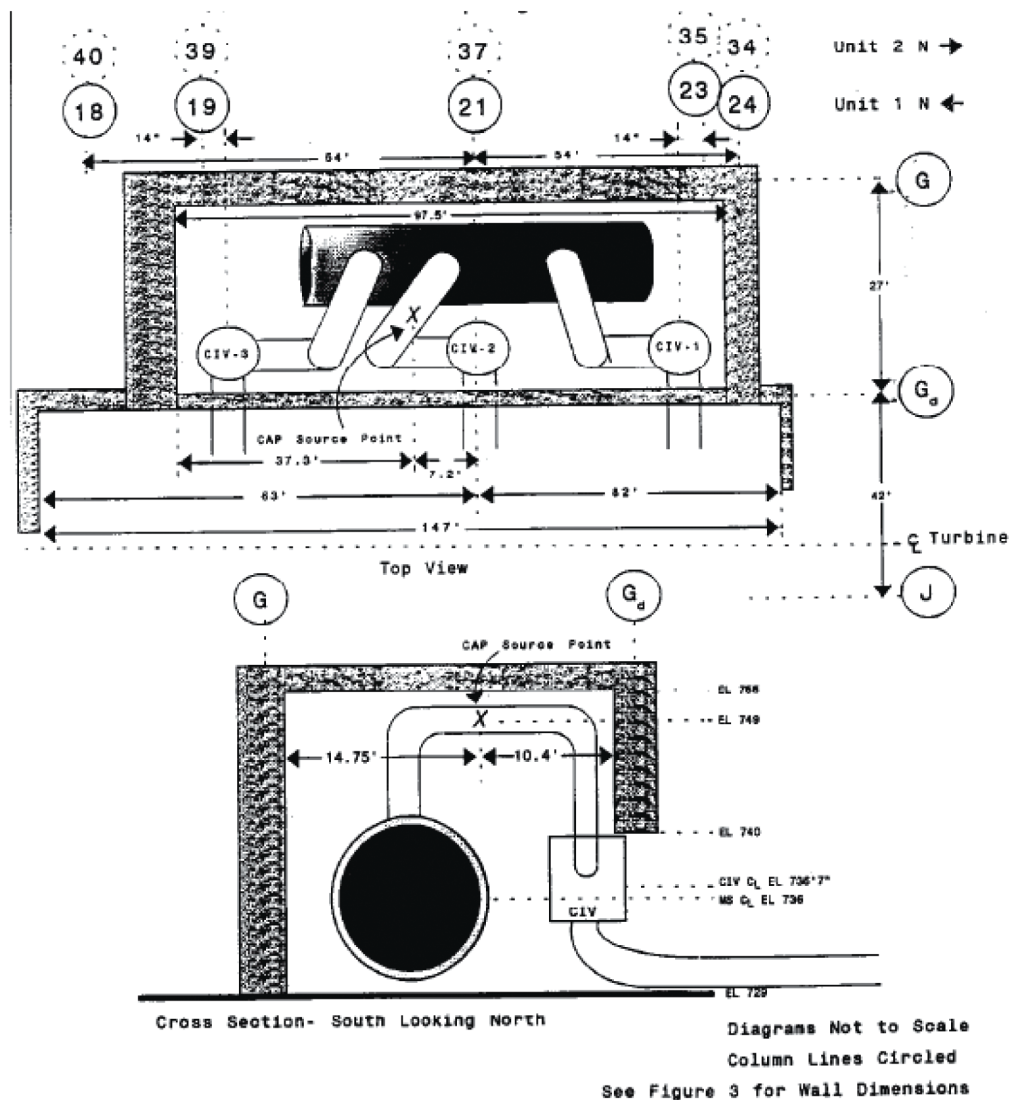
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3.8.5 Cross-Around Piping

A simplified sketch of the CAP and CIVs is shown in Figure 3-10. The 42 inch cross-around piping from the moisture separators to the CIVs are located inside the moisture separator rooms. For direct dose calculations, the Unit 2 east CAP is farther away from construction workers and is shielded by the turbines and west moisture separator. The Unit 1 CAP is also farther away than the Unit 2 CAP and is shielded by the turbines and moisture separators. Thus, only the Unit 2 west CAP is considered in the direct dose calculation.

Figure 3-10: Cross Around Piping/CIV Model

[Reference 4, Figure 4]



The data for the CAP of Table 3-19 is used as input for MicroShield® and the data of Table 3-19 is used as input for MicroSkyshine®.



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Table 3-18: CAP MicroShield® Inputs

Parameter	Description	Value	Reference
X	East to west distance	660 ft (20102 cm)	Reference 6, Section 5.4.1.2
Y	North to south lateral displacement	1116 ft (34000 cm)	Reference 6, Section 5.4.1.2
T1	Air space between source point and west shield wall	14.75 ft (450 cm)	Reference 6, Section 5.4.1.2
T2	Steel pipe wall	0.375 inches (0.953 cm)	Reference 6, Section 5.4.1.2
T3	Concrete shield wall	3 ft (91 cm)	Reference 6, Section 5.4.1.2
	Source density	0.400 lb/ft ³ (0.0064 g/cm ³) water	Reference 6, Section 5.2.2
	Source activity	40.3 Ci (1.49E+12 Bq) N-16	Reference 2, Table 3-1

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Table 3-19: CAP MicroSkyshine® Inputs

Parameter	Description	Value	Reference
T1	Cover slab	1.5 ft (0.457 m) concrete	Reference 6, Section 5.2.2
T2	Pipe Wall	0.373 in (0.00953 m) iron	Reference 6, Section 5.2.2
R1	Distance between near source edge and turbine building wall (Unit 1 and 2 east CAP)	10.5 ft (3.2 m)	Reference 6, Section 5.3.1.2
	Distance between near source edge and turbine building wall (Unit 1 and 2 west CAP)	14.75 ft (4.5 m)	Reference 6, Section 5.3.1.2
Z	North to South distance to SW corner of turbine building from Unit 1 CAP	= distance from CAP source point to column 21+ distance from column 21 to 24 + 24 to 34 + 34 to 40 + 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 7.2 ft + 54 ft + 198 ft + 108 ft + 36 ft + 72 ft + 9 in = 475.95 ft (145 m)	Figure 3-5 and Figure 3-10
	North to South distance to SW corner of turbine building from Unit 2 CAP	= distance from CAP source point to column 40 + distance from column 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = (54 ft - 7.2 ft) + 36 ft + 72 ft + 9 in = 155.55 ft (47 m)	Figure 3-5 and Figure 3-10
X	East to West distance to SW corner of turbine building (Unit 1 and 2 east CAP)	= distance from inner turbine building wall to column J + distance from J to Gd + Gd to G + G to outer turbine building wall = (2 ft - 1 ft 2 in) + (21 ft + 21 ft) + 27 ft + 3 ft 9 in = 73.58 ft (2243 cm)	Figure 3-6, Figure 3-7, and Figure 3-10
	East to West distance to SW corner of turbine building (Unit 1 and 2 west CAP)	= distance from inner turbine building wall to column G + distance from G to outer turbine building wall = 1 ft + 3 ft 9 in = 4.75 ft (145 cm)	Figure 3-6, Figure 3-7, and Figure 3-10
Y	Depth of source behind wall	6 ft (1.83 m)	Reference 6, Section 5.2.2
	Elevation of bottom of concrete slab	755 ft (230 m)	Figure 3-10
H	Vertical distance from top of shield wall to dose receiver point	755 ft – 700 ft + 6 ft = 61 ft (18.59 m)	Calculated



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Parameter	Description	Value	Reference
	Source density	0.400 lb/ft ³ (0.0064 g/cm ³) water	Reference 6, Section 5.2.2
	Source activity	40.3 Ci (1.49E+12 Bq) N-16	Reference 2, Table 3-1

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Table 3-20: CIV MicroSkyshine® Inputs

Parameter	Description	Value	Reference
W	Source radius	3 ft (0.91 m)	Reference 6, Section 5.2.3
L	Source length	64 in (1.63 m)	Reference 6, Section 5.2.3
T1	Cover slab	0	Reference 6, Section 5.2.3
T2	Pipe wall	1.97 inches (0.05 m) iron	Reference 6, Section 5.2.3
R1	Distance between center of source and shield wall (east CIVs)	36.4 ft (11.1 m)	Reference 6, Section 5.2.3
	Distance between center of source and shield wall (west CIVs)	3.28 ft (1 m)	Reference 6, Section 5.2.3
Y		16.9 ft (5.2 m)	Reference 6, Section 5.2.3
Z	North to South distance to SW corner of turbine building from Unit 1 CIVs	= distance from column 21 to 24 + 24 to 34 + 34 to 40 + 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 54 ft + 198 ft + 108 ft + 36 ft + 72 ft + 9 in = 468.75 ft (143 m)	Figure 3-5 and Figure 3-8
	North to South distance to SW corner of turbine building from Unit 2 CIVs	= distance from column 37 to 40 + 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 54 ft + 36 ft + 72 ft + 9 in = 162.75 ft (50 m)	Figure 3-5 and Figure 3-8
X	East to West distance to SW corner of turbine building (Unit 1 and 2 CIVs)	= distance from inside shield wall to column G _d + distance from column G _d to G + G to outer turbine building wall = 1 ft 1.5 in + 27 ft + 3 ft 9 in = 31.875 ft (9.7 m)	Figure 3-5 and Figure 3-8
	Elevation of bottom of concrete slab	756.5 ft (231 m)	Reference 2, Section 3.5.3
H	Vertical distance from top of shield wall to dose receiver point	756.5 ft – 700 ft + 6 ft = 62.5 ft (19 m)	Calculated
	Source density	0.400 lb/ft ³ (0.0064 g/cm ³) water	Reference 6, Section 5.2.3
	Source activity	5.5 Ci (2.04E+11 Bq) N-16	Reference 2, Table 3-1



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3.8.6 Combined Intermediate Valves

The combined intermediate valves (CIVs) are inside the moisture separator rooms, but only partially shielded by the shield panels along column lines G₄ and J (see Figure 3-3). The piping from the CIVs to the low pressure (LP) turbines runs from the inside of the moisture separator room to the LP turbine outside the room. Reference 6, Section 5.3.1.3 demonstrates that the dose rate from a set of CIVs can be calculated by multiplying the dose rate from the center CIVs by three.

The data of Table 3-20 for the combined intermediate valves (CIVs) is used as input for MicroSkyshine[®].



Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

3.8.7 Combined Intermediate Valve Piping Model

Piping from the combined intermediate valves (CIVs) to the LP turbines is depicted in Figure 3-9. The N-16 inventory of the elbow as well as the horizontal pipe run is assumed to be a horizontal run with its end at the outside edge of the partial shield wall. As described in Section 3.8.6 for the CIVs, the CIV piping dose rate can also be calculated by multiplying the dose rate from the center CIV by three because of the similarity between the CIV model and CIV piping model.

The data for the CIV piping used as input for MicroSkyshine[®] is given in Table 3-21.

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Table 3-21: CIV Piping MicroSkyshine® Inputs

Parameter	Description	Value	Reference
W	Source radius	20.5 inches (0.52 m)	Reference 6, Section 5.2.4
L	Source length	10 ft (3 m)	Reference 6, Section 5.2.4
T1	Cover slab	0	Reference 6, Section 5.2.4
T2	Pipe wall	0.375 in (0.01 m) iron	Reference 6, Section 5.2.4
R1 = R2	Distance between source and building wall for east piping	29.5 ft (9.0 m)	Reference 2, Section 4.2.6.1
	Distance between source and building wall for west piping	0.328 ft (0.1 m)	Reference 2, Section 4.2.6.1
Z	North to South distance to SW corner of turbine building from Unit 1 CIV piping	= distance from column 21 to 24 + 24 to 34 + 34 to 40 + 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 54 ft + 198 ft + 108 ft + 36 ft + 72 ft + 9 in = 468.75 ft (143 m)	Figure 3-5 and Figure 3-8
	North to South distance to SW corner of turbine building from Unit 2 CIV piping	= distance from column 37 to 40 + 40 to 42 + 42 to 46 + distance from 46 to outer turbine building wall = 54 ft + 36 ft + 72 ft + 9 in = 162.75 ft (50 m)	Figure 3-5 and Figure 3-8
X	East to West distance to SW corner of turbine building (Unit 1 and 2 CIV piping)	= distance from inside shield wall to column G _d + distance from column G _d to G + G to outer turbine building wall = 1 ft 1.5 in + 27 ft + 3 ft 9 in = 31.875 ft (9.7 m)	Figure 3-5 and Figure 3-8
	Elevation of bottom of concrete slab	756.5 ft (231 m)	Reference 6, Section 5.2.4
H	Vertical distance from top of shield wall to dose receiver point	756.5 ft – 700 ft + 6 ft = 62.5 ft (19 m)	Calculated
Y	Depth of source behind wall	25.75 ft (7.8 m)	Reference 6, Section 5.2.4
	Source density	0.400 lb/ft ³ (0.0064 g/cm ³) water	Reference 6, Section 5.2.4
	Source activity	5.5 Ci (2.04E+11 Bq) N-16	Reference 2, Table 3-1



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4.0 COMPUTER USAGE

4.1 Software

The dose to the shoreline and fenceline is calculated with MicroShield[®], version 7.02 [10]. MicroShield[®] version 6.02 was validated for safety related calculations of gamma dose rates for various simple source and shielding configurations in Reference 11. Several of the version 7.02 installation test cases are the same as the validation cases for version 6.02, with identical results. This is taken as proof that Reference 11 applies to version 7.02 and that version 7.02 is acceptable for safety related calculations. Skyshine doses are calculated with MicroSkyshine[®], version 2.10. The test case was run as shown in Figure 4-1 and has been compared to an identical calculation in Reference [12] (Example 6.1). In both cases, the results are identical.

Figure 4-1: MicroSkyshine[®] Test Case

Case Information					
Geometry	Point Source in a Rectangular Enclosure				
Name	Point Source in a Rectangular Enclosure				
Time	Monday, June 30, 2008 1:59:04 PM				
Results					
Energy Groups			Dose Results		
Group	Energy (MeV)	Activity (Photons / sec)	Rads / Photon	mR / hr	
1	6.200	1.000e+0	3.648e-20	1.504e-13	
Totals:	6.200	1.000e+0	3.648e-20	1.504e-13	
Geometry Parameters (Units: Feet)					
Name	Value	Name	Value	Name	Value
X	200	Y	2	Z	0
Length	150	Width	100	Height	59
Radius One	50	Radius Two	75	Thickness One	0
Thickness Two	0				
Material Densities					
Material	Ambient Air	Cover Slab	Lower Shield	Source Volume	
Air	0.00122				
Water					
Concrete					
Iron					
Lead					
Zirconium					
Urania					
Buildup Factor and Attenuation Coefficients					
No shield materials have been selected. Buildup will be based on air.					
Integration Parameters					
Numerical Quadrature			Sixteen		

Case Information					
Geometry	Point Source in a Rectangular Enclosure				
Name	Point Source in a Rectangular Enclosure				
File	Not Saved				
Time	Monday, June 30, 2008 2:00:21 PM				
Results					
Energy Groups			Dose Results		
Group	Energy (MeV)	Activity (Photons / sec)	Rads / Photon	mR / hr	
1	6.200	1.000e+0	6.592e-21	2.718e-14	
Totals:	6.200	1.000e+0	6.592e-21	2.718e-14	
Geometry Parameters (Units: Feet)					
Name	Value	Name	Value	Name	Value



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X	1000	Y	2	Z	0
Length	150	Width	100	Height	59
Radius One	50	Radius Two	75	Thickness One	0
Thickness Two	0				
Material Densities					
Material	Ambient Air	Cover Slab	Lower Shield	Source Volume	
Air	0.00122				
Water					
Concrete					
Iron					
Lead					
Zirconium					
Urania					
Buildup Factor and Attenuation Coefficients					
No shield materials have been selected. Buildup will be based on air.					
Integration Parameters					
Numerical Quadrature			Sixteen		

4.2 Computer Files

The MicroShield® and MicroSkyshine® files were uploaded to the AREVA COLD server for storage. Table 4-1 shows the files that were uploaded.

Table 4-1: Files Uploaded to COLD Server

Filename/Job Name	File Size	Date
CST Part A.sky2 CST Part A Skyshine	9 KB	8/19/2008
CST Part B.sky2 CST Part B Skyshine	9 KB	8/19/2008
CST Part C.sky2 CST Part C Skyshine	8 KB	8/19/2008
LLRWHF.ms7 LLRWHF Direct	18 KB	8/19/2008
SEALAND.ms7 SEALAND Direct	19 KB	8/19/2008
SEALAND.sky2 SEALAND Skyshine	9 KB	8/19/2008
Steam Dryers.ms7 Steam Dryer Direct	19 KB	8/25/2008
Steam Dryers.sky2 Steam Dryer Skyshine	7 KB	8/25/2008
Unit 1 East CAP.sky2 U1 E CAP Skyshine	7 KB	8/19/2008
Unit 1 East CIV Piping.sky2 U1 E CIV Piping	7 KB	8/25/2008
Unit 1 East CIVs.sky2 U1 E CIV Skyshine	7 KB	8/19/2008
Unit 1 East Horizontal HPT Inlet Piping.sky2 U1 E Horiz Piping	7 KB	8/19/2008
Unit 1 East MS.sky2 U1 E MS Skyshine	7 KB	8/25/2008
Unit 1 East Vertical HPT Inlet Piping.sky2 U1 E Vert. Piping	7 KB	8/19/2008
Unit 1 HPT.sky2 U1 HPT Skyshine	7 KB	8/19/2008
Unit 1 LPT.sky2 U1 LPT Skyshine	7 KB	8/19/2008



Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

Filename/Job Name	File Size	Date
Unit 1 LPTs.ms7 Unit 1 LPTs Direct	11 KB	8/19/2008
Unit 1 West CAP.sky2 U1 W CAP Skyshine	7 KB	8/19/2008
Unit 1 West CIV Piping.sky2 U1 W CIV Piping	7 KB	8/25/2008
Unit 1 West CIVs.sky2 U1 W CIV Skyshine	7 KB	8/19/2008
Unit 1 West Horizontal HPT Inlet Piping.sky2 U2 W Horiz Piping	7 KB	8/19/2008
Unit 1 West Moisture Separator.ms7 Unit 1 W MS Direct	20 KB	8/19/2008
Unit 1 West MS.sky2 U1 W MS Skyshine	7 KB	8/19/2008
Unit 1 West Vertical HPT Inlet Piping.sky2 U1 W Vert Piping	7 KB	8/19/2008
Unit 2 East CAP.sky2 U2 E CAP Skyshine	7 KB	8/19/2008
Unit 2 East CIV Piping.sky2 U2 E CIV Piping	7 KB	8/25/2008
Unit 2 East CIVs.sky2 U2 E CIV Skyshine	7 KB	8/19/2008
Unit 2 East Horizontal HPT Inlet Piping.sky2 U2 E Horiz Piping	7 KB	8/19/2008
Unit 2 East MS.sky2 U2 E MS Skyshine	7 KB	8/19/2008
Unit 2 East Vertical HPT Inlet Piping.sky2 U2 E Vert Piping	7 KB	8/19/2008
Unit 2 HPT.ms7 Unit 2 HPT Direct	11 KB	8/19/2008
Unit 2 HPT.sky2 U2 HPT Skyshine	7 KB	8/19/2008
Unit 2 LPT.sky2 U2 LPT Skyshine	7 KB	8/19/2008
Unit 2 West CAP.ms7 Unit 2 W CAP Direct	20 KB	8/19/2008
Unit 2 West CAP.sky2 U2 W CAP Skyshine	7 KB	8/19/2008
Unit 2 West CIV Piping.sky2 U2 W CIV Piping	7 KB	8/25/2008
Unit 2 West CIVs.sky2 U2 W CIV Skyshine	7 KB	8/19/2008
Unit 2 West Horizontal HPT Inlet Piping.sky2 U2 W Horiz Piping	7 KB	8/19/2008
Unit 2 West Moisture Separator.ms7 Unit 2 W MS Direct	11 KB	8/19/2008
Unit 2 West MS.sky2 U2 W MS Skyshine	7 KB	8/19/2008
Unit 2 West Vertical HPT Inlet Piping.sky2 U2 W Vert Piping	7 KB	8/19/2008



Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

5.0 CALCULATIONS

5.1 Condensate Storage Tanks

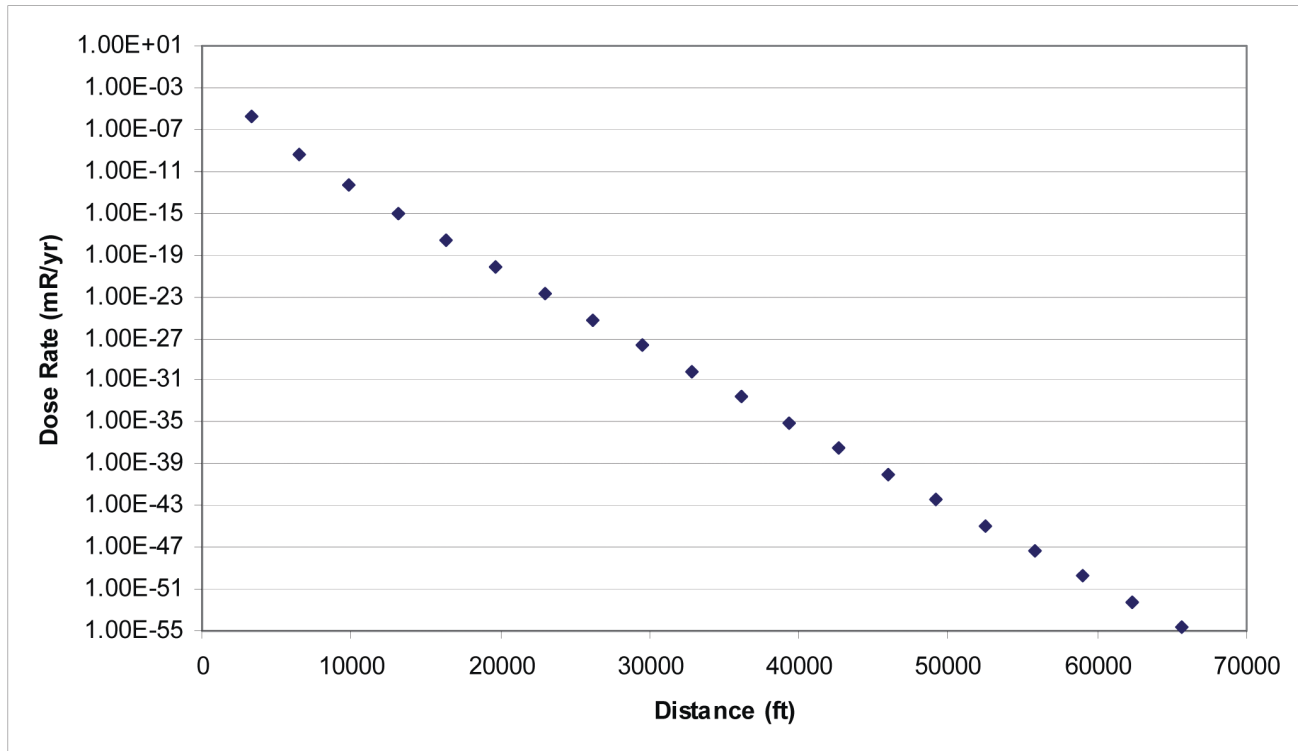
MicroSkyshine[®] is run for the Unit 1 and the Unit 2 CST using the parameters of Table 3-2 and the source term from Table 3-1. The MicroSkyshine[®] computer code is unable to interpret the large number of source isotopes in the source term. Therefore, the source term is split into thirds and MicroSkyshine[®] is run three times and summed to find the total dose emanating from a CST. The three runs are titled "CST Part A.ms7," "CST Part B.ms7," and "CST Part C.ms7" and are shown and summed in Table 5-1. The total annual dose is plotted as a function of distance in Figure 5-1 and a "best fit" exponential equation is found.

Table 5-1: Annual Dose from CSTs

Distance m (ft)	Skyshine Dose Part A (mR/hr)	Skyshine Dose Part B (mR/hr)	Skyshine Dose Part C (mR/hr)	Skyshine Dose (mR/hr)	Annual Dose for 2 CSTs (mR/yr)
1000 (3281)	8.07E-11	8.30E-12	1.99E-11	1.09E-10	1.91E-06
2000 (6562)	1.18E-14	1.77E-15	1.04E-14	2.40E-14	4.20E-10
3000 (9843)	7.41E-18	1.14E-18	1.50E-17	2.36E-17	4.13E-13
4000 (13123)	9.92E-21	1.30E-21	3.39E-20	4.51E-20	7.91E-16
5000 (16404)	1.90E-23	1.98E-24	9.42E-23	1.15E-22	2.02E-18
6000 (19685)	4.32E-26	3.59E-27	2.89E-25	3.36E-25	5.89E-21
7000 (22966)	1.08E-28	7.26E-30	9.35E-28	1.05E-27	1.84E-23
8000 (26247)	2.84E-31	1.58E-32	3.11E-30	3.41E-30	5.98E-26
9000 (29528)	7.86E-34	3.66E-35	1.06E-32	1.14E-32	2.00E-28
10000 (32808)	2.26E-36	8.82E-38	3.64E-35	3.88E-35	6.79E-31
11000 (36089)	6.73E-39	2.19E-40	1.27E-37	1.34E-37	2.34E-33
12000 (39370)	2.07E-41	5.55E-43	4.45E-40	4.66E-40	8.16E-36
13000 (42651)	6.53E-44	1.43E-45	1.57E-42	1.64E-42	2.87E-38
14000 (45932)	2.12E-46	3.73E-48	5.58E-45	5.80E-45	1.02E-40
15000 (49213)	7.02E-49	9.79E-51	1.99E-47	2.06E-47	3.61E-43
16000 (52493)	2.37E-51	2.59E-53	7.13E-50	7.37E-50	1.29E-45
17000 (55774)	8.15E-54	6.86E-56	2.56E-52	2.65E-52	4.64E-48
18000 (59055)	2.84E-56	1.83E-58	9.24E-55	9.53E-55	1.67E-50
19000 (62336)	9.99E-59	4.87E-61	3.33E-57	3.43E-57	6.02E-53
20000 (65617)	3.54E-61	1.30E-63	1.21E-59	1.24E-59	2.18E-55



Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

Figure 5-1: CST Dose Rate as a Function of Distance

The equation was found to be

$$D = 2E - 05e^{-0.0018r}$$

where D is in mrem/yr and r is in ft.

5.2 Low Level Radwaste Holding Facility

The MicroShield® computer code is used to evaluate the direct radiation dose rates for one CD LSM. The MicroShield® case is titled "LLRWHF.ms7".

The direct dose, as calculated by MicroShield® and shown in Table 5-2, is multiplied by 46 and added to the skyshine dose rate. The results are multiplied by an occupancy factor (8760 hr/yr) to achieve the annual dose from an array of 23x2 CD LSMs.

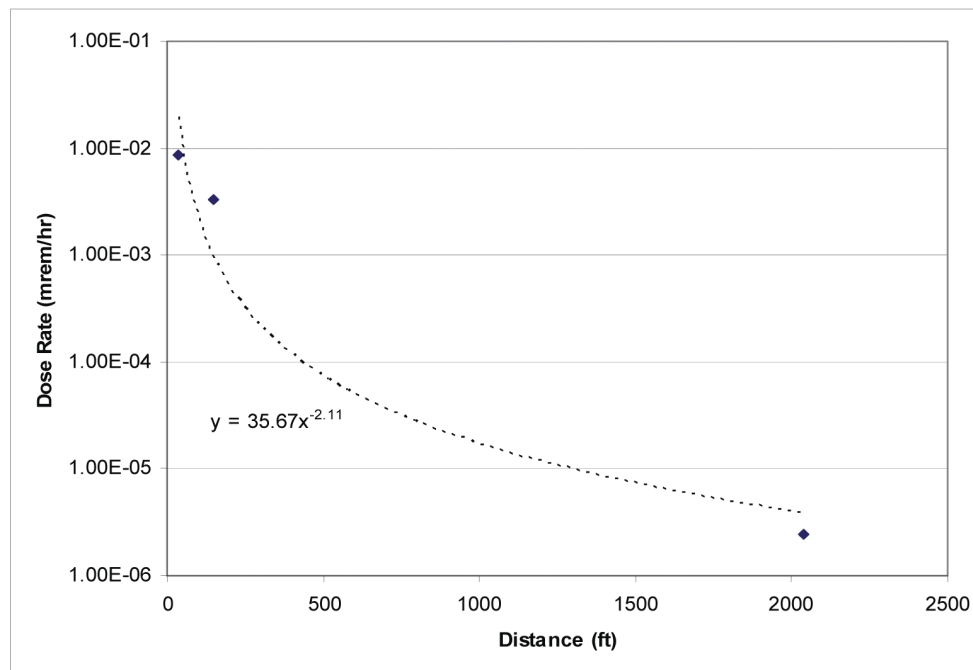
A representative equation is found for the skyshine dose rate for the array of CD LSMs by plotting the data of Table 3-5 as shown in Figure 5-2 and finding the "best fit" equation

$$D_{\text{sky}} = 35.67r^{-2.11}$$

where D is in mrem/hr and r is in feet. The skyshine dose is calculated at the distances shown in Table 5-2 using this equation.



Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

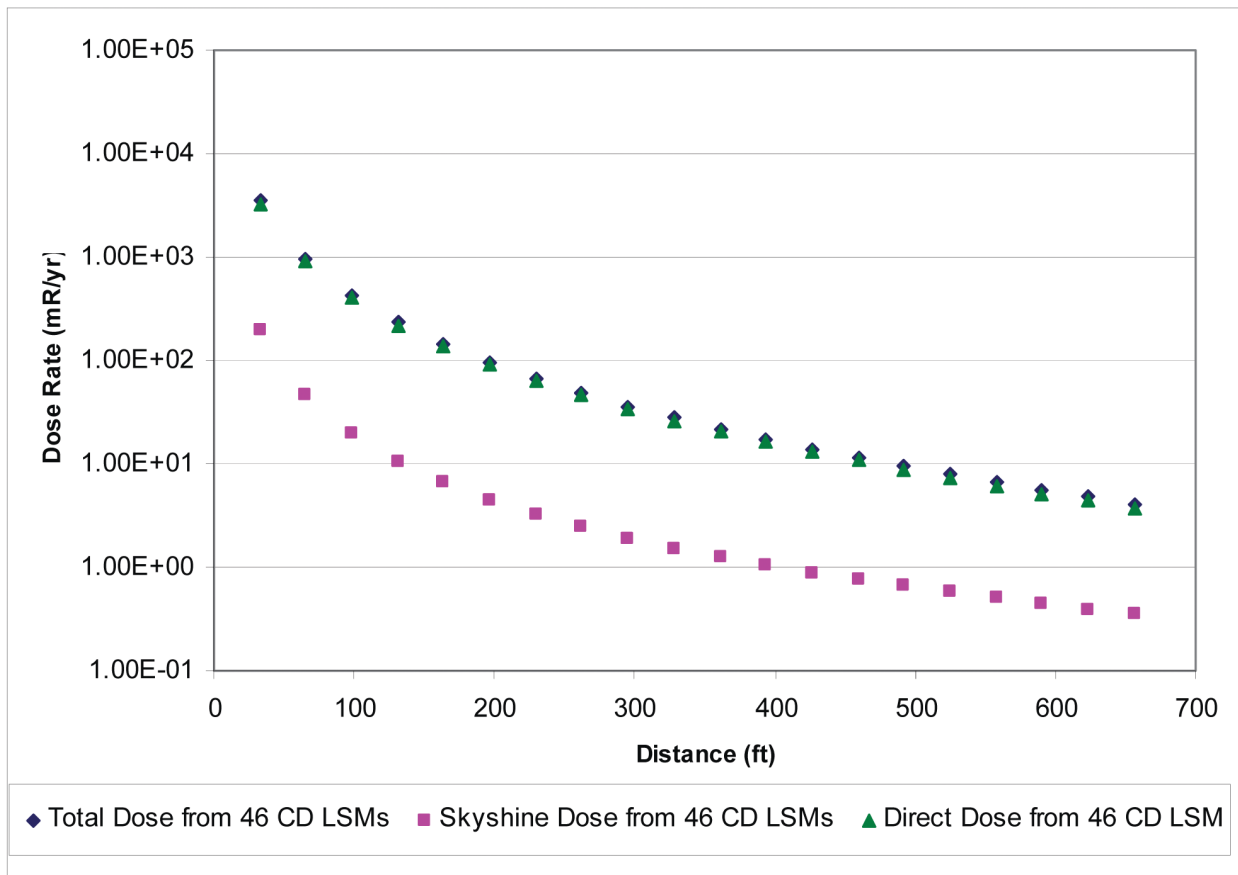
Figure 5-2: LLRWHF Skyshine Dose as a Function of Distance

The resulting annual doses, shown in Table 5-2, are plotted, as shown in Figure 5-3, and a “best fit” power equation was found.

Table 5-2: Annual Dose from LLRWHF

Distance m (ft)	Direct Dose from 1 CD LSM (mR/hr)	Direct Dose from 46 CD LSMs (mR/hr)	Skyshine Dose from 46 CD LSM (mR/hr)	Total Dose Rate (mR/hr)	Total Annual Dose Rate (mrem/yr)
10 (32.8)	8.16E-03	3.75E-01	2.26E-02	3.98E-01	3.48E+03
20 (65.6)	2.27E-03	1.04E-01	5.23E-03	1.09E-01	9.59E+02
30 (98.4)	1.00E-03	4.61E-02	2.22E-03	4.83E-02	4.23E+02
40 (131)	5.46E-04	2.51E-02	1.21E-03	2.63E-02	2.31E+02
50 (164)	3.35E-04	1.54E-02	7.56E-04	1.62E-02	1.42E+02
60 (197)	2.22E-04	1.02E-02	5.15E-04	1.07E-02	9.40E+01
70 (230)	1.55E-04	7.14E-03	3.72E-04	7.52E-03	6.58E+01
80 (263)	1.13E-04	5.19E-03	2.81E-04	5.47E-03	4.80E+01
90 (295)	8.46E-05	3.89E-03	2.19E-04	4.11E-03	3.60E+01
100 (328)	6.49E-05	2.99E-03	1.75E-04	3.16E-03	2.77E+01
110 (361)	5.08E-05	2.34E-03	1.43E-04	2.48E-03	2.17E+01
120 (394)	4.04E-05	1.86E-03	1.19E-04	1.98E-03	1.73E+01
130 (427)	3.26E-05	1.50E-03	1.01E-04	1.60E-03	1.40E+01
140 (459)	2.66E-05	1.22E-03	8.61E-05	1.31E-03	1.15E+01
150 (492)	2.19E-05	1.01E-03	7.45E-05	1.08E-03	9.47E+00
160 (525)	1.82E-05	8.36E-04	6.50E-05	9.01E-04	7.90E+00
170 (558)	1.52E-05	7.01E-04	5.72E-05	7.58E-04	6.64E+00
180 (591)	1.28E-05	5.91E-04	5.07E-05	6.41E-04	5.62E+00
190 (623)	1.09E-05	5.01E-04	4.52E-05	5.46E-04	4.78E+00
200 (656)	9.29E-06	4.27E-04	4.06E-05	4.68E-04	4.10E+00

Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

Figure 5-3: LLRWHF Annual Dose as a Function of Distance

The equation was found to be

$$D = 15068653r^{-2.30}$$

where D is in mrem/yr and r is in ft.

5.3 SEALAND Containers

The MicroShield® computer code is used to evaluate the direct radiation dose rates for an array of 40 SEALAND containers. The dirt embankment is modeled as concrete with a density of 1.5 g/cm³. The MicroShield® case is titled "SEALAND.ms7". A MicroSkyshine® case, titled "SEALAND.sky2" is also run. The results from the two codes are summed, multiplied by 2, and multiplied by an occupancy factor (8760 hr/yr) to achieve the annual dose from an array of 80 SEALAND containers.

The resulting annual doses, shown in Table 5-3, are plotted, as shown in Figure 5-4, and a "best fit" exponential equation is found.

Dose to Construction Workers at Bell Bend from Skyshine and Direct Sources at SSES Units 1 & 2

Table 5-3: Annual Dose from SEALAND Containers

Distance m (ft)	Direct Dose Rate (mR/hr) from 40 Containers	Skyshine Dose Rate (mR/hr) from 40 Containers	Annual Dose (mR) from 80 Containers
1000 (3281)	1.68E-06	1.83E-04	3.24E+00
2000 (6562)	7.78E-08	1.12E-05	1.98E-01
3000 (9843)	6.04E-09	9.44E-07	1.66E-02
4000 (13123)	5.81E-10	9.60E-08	1.69E-03
5000 (16404)	6.27E-11	1.10E-08	1.95E-04
6000 (19685)	7.26E-12	1.38E-09	2.43E-05
7000 (22966)	8.82E-13	1.81E-10	3.19E-06
8000 (26247)	1.11E-13	2.47E-11	4.35E-07
9000 (29528)	1.42E-14	3.46E-12	6.08E-08
10000 (32808)	1.86E-15	4.93E-13	8.68E-09
11000 (36089)	2.47E-16	7.15E-14	1.26E-09
12000 (39370)	3.31E-17	1.05E-14	1.84E-10
13000 (42651)	4.48E-18	1.55E-15	2.73E-11
14000 (45932)	6.11E-19	2.32E-16	4.08E-12
15000 (49213)	8.37E-20	3.49E-17	6.13E-13
16000 (52493)	1.15E-20	5.29E-18	9.30E-14
17000 (55774)	1.60E-21	8.07E-19	1.42E-14
18000 (59055)	2.22E-22	1.24E-19	2.17E-15
19000 (62336)	3.09E-23	1.91E-20	3.34E-16
20000 (65617)	4.30E-24	2.95E-21	5.17E-17

Figure 5-4: SEALAND Container Annual Dose as a Function of Distance