October 11, 2001

MEMORANDUM TO: Eric R. Pogue
Project Manager
Special Projects Section
Decommissioning Branch, DWM

FROM: Rateb (Boby) Abu Eid ***/RA/***
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SUBJECT: DECOMMISSIONING BRANCH TECHNICAL ASSISTANCE REQUEST: EVALUATION OF THE DCGLs FOR SAFETY LIGHT CORPORATION SITE

This is in response to the Decommissioning Branch Technical Assistance Request (TAR) which was originated by Region I and submitted on June 1, 2001, to the Environmental and Performance Assessment Branch. The TAR requested assistance for review and evaluation of the licensee's proposed derived concentration guideline limits (DCGLs) for the Safety Light Corporation Site Decommissioning Management Plan site.

In accordance with your TAR, I conducted a review and assessment of the licensee's proposed DCGLs for radionuclides contamination on building surfaces and in surface/subsurface soils. In addition, I conducted evaluation of the proposed groundwater concentration limits (GCLs) based on compliance with either 25 or 4 mrem/yr dose criteria. Based on my review and analysis, I found that the licensee's derived DCGLs and GCLs and were, in most cases, either similar or more restrictive than those derived by staff using prudently conservative assumptions and site specific data as practicable. In some few cases the licensee's derived limits were less restrictive and therefore need to be revised. The attached technical report presents a summary of the dose modeling approach, the assumptions and input parameters, the DCGLs results, and a brief discussion of the DCGLs and recommendations. This report should fulfil the actions required in your TAR.

Please let me know if you have any questions or comments.

cc: S. W. Moore
S. Wastler

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Enclosure (1)

EVALUATION OF THE DCGLs PROPOSED FOR SAFETY LIGHT CORPORATION SITE

By: Boby Eid
October 1, 2001

Objective

The objective of this report is to evaluate the derived concentration guideline limits (DCGLs) submitted by the Safety Light Corporation, hereafter referred to "the licensee's DCGLs," for its Site Decommissioning Management Plan (SDMP) site located at Bloomsburg, PA. This report is intended to assist the Decommissioning Branch (DCB) and Region I staff in their technical reviews of the "Decommissioning Plan" for Safety Light Corporation site and in the assessment of "Decommissioning Cost Estimates." It is also intended to provide the necessary technical information on DCGLs for an NRC contractor to refine its decommissioning cost analysis.

Approach

Site characterization survey data pertaining to the nature and the extent of contamination (e.g., horizontal/ vertical extent) was analyzed to establish the source term(s) for the dose modeling analysis. The radionuclides of concern in this analysis include: Am-241, Ra-226, Cs-137, Sr-90, and H-3. A tiered approach was adopted to categorize the contaminated media and associated areas of contamination based on availability, or limitation, of specific characterization data. The approach also attempted to encompass different physical and radiological contamination conditions at the site. In this context, radionuclide sources were classified into three main categories: 1. Radionuclide contamination on building surfaces; 2. Radionuclide contamination in surface soil (e.g., top 15 cm); and 3. Radionuclide contamination in subsurface soil. The dose corresponding to existing groundwater contamination was assessed separately based on the ingestion dose conversion factor for the drinking water pathway and the relative dose fraction of the water-dependent pathways. Dose impacts associated with each of the sources or the contaminated media were analyzed independent of each other. However, the total dose from all of these sources (if contaminated) should be calculated based on specific characterization data. Subsequently, the total dose from all contaminated media should be compared with the compliance dose criteria (e.g., 25 mrem/yr). The RESRAD-BUILD 3.1 code was used for dose impact analysis of contamination on building surfaces and the RESRAD 6.1 code was used for dose impact analysis of surface and subsurface soil contamination.

Assumptions and Input Parameters

1. For contamination on building surfaces the following assumptions and parameters were used:

   <u>Assumptions:</u>

   (a) Room size was assumed to match the main building room No. 88 (10.6 m wide x 16.7 m long x 3.6 m high).

Attachment

(b) Exposure conditions (e.g., occupancy, behavior, and metabolic parameters) were those of the light-industry critical group receptor as defined in NUREG/ CR-5512, Vols. I, II, and III.

(c) RESRAD-BUILD 3.1, was used with input parameters consistent with the light-industry occupancy parameters and room physical conditions. These parameters are consistent with the RESRAD-BUILD template file used for prudently conservative dose modeling transition from screening to site-specific analysis mode.

(d) A unit contamination level of 100dpm/m^2 (or1dpm/100cm^2) was used for each radionuclide.

(e) Other RESRAD-BUILD 3.1, pathways and input parameters were selected to harmonize with the light-industry critical group receptor scenario. For example, direct ingestion, inhalation, and direct exposure pathways were selected. Occupancy as well as inhalation parameters corresponding to the light-industry scenario were used.

Input Parameters Selections:

Table 1 presents a summary of the input parameters values used in RESRAD-BUILD 3.1, runs and brief comments on rationale for selection of each parameter. Table 2 lists the sensitive parameters and the corresponding distributions used in RESRAD-BUILD 3.1, probabilistic runs.

2. For contamination in surface soil the following assumptions and parameters were used:

Surface Soil Assumptions:

(a) The contamination is homogeneously distributed in the top 15 cm.

(b) There is no surface soil cover layer (e.g., thickness of cover was set to zero).

(c) An average annual precipitation of 1.18 m was selected.

(d) The thickness of the unsaturated layer was assumed to have a bounded log-normal distribution with a mean value of 2.29 m, a standard deviation of 1.276 m, a minimum thickness of 0.18 m, and a maximum thickness of 10.0 m.

(e) The area of contaminated zone was assumed to have a uniform distribution with a maximum value of 10000 m^2 and a minimum value of 100 m^2.

(f) The length parallel to the aquifer was assumed to have a uniform distribution with a minimum value of 20 m and a maximum value of 200 m.

(g) The distribution coefficients for each radionuclide for the contaminated zone, the unsaturated zone, and the saturated zone were assumed to have log-normal distribution.

Table 1: RESARD-BUILD 3.1 input parameters.

Parameter	Unit	Value	Distribution	Remarks
Radionuclide Concentration	dpm/m^2	100	NA	
Receptor Location	m	8.35, 5.3, 1	NA	1 m height from the source
Receptor Exposure Duration	d	365.25	NA	Occupancy period of 1 yr
Indoor Fraction		0.228	Continuous with linear interpolation	Match light industry scenario (97.4 d/yr)
Receptor Time Fraction		1	NA	Receptor is located for all working time in one room
Deposition velocity	m/s	0	Loguniform	
Resuspension rate	1/s	0	Loguniform	
Room height	m	3.6	Triangular	Per licensee assumption
Air Exchange rate	1/h	0.88	Truncated lognormal-n	
Receptor inhalation rate	m^3/d	33.6	Triangular	Light industry worker
Number of sources		6		Only source location and dimensions will change
Source direction		Floor & Ceiling Z		Perpendicular to the exposed area
Air release fraction		0.1	Triangular	10 percent of the removable fraction is respirable
Room Area	m^2	170	Triangular	Per licensee

Table 1: RESARD-BUILD 3.1 input parameters (continued)

Parameter	Unit	Value	Distribution	Remarks
Direct ingestion rate	1/h	6.2E-7		
Removable Fraction		0.1	Triangular	
Time for source removal	d	10,000	Triangular	
Shielding Thickness	cm	0	Triangular	

Table 2: Sensitive parameters and corresponding distributions selected for RESRAD-BUILD 3.1 probabilistic runs for surface contamination.

Parameter/Unit	Distributions	Mean (Mu), Standard Deviation & Other Parameters
Building Air Exchange Rate (1/h)	Truncated LOGNORMAL-N	Mu 0.4187 σ 0.88 Min 0.001 Max 0.99
Floor Area (m^2)	Triangular	Mode 170 Lower quantile 20 Upper quantile 200
Room Height (m)	Triangular	Mode 3.7 Lower quantile 2.4 Upper quantile 9.1
Air Fraction (dimension less)	Triangular	Mode 0.07 Lower quantile 1E-05 Upper quantile 0.75
Removable Fraction (dimension less)	Triangular	Mode 0.10 Lower quantile 0.0 Upper quantile 1.0
Release Time (days)	Triangular	Mode 10,000 Lower quantile 1000 Upper quantile 100,000
Area of Source (m^2)	Log Uniform	Lower 20 Upper 200
Direct Ingestion Rate (1/h)	Log Uniform	Lower 1E-07 Upper 1E-06

The soil-to-plant transfer factors were assumed to have a log-normal distribution for each radionuclide.

(h) The soil was assumed to be primarily of a gravelly silt loam. Therefore, soil physical parameters were selected to harmonize with the assumed soil type.

(i) Groundwater was assumed to be uncontaminated (e.g., with background concentration)

<u>Surface Soil Input Parameters Selections:</u>

Table 3 presents important input parameters values used in RESRAD 6.1. Table 4 presents sensitive parameters and corresponding distributions selected for RESRAD 6.1 probabilistic runs. Attachment #1 lists detailed input parameters and dose conversion factors.

3. For contamination in sub-surface soil (e.g., below 0.15 m to a depth reaching the unsaturated and uncontaminated zone), the following assumptions and parameters were used:

(a) The contamination is homogeneously distributed below a clean cover. The thickness of the cover was assumed to have a uniform distribution with a minimum thickness of 0.0 m and a maximum of 0.15 m.

(b) The thickness of the contaminated zone was assumed to have a uniform distribution with a minimum value of 0.15 m and a maximum value of 3.0 m.

(c) The thickness of the unsaturated layer was assumed to have a bounded log-normal distribution with a mean thickness of 1.0 m, a thickness standard deviation of 1.276 m, a minimum thickness of 0.18 m, and a maximum thickness of 5.0 m.

(d) All other assumption listed under surface soil contamination (e.g., contaminated area, precipitation, soil type, area of contaminated zone, length parallel to aquifer, distribution coefficients, and soil-to-plant transfer factors) apply.

(e) Groundwater was assumed to be uncontaminated (e.g., with background concentration).

<u>Sub-Surface Soil Input Parameters Selections:</u>

Attachment No. 1 presents a summary of most input parameters values used in RESRAD 6.1 for assessment of surface/subsurface soil doses. The sensitive parameters are similar to those listed in Table 4 (for surface soil) except for the changes made for the cover thickness, the contaminated zone thickness, and the unsaturated zone thickness as was described above.

4. For contamination in groundwater the following assumptions were made:

   (a) RESRAD 6.1 dose conversion factors for ingestion (mrem/pCi) were used (see Attachment No. 1).

   (b) The critical group receptor drinking water intake was assumed to be 510 L/yr.

Table 3: RESARD 6.1 Important Input Parameters for Surface Soil

Parameter	Unit	Value	Distribution	Remarks
Radionuclide Concentration	pCi/g	1	NA	
Cover depth	m	0.0	NA	
Density of contaminated zone (CZ)	g/cm^3	1.28	NA	Soil type&Licensee value
Area of CZ	m^2	1.0E+04		RESRAD default
Length parallel to aquifer flow	m	100	NA	RESRAD default
CZ erosion rate	m/yr	1.0E-03		RESRAD Default
CZ & unsaturated zone (UZ) hydraulic conductivity	m/yr	2.0E+01		Site
Precipitation Rate	m/yr	1.18E+00		Site
UZ thickness	m	2.0		Site
Saturated zone (SZ) hydraulic conductivity	m/yr	2.0E+02		Site
K_d for CZ, UZ, and SZ for Am-241	g/cm^3	2.0 E+01		RESRAD Default
K_d for CZ, UZ, and SZ for Cs-137	g/cm^3	1.0 E+03		RESRAD Default
K_d for CZ, UZ, and SZ forH-3	g/cm^3	0.0		RESRAD Default
K_d for CZ, UZ, and SZ for Ra-226	g/cm^3	7.0 E+01		RESRAD Default
K_d for CZ, UZ, and SZ for Sr-90	g/cm^3	3.0 E+01		RESRAD Default
Soil-to-plant transfer factor for Am-241	-	1.0 E-03		RESRAD Default
Soil-to-plant transfer factor for Cs-137	-	4.0 E-02		RESRAD Default
Soil-to-plant transfer factor for H-3	-	4.8 E 00		RESRAD Default
Soil-to-plant transfer factor for Ra-226	-	4.0 E-02		RESRAD Default
Soil-to-plant transfer factor for Sr-90	-	3.0 E-01		RESRAD Default

Table 4: Sensitive parameters and corresponding distributions selected for RESRAD 6.1 Probabilistic runs for surface/subsurface contamination

Parameter/Unit	Distributions	Mean (Mu), Standard Deviation & Other Parameters
K_d for Am-240 (CON, US, and SAT zones); cm^3/g	Log-Normal	Mu 7.28 σ 3.15
Plant transfer factor for Am-240; dimension less	Log-Normal	Mu -6.91 σ 0.916291
K_d for Cs-137 (CON, US, and SAT zones); cm^3/g	Log-Normal	Mu 6.1 σ 1.7
Plant transfer factor for Cs-137; dimension less	Log-Normal	Mu -3.22 σ 0.993252
K_d for Ra-226 (CON, US, and SAT zones); cm^3/g	Log-Normal	Mu 8.17 σ 1.70
Plant transfer factor for Ra-226; dimension less	Log-Normal	Mu -3.22 σ 0.993252
K_d for Sr-90 (CON, US, and SAT zones); cm^3/g	Log-Normal	Mu 3.45 σ 2.12
Plant transfer factor for Sr-90; dimension less	Log-Normal	Mu -1.20 σ 0.993252
Area of contaminated zone; m^2	Uniform	Min 100 Max 10000
Length parallel to aquifer, m	Uniform	Min 20 Max 200
Unsaturated zone thickness, m	Bounded Log-Normal	Mu 2.29 σ 1.276 Min 0.18 Max 10.00

(c) For each radionulide, water dependent pathways (e.g., pathways associated with ingestion of food dependent on irrigation of contaminated groundwater) were estimated to be equal to 25 percent of the drinking water pathway dose. This estimate was based on numerous deterministic runs using RESRAD 6.1 and analysis of the dose fraction of the water dependent pathway relative to the drinking water pathway dose fraction.

RESULTS:

The DCGLs were derived for each of the contaminated sources or media: building surfaces, surface soil (top 15 cm), subsurface soil (soil at depths down to 3m), and groundwater. The approach and methodology described above were employed in derivation of the DCGLs. RESRAD 6.1, and RESRAD-BUILD 3.1 probabilistic codes were used. The input parameters and distributions used in this dose impact analysis are listed in Tables 1, 2, 3, 4, and Attachment No. 1. Table 5 presents a list of the DCGLs and the groundwater concentration limits (GCLs) derived for each contaminated source or medium for each specific radionuclide. The DCGLs/DCLs derived by the licensee as well as the DCGLs derived for screening purposes using DandD model are also presented for comparison.

DISCUSSION OF THE DCGLs AND RECOMMENDATIONS:

Building Surfaces DCGLs:

The DCGL derived by the staff for Am-241 is less restrictive than the licensee's DCGL. Therefore, the DCGL proposed by the licensee should be accepted.

The DCGL derived by the staff for Ra-226 is similar to the licensee's derived DCGL. Therefore, the DCGL proposed by the licensee should be accepted.

The DCGL derived by the staff for H-3 (e.g., 6.6 E+07) is more restrictive than the licensee's DCGL by approximately a factor of 2. However, the DandD DCGL screening value (e.g., 1.2 E+08 dpm/100 cm^2) is less restrictive than the licensee's, as well as the staff DCGLs derived using RESRAD-BUILD 3.1 code. Therefore, the H-3 DCGL proposed by the licensee is acceptable because it is slightly more conservative than the screening value.

The DCGL derived by the staff for Cs-137 (e.g., 1.72 E+04) is more restrictive than the licensee's DCGL by approximately a factor of 2. The DandD DCGL screening value (e.g., 2.8 E+04) is also more restrictive than the licensee and slightly less restrictive than RESRAD-BUILD 3.1 code. Therefore, the licensee should use the DCGL of 2.8 E+04 dpm/100 cm^2 or provide additional justification for the input parameters and the methods used in deriving Cs-137 DCGL.

The DCGL derived by the staff for Sr-90 is more restrictive than the licensee's DCGL by approximately a factor of 2. The DandD DCGL screening value is also more restrictive than the licensee and more restrictive than RESRAD-BUILD 3.1 code. Therefore, the licensee should use the staff derived DCGL 2.6 E+04 dpm/100 cm or provide additional justification for the input parameters and the methods used in deriving Sr-90 DCGL

Surface Soil DCGLs:

The DCGL derived by the staff for Am-241 is less restrictive than the licensee's DCGL. Therefore, the DCGL proposed by the licensee should be accepted.

The DCGL derived by the staff for Ra-226 is similar to the licensee's derived DCGL. Therefore, the DCGL proposed by the licensee should be accepted.

The DCGL derived by the staff for H-3 is more restrictive by approximately a factor of 2. In addition the DandD DCGL screening value is much more restrictive than the licensee and the RESRAD6.1 code value. Therefore, the H-3 DCGL proposed by the licensee should not be accepted. The licensee may adopt the staff derived DCGL (e.g., 5060 pCig) or provide further justification for the input parameters and dose calculation methodology.

The DCGL derived by the staff for Cs-137 is similar to the DCGL derived by the licensee and within the statistical error. Therefore, the DCGL proposed by the licensee should be accepted.

The DCGL derived by the staff for Sr-90 is more restrictive by approximately a factor of 2. The DandD DCGL screening value is also much more restrictive than the licensee and more restrictive than RESRAD-BUILD 3.1 code. Therefore, the licensee should use the DCGL of 15 pCi/g or provide additional justification for the input parameters and the methods used in deriving the Sr-90 DCGL

Sub-Surface Soil DCGLs:

The DCGL derived by the staff for Am-241 is less restrictive than the licensee's DCGL. Therefore, the DCGL proposed by the licensee should be accepted.

The Ra-226 DCGL derived by the staff is slightly less restrictive than the licensee's derived DCGL. Therefore, the DCGL proposed by the licensee is acceptable.

The DCGL derived by the staff for H-3 is less restrictive than the licensee's DCGL. Therefore, the DCGL proposed by the licensee is acceptable.

The DCGL derived by the staff for Cs-137 is slightly less restrictive than the DCGL derived by the licensee. Therefore, the DCGL proposed by the licensee is acceptable.

The DCGL derived by the staff for Sr-90 is slightly more restrictive than the DCGL derived by the licensee. Therefore, the licensee should use the DCGL of 3.8 pCi/g instead of 5 pCi/g. Otherwise the licensee may provide additional justification of input parameters and further explanation of the methods used in deriving the Sr-90 DCGL.

Groundwater Concentration Limits (GCL)

The licensee may either use the staff's groundwater derived concentration limit (e.g., staff GCL) which is equivalent to 25 mrem/yr or use more restrictive GCLs equivalent to 4 mrem/yr (e.g., EPA's drinking water dose limits). In the first case, the licensee may comply with NRC dose standard assuming no radiological contamination above background exist in any other environmental media (e.g., buildings surfaces, surface soil, and subsurface). However, selecting this option may not demonstrate compliance with EPA's drinking water dose limit of 4 mrem/yr. In the second case, the licensee's option is more conservative and may demonstrate compliance with EPA's drinking water dose limit.

For Am-241, the licensee did not propose any groundwater concentration limit (GCL). Therefore, the licensee may select either 11 pCi/L (equivalent to 25 mrem/yr) or 1.6 pCi/L (equivalent to 4 mrem/yr).

The licensee's proposed GCL for Ra-226 of 5 pCi/L is similar to staff GCL equivalent to 4 mrem/y. Therefore, the licensee's GCL should be acceptable.

The licensee's GCL for Cs-137 of 200 pCi/L is more restrictive than the staff GCL equivalent to 25 mrem/yr. Therefore, the licensee's GCL is acceptable from NRC standpoint.

However, it should be noted that the dose corresponding to such GCL is higher than the EPA's 4 mrem/yr dose limit.

The licensee's proposed GCL for Sr-90 of 8 pCi/L is more restrictive than the staff GCL equivalent to 25 mrem/yr and the staff GCL equivalent to 4 mrem/yr. Therefore, the licensee's GCL should be accepted.

The licensee's proposed GCL for H-3 of 2E+04 pCi/L is more restrictive than both the staff GCL equivalent to 25 mrem/yr as well as the staff GCL equivalent to 4 mrem/yr. Therefore, the licensee's GCL is acceptable.

SUMMARY AND CONCLUSION:

The DCGLs for Safety Light decommissioning site were derived for building surfaces, surface soil (e.g., top 0.15 m), and sub-surface soil (e.g., at depths reaching 3m). These DCGLs were derived using probabilistic RESRAD 6.1 and RESRAD-BUILD 3.1 codes and specific input parameters or parameter distributions corresponding to site-specific conditions and to the assumed critical group receptor scenarios. In addition, GCLs equivalent to 25 mrem/yr and 4 mrem/yr were derived using dose conversion factors for the annual drinking water ingestion and estimated ratios of the doses associated with the water dependent pathways. The DCGLs and the GCLs were compared with the licensee's derived DCGLs and GCLs and were found, in most cases, either similar or more restrictive than those derived by staff. In some few cases the licensee's derived limits were less restrictive and therefore, need to be revised. Alternatively the licensee may adopt staff more restrictive DCGLs or GCLs for these few cases.

Table 5: DCGLS Derived for Building Surfaces, Surface Soil, Subsurface Soil, and Groundwater Using Probabilistic RESRAD- BUILD 3.1 and RESRAD 6.1 Codes

Environmental Medium/Units	Radionuclide	DCGLs calculated by NRC Staff	DCGLs Calculated by SLC	D&D Screening Values
Building Surfaces (dpm/100 cm^2)	Am-241	8.35E+02	1.12E+02	2.7E+01
	Ra-226	2.182 E+03	2.17E+03	1.12E+03
	Cs-137	1.72 E+04	4.05E+04	2.8E+04
	Sr-90	2.6 E+04	4.316E+04	8.7E+03
	H-3	6.6 E+07	1.1E+08	1.2E+08
Surface Soil (top 15 cm) (pCi/g)	Am-241	100	10.0	2.1
	Ra-226	3.98	4.1	0.7
	Cs-137	13.30	14.1	11.0
	Sr-90	14.70	30.1	1.7
	H-3	5060	11,420	110
Subsurface Soil Below top 15 cm with thickness 0.15 - 3.0 m (pCi/g)	Am-241	48.60	1	NA
	Ra-226	2.07	1.5	NA
	Cs-137	18.8	11	NA
	Sr-90	3.80	5	NA
	H-3	1302	1024	NA

Table 5: DCGLS Derived for Building Surfaces, Surface Soil, Subsurface Soil, and Groundwater Using Probabilistic RESRAD- BUILD 3.1 and RESRAD 6.1 Codes (Continued)

Groundwater concentration (pCi/L)	Am-241	11 (25 mrem); 1.55 (4 mrem)	NA	
	Ra-226	30 (25 mrem); 4.8 (4 mrem)	5	NA
	Cs-137	784 (25 mrem); 125 (4 mrem)	200	NA
	Sr-90	228 (25 mrem);36.5 (4 mrem)	8	NA
	H-3	6.12E+05 (25 mrem); 9.8E+ 04 (4 mrem)	2E+04	NA