INDUSTRIAL REACTOR LABORATORIES, INC.
Subsidiary of N. L. Industries Inc.
PLAINSBORO, NEW JERSEY 08536
609-799-1800

NL INDUSTRIES

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September 14, 1977

Mr. Eugene Fisher
Bureau of Radiation Protection
New Jersey Department of
Environmental Protection
380 Scotch Road
Trenton, NJ 08628

Mr. Daniel B. Howell
Radiation Safety Dept.
Doolittle Bldg. 3572
Bevier Road
Busch Campus
New Brunswick, NJ 08903

Mr. James A. Jones
United States
Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Robert G. Levesque
ATCOR
Park Mall
Peekskill, NY 10566

Dr. Kenneth W. Skrable
University of Lowell (N)
1 University Avenue
Lowell, MA 01854

Mr. John White
USNRC - Region 1
Office of Inspection
and Enforcement
631 Park Avenue
King of Prussia, PA 19406

Gentlemen:

The attached errata are enclosed for the July 1, 1977, edition of the Final Survey Results After Decontamination, Industrial Reactor Laboratories Facilities, Plainsboro, New Jersey.

Very truly yours,

David W. Leigh
Decommissioning Project Manager

DWL/ljl

Attachment

cc: J.M. Gleason, Esq.
J.L. Jacobs, Esq.

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FACILITY RELEASE SPECIFICATIONS

1. The maximum amount of removable (capable of being removed by wiping the surface with a filter paper or other suitable absorbent material) beta-gamma activity in disintegrations per minute per 100 square centimeters on buildings or equipment should not exceed 1,000.

2. The average amount of fixed beta-gamma activity in disintegrations per minute per 100 square centimeters on buildings or equipment should not exceed 5,000.

3. The maximum amount of fixed beta-gamma activity in disintegrations per minute per 100 square centimeters on buildings or equipment should not exceed 15,000.

4. The maximum amount of removable alpha activity in disintegrations per minute per 100 square centimeters on buildings or equipment should not exceed 1,000.

5. The average amount of fixed alpha activity in disintegrations per minute per 100 square centimeters on buildings or equipment should not exceed 5,000.

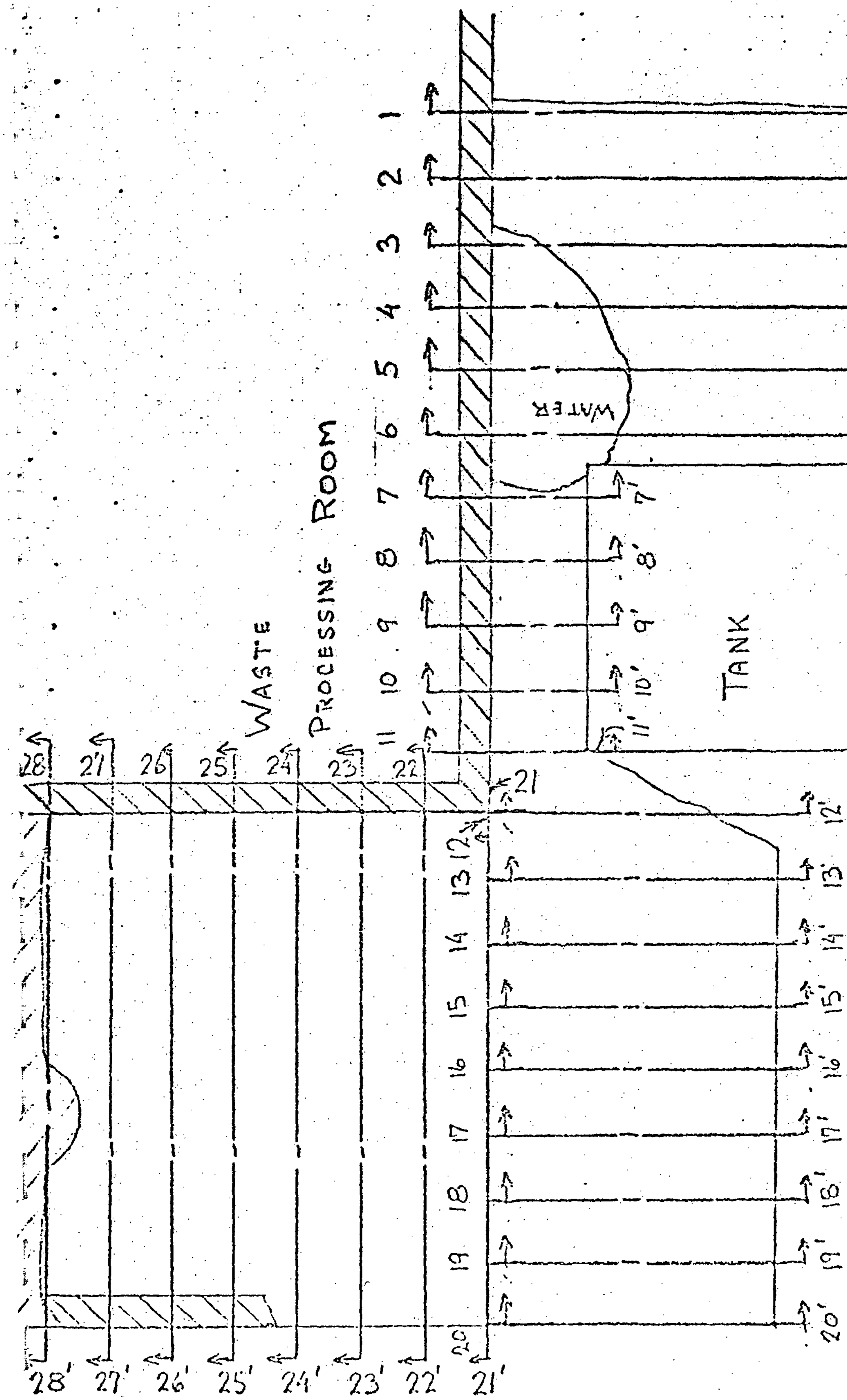
6. The maximum amount of fixed alpha activity in disintegrations per minute per 100 square centimeters on buildings or equipment should not exceed 15,000.

7. The average and maximum radiation levels associated with surface contamination resulting from Beta-Gamma emitters should not exceed 0.2 MRAD/hr at 1 cm and 1.0 MRAD/hr at 1 cm; respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

8. Liquid effluents should be held and checked to insure that concentrations are less than 10 CFR 20, Appendix B, Table II limits prior to discharge. Dilution will not be allowed to reduce concentrations in order to discharge.

9. Airborne radioactivity should be controlled at the individual work sites to insure airborne effluents discharged to the environment are less than 10 CFR 20, Appendix B, Table II limits.

10. Excavations in which radioactivity exists shall have the total activity reduced such that the remaining activity is not an internal radiological problem and the resulting dose rates from this activity is not an external radiation problem.



NOTE:

Numbered Arrows, (i.e., 1 —— 1',) are locations of Vertical Section Views on Page 159 through Page 165.

Vertical Section Views present Gamma Radiation Survey Data at 1 foot from excavation surfaces.

WASTE EVAPORATOR SUMP EXCAVATION

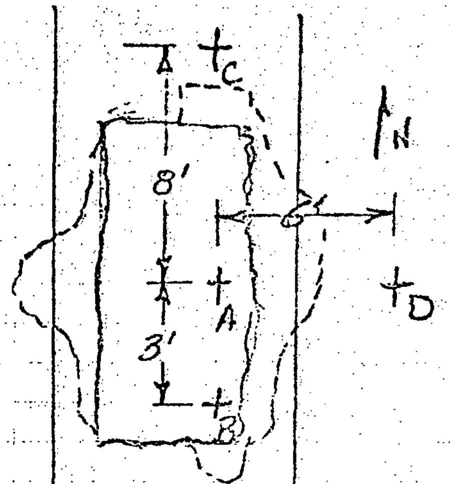
BY ____ DATE ____ SUBJECT ____ SHEET NO. ____ OF ____

CHKD. BY ____ DATE ____ JOB NO. ____

SECTION 8.0

RESULTS OF CORE SAMPLES IN EAST CORRIDOR REMAINING AFTER EXCAVATION

SAMPLE POINT "A" IS AT THE FAILED CLEAN OUT



SAMPLE SIZE 12.5 gms

SAMPLE POINT	DEPTH FROM FLOOR IN Ft	ACTIVITY IN μCi/cc Cs^{137}	Co^{60}
A	8	3.22×10^{-5}	3.04×10^{-5}
A	9	3.15×10^{-5}	3.84×10^{-5}
A	10	2.13×10^{-4}	1.16×10^{-4}
A	11	5.16×10^{-6}	$\leq 2 \times 10^{-6}$
B	7	6.13×10^{-5}	3.69×10^{-5}
B	8	5.82×10^{-5}	5.85×10^{-5}
B	9	7.71×10^{-5}	1.86×10^{-4}
B	10	2.29×10^{-4}	1.21×10^{-4}
B	11	$\leq 1.3 \times 10^{-6}$	$\leq 2 \times 10^{-6}$
C	3	1.82×10^{-5}	1.82×10^{-5}
C	4	2.42×10^{-5}	2.32×10^{-5}
C	5	7.76×10^{-6}	2.36×10^{-5}
C	6	1.41×10^{-4}	$\leq 2 \times 10^{-6}$
C	7	9.28×10^{-6}	3.22×10^{-5}
C	8	9.53×10^{-6}	6.13×10^{-5}
C	9	1.74×10^{-4}	7.20×10^{-5}
C	10	1.69×10^{-5}	2.55×10^{-5}
D	6	3.44×10^{-6}	2.56×10^{-5}
D	7	3.36×10^{-5}	4.15×10^{-5}
D	8	$\leq 1.3 \times 10^{-6}$	1.01×10^{-5}

Septic Tank

Inlet side about 5' x 5' area with gamma dose rate being 1 mr/hr.

Approach

1. Assume all readings are from ^{60}Co.
2. Calculate activity in tank using surface source geometry.
3. Determine other activities using Teledyne Isotope analysis by ratioing their activities to that of ^{60}Co.

$\emptyset = 3/2\ S/A$ where $450\ ph/cm^2/sec = 1\ mr/hr$

$D = 1\ mr/hr$

$S = 450\ ph/cm^2/sec \times 2/3 \times A$

$$A = 25\ ft^2 \times \frac{(12\ in)^2}{ft^2} \times \frac{(2.54\ cm)^2}{in^2} = 23,226\ cm^2$$

$$S = 4.5 \times \frac{10^2\ ph}{cm^2\ sec} \times \frac{2}{3} \times 2.32 \times 10^4\ cm^2 \times \frac{dis}{2\ ph} \times \frac{mci\ of\ ^{60}Co}{3.7 \times 10^7\ dis/sec}$$

$S = 0.94 \times 10^{-1}\ mci\ ^{60}Co \simeq 0.09\ ^{60}Co$

$$\boxed{S = 0.1\ mci,\ ^{60}Co}$$

From Teledyne Report

^{60}Co	$4.18 \times \overset{A}{1}0^3$ pCi/gm
^{137}Cs	5.57×10^2 pCi/gm
^{90}Sr	3.2×10^2 pCi/gm

$$\frac{[^{137}Cs]}{[^{60}Co]} = \frac{5.57 \times 10^2}{4.18 \times 10^2} = 0.133$$

$$\frac{[^{90}Sr]}{[^{60}Co]} = \frac{3.2 \times 10^2}{4.18 \times 10^3} = 0.076$$

^{60}Co	1×10^{-1} mci
^{137}Cs	1.33×10^{-2} mci
^{90}Sr	7.66×10^{-3} mci

Waste Process Septic Sump

After cleaning sludge from the septic sump, the average gamma dose rate on the bottom of the tank was 0.6 mr/hr.

The tank diameter is about three (3) feet.

Approach

1. Assume all readings are from ^{60}Co.

2. Calculate activity in the tank using surface source geometry.

3. Determine other activities using the Teledyne Isotope analysis by ratioing their activities to that of ^{60}Co.

$$\emptyset = 3/2\ S/A \text{ where } \emptyset = 0.6\ \frac{mr}{hr} \times \frac{450\ ph/cm^2/sec}{1\ mr/hr}$$

$$S = 270\ ph/cm^2/sec \times 2/3 \times A$$

$$A = \pi R^2 = \pi \times (1.5)^2\ ft^2 \times \frac{(12\ in)^2}{ft^2} \times \frac{(2.54\ cm)^2}{in^2}$$

$$A = 6.57 \times 10^3\ cm^2$$

$$S = 2.70 \times 10^2\ \frac{ph}{cm^2\ sec} \times \frac{2}{3} \times 6.57 \times 10^3\ cm^2 \times \frac{dis}{2ph} \times \frac{mci\ of\ ^{60}Co}{3.7 \times 10^7 dis/sec}$$

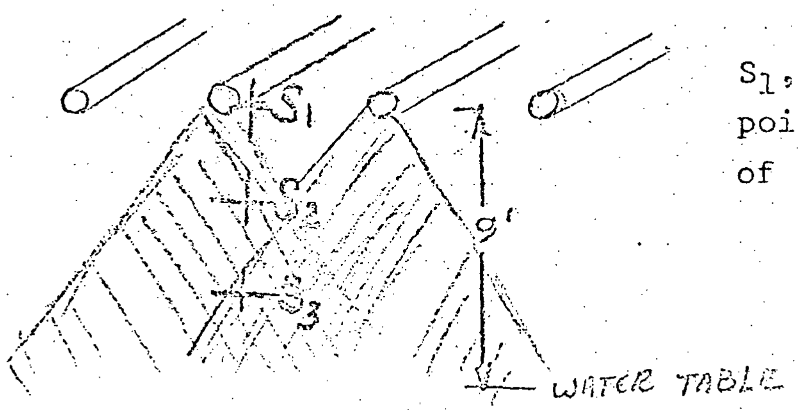
$$S = 1.60 \times 10^{-2}\ mci,\ ^{60}Co$$

I	A
^{60}Co	1.60×10^{-2} mci
^{137}Cs	2.15×10^{-3} mci
^{90}Sr	1.23×10^{-3} mci

Estimate of Radioactivity in Leaching Field

Additional samples were taken in the two (2) leaching fields in order to determine their radiological status. The two (2) leaching fields are about twenty-five (25) feet wide and sixty (60) feet long. The tiles are one (1) foot below ground level and water table is about ten (10) feet below ground level.

Assume that dispersion of water from the tiles is in the pattern shown in the diagram below:



S_1, S_4 and S_7 are sample point locations at depths of 1 ft, 4 ft and 7 ft.

Soil samples were taken at the distribution box and far ends of each leaching field at depths of one (1), four (4) and seven (7) feet. A water sample was also collected at the water table.

The water was analyzed and was determined to be less than or equal to 1.5×10^{-7} μci/ml counted as equivalent to Strontium-90 and gamma isotopes by an independent laboratory. Table 1 contains results of soil contamination:

Table 1

Leaching Field Soil Analysis

Identification	Depth (ft)	A (pci/gm)			
		Co^{60}	Cs^{134}	Cs^{137}	Sr^{90}
South Field Distribution box end	1	2.24×10^{-1}	3×10^{-2}	2.36×10^{-1}	<0.08
	4	9.53×10^{-2}	1.22×10^{-1}	9.78×10^{-1}	<0.08
	7	2.76×10^{-1}	1.16×10^{-1}	3.76×10^{0}	0.22
South Field Far End	1	3.79×10^{-1}	1.97×10^{-1}	2.28×10^{0}	<0.08
	4	3×10^{-2}	4×10^{-2}	4×10^{-2}	<0.08
	7	2×10^{-2}	3×10^{-2}	4.06×10^{-2}	<0.08
North Field Distribution box end	1	7.59×10^{-2}	3×10^{-2}	4.56×10^{-1}	<0.08
	4	2×10^{-2}	3×10^{-2}	3.63×10^{-1}	<0.08
	7	4.27×10^{-2}	3×10^{-2}	4.51×10^{-1}	<0.08
North Field Far End	1	5.34×10^{-2}	3×10^{-2}	1.97×10^{0}	<0.08
	4	2×10^{-2}	3×10^{-2}	1.29×10^{-1}	<0.1
	7	6.76×10^{-2}	3×10^{-2}	1.18×10^{0}	<0.1
Average	NA	1.09×10^{-1}	4.46×10^{-2}	9.91×10^{-1}	9.5×10^{-2}

The estimated contaminated volume is calculated below:

$$V = [(W + D)\ (L + D)\ (D)] \times 2$$
$$V = 34' \times 69' \times 9' \times 2 = 4.22 \times 10^{4}\ ft^{3}$$
$$\rho = 5.1 \times 10^{4}\ gm/ft^{3}$$
$$M = V \cdot P$$
$$M = 4.22 \times 10^{4}\ ft^{3} \times 5.1 \times 10^{4}\ gm/ft^{3} = 2.15 \times 10^{9}\ gm$$

High Level Lab Counting Room

This contamination occurred through cross-contamination. That is, the leakage entered the earth via the vall penetration through the footing from the South Corridor leaks.

It is reasonable to expect the same ratio of activity to be present in this excavation as that in the South Corridor.

The concentration at the 8 foot depth is about:

^{60}Co	3.47×10^{-4}	$\mu ci/cm^3$
^{137}Cs	7.12×10^{-4}	$\mu ci/cm^3$

The contamination followed the wall footing down probably to 15 feet and appears to be within 2 feet of the foundation. The dimensions of this contaminated volume is:

L	-	4' along wall
W	-	2' out from wall
D	-	7' present depth 8' to 15'

$V = 4' \times 2' \times 7' = 56\ ft^3$ or $1.59 \times 10^6\ cm^3$

$A = 3.47 \times 10^{-4}\ \mu ci/cm^3 \times 1.59 \times 10^6\ cm^3$

$A = 552\ \mu ci$ or 0.552 mci, ^{60}Co

$A = 7.12 \times 10^{-4}\ \mu ci/cm^3 \times 1.59 \times 10^6$

$A = 1132\ \mu ci$ or 1.132 mci, ^{137}Cs

Other isotopes will be minor.

^{60}Co	0.552 mci
^{137}Cs	1.132 mci

Estimated Quantity of Activity Remaining in the South Corridor

Results of soil samples taken in the excavation were mathematically averaged from a depth of twelve (12) feet to a depth of eighteen (18) feet directly below the area in which the "B Waste" system had failed. These averages are contained in the following table.

Average concentrations in earth from twelve (12) feet to eighteen (18) feet within four (4) feet of the clean out in the south corridor excavation.

Isotope	*A, Concentration (pci/gm)
^{54}Mn	4.57
^{60}Co	28.4
^{134}Cs	2.51
^{137}Cs	106.2
^{65}Zn	1.33
^{90}Sr	2.30

The volume estimated to be contaminated at concentrations listed in the above table is sixteen (16) feet length by six (6) feet width by six (6) feet depth.

$$V = 16' \times 6' \times 6' \text{ or } 576 \text{ ft}^3$$

With a soil density of 5.1×10^4 gm/ft^3, the resulting activity remaining is contained in the following table.

Estimated activity in south corridor.

Isotope	A (mci)
^{54}Mn	0.13
^{60}Co	0.84
^{134}Cs	0.07
^{137}Cs	3.12
^{65}Zn	0.04
^{90}Sr	0.07

*Data on Page 224 - 230 is 4 feet from cleanout. Reported sample concentrations are averages of 10-18 samplings for each of 3 sample locations; 1) 4 feet North of Cleanout, 2) 4 feet South of Cleanout and 3) Center of Cleanout.

pathways. Because of the current commercial value of the IRL facility, it is extremely unlikely that early intrusion into the contaminated soil will occur, probably not within the next 10 to 20 years. The photon dose rate will decrease to about 50% and 30% of its current value at the end of these times respectively. At the end of about 50 years the maximum surface exposure rate observed in the excavation will have decreased to 8.2×10^{-2} mR/h (i.e., 718 m rem/y). The average exposure rate within the excavated hole shown in Ref. 8 will have decreased to about 0.01mR/h. These considerations clearly demonstrate that no potential external radiation dose pathway is likely to cause the exposure of any individual in excess of 0.5 rem to the whole body in any one year provided that intrusion may be assumed to be delayed by 50 years. Since the contaminated soil will be buried under 10 to 12 feet of uncontaminated soil and a concrete floor and located under a building of considerable commercial value, intrusion will be extremely unlikely during this time frame. Since continuous exposure at the surface of maximum contamination is unlikely under any circumstance, it need not be assumed that intrusion is delayed at all. Such considerations are included in the pathway analyses requested by the NRC.

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Use of Contaminated Soil as Building Material

The contamination remaining in the South Corridor excavation is fixed to soil comprised primarily of sand and smaller amounts of clay; it would not be considered as building material. Certainly, it is inconceivable that any one would purposely dig 10 feet below the surface of the earth to obtain this material. If surrounding materials in the area of the IRL facility (e.g., gravel or sand) were to be used as building materials in the future, slight contamination would be possible. Such building materials would not be expected to contain more than 1% by weight of contaminated soil. The NRC dose pathway, however, suggests the use of the contaminated soil directly as building material. The most likely use of the contaminated soil would be as sand in concrete or concrete blocks. Normal concrete[(5)] contains 1 part cement, 2 parts sand, and 4 parts stone so that to a first approximation the current contamination would be diluted by the factor 2/7 or 0.286. Close to energy spatial equilibrium would be achieved at the surface of concrete