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Results of the Independent Radiological Verification Survey of Remediation at Building 14, Former Linde Uranium Refinery, Tonawanda, New York (LI001V)

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ABSTRACT

As part of the Formerly Utilized Sites Remedial Action Program, a team from Oak Ridge National Laboratory (ORNL) conducted a radiological verification survey of Building 14 at the former Linde Uranium Refinery, Tonawanda, New York. The purpose of the survey was to verify that remedial action completed by the project management contractor had reduced contamination levels to within authorized limits. Prior to remediation, fixed and removable beta-gamma emitting material was prevalent throughout Building 14 and in some of the process piping. Decontamination consisted of removal of surface contamination from floors, floor-wall interfaces, walls, wall-ceiling interfaces, and overhead areas; decontamination or removal of process piping; excavation and removal of subsurface soil; and vacuuming of dust. This independent radiological assessment was performed to verify that the remedial action had reduced contamination levels to within authorized limits.

Building 14 at the former Linde site in Tonawanda, New York, was thoroughly investigated inside for radionuclide residues. Surface residual activity levels were generally well below applicable guidelines for protection against radiation. Similarly, removable alpha and beta-gamma activity levels were below guidelines. Gamma exposure rates within the building were at typical background levels, and no elevated indoor radon concentrations were measured.

However, numerous areas exceeding U.S. Department of Energy (DOE) applicable guidelines still remain inside and underneath the building. These areas were either (1) inaccessible or (2) removal was not cost-effective or (3) removal would affect the structural integrity of the building. These above-guideline areas have been listed, described, and characterized by the remediation subcontractor (Appendix A), and dose to an exposed worker during typical exposure scenarios has been calculated. Based on the remediation subcontractor's characterization data[1] and dose assessment calculations, these areas pose insignificant risk to building inhabitants under current use scenarios. However, future renovations, repairs, or demolition of the building must require prior evaluation and consideration of the areas.

Analysis of the project management contractor's post-remedial action data and results of this independent radiological verification survey by ORNL confirm that residual contamination inside the building is either below the limits prescribed by DOE applicable guidelines for protection against radiation or areas exceeding applicable guidelines have been characterized and a risk assessment completed. Building 14 can be released for unrestricted use under current use scenarios; however, arrangements must be made to inform current and future building owners of the locations of areas exceeding DOE guidelines and any associated restrictions concerning renovations, repairs, or demolition of the building.

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[1]Radiological verification activities in these above-guideline areas were designated as outside the scope of the independent verification survey. No radiological survey activities were conducted in these areas by ORNL.

Results of the Independent Radiological Verification Survey of the Remediation at Building 14, Former Linde Uranium Refinery, Tonawanda, New York (LI001V)[1]

INTRODUCTION

From 1942 through approximately 1948, the Linde Air Products Division of Union Carbide Corporation, Tonawanda, New York, was one of many companies performing work associated with the development of nuclear energy for defense-related projects. This work was conducted under government contract to the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC). During the first 3 years, pitchblende ore from the Belgian Congo and concentrates from the Colorado Plateau ore were converted to U_3O_8. A second process yielding UO_2 was conducted for about a year, and a third process, converting UO_2 to green salt (UF_4), operated during World War II and the following 2 years. Linde also developed and produced barrier material for the Oak Ridge Gaseous Diffusion Plant. Other contracts have been identified, but the exact nature of the work involved is unknown (DOE 1980).

As a result of these and similar activities, equipment, buildings, and land at some of the sites became radiologically contaminated resulting in low levels of contamination on the properties. At contract termination, sites used by contractors were decontaminated in accordance with the standards and survey methods in use at that time. Since the original assessments, radiological criteria and guidelines for the release of such sites for unrestricted use have become more stringent. In some instances, records documenting decontamination efforts could not be found, and the final radiological conditions of the site could not be adequately determined. As a result, the Formerly Utilized Sites Remedial Action Program (FUSRAP) was established in 1974 to identify these formerly used sites and to reevaluate their radiological status (DOE 1980). The radiological survey detailed in this report was performed under the FUSRAP program.

The Linde site was investigated in October and November 1976 to determine the extent of on-site radiological contamination (DOE 1978). At that time, the investigation included direct measurements of alpha contamination and beta-gamma dose rates on floors, walls, ceilings, supports, and roof; collection of smear samples in the same locations to assess transferable contamination; measurement of external gamma levels; radiological analysis of exterior soil samples; and measurement of instantaneous radon concentrations. Because contamination in some areas was above limits set by then current federal guidelines for release of property for unrestricted use, the property was designated for remediation under FUSRAP (DOE 1978).

A remedial investigation/feasibility study–environmental impact statement process was conducted to obtain sufficient site-specific information for assessment of the nature and extent of contamination at the Tonawanda site and evaluation of remedial action alternatives (DOE 1993). This process included performing a characterization and identifying areas requiring additional investigation. Survey results at Building 14 indicated that most of the first floor contained fixed residual radioactivity

[1]The survey was performed by members of the Measurement Applications and Development Group of the Life Sciences Division at Oak Ridge National Laboratory.

exceeding U.S. Department of Energy (DOE) guidelines[1] with fixed-point beta-gamma measurements ranging from <720 to 280,000 dpm/100 cm^2. Dust from the basement stairwell contained 590 pCi/g ^{238}U. The second floor appeared to be free of contamination. Based on these results, Building 14 was scheduled for further investigation and remedial action.

In 1996, Bechtel National, Inc. (BNI), the project management contractor designated by the DOE, began remediation activities at Building 14. After significant effort by BNI, remediation activities were turned over to IDM Environmental Corporation, a turnkey remediation subcontractor under the supervision of BNI. When remediation in an area of the building was completed, an independent verification survey of the remediated area was conducted by the Measurement Applications and Development Group of ORNL. Under DOE, an independent verification contractor (IVC) was assigned to ensure the effectiveness of remedial activities performed within FUSRAP and to confirm compliance with applicable guidelines.

This report describes the independent radiological verification activities conducted intermittently by ORNL from March 1996 through January 1999 in connection with Building 14.The objectives of the verification activities were to confirm (1) that available documentation adequately and accurately described the post-remedial action status of the property that was to be verified, and (2) that remedial action reduced contamination levels to within authorized limits. Figure 1 shows the general location of the former Linde property in relation to other sites in Tonawanda. Figure 2 shows the location of Building 14 at the Linde site, and Fig. 3 show the basic floor plan of the building.

SCOPE OF THE INVESTIGATION

The radiological verification investigation included the following:

- Floor monitor[2] surveys of all smooth floor areas with further characterization of any suspect contamination with hand-held beta-gamma detectors.
- Beta-gamma scans of the building interior floor areas not appropriate for the floor monitor,[1] interior floor-wall interfaces, and interior walls up to ~10 ft.
- Beta-gamma scans of the horizontal surfaces associated with interior overhead areas, including I-beams, cross ties, ledges, and wall-ceiling interfaces where contamination would most likely be concentrated.
- Spot checks for contamination in additions and newly remodeled areas of the building.
- Measurement of transferable alpha and beta-gamma radiation levels at selected locations in the building.
- Collection and radiological analysis of soil samples from subsurface areas exposed after removal of the concrete floor and/or excavation of contaminated soil or after drilling through the concrete slab.
- Measurement of gamma exposure rates at 1 m above the surface, at the surface, and at depths of 6 and 12 in. at soil sample locations.
- Systematic measurements using thin window NaI detectors (FIDLER) at 2-m intervals in Areas 8, 10, and 11 and at 1-m intervals in Areas 20B and 20B-1.

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[1]DOE guidelines for total residual surface contamination in any one square meter for beta-gamma emitters: 5000 dpm/100 cm^2 averaged over 1 m^2 and 15,000 dpm/100 cm^2 maximum. (More details are given in Table 1.)

[2]"Floor monitor" described in Survey Methods section.

- Measurement of indoor radon levels in several areas of the building using electret radon monitors.
- Examination of post-remedial action data collected by BNI and IDM Environmental Corporation and review of the post-remedial action report (BNI 1999).

A radiological survey of the building exterior and exterior surface soil and grounds in the vicinity of Building 14 was not within the scope of this investigation.

SURVEY METHODS

A comprehensive description of the survey methods and instrumentation used in this survey is given in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (Myrick et al. 1987) and *Measurement Applications and Development Group Guidelines*, ORNL-6782 (ORNL 1995).

Bicron miniscaler/ratemeters with Geiger-Mueller (GM) pancake detectors were used to measure beta-gamma radiation levels. Radiation levels in counts per minute (cpm) were converted to disintegrations per minute (dpm) per 100 cm^2. Gamma radiation levels were determined using portable sodium iodide (NaI) gamma scintillation counters connected to Victoreen Model 490 Thyac III ratemeters. Because NaI gamma scintillators are energy dependent, measurements of gamma radiation levels in counts per minute were correlated to pressurized ionization chamber (PIC) measurements to determine gamma exposure rates in microroentgen per hour (μR/h) (Rodriguez et al. 1992).

Electret radon monitors manufactured by Rad Elec Inc. were used to measure radon concentrations in indoor air. The electret ion chamber contains an electrically charged Teflon™ disk that attracts ions produced by the decay of radon and its decay products. The attracted ions cause a reduction in the electret's surface voltage. When the electret charge is measured before and after deployment, the change in total charge over the elapsed time period is proportional to the cumulative radon exposure. (Only the radon present in the room air, and not the radon progeny, can enter the electret chamber. The subsequent decay of the radon and the progeny resulting inside the chamber produces the measured ionization.)

Bicron Model GJ FIDLER detectors connected to Ludlum 2221 scaler/ratemeters were used to measure the relative gamma fluence at the surface with the purpose of detecting gamma emitting radionuclide contamination beneath poured concrete floors. The FIDLER is a NaI(Tl) scintillation probe that is designed to be particularly sensitive to low-energy gamma and x-ray radiation. The sensitive volume is 5 in. in diameter by 0.063 in. thick and is very efficient at measuring gamma fluence rates entering perpendicular to the entrance window. The FIDLER is also sensitive to beta radiation and can be highly efficient for detecting this depending on the configuration used.

FIDLER measurements were not used for final verification purposes, but, rather, as a tool for further evaluation. FIDLER measurements were taken to assist IDM Environmental Corporation in selecting subsurface soil sampling locations. Measurements in counts per minute were taken with two different instruments. Because the results were not normalized, the observed values were compared only with other measurements taken with the same instrument.

Fifty-two systematic soil samples were collected at 49 locations after removal of the concrete slab and excavation of subsurface soil or after core drilling through concrete. Eighteen biased samples were collected at 17 locations. Systematic samples are taken from preselected or random grid locations irrespective of surface gamma exposure rates. Biased samples are collected at locations with slightly higher surface gamma exposure rates relative to surrounding areas. Concentrations of ^{238}U, ^{226}Ra, and

^{232}Th were determined in soil samples using gamma spectrometry with high-purity germanium (HPGe) systems.

Smooth floor areas of the building were surveyed with the Ludlum Model 239-1F gas flow proportional detector system ("floor monitor"), which includes a Ludlum Model 2221 scaler/ratemeter connected to a Ludlum Model 43-37 detector probe mounted on a roll-around cart. The monitor was set in the beta mode (high voltage setting) where it is primarily used to detect beta radiation, although it is also sensitive to alpha and gamma in this mode. Anomalies detected with the floor monitor were further characterized with the GM pancake detector. Questionable spots with elevated radiation levels were sometimes analyzed on-site using a portable NaI gamma spectroscopy system. Gamma spectra were observed and compared to spectra of the radionuclides of concern.

Smear samples were obtained by wiping selected surfaces inside the building in order to assess removable alpha and beta-gamma activity levels. Samples were counted using a gross alpha smear counter and a gross beta smear counter.

A scissor lift and a man lift were used to access high overhead areas inside the building such as I-beams, cross ties, and ceiling-wall interfaces.

VERIFICATION SURVEY RESULTS

Applicable guidelines for protection against radiation are summarized in Table 1. Typical background radiation levels for the Tonawanda, New York, area are presented in Table 2. These data are provided for comparison with survey results presented in this section. Gamma radiation levels are presented in gross microroentgens per hour and FIDLER measurements in gross counts per minute. Similarly, background concentrations have not been subtracted from radionuclide concentrations in soil. Background count rates are subtracted in the conversion of alpha and beta-gamma count rates to disintegrations per minute per 100 cm^2 (dpm/100 cm^2).

In some instances, removal of the contamination or the contaminated structure would have affected the structural integrity of the building. In others, the contamination was inaccessible or removing it was not cost-effective. Therefore, the remediation subcontractor has listed, described, and characterized these areas in a "Summary of Locations Exceeding Remedial Action Criteria" (BNI 1999), provided in Appendix A. (Figure 5-1 of BNI 1999, which is not included in this report, shows more precisely the locations of these areas.) Independent verification surveys confirmed that the areas were above applicable guidelines and that the list was complete. Characterization data collected by the remediation subcontractor and subsequent dose assessment calculations for areas exceeding remedial action criteria were reviewed by the IVC but not verified.

PROCESS PIPING RADIOLOGICAL INVESTIGATION

Process lines throughout Building 14 were evaluated and characterized for radioactive contamination by the remediation subcontractor. The methods and procedures used to conduct this evaluation and characterization were discussed with and agreed upon by the IVC. The IVC also concurred with the findings of this investigation. The first section and Attachment 1 of *Summary Report for the Process Piping Radiological Investigation Praxiar Building 14* are provided in Appendix. B. [Additional attachments to this report (numbered 2–6) are not included in Appendix B.]

GAMMA RADIATION LEVELS

Gamma exposure rates in areas where the concrete floor had been removed and the exposed soil was being sampled are shown in Table 3. Gamma exposure rates in Building 14 generally ranged from 10 to 14 μR/h at 1 m above the soil surface and from 9 to 14 μR/h at the surface (Table 3). These levels are similar to typical background levels in the Tonawanda, New York, area (Table 2). Higher surface levels up to 18 μR/h were measured in exposed soil with elevated ^{238}U. Further excavation was conducted to remove additional soil when ^{238}U concentrations above guidelines were measured.

FIDLER MEASUREMENTS

Results of FIDLER measurements in Areas 8, 10, 11, 21B, and 20B-1 are shown in Appendix C. Measurements from each detector were compared with other measurements from the same detector to locate possible subsurface contamination and potential sampling locations for IDM.

SOIL SAMPLES

Soil sample locations are shown in Fig. 4, and results of radiological analyses are listed in Table 4. Concentrations of ^{238}U in surface soil (0–15 cm) ranged from 0.50 to 5.5 pCi/g at 41 sample locations and from 8.1 to 670 pCi/g at 25 locations; subsurface soil (15–30 cm) ranged from 44 to 195 pCi/g at four sample locations. Fourteen samples were above guideline values of 30 pCi/g for ^{238}U at this site. Further excavation of soil was conducted to remove uranium-contaminated soil in Areas 12, 13, 14A, and 20A after these soil samples were analyzed. Results from additional samples collected and analyzed by IDM were verified.

All accessible soil above guideline values was removed. In several areas, removing the soil would compromise the structural integrity of the building. In these cases, the areas were described, characterized, and listed by the remediation subcontractor (BNI 1999) in the "Summary of Locations Exceeding Remedial Action Criteria" (provided in Appendix A). Included in the list are soil underneath Area 12 west, east, and south walls; soil underneath Area 14N north wall and west wall; and soil underneath Area 14S west wall.

Concentrations of ^{226}Ra and ^{232}Th at soil sample locations (Table 4) ranged from 0.50 to 2.0 pCi/g and from 0.26 to 1.3 pCi/g, respectively, in 70 samples from 66 locations. These levels are similar to typical background levels of ^{226}Ra and ^{232}Th found in the Tonawanda area (Table 2).

SMEAR SAMPLE ANALYSIS

Results of smear sample analysis are given in Table 5. No removable (transferable) alpha or beta-gamma emitting material was measured in 21 smear samples collected in 5 different areas of Building 14. All samples were less than the minimum detectable activity (MDA) of the smear counters. Removable radioactivity levels were well below applicable guidelines (Table 1).

BETA-GAMMA ACTIVITY LEVELS

Results of the surface beta-gamma scans of the floors, walls, and overhead areas on both the first and the second floor are summarized in Table 6. Detailed survey drawings are on file. Table 6 also notes other verification activities conducted in each area (e.g., collection of soil samples or smear samples, results of gamma scans, review of data collected by the remediation subcontractor, etc.). The last column of Table 6 references correspondence (included in Appendix D) releasing the area as below

the applicable guideline limits listed in Table 1. Total residual surface contamination limits for uranium in any one square meter (Table 1) are maximum 15,000 dpm/100 cm^2, average 5000 dpm/100 cm^2, and removable 1000 dpm/100 cm^2. Therefore, an area with scan results ranging from 3400 to 6400 dpm/100 cm^2, is below guidelines if the average measurement is $\leq$5000 dpm/100cm^2 in any one square meter. Areas exceeding applicable guideline limits required further remediation.

As indicated by the survey results listed in Table 6, all areas not designated for inclusion in the "Summary of Locations Exceeding Remedial Action Criteria" (Appendix A) were below guideline limits on the date they were released by the verification contractor.

INDOOR RADON LEVELS

Twenty electret radon monitors were deployed for periods of 18 to 33 days at 17 locations between May, 28, 1998, and September 29, 1998. Sampling results are shown in Fig. 5 and Table 7. Radon concentrations in indoor air at Building 14 ranged from 0.4 to 1.6 pCi/L. All measurements were well below the EPA action level of 4 pCi/L.

SIGNIFICANCE OF FINDINGS

Prior to remediation, fixed and removable beta-gamma emitting material was prevalent throughout most of Building 14 and in some of the process piping. Decontamination, performed by BNI and subcontractors under the direction of BNI, consisted of removal of surface contamination from floors, floor-wall interfaces, walls, wall-ceiling interfaces, and overhead areas; decontamination or removal of process piping; excavation and removal of subsurface soil; and vacuuming of dust. This independent radiological verification survey was performed to verify that the remedial action had reduced contamination levels to within authorized limits.

Building 14 at the former Linde site in Tonawanda, New York, was thoroughly investigated inside for radionuclide residues. Surface residual activity levels were generally well below applicable guidelines for protection against radiation. Similarly, removable alpha and beta-gamma activity levels were below guidelines. Gamma exposure rates within the building were at typical background levels, and no elevated indoor radon concentrations were measured.

However, numerous areas exceeding DOE applicable guidelines still remain inside and underneath the building. These areas were either (1) inaccessible or (2) removal was not cost-effective or (3) removal would affect the structural integrity of the building. These above-guideline areas have been listed, described, and characterized by the remediation subcontractor (Appendix A), and dose to an exposed worker during typical exposure scenarios has been calculated. Based on the remediation subcontractor's characterization data[1] and dose assessment calculations, these areas pose insignificant risk to building inhabitants under current use scenarios. However, future renovations, repairs, or demolition of the building must require prior evaluation and consideration of the areas.

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[1]Radiological verification activities in these above-guideline areas (see Appendix A) were designated as outside the scope of the independent verification survey. No radiological survey activities were conducted in these areas by ORNL.

Analysis of the project management contractor's post-remedial action data (BNI 1999) and results of this independent radiological verification survey by ORNL confirm that residual contamination inside the building is either below the limits prescribed by DOE applicable guidelines for protection against radiation or areas exceeding applicable guidelines have been characterized and a risk assessment completed. Building 14 can be released for unrestricted use under current use scenarios; however, arrangements must be made to inform current and future building owners of the locations of areas exceeding DOE guidelines and any associated restrictions concerning renovations, repairs, or demolition of the building.

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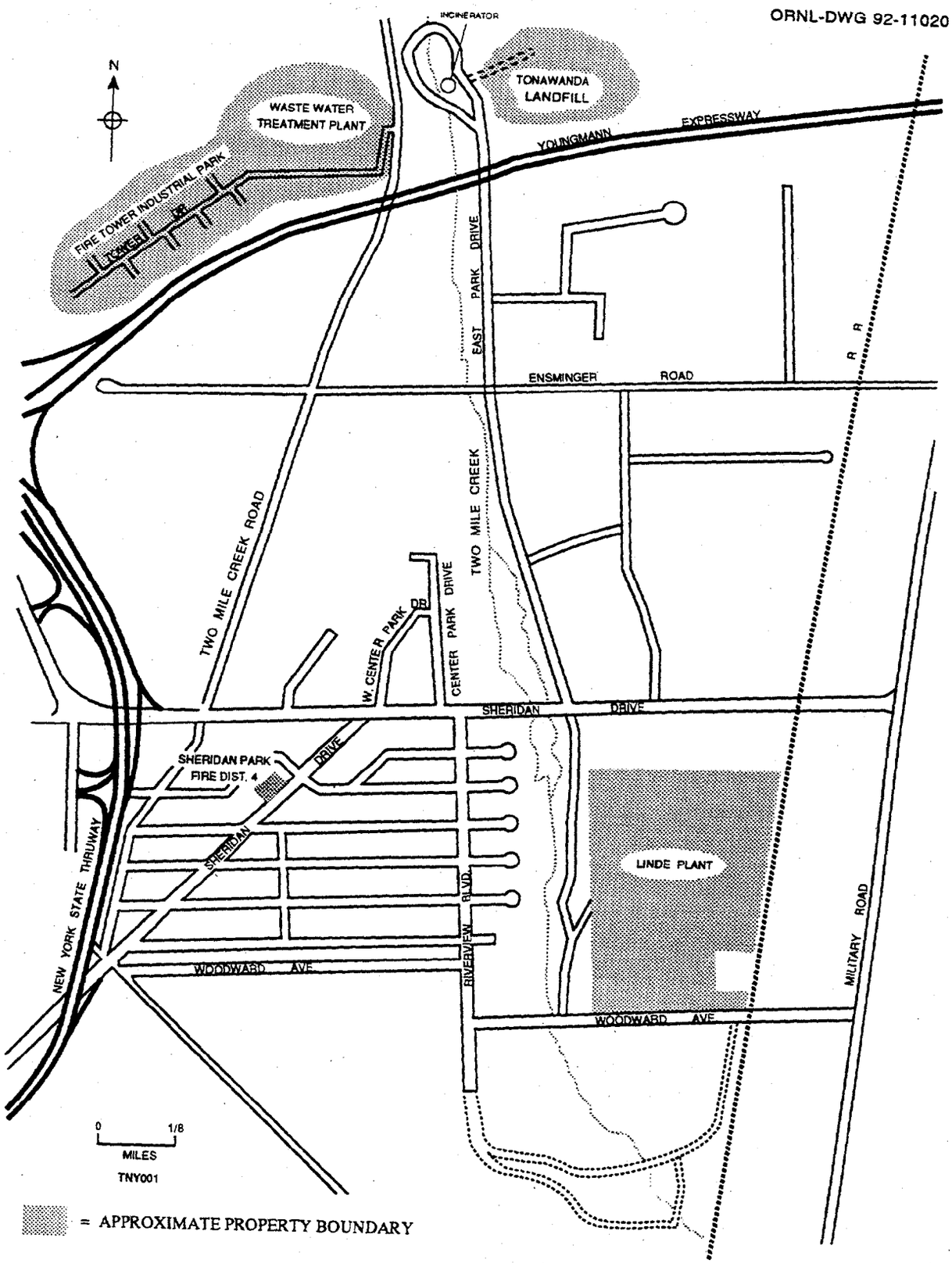

Fig. 1. Diagram showing general location of the former Linde site in Tonawanda, New York.

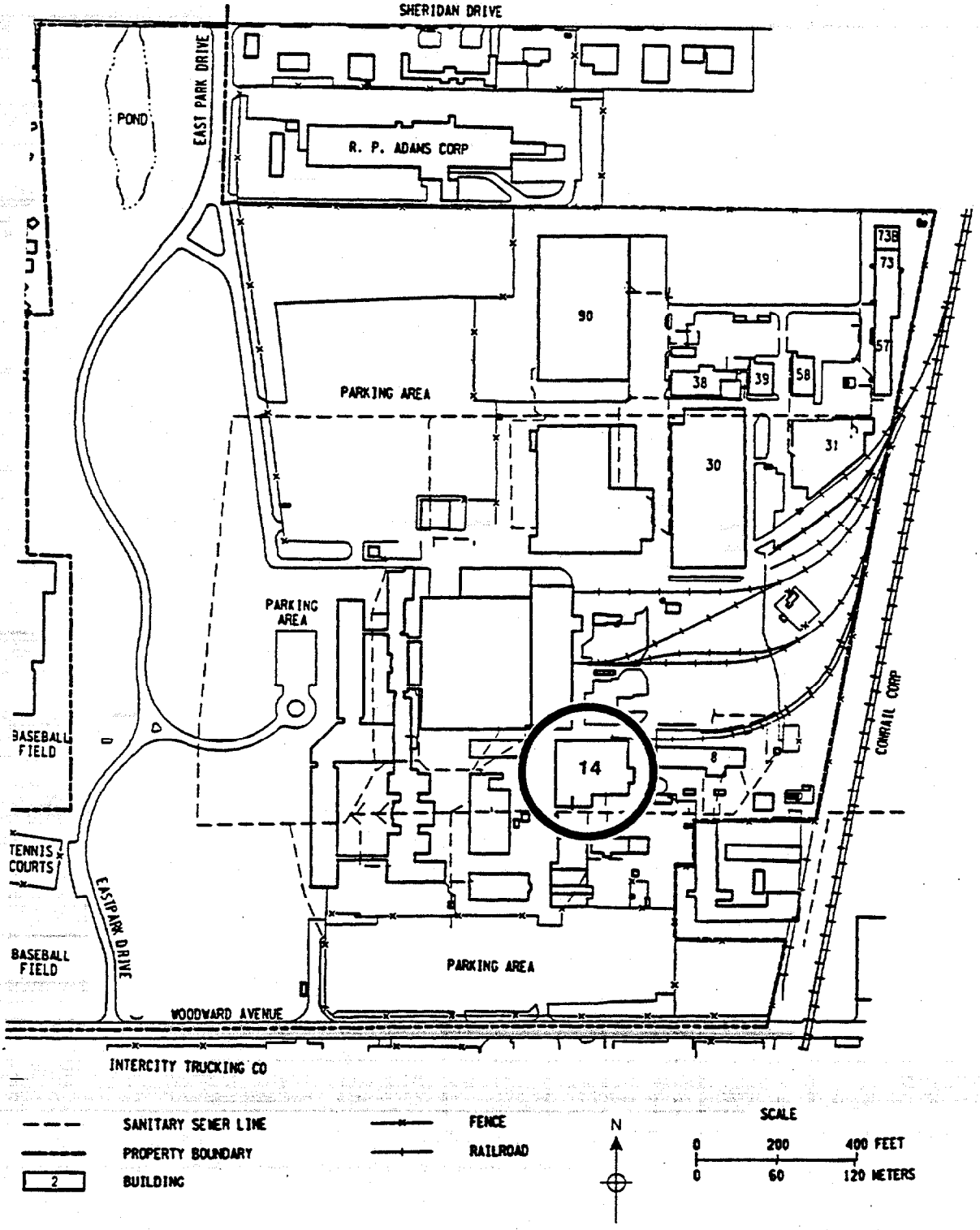

Fig. 2. Diagram showing general location of Building 14, at the former Linde site, Tonawanda, New York.

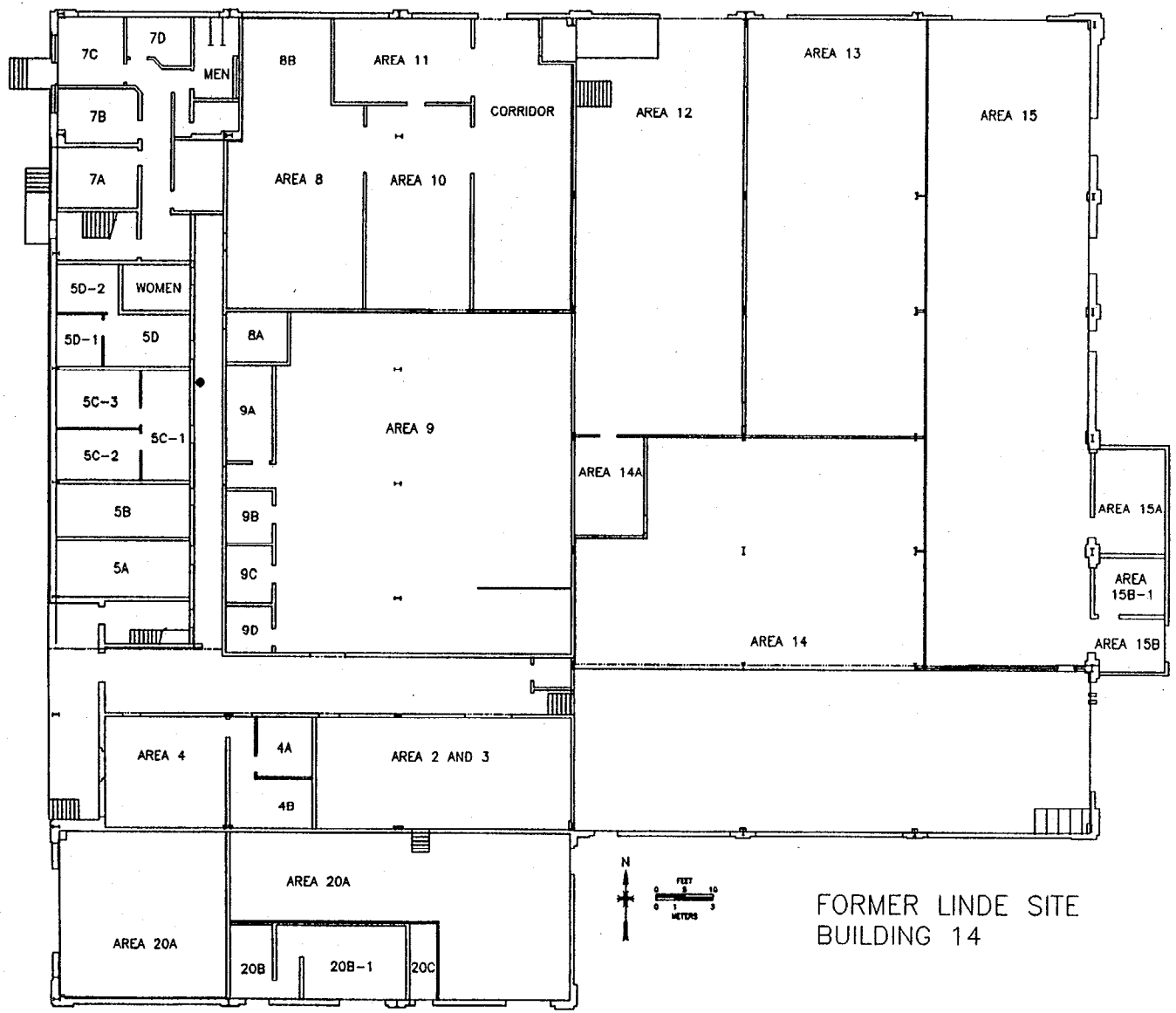

Fig. 3. Diagram showing general layout of the first floor at Building 14.

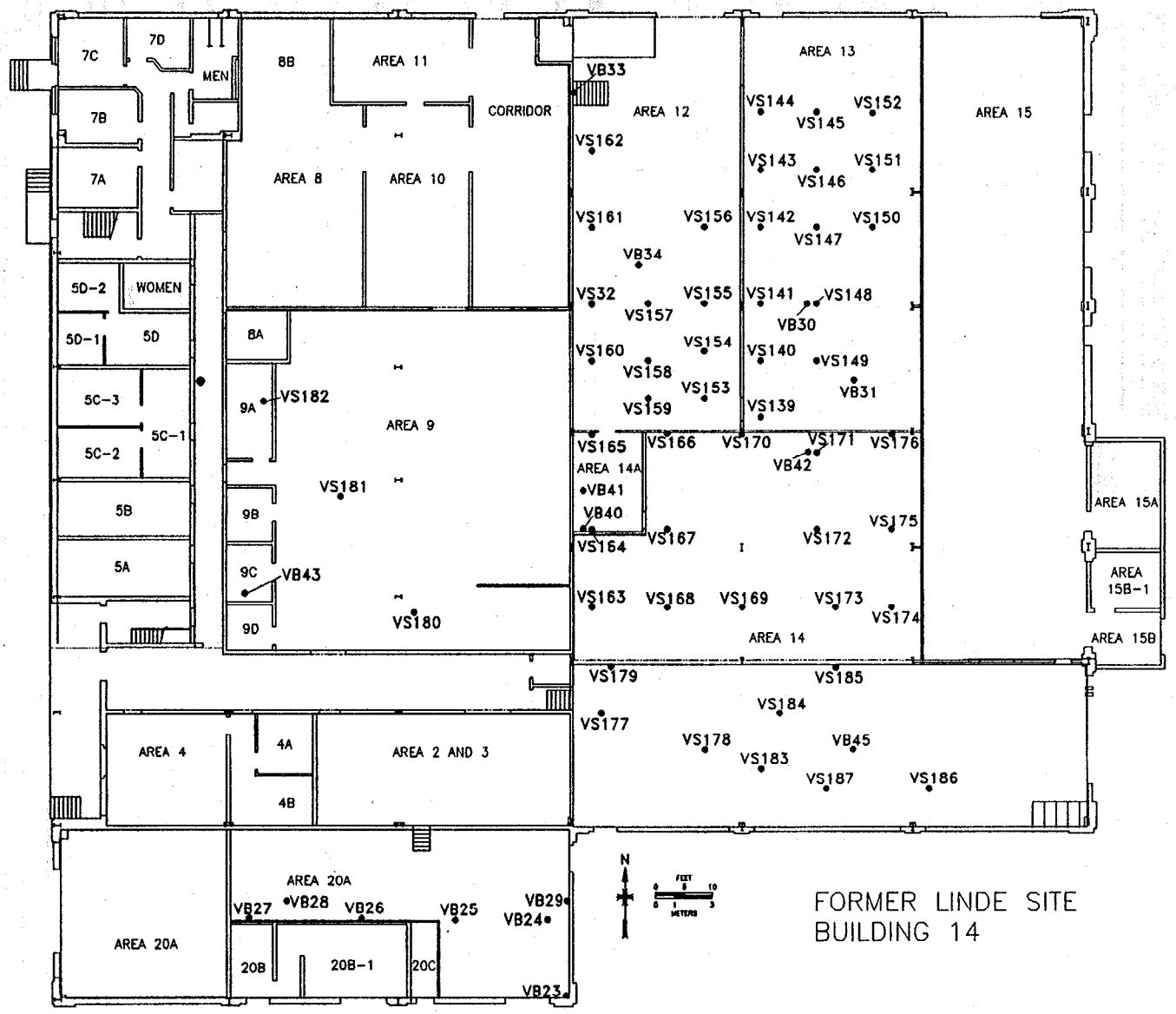

Fig. 4. Diagram showing soil sampling locations at Building 14.

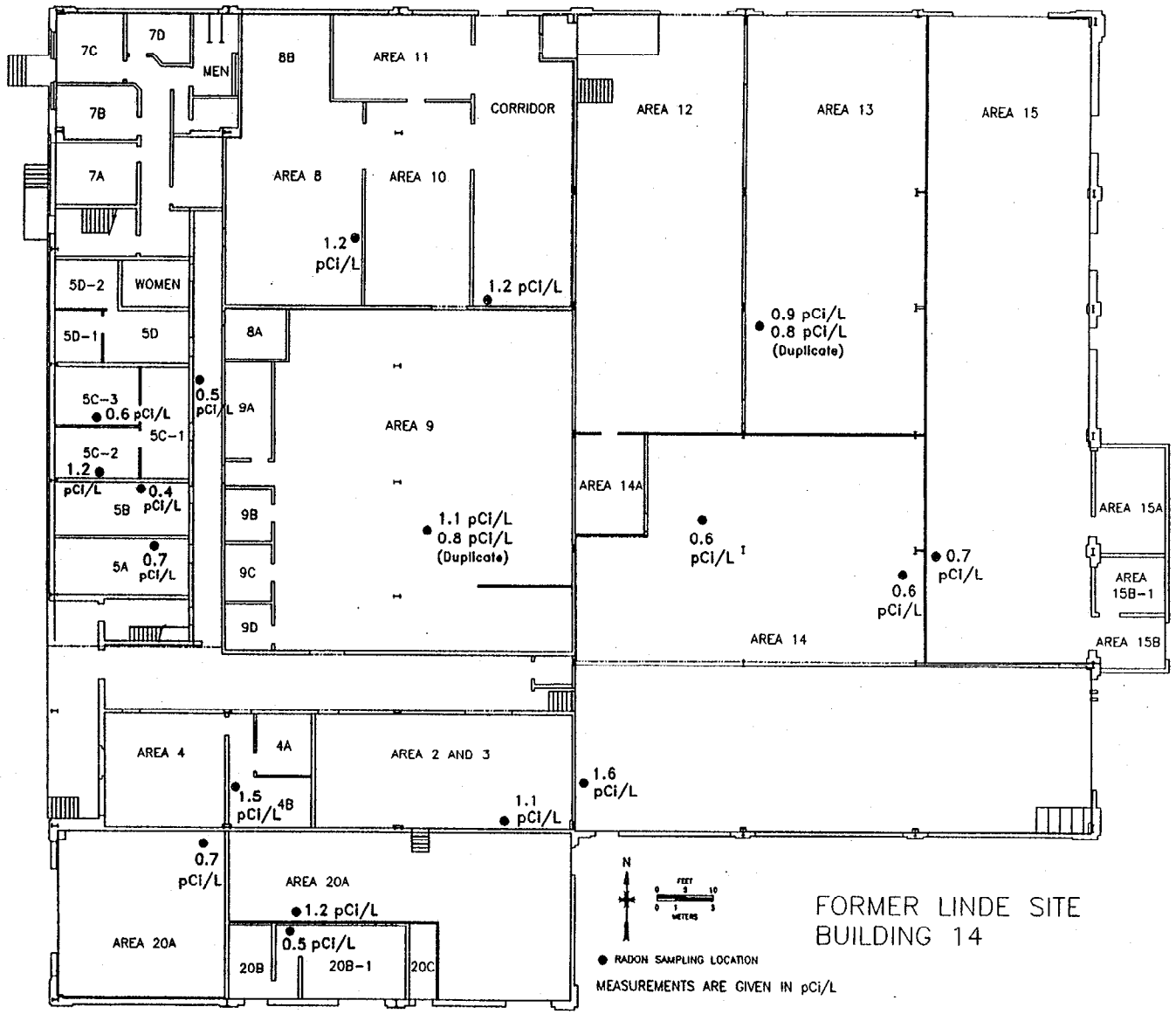

Fig. 5. Diagram showing results of radon measurements at Building 14.

Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
	Indoor gamma	
Gamma radiation	Indoor gamma radiation level (above background)	20 μR/h[a]
	Surface contamination	
Total residual surface contamination in any one square meter [b]	^{238}U, ^{235}U, U-natural (alpha emitters)	
	or	
	Beta-gamma emitters[c]	
	Maximum	15,000 dpm/100 cm^2
	Average	5,000 dpm/100 cm^2
	Removable	1,000 dpm/100 cm^2
	^{232}Th, Th-natural (alpha emitters)	
	or	
	^{90}Sr (beta-gamma emitter)	
	Maximum	3,000 dpm/100 cm^2
	Average	1,000 dpm/100 cm^2
	Removable	200 dpm/100 cm^2
	^{226}Ra, ^{230}Th, transuranics	
	Maximum	300 dpm/100 cm^2
	Average	100 dpm/100 cm^2
	Removable	20 dpm/100 cm^2
	Radionuclides in soil	
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m^2 area	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm-thick soil layers more than 15 cm below the surface
	^{226}Ra	
	^{232}Th	
	^{230}Th	
Derived concentrations	Total uranium	60 pCi/g[d]

Table 1 (continued)

Mode of exposure	Exposure conditions	Guideline value
	Soil hot spot criteria	
Guideline for non-homogeneous contamination (used in addition to the 100-m^2 guideline)[e]	Applicable to locations with an area ≤25 m^2, with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{½}$, where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m^2 area

[a]The 20 μR/h shall comply with the basic dose limit (100 mrem/year) when an appropriate-use scenario is considered.

[b]These surface contamination guidelines are consistent with *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material*, May 1987.

[c]Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr, ^{228}Ra, ^{223}Ra, ^{227}Ac, ^{133}I, ^{129}I, ^{126}I, ^{125}I.

[d]Guidelines for uranium were derived by DOE on a site-specific basis. A total uranium guideline of 60 pCi/g will be applied at the former Linde site. This corresponds to a ^{238}U concentration of ~30 pCi/g.

[e]Guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area (adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987).

Sources: Adapted from U.S. Department of Energy, DOE Order 5400.5, April 1990; U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987; and U.S. Department of Energy, *Radiological Control Manual*, DOE/EH-0256T, April 1994.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil near Tonawanda, New York

Type of radiation measurement or sample	Radiation level or radionuclide concentration	
	Range	Average
Gamma exposure rate at ground surface (μR/h)[a]	8–11	9
Concentration of radionuclides in soil (pCi/g)[a]		
^{238}U	0.8–1.1	1.0
^{226}Ra	0.7–1.1	0.9
^{232}Th	0.5–0.9	0.8

[a]Values obtained from four locations in the Tonawanda area.

Source: R. E. Rodriguez, M. E. Murray, and M. S. Uziel. October 1992. *Results of the Radiological Survey at the Town of Tonawanda Landfill, Tonawanda, New York (TNY001)*, ORNL/RASA-92/12, Oak Ridge National Laboratory.

Table 3. Gamma exposure rates at soil sample locations, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Area	Grid Location[b]	Gamma exposure rate (μR/h)			Comments
			1 m above surface	Surface	depth of 6 in.	
			Systematic soil samples[c]			
VS139	13	F, 10	*d*	18	17	~3 ft below grade
VS140	13	I, 10	14	14	16	~3 ft below grade
VS141A	13	L, 10	14	18	20	~3 ft below grade
VS141B	13	L, 10	14	20[e]	19[f]	Refusal at depth of 11 in.
VS142A	13	P, 10	13	13	18	~2 ft below grade
VS142B	13	P, 10	13	18[e]	18[f]	Refusal at depth of 12 in.
VS143A	13	S, 10	13	14	18	~3 ft below grade
VS143B	13	S, 10	*d*	18[e]	18[f]	
VS144	13	V, 10	13	13	13	~3 ft below grade
VS145	13	V, 13	13	13	14	~2 ft below grade
VS146	13	S, 13	13	13	14	~2.5 ft below grade
VS147	13	P, 13	13	14	14	~3 ft below grade
VS148	13	L, 13	14	14	16	~3 ft below grade
VS149	13	I, 13	13	13	13	~3 ft below grade
VS150	13	P, 16	13	13	13	~2.5 ft below grade
VS151	13	S, 16	13	13	13	~2.5 ft below grade
VS152	13	V, 16	13	13	13	~2 ft below grade
VS153	12	G, 7	15	15	14	~3 ft below grade
VS154	12	I+0.5, 7	14	14	15	~3 ft below grade
VS155	12	L, 7	14	14	14	~3 ft below grade
VS156	12	P, 7	13	13	13	~3 ft below grade
VS157	12	L, 4	14	14	13	~3 ft below grade
VS158	12	I, 4	13	14	14	~3 ft below grade
VS159	12	G, 4	13	13	13	~3 ft below grade
VS160	12	I, 1	13	14	14	~3 ft below grade
VS161	12	P, 1	13	14	15	~3 ft below grade
VS162	12	T, 1	13	14	14	~3 ft below grade
VS163	14N	C, 1	13	13	13	~4.5 ft below grade
VS164	14N	G, 1	13	13	14	~4.5 ft below grade

Table 3 (continued)

Sample ID[a]	Area	Grid Location[b]	Gamma exposure rate (μR/h)			Comments
			1 m above surface	Surface	depth of 6 in.	
VS165	14A	L, 1	13	13	13	~4 ft below grade
VS166	14N	L, 5	13	13	13	~4 ft below grade
VS167	14N	G, 5	13	13	13	~4 ft below grade
VS168	14N	C, 5	13	13	14	~3 ft below grade
VS169	14N	C, 9	12	12	13	~2 ft below grade
VS170	14N	L, 9	13	13	13	~4 ft below grade
VS172	14N	G, 13	13	13	13	~3 ft below grade
VS173	14N	C, 14	11	13	13	~4 ft below grade
VS174	14N	C, 17	12	13	13	~2 ft below grade
VS175	14N	G, 17	13	13	13	~3 ft below grade
VS176	14N	L, 17	13	13	14	~2 ft below grade
VS 177	14S	F, 1.5	13	13	13	~4 ft below grade
VS178	14S	D, 7	12	12	*g*	~4 ft below grade, rocky, water at 6 in.
VS179	14S	I, 2	13	13	13	~3 ft below grade
VS180	9	B, 10	13	14	14	~18 in. below grade
VS181	9	H, 6	13	13	13	~18 in. below grade
VS182	9A	M, 2	13	13	10	
VS183	14S	C,10	12	13	13	~3 ft below grade
VS184	14S	F, 11	12	12	*d*	~2 ft below grade
VS185	14S	I, 14	10	9	*d*	~1 ft below grade
VS186	14S	B, 19	11	12	13	~2.5 ft below grade
VS187	14S	B, 13.5	12	12	13	~2.5 ft below grade
			Biased soil samples[f]			
VB23	20A	N (-4), E18	13	18	16	~Sample taken below 5-in. concrete slab
VB24	20A	N0, E17	12	13	13	~Sample taken below 12-in. concrete slab
VB25	20A	N0, E12	11	12	13	~Sample taken below 12-in. concrete slab
VB26	20A	N0, E7	11	13	12[h]	~Sample taken below 12-in. concrete slab

Table 3 (continued)

Sample ID[a]	Area	Grid Location[b]	Gamma exposure rate (μR/h)			Comments
			1 m above surface	Surface	depth of 6 in.	
VB27	20A	N0, E1	11	11	13[h]	~Sample taken below 12-in. concrete slab
VB28	20A	N1, E3	*d*	*d*	*d*	~2.5 ft below grade
VB29	20A	N1, E18	*d*	*d*	*d*	~2 ft below grade
VB30	13	L, 12.5	13	14	16	~3 ft. below grade
VB31	13	H, 15	13	14	16	~3 ft below grade
VB32	12	L, 1	14	18	18	~3 ft below grade
VB33A	12	W, 0	13	14	18	~4 ft below grade
VB33B	12	W, 0	13	18[e]	18[f]	
VB34	12	N, 3.5	13	14	14	~3 ft below grade
VB40	14A	G, 5	13	14	15	~4 ft below grade
VB41	14A	I, 5	13	14	14	~4 ft below grade
VB42	14N	K, 12.5	13	13	14	~2.5 ft below grade
VB43	9C	C, 1	13	23	20	
VB45	14SE	D, 15	*d*	13	13	~2 ft below grade; scraped into wall to depth of ~3 in.

[a]Sample locations are shown on Fig. 4.
[b]Grid locations in meters measured north and east of the southwest corner of the room (N0, E0). In most rooms the number of meters north is indicated by a letter (e.g., A=1 m, B=2 m, ...F=6 m, etc.) and the number of meters east by a number.
[c]Systematic samples were collected in a systematic manner without regard to gamma radiation levels.
[d]Not recorded.
[e]Depth of 6 in.
[f]Depth of ~12 in.
[g]Water at depth of 6 in.
[h]Depth of 3 in.
[i]Biased samples were collected at random and at points with slightly gamma radiation levels.

Table 4. Concentrations of radionuclides in soil samples, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Area	Grid Location[b]	Depth (cm)	Radionuclide concentration (pCi/g)[c]		
				^{238}U	^{226}Ra	^{232}Th
Systematic soil samples[d]						
VS139	13	F, 10	0-15	41 ± 2	1.0 ± 0.1	0.89 ± 0.14
VS140	13	I, 10	0-15	13 ± 1	0.89 ± 0.08	0.82 ± 0.13
VS141A	13	L, 10	0-15	53 ± 2	1.1 ± 0.1	0.99 ± 0.13
VS141B	13	L, 10	15-30	140 ± 10	1.1 ± 0.1	1.0 ± 0.1
VS142A	13	P, 10	0-15	20 ± 2	0.94 ± 0.08	0.95 ± 0.13
VS142B	13	P, 10	15-30	44 ± 2	0.95 ± 0.09	0.96 ± 0.13
VS143A	13	S, 10	0-15	20 ± 1	0.91 ± 0.08	1.0 ± 0.14
VS143B	13	S, 10	15-30	95 ± 2	0.94 ± 0.09	1.1 ± 0.15
VS144	13	V, 10	0-15	2.3 ± 0.4	0.86 ± 0.08	0.94 ± 0.13
VS145	13	V, 13	0-15	3.9 ± 0.5	0.94 ± 0.08	0.94 ± 0.13
VS146	13	S, 13	0-15	1.7 ± 0.3	0.84 ± 0.08	1.0 ± 0.1
VS147	13	P, 13	0-15	3.6 ± 0.5	0.92 ± 0.08	0.83 ± 0.13
VS148	13	L, 13	0-15	45 ± 2	0.96 ± 0.08	1.0 ± 0.1
VS149	13	I, 13	0-15	1.8 ± 0.3	0.87 ± 0.08	0.94 ± 0.12
VS150	13	P, 16	0-15	1.9 ± 0.4	0.73 ± 0.07	0.85 ± 0.11
VS151	13	S, 16	0-15	1.8 ± 0.3	0.82 ± 0.08	0.85 ± 0.14
VS152	13	V, 16	0-15	2.1 ± 0.4	0.99 ± 0.08	0.98 ± 0.13
VS153	12	G, 7	0-15	8.4 ± 0.7	0.91 ± 0.08	0.96 ± 0.13
VS154	12	I+0.5, 7	0-15	18 ± 1	0.93 ± 0.09	0.95 ± 0.13
VS155	12	L, 7	0-15	9.4 ± 0.7	1.1 ± 0.1	0.92 ± 0.12
VS156	12	P, 7	0-15	12 ± 1	0.62 ± 0.06	0.76 ± 0.11
VS157	12	L, 4	0-15	8.1 ± 0.7	0.91 ± 0.08	0.92 ± 0.12
VS158	12	I, 4	0-15	5.5 ± 0.5	0.93 ± 0.08	0.87 ± 0.12
VS159	12	G, 4	0-15	4.5 ± 0.5	0.85 ± 0.08	0.85 ± 0.11
VS160	12	I, 1	0-15	12 ± 1	0.78 ± 0.07	0.88 ± 0.12
VS161	12	P, 1	0-15	20 ± 1	0.83 ± 0.07	0.88 ± 0.13
VS162	12	T, 1	0-15	12 ± 1	0.93 ± 0.08	0.85 ± 0.12
VS163	14N	C, 1	0-15	1.4 ± 0.4	0.75 ± 0.15	0.58 ± 0.08
VS164	14N	G, 1	0-15	12 ± 1	0.60 ± 0.10	0.60 ± 0.08
VS165	14A	L, 1	0-15	2.9 ± 0.4	0.80 ± 0.18	0.48 ± 0.08
VS166	14N	L, 5	0-15	2.0 ± 0.4	0.86 ± 0.08	0.91 ± 0.13

Table 4 (continued)

Sample ID[a]	Area	Grid Location[b]	Depth (cm)	Radionuclide concentration (pCi/g)[c]		
				^{238}U	^{226}Ra	^{232}Th
VS167	14N	G, 5	0-15	1.8 ± 0.4	0.86 ± 0.08	0.92 ± 0.13
VS168	14N	C, 5	0-15	3.3 ± 0.8	0.98 ± 0.11	1.1 ± 0.2
VS169	14N	C, 9	0-15	5.5 ± 0.8	1.2 ± 0.1	1.3 ± 0.2
VS170	14N	L, 9	0-15	1.3 ± 0.4	0.89 ± 0.09	1.0 ± 0.1
VS171	14N	K, 13	0-15	2.2 ± 0.5	1.2 ± 0.1	1.1 ± 0.1
VS172	14N	G, 13	0-15	3.3 ± 0.8	0.90 ± 0.10	1.0 ± 0.2
VS173	14N	C, 14	0-15	2.7 ± 0.6	0.60 ± 0.10	0.61 ± 0.08
VS174	14N	C, 17	0-15	4.0 ± 0.7	1.4 ± 0.1	1.3 ± 0.1
VS175	14N	G, 17	0-15	3.0 ± 1.0	0.70 ± 0.15	0.85 ± 0.15
VS176	14N	L, 17	0-15	1.3 ± 0.4	1.2 ± 0.1	1.2 ± 0.1
VS 177	14S	F, 1.5	0-15	1.8 ± 0.4	0.88 ± 0.08	0.92 ± 0.12
VS178	14S	D, 7	0-15	4.5 ± 1.3	1.0 ± 0.1	0.96 ± 0.13
VS179	14S	I, 2	0-15	1.2 ± 0.4	0.81 ± 0.08	0.94 ± 0.13
VS180	9	B, 10	0-15	1.3 ± 0.3	1.1 ± 0.1	1.2 ± 0.2
VS181	9	H, 6	0-15	9.5 ± 1.0	0.89 ± 0.12	1.1 ± 0.2
VS182	9A	M, 2	0-15	0.5 ± 0.2	0.56 ± 0.08	0.28 ± 0.09
VS183	14S	C,10	0-15	1.2 ± 0.3	0.97 ± 0.12	1.3 ± 0.2
VS184	14S	F, 11	0-15	1.9 ± 0.7	1.3 ± 0.1	1.1 ± 0.2
VS185	14S	I, 14	0-15	1.5 ± 0.3	0.60 ± 0.08	0.26 ± 0.09
VS186	14S	B, 19	0-15	3.8 ± 0.5	1.0 ± 0.1	1.0 ± 0.2
VS187	14S	B, 13.5	0-15	4.5 ± 0.6	1.0 ± 0.1	1.2 ± 0.2
			Biased soil samples[e]			
VB23	20A	N(-4), E18	0-15	170 ± 20	1.6 ± 0.1	0.73 ± 0.13
VB24	20A	N0, E17	0-15	2.3 ± 0.4	1.1 ± 0.1	0.83 ± 0.10
VB25	20A	N0, E12	0-15	2.0 ± 0.4	0.94 ± 0.07	0.89 ± 0.10
VB26	20A	N0, E7	0-8	9.8 ± 1.0	1.0 ± 0.1	0.37 ± 0.07
VB27	20A	N0, E1	0-8	5.4 ± 1.0	1.0 ± 0.1	0.51 ± 0.09
VB28	20A	N1, E3	0-15	0.63 ± 0.19	0.50 ± 0.05	0.28 ± 0.06
VB29	20A	N1, E18	0-15	1.4 ± 0.3	1.6 ± 0.1	0.95 ± 0.12
VB30	13	L, 12.5	0-15	3.5 ± 0.4	3.0 ± 0.1	0.93 ± 0.16

Table 4 (continued)

Sample ID[a]	Area	Grid Location[b]	Depth (cm)	Radionuclide concentration (pCi/g)[c]		
				^{238}U	^{226}Ra	^{232}Th
VB31	13	H, 15	0-15	30 ± 1	0.78 ± 0.20	0.39 ± 0.11
VB32	12	L, 1	0-15	33 ± 1	0.99 ± 0.13	0.91 ± 0.18
VB33A	12	W, 0	0-15	90 ± 10	0.90 ± 0.15	1.1 ± 0.2
VB33B	12	W, 0	15-30	55 ± 10	0.82 ± 0.13	1.1 ± 0.2
VB34	12	N, 3.5	0-15	36 ± 2	0.96 ± 0.14	0.77 ± 0.22
VB40[f]	14A	G, 5	0-15	39 ± 5	0.85 ± 0.10	0.80 ± 0.20
VB41	14A	I, 5	0-15	70 ± 15	0.90 ± 0.15	0.77 ± 0.10
VB42	14N	K, 12.5	0-15	2.1 ± 0.4	0.90 ± 0.10	0.80 ± 0.10
VB43	9C	C, 1	0-15	670 ± 70	2.0 ± 0.2	1.3 ± 0.3
VB45[f]	14SE	D, 15	0-15	4.8 ± 0.6	1.0 ± 0.1	1.2 ± 0.2

[a]Sample locations are shown on Fig. 4.

[b]Grid locations in meters measured north and east of the southwest corner of the room (N0, E0). In most rooms the number of meters north is indicated by a letter (e.g., A=1 m, B=2 m, ...F=6 m, etc.) and the number of meters east by a number.

[c]Indicated counting error is at the 95% confidence level (±2σ).

[d]Systematic samples were collected in a systematic manner without regard to gamma radiation levels.

[e]Biased samples were collected at random and at points with slightly gamma radiation levels.

[f]No samples numbered VB35–VB39 or VB44.

Table 5. Transferable alpha and beta-gamma measurements at Building 14, former Linde Uranium Refinery, Tonawanda, New York

Smear sample ID	Location	Date smear collected	Removable radioactivity (smears)	
			Alpha[a] (dpm/100 cm^2)	Beta-gamma[b] (dpm/100 cm^2)
VT50	Large hallway, east wall	9-16-97	[0]	[-28]
VT51	Large hallway, west wall	9-16-97	[0]	[-11]
VT52	Area 4, 2 m east of SW corner	9-18-97	[0]	[-39]
VT53	Area 4, 3 m north of E wall	9-18-97	[0]	[0]
VT54	Large hallway; N0, E3[c]	9-18-97	[0]	[-6]
VT55	Large hallway; south wall; N0, E17; beam[c]	9-18-97	[0]	[-28]
VT56	Area 2; N3.5, E5[c]	9-18-97	[0]	[-17]
VT57	Area 2; N3.5, E9[c]	9-18-97	[0]	[17]
VT58	Area 15, 15A	11-12-97	[-7]	[-45]
VT59	Area 15, 15A	11-12-97	[-7]	[25]
VT60	Area 15, 15A	11-12-97	[0]	[0]
VT61	Area 15, 15A	11-12-97	[0]	[-65]
VT62	Area 15, 15A	11-12-97	[0]	[-90]
VT63	Area 15, 15A	11-12-97	[-7]	[-40]
VT64	Area 15, 15A	11-12-97	[-7]	[-10]

Table 5 (continued)

Smear sample ID	Location	Date smear collected	Removable radioactivity (smears)	
			Alpha[a] (dpm/100 cm²)	Beta-gamma[b] (dpm/100 cm²)
VT65	Area 15, 15A	11-12-97	[7]	[-40]
VT66	Area 15, 15A	11-12-97	[7]	[-35]
VT67	Area 15, 15A	11-12-97	[-7]	[0]
VT70	Area 14N, overhead beam	1-13-98	[0]	[-22]
VT71	Area 14N; H, 9[d]	1-14-98	[0]	[28]
VT72	Area 14N; D, 2[d]	1-14-98	[0]	[-39]

[a]MDA for alpha activity = 9 dpm/100 cm².
[b]MDA for beta activity = ~125 dpm/100 cm².
[c]Grid locations in meters measured north and east of the southwest corner of the room (N0, E0).
[d]Grid location with number of meters north of southwest corner of room indicated by a letter. (e.g., A=1 m, B=2 m, ...F=6 m, etc.) and number of meters east by a number.

Note: All values represent the actual measurement less the background response of the detector used. A value in brackets [##] indicates that the measurement was not discernable from the background response of the detector (95% confidence).

Table 6. Verification survey activities summarized by area, Building 14, former Linde Uranium Refinery, Tonawanda, New York

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
		Second floor	
2nd floor	4-14-97	•Surveyed ~60% of overhead areas and ~50% of wall area. No areas elevated above guidelines. - Overheads 600–2300 dpm/100 cm^2. - Walls 600–1500 dpm/100 cm^2. •2nd floor added after Manhattan Engineering District activities. No contamination suspected on floors and internal walls that have not been surveyed. •2nd floor completed	
2nd floor	4-15-97	•Random FIDLER measurements. Nothing above typical background. Completes 2nd floor.	2nd floor 5-5-97
		First floor	
2, 3, 4, & large hallway	9-15-97 9-16-97	•Walls surveyed. No elevated areas.	
2	9-15-97 9-16-97	•Overheads 300–1800 dpm/100 cm^2. •Walls 1200–2100 dpm/100 cm^2. •Floor monitor. No anomalies. •Beta-gamma pancake survey 600–1800 dpm/100 cm^2. •Smears VT56, VT57.	Area 2 10-27-97
3	9-15-97	•Walls 750–1800 dpm/100 cm^2. •No anomalies.	
3	9-18-97	•Floors, 600–1500 dpm/100 cm^2; corners and edging 600–1800 dpm/100 cm^2. •Overheads 600–1200 dpm/100 cm^2. •No anomalies.	Area 3 10-27-97
4	9-15-97 9-16-97	•Overheads, 900–2100 dpm/100 cm^2. •Walls, 750–1800 dpm/100 cm^2. •Floors, 600–1800 dpm/100 cm^2; smears VT52 and VT53. •No anomalies.	Area 4 10-27-97

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
Large hallway (north of Area 4)	9-15-97 9-16-97	•Surveyed with floor monitor. No anomalies. •Results of beta-gamma pancake survey: - Overheads 600–3600 dpm/100 cm^2. - Walls 1200–1800 dpm/100 cm^2. - Floor-wall interface 900–1800 dpm/100 cm^2. - 2 floor anchors 24,000 dpm/100 cm^2 and 27,000 dpm/100 cm^2. (Removed by IDM.) •Smears VT50, VT51, VT54. •IDM poured a slushy concrete mix (fillable flow) into excavated pits and trenches located in large hallway area. Previously verified data sent by IDM.	Large hallway 10-27-97
5A 5B 5C1 5C2 5C3 5D 5D1 5D2 Ladies Hallway	9-15-97 9-16-97	•Overheads this area built after Manhattan Engineering District activities ceased. Not surveyed. •Walls and floors generally 900–2100 dpm/100 cm^2. Specifics all below guidelines: - 5A, 2 small spotty areas ~14 in. × 20 in., ~3300–4800 dpm/100 cm^2. - Stairwell south of 5A, area ~15 in. × 10 in., spotty 1800–3300 dpm/100 cm^2. - 5B, spot on outside wall 1400–2200 dpm/100 cm^2. - 5C2, spot on outside wall 600–2300 dpm/100 cm^2. - East wall of hall, know area 11,000–12,000 dpm/100 cm^2 under wall ledge. Considered part of Area 9 and remediated during cleanup of Area 9.	Offices, ladies' room, hallway 10-27-97
7A 7B 7C 7D Men's Room	9-16-97 9-17-97	•Overheads this area built after Manhattan Engineering District activities ceased. Not surveyed. •Surveyed this area with floor monitor and beta-gamma pancake detector. •General range walls and floors 600–800 dpm/100 cm^2. •Room 7B, 1 anomaly 1800–3300 dpm/100 cm^2 inside larger area 3300–7800 dpm/100 cm^2.	Offices, men's room 10-27-97
8A	9-15-97 9-16-97	•Walls, floors 750–2100 dpm/100 cm^2.	
8A	6-2-98	•Overheads surveyed with Area 9, generally 300–1800 dpm/100 cm^2. No areas near guidelines.	Ceilings 6-10-98 (with Area 9)

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
8A	7-16-98	•Floor and 3 walls below guidelines, 300–1200 dpm/100 cm^2.	Other areas 9-16-98 (with Area 9)
8	4-14-97	•Completed accessible overhead area (~30% area blocked); 600–1800 dpm/100 cm^2.	
8	4-15-97	•Blocked area cleared. Completed survey. - Floors 600–2700 dpm/100 cm^2. - Overheads 600–1800 dpm/100 cm^2 with one spot 11,000 dpm/100 cm^2. This is a small spot that meets guidelines.	Above-ground surfaces 5-5-97; Subsurface 10-27-97
8, 10, 11	4-15-97	•FIDLER measurements on 2-m grid. Results provided 2 sampling locations for IDM	Above-ground surfaces 5-5-97; Subsurface 10-27-97; Remaining areas 7-7-98
9 Lab	6-2-98	•Overheads. - Scaffolding erected with walkboards. - ~40% of horizontal surfaces surveyed concentrating on I-beams and other structures most likely in place during Manhattan Engineering District activities. - Much of 9 Lab overhead inaccessible due to ventilation system. - Generally 300–1800 dpm/100 cm^2. Few spots 4800–6300 dpm/100 cm^2. No areas near guidelines.	Ceilings and overheads 6-10-98

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
9	7-9-98	•Surveyed floor and subsurfaces, 13–16 μR/h. Below guidelines with the following exceptions. - Floor underneath two large hoods on east side of room will remain as contaminated surfaces.[d] - Room 9B, ~3-m^2 area on N wall up to 17,000 dpm/100 cm^2; typically 9000–11,000 or 12,000 dpm/100 cm^2. (Wall removed by IDM.) - Room 9D, end of one pipe = 71,000 dpm/100 cm^2. (Not cost-effective to remove.[d]) - Area on south wall at location A, 10 ranged up to 32,000 dpm/100 cm^2 (generally 11,000–17,000 dpm/100 cm^2). (Wall removed by IDM.) - 4 lead anchors up to 53,000 dpm/100 cm^2; lots of non-contaminated lead anchors. (Removed by IDM.) - Column at location D, 9 contaminated around base 17,000–44,000 dpm/100 cm^2. (Removed by IDM.) - Hottest spot in trench = 23 μR/h, 130,000 dpm/100 cm^2. (Removed by IDM.) - Biased soil sample VB43 containing 670 pCi/g ^{238}U collected at this location (C, 1). (Area excavated further by IDM.) - Systematic soil samples VS180–VS182 collected in Area 9; VS181 contained 9.5 pCi/g ^{238}U; others similar to typical background.	
9	7-16-98	•After additional excavation, IDM supplied soil sample data to ORNL for verification. •Inside walls with associated contamination had been removed by IDM.	Exposed soil, concrete floor, walls 9-16-98; Soil samples 10-23-98
10	4-14-97	•Surveyed ~50% of overheads, ~70% of floors, and 1 m up on wall. - Floors 600–3600 dpm/100 cm^2. - Overheads 600–1800 dpm/100 cm^2. - Walls, 2 spots with elevated measurements within guidelines. No action needed. (1) East wall upper horizontal surface, 1 m × 30 cm = 5000 dpm/100 cm^2. (2) South wall upper horizontal surface 1 cm × 75 cm = 5000–7500 dpm/100 cm^2.	Above-ground surfaces 5-5-97 Subsurface 10-27-97
11	4-14-97	•Surveyed ~50% of overheads, ~70% of floors, and 1 m up on wall. - Floors 600–2700 dpm/100 cm^2. - Overheads 600–1800 dpm/100 cm^2.	

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
11	4-15-97	•Surveyed 30% walls. No anomalies	Above-ground surfaces 5-5-97; Subsurface 10-27-97
Corridor	8-28-97	•Floor (300–1500 with exception of a few elevated areas that will be remediated) below guidelines. •Walls 1800-2700 due to high background from brick. •Overheads 0–900 dpm/100 cm^2 (only looked at certain areas).	10-27-97 7-7-98
Stairwell leading to utility tunnel in Area 12	5-4-98	•0–1200 dpm/100 cm^2. •Overhead electrical conduits elevated on top of the steam line. IDM will remediate.	5-20-98 9-21-98
Stairwell leading to utility tunnel		•Walls, stairs, floor, ceiling, and electrical conduits.	10-23-98
Pipes in utility tunnel near Area 12	5-6-98	•IDM to conduct more decon work on pipes in this area. After decon, IDM supplied data to ORNL for verification.	9-21-98
Pipe in Area 12 sump (tunnel access)	7-16-98	•Re-surveyed after decon, 300–1800 dpm/100 cm^2; highest spot 3300 dpm/100 cm^2.	9-21-98
Sump in utility tunnel		•Reviewed IDM data. •Released surface of sump and east and west drain lines. •North drain line exceeds DOE criteria.[d]	11-10-98

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
12	4-15-97	•High bay room with 30-ft ceilings. •Floor and floor-wall interfaces contaminated. This will be removed to access subsurface contamination. •Surveyed walls and overheads (50-60% of overheads). - Hot spot above guidelines on lower horizontal surface of upper I-beam (overheads on west wall).[d] - Ledge on the west wall with several areas on upper horizontal surfaces above guidelines. Will be demolished with the floor. (Removed.)	Surface above 1 ft of floor-wall interface 5-5-97
12 & 13	7-15-97	•Gamma scan, 4 biased soil sampling locations identified.	
12 &13	7-16-97	•Beta-gamma scan of edges of footers. •Began taking soil samples.	
12 & 13	7-17-97	•Highest count rate where can access underside of concrete; maximum 37,000 dpm/100 cm^2 at location J+0.5, 1. •Several spots along west knee wall 5000–10,000 dpm/100 cm^2. (Approved as above-guideline area.[d]) •Southwest corner, concrete at wall-floor interface 25,000 dpm/100 cm^2. (Removed) •One area soil contamination identified and remediated by IDM.	Area 12 &13 subsurface & remaining floor 7-30-97; Area 12 10-27-97

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
13	3-4-96 3-5-96	•Using man lift, surveyed overheads including cranes, trusses, and supports. 30-ft ceiling and several pieces of equipment hindered mobility. Generally, west side of beams against west wall >5000 dpm/100 cm^2, and rivets at junctions above criteria. Contamination noted [beams and junctions numbered for reference (see site sketch on data sheet)]: - Steel plate between western most north-to-south I-beam and west wall; area = ~108 ft^2; loose dust and debris up to 8000 dpm/100 cm^2. - Steel place/brace connecting crossbeams at ceiling-wall interface (west face); area = 0.3 m^2; 11,000 dpm/100 cm^2. - Junction coupling plate (rivets) at junction #5; area = 500 cm^2; 11,000 dpm/100 cm^2. - Steel place/brace, rivet area coupling crossbeams at ceiling-wall interface (western face); area = 0.3 m^2; 35,000 dpm/100 cm^2. - Brace south side of beam #2 at crane-rail interface; area = 600 cm^2; 58,000 dpm/100 cm^2. - Brace/beam support at west wall ~2.5 ft above crane support top; area = ~700 cm^2 (riveted area); 21,000 dpm/100 cm^2. - Crossbeam south of junction 6 western face; area = 100 cm^2; 20,000 dpm/100 cm^2. - Riveted area west of beam #9 and north of beam 3; area = ~400 cm^2; 17,000 dpm/100 cm^2. - I-beam running north to south, I-beam #10; 0.1 by 1.5 m; average 6300 dpm/100 cm^2, up to 7800 dpm/100 cm^2. - Location #3 ~1 m down from ceiling, painted white; area = 100 cm^2; 15,000 dpm/100 cm^2. - Center brace for long crossbeam running from #5 at west wall to #8 at east wall; area = 500 cm^2; 23,000 dpm/100 cm^2. - North of junction #1 on crossbeam; area ~500 cm^2; 23,000 dpm/100 cm^2. - South of junction #1 on crossbeam; area = ~200 cm^2; 23,000 dpm/100 cm^2. •Floors and baseboards checked; floors, baseboards, and north wall need further decontamination. •NOTE: This was the first area surveyed in Bldg. 14. A new remediation contractor (IDM Environmental Corp) took over cleanup activities after this date.	
13	4-16-97	•Surveyed walls and overheads (50–60% overheads). - Crain rail approved for above-guideline area.[d] •Checked floors and floor-wall interfaces.	7-30-97 7-7-98

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
14N	1-13-98	•Began survey of overheads. Generally 600–1800 dpm/100 cm^2. - Spot on I-beam (at D, 2) 17,000 dpm/100 cm^2. See smear VT72. - Spot on cross member (at H, 9) 17,000 dpm/100 cm^2. See smear VT71. - Small spot ~20 cm^2 (at C, 14) 14,000 dpm/100 cm^2. Will average. See smear VT70.	
14N	1-14-98	•Overheads scanned. •Lower portion of walls scanned.	
14N	1-15-98	•Completed survey of ~50% of overheads concentrating on probable areas of contamination (i.e., horizontal surfaces, bolts, cross members). •Surveyed bottom 3 meters of walls (~30%). - Walls range from 300–1800 dpm/100 cm^2 with an area ~2600 dpm/100 cm^2.	All surfaces above 6 in. from floor-wall interface 1-30-98
14SW	1-16-98	•Surveyed lower areas to ~10 ft up wall (600–1800 dpm/100 cm^2). •Anchor bolts 2700–3300 dpm/100 cm^2.	
14N 14SW	3-4-98	•Surveyed soil and lower portion of wall this trip. •Several areas along the knee wall (concrete surface and soil underneath) above criteria. These have also been identified by IDM and are to be included in the hazard assessment. •Soil scanned with NaI detector; 3 biased soil sample locations identified. •Collected 3 biased soil samples and 15 systematic samples. •Scanned lower portion of wall (up to ~10 ft). •Conferred with IDM (remediation contractor). Elevated soil on 14N–14SW boundary to be removed overnight. Area will be ready for verification tomorrow.	14N and 14SW subsurface and remaining floor 3-16-98
14SW	3-4-98	•Contaminated concrete ledge 20 ft up bordering 14SE (area with 55-ft ceiling) will be removed with decon of 14SE.	
14SE 14SW	3-5-98	•Completed surface surveys and soil sampling.	14SE 6-10-98
14SW	5-4-98	•Overheads (not ceiling) 0–1200 dpm/100 cm^2. - NW corner (overheads) on a former window sill, crack in concrete ~4000–7000 dpm/100 cm^2.	

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
14SW	5-5-98	•Overheads (I-beams and cross members) surveyed with lift. - ~50% coverage. - All areas clean except the lower horizontal surfaces of I-beams closest to the wall. Areas will be added to hazard assessment.	14SW areas 12 ft above floor 5-20-98; Ceilings 6-10-98
14SW 14SE	6-1-98	•Surveyed ~35–40% of ceiling (55-ft ceiling in Area 14SW) using scissor lift, generally 300–1800 dpm/100 cm^2. - Found one slightly elevated area (2400–3000 dpm/100 cm^2) and one significantly elevated area (3300–59,000 dpm/100 cm^2) located on the uppermost I-beam on the N wall. Contamination covered ~10–15 ft on horizontal (lower) surface. IDM chiseled away the significantly contaminated area.	14SW accessible areas above 6 in. from floor-wall interface 1-30-98
14SE	6-3-98	•Overheads and walls. - After climbing 25–30 ft on scaffolding, decided unsafe. - Reviewed IDMs post-remedial action survey data.	10-10-98; Ceilings 10-23-98
14S	7-8-98	•Surveyed above the bridge crane, ~25% of horizontal surfaces and cracks and crevices likely to contain contamination. The following spots and small areas were noted. All are below guidelines. - Spot in NW corner, ~500 cm^2 = 12,000 dpm/100 cm^2. - NW corner, horizontal on I-beam, ~4 ft × 10 cm = 3300 dpm/100 cm^2. - Spot at NW wall = 1600 dpm/100 cm^2. - Spot at N center wall, <100 cm^2 = 3800 dpm/100 cm^2 (smear showed no transferable contamination). - Along N wall, generally 900–2400 dpm/100 cm^2 (red brick). - Spot at NE wall = 1600 dpm/100 cm^2. - W ceiling vent = background. - E ceiling vent = 900–2100 dpm/100 cm^2. - SE, 2-ft × 4-ft area = 5000 dpm/100 cm^2. - SE, area 18 in. × 3 in. = 10,000–15,000 dpm/100 cm^2 (smear showed no transferable contamination).	
14SE	7-16-98	•Gamma scan of floor and subsurface (11–13 μR/h). •Systematic samples VS183–VS187 and biased sample VB45 (13 μR/h) collected this date. •Remaining floor scanned with beta-gamma pancake detector (300–2400 dpm/100 cm^2). •One area above guidelines. This area to be chipped and IDM to take additional HP data.	
14		•Soil samples cleared	10-23-98

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
15	11-10-97	•Gamma scan 10–13 μR/h, 14 μR/h in corner geometry. •Beta-gamma scan of floor-wall interfaces; small spot 2500 dpm/100 cm^2; No contamination above guidelines. •Surveyed all accessible floor areas with floor monitor; one area 15,000 dpm/100 cm^2; remediated by IDM. •~33% of overheads surveyed; 600-3300 dpm/100 cm^2. •Began wall scan.	
15	11-11-97	•Continued survey of overheads and walls. •Surveyed pit in southern end of area. •Released 11-12-97	12-12-97
15A	11-11-97	•Contamination on column adjacent to Area 15 (10,000–15,000 dpm/100 cm^2) covering area of ~½ m^2. •Cleaned up by IDM. Cleared 11-12-98. •Completed walls. •Took smears and alpha measurements	
15A 15B1 15B	11-12-97	•Need IDM data on overhead.	
15A	11-12-97	•Need IDM data on drain and pit.	
15A	11-12-97	•Completed overhead scan.	
15B-1	11-12-97	•One spot 15,000 dpm/100 cm^2. Cleaned up by IDM.	
15B-1	11-12-97	•Checked drain near 15B-1. No contamination detected. •Finished overheads. Overhead area cleared.	
15A, 15B, 15B-1		•Interior surfaces and subsurface cleared	Interior surfaces and subsurfaces cleared 12-22-97

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
20A	7-18-96	•Survey of remaining concrete floor and exposed subsurface area. Area cluttered by equipment, tools, and storage shelves. Areas of note: - 2-ft by 15-ft area on concrete floor at base of north wall with 4 to 6 spots >15,000 dpm/100 cm^2. Recommend remediation. - Subsurface area in southeast corner 18 μR/h; 14,000 dpm/100 cm^2 appears to continue north and east of corner. - Subsurface trench generally 3300–5100 dpm/100 cm^2. - Plastic cover on pipe in trench 15,000 dpm/100 cm^2. - 0N, 7E vertical pipe, ~3 in., 16,000 dpm/100 cm^2.	7-7-98
20A East	10-28-96 10-29-96	•No elevated areas.	12-30-96 7-7-98
20A West		•Review of IDM data.	1-30-98
20B 20B-1	10-28-96 10-29-96	•Surveyed ~50% floor and wall surfaces. No elevated areas.	12-30-96 7-7-98
20C	10-28-96 10-29-96	•No elevated areas.	12-20-96 7-7-98
21	2-5-98	•Obtained background information on activities conducted in the 2 sumps. Toured area. •Sumps removed and excavated down to 12–15 ft. •Reviewed data from IDM. •IDM split soil samples sent to ORNL for analysis.	7-7-98 9-21-98

Table 6 (continued)

Area No.[a]	Date of survey	Survey results and/or comments[b]	Date released as below guidelines[c]
Bldg. 14	5-6-98	Meeting to decide on placement of radon chambers.	
Bldg. 14	5-28-98	Radon detectors placed by Doug Davis of SEC and Steve Nakasaki of BNI.	

BNI = Bechtel National, Inc., remediation contractor.
FIDLER = field instrument for the detection of low-energy radiation.
IDM = IDM Environmental Corporation, remediation turnkey subcontractor.
[a]Area numbers shown on Fig. 3. No second floor drawing shown.
[b]Grid locations in meters measured north and east of the southwest corner of the room (N0, E0). In most rooms the number of meters north is indicated by a letter (e.g., A=1 m, B=2 m, ...F=6 m, etc.) and the number of meters east by a number.
[c]See correspondence in Appendix D.
[d]See "Summary of Locations Exceeding Remedial Action Criteria" in Appendix A.

Table 7. Results of radon measurements in indoor air at Building 14, former Linde Uranium Refinery, Tonawanda, New York

Location in Building 14 (see Fig. 5)	Electret serial number	Start date	Stop date	Total time hours (days)	Radon concentration (pCi/L)	Radon concentration[a] (WL)
Areas 2 and 3	SR5034	5-28-98	6-29-98	775.9 (~32)	1.1	0.0055
Area 4B	SR5119	5-28-98	6-29-98	775.8 (~32)	1.5	0.0075
First floor offices, 5A	SO6225	5-28-98	6-29-98	775.4 (~32)	0.7	0.0035
First floor offices, 5A		5-28-98	6-29-98	768.2 (~32)	0.5	0.0025
Frist floor offices, 5B	SR5026	5-28-98	6-30-98	792.9 (~33)	0.4	0.002
First floor offices, 5C2	SO6122	5-28-98	6-29-98	775.5 (~32)	1.2	0.006
First floor offices, 5C3	SO6152	5-28-98	6-29-98	775.5 (~32)	0.6	0.003
Small Hallway	SR5168	5-28-98	6-29-98	775.9 (~32)	0.5	0.0025
Area 8	SR5182	5-28-98	6-29-98	776.1 (~32)	1.2	0.006
Area 9	SO6149	8-26-98	9-28-98	787.3 (~33)	1.1	0.0055
Area 9 (duplicate)	SO6275	8-26-98	9-28-98	787.3 (~33)	0.8	0.004
Corridor	SO6323	8-26-98	9-28-98	787.1 (~33)	1.2	0.006
Area 13	SR5233	5-28-98	6-29-98	776.2 (~32)	0.9	0.0045
Area 13 (duplicate)	SR5199	5-28-98	6-29-98	775.2 (~32)	0.8	0.004
Area 14-North	SO6157	8-26-98	9-28-98	787.2 (~33)	0.6	0.003
Area 14-South	SO6245	9-10-98	9-28-98	427.4 (~18)	1.6	0.008
Area 15	SO6126	5-28-98	6-29-98	775.8 (~32)	0.7	0.0035
Area 20A-East	SR5229	5-28-98	6-29-98	775.7 (~32)	1.2	0.006
Area 20A-West	SR5013	5-28-98	6-29-98	775.8 (~32)	0.7	0.0035
Area 20B	SR5225	5-28-98	6-29-98	775.8 (~32)	0.5	0.0025

[a]Working level (WL) measurements were not performed. The listed values were estimated using the assumption that the concentration of radon progeny in room air was equal to 50% of the measured ^{222}Rn concentration.

APPENDIX A

SUMMARY OF LOCATIONS EXCEEDING REMEDIAL ACTION CRITERIA

A number of locations were identified where residual contamination exceeding the remedial action criteria remained after decontamination efforts. These locations occur in Areas 9, 12, 13, 14 North, 14 South, 15, 20A East, and 21. Contamination exceeding the criteria was left in place only after all best efforts at decontamination were made and the criteria for supplemental limits were carefully evaluated. These locations fall into several categories. The first category includes areas of soils underlying building walls in Areas 12, 13, 14 North, and 14 South where further removal would undermine the walls and place the structural integrity of the building at risk. A second type, which occurred at five locations in Area 14 South, is on the sill of a beam adjacent to walls where limited access by remediation equipment prevented complete decontamination. Similarly, on the crane rails in Areas 12, 13, and 14 North, restricted access prevented full decontamination around bolt heads. Four floor locations in Areas 9, 14 South, and 15 were inaccessible because of the presence of large equipment. Based on data from surrounding floor measurements, these locations were estimated to exceed guidelines. Interior wall contamination exceeding remedial action criteria in the south wall of Area 14 South was discovered. Several subsurface drainpipes in Area 9, the Area 12 stairwell sump, Area 20A East, and the existing in-bed drainline system that was left in place contained contamination exceeding remedial action criteria. This determination was based on survey measurements obtained at locations where drainlines were exposed during remediation of sumps or pipes. Portions of the drainline were removed during the remedial action, but most of the potentially contaminated drainline system remain in place. (Excerpt from Executive Summary in *Post-Remedial Action Report for Building 14 at the Linde Site, Tonawanda, New York*, June 1999.)

Table 5-1 (Page 1 of 5)
Summary of Locations Exceeding Remedial Action Criteria

Location No. (Area)	Description[a]	Rationale for Residual Contamination Exceeding Criteria
LEC-B14-1 (Building 14 subsurface)	IN-BED DRAINLINES. Description: Includes an estimated 543 linear feet of the trench drainline system left in place (191 feet were removed) beneath Building 14. The drainlines were delineated at seven locations where exposed and limited remedial actions were taken on certain sections. Drainlines are estimated to be up to 8 feet below grade and pass underneath load-bearing walls. Remedial Actions: Exposed sections of drainline were removed or plugged in the Area 12 stairwell, the Corridor, Area 9 and the Large Hallway. Contamination Levels: Direct β/γ activity measurements ranged from 5,480 to 160,000 dpm/100 cm^2 in the accessible sections. Data References: IDM Surveys 217, 373, 403, 687, 747, 1040, and 1670. IDM Sample 268.	Contaminated drainlines are inaccessible and remediation not cost-effective.
LEC-9-1 LEC-9-2 (Area 9)	FLOOR UNDERNEATH FUME HOODS. Description: Floor under two banks of fume hoods near the east wall. Each fume hood covers an area of about 2 m by 5 m or about 107 square feet for a total of 214 square feet. Remedial Actions: Floor inaccessible except in the northeast corner, which were decontaminated and a drain removed and plugged. Contamination Levels: Adjacent concrete direct β/γ activity — 15,620 to 19,015 dpm/100 cm^2 — was assumed representative of fume hood floor. Data References: IDM Surveys 1032 and 1033.	Floor inaccessible without removal of fume hoods. Estimated cost was ~$250,000.
LEC-9-3 (Area 9)	DRAINPIPE. Description: A 10-foot-long section of a 4-inch-diameter cast iron drainpipe was left in place. Pipe was encased in concrete block which went underneath the south wall of Area 9. Pipe appears to be MED-era drainpipe from Linde drawing A63726. Remedial Actions: The remainder of the drainpipe and surrounding soil was removed up to the eastern wall. Contamination Levels: Direct β/γ activity was 21,000 to 73,000 dpm/100 cm^2 at west end of drainpipe. Data References: IDM Survey 1500.	Removal of remaining drainpipe and subgrade concrete block would affect the structural integrity of the south wall.
LEC-9-4 (Area 9)	DRAINPIPE. Description: A drainpipe is present underneath the fume hood designated at LEC-9-1. The pipe is presumed contaminated based on the connecting contaminated floor drain removed from underneath the northeast corner of this fume hood. The direction of the pipe run is believed to be north-to-south but could not be confirmed. Remedial Actions: The floor underneath the northeast corner of the fume hood, the only part accessible, was decontaminated and a floor drain removed as part of the floor decontamination. The drain passed through an elbow beyond which the drainpipe could not be observed. No further remedial action was taken on the elbow or drainpipe. Contamination Levels: A direct β/γ measurement taken on the floor drain showed activity at 21,000 dpm/100 cm^2. Data References: IDM Survey 1670.	Removal of the drainpipe would require removal of the fume hoods which has already been deemed not cost-effective.

Location No. (Area)	Description[a]	Rationale for Residual Contamination Exceeding Criteria
LEC-12/13-1 LEC-12/13-2 (Areas 12/13)	SOIL UNDERNEATH WEST WALL. Description: Soil was left underneath the horizontal concrete slab which encases the electrical conduit down to the base of the excavation and back to the concrete footer supporting the west wall. LEC-12/13-1 is estimated to be 18 feet long by 1 foot wide by 1.5 feet deep for a total volume of 27 cubic feet. LEC-12/13-2 is estimated to be 24.5 feet long by 1 foot wide by 1.5 feet deep for a total volume of 37 cubic feet. Remedial Action: The adjacent soil in Area 12 was excavated to a depth of 4 feet. Soil was excavated in spots beneath the horizontal slab. Contamination Levels: Soil samples collected underneath the horizontal slab had total uranium activities ranging from 35.83 to 17,910 pCi/g. Data References: IDM Survey 3001. IDM Samples 344, 346, 352, 357, 365, 417, and 429.	Removal would compromise the structural integrity of the building.
LEC-12/13-3 LEC-12/13-4 (Areas 12/13)	SOIL UNDERNEATH CENTER WALL. Description: Soil was left underneath the center wall dividing Areas 12 and 13 extending out 1 foot from each side. LEC-12/13-3 is estimated to be 16 feet long by 2.5 feet wide by 1 foot deep for a total volume of 41 cubic feet. LEC-12/13-4 is estimated to have the same dimensions for a total volume of 41 cubic feet. Remedial Action: Soil was excavated on both sides of the walls up to within a foot of either side. The soil on the Area 12 side was removed to a depth of about 4 feet and on the Area 13 side to a depth of about 3 feet. Contamination Levels: Eight samples were collected from the sides of the walls containing total uranium activities of 8 to 4,297 pCi/g. Data References: IDM Surveys 3002 and 3003. IDM Samples 338, 345, 350, 354, 355, 356, 359, 364, 366, 411, 412 and 418.	Removal would compromise the structural integrity of the building.
LEC-12/13-5 LEC-12/13-6 (Areas 12/13)	SOIL UNDERNEATH SOUTH WALL. Description: Soil was left underneath the south wall of Areas 12 and 13 extending out 1 foot from each side. LEC-12/13-5 is estimated to be 41 feet long by 2 feet wide by 1 foot deep for a total volume of 82 cubic feet. LEC-12/13-6 is estimated to be 6.5 feet long by 2 feet wide by 1 foot deep for a total volume of 13 cubic feet. Remedial Action: Soil was excavated up to within a foot of the wall. The depth of excavation ranged from 4 feet in Area 12 to 2 feet in Area 13. Contamination Levels: Seven samples collected from the sides of the excavation contained total uranium concentrations of 38 to 3,614 pCi/g. Data References: IDM Surveys 3004 and 3005. IDM Samples 337, 353, 360, 362, 363, 367, and 368.	Removal would compromise the structural integrity of the building.
LEC-12/13-7 (Areas 12/13)	STAIRWELL SUMP NORTH DRAINLINE. Description: This drainline connects the sump at the base of the stairwell to the trench in the utility tunnel to the north. The drainline is about ten feet long. Remedial Action: The sump floor and walls were decontaminated and rebuilt. The drainline was not decontaminated. Contamination Levels: Direct β/γ activity within the drainline ranged from 9,600 up to 54,000 dpm/100 cm^2. A sample of scale material removed from the pipe contained total uranium at 6,573 pCi/g. Data References: IDM Surveys 810 and 1260. IDM Sample 790.	Conventional decontamination methods judged ineffective. Alternative removal methods destructive or not cost-effective. The potential for recontamination from utility tunnel should be addressed before pipe decontamination is considered.

Location No. (Area)	Description[a]	Rationale for Residual Contamination Exceeding Criteria
LEC-12/13-8 LEC-12/13-9 (Areas 12/13)	CENTER CRANE RAILS. Description: Channel steel (cross members) connect center crane rails to each other. Area surrounding bolts connecting cross members to the crane rails remains contaminated above surface guidelines following decontamination. Total area estimated at 17 ft^2. Remedial Action: Crane rails and cross members at these locations were decontaminated repeatedly by sponge blasting. Confined space (2 to 3 inches clearance) prevented decontamination to below guidelines around bolts. Contamination Levels: Post-decontamination direct β/γ activity was 8,300 to 19,000 dpm/100 cm^2. Data References: IDM Survey 404.	Removal of contamination is not feasible due to inaccessibility with conventional decontamination equipment.
LEC-14N-1 LEC-14N-2 LEC-14N-3 (Area 14N)	WEST KNEE WALL: Description: Concrete on knee wall below grade remains contaminated above criteria. LEC-14N-1 –2 and –3 total 5.5, 1.3, and 0.5 square feet, respectively. Remedial Actions: The knee wall was aggressively decontaminated with only these locations remaining above surface guidelines. Contamination Levels: Direct β/γ activity after decontamination was 600 to 19,062 dpm/100 cm^2. Data References: IDM Survey 1267.	Further decontamination or removal of the knee wall would affect the structural integrity of the building.
LEC-14N-4 LEC-14N-5 LEC-14N-6 (Area 14N)	SOIL UNDERNEATH NORTH WALL: Description: Soil underlying wall left in place to support wall. LEC-14N-4 comprises 12 ft^3 of ash 4 to 8 inches beneath slab. LEC-14N-5 contains 12 ft^3 of ash and 12 ft^3 of clay soil 4 to 20 inches beneath slab. LEC-14N-6 contains 9 ft^3 of ash 4 to 8 inches beneath slab. Remedial Actions: Concrete floor slab and underlying soil were excavated as close as practical to the wall. Contamination Levels: LEC-14N-5 and -6 at 247 pCi/g total uranium (Sample 877). LEC-14N-4 measured at 14.9 pCi/g total uranium (Sample 876), but contamination on Area 12 side of wall makes this a supplemental limit location. Data References: IDM Samples 876 and 877, IDM Survey 1267.	Further removal of the soil would affect the structural integrity of the building.
LEC-14N-7 LEC-14N-8 (Area 14N)	CRANE RAIL CROSS MEMBERS: Description: Channel steel (cross members) connect center crane rails to each other and east crane rail to wall. Area surrounding bolts connecting cross members to the crane rails remains contaminated above surface guidelines following decontamination. Total area estimated at 15 ft^2. Remedial Actions: Crane rails and cross members at these locations were decontaminated repeatedly by sponge blasting. Confined space (2 to 3 inches clearance) prevented decontamination to below guidelines around bolts. Contamination Levels: Post-decontamination direct β/γ activity was 4,600 to 27,000 dpm/ 100 cm^2. Data References: IDM Surveys 1131 and 1139.	Removal of contamination is not feasible due to inaccessibility with conventional decontamination equipment.
LEC-14S-1 LEC-14S-2 (Area 14S)	WEST WALL FOOTER AND SOIL. Description: LEC-14S-1 contains 1 ft^3 of soil beneath the knee wall which exceeds criteria and 2 ft^2 of subgrade knee wall which exceeds guidelines. At LEC-14S-2, 1 ft^2 of knee wall concrete exceeds guidelines. Remedial Actions: Soil was excavated as close to the knee wall as practical and underneath it at some locations, and the concrete surface was aggressively decontaminated. Contamination Levels: Soil at 78.9 to 87.8 pCi/g, knee wall at 600 to 5,215 dpm/100 cm^2. Data References: IDM Samples 878 and 879. IDM Survey 1267.	Further decontamination or removal of the knee wall and soil would affect the structural integrity of the building.

Location No. (Area)	Description[a]	Rationale for Residual Contamination Exceeding Criteria
LEC-14S-3 (Area 14S)	SOUTH WALL CONCRETE FOOTER/BRICK WALL INTERFACE. Description: Interface between concrete south wall footer and the brick remains contaminated above surface guidelines. Extends about 42 feet underneath the outermost brick, or two bricks, at the east end. Total area impacted about 13 ft^2. Remedial Actions: First two layers of inner two courses of brick removed from interior wall and footer surface decontaminated. Contamination Levels: Pre-decontamination direct β/γ activity of footer ranged from 10,164 dpm/100 cm^2 to 132,492 dpm/100 cm^2. Assumed direct β/γ activity average is 30,769 dpm/100 cm^2. Data References: IDM Survey 1752 (pre-remedial data) and 1737 (post-remedial data).	Further removal of the brick wall would affect the structural integrity of the building.
LEC-14S-4 LEC-14S-5 LEC-14S-6 LEC-14S-7 LEC-14S-8 (Area 14S)	HORIZONTAL I-BEAMS (SOUTH, NORTH, AND EAST WALLS). Description: These are structural steel beams which are adjacent to the walls in Area 14 South. Locations are on the upper surface of the lower lip of each I-beam on the side of the beam closest to the wall. Access to this surface by decontamination equipment was difficult, but the vertical and upper surfaces of the same side of the beams were successfully decontaminated below criteria. Total area = 7.3 ft^2 per I-beam and 36.5 ft^2 total. Remedial Actions: All surfaces of the beams were decontaminated by sponge blasting. Repeated attempts were made to remove contamination on these locations. Contamination Levels: Residual direct β/γ activity levels ranged 3,000 to 36,000 dpm/100 cm^2 (south wall), 5,000 to 10,000 dpm/100 cm^2 (east wall) and 6,000 to 9,000 dpm/100 cm^2 (north wall). Data References: IDM Surveys 1347, 1351, 1354, 1374, and 1498.	Removal of contamination is not feasible due to inaccessibility with conventional decontamination equipment
LEC-14S-9 LEC-14S-10 (Area 14S)	FORMER WINDOW CONCRETE LEDGE AND BRICK ON SOUTH WALL. Description: Two areas with brick installed in former window locations. Removal and installation of a mandoor and rollup door at the west end of the wall detected elevated levels of contamination on the former window ledges and within the brick mortar. These two areas are conservatively assumed to be potentially similarly contaminated. Total areas are estimated at 100 and 250 ft^2 for LEC-14S-9 and LEC -14S-10, respectively. Remedial Actions: Interior wall surfaces were decontaminated as needed, and verification surveys were performed. Minor decontamination was performed on exterior of wall within Area 21 footprint. Contamination Levels: Surveys from the rollup door installation indicated direct β/γ activity within the wall ranging from 31,000 up to 805,000 dpm/100 cm^2. Three samples of mortar from the wall contained total uranium at concentrations of 1,566, 2,088, and 27,566 pCi/g. Data References: IDM Surveys 1031 and 1041. IDM Samples 802, 803, and 804.	Further removal of the brick wall would affect the structural integrity of the building.
LEC-14S-11 (Area 14S)	FLOOR UNDERNEATH COLUMN 1. Description: The floor underneath the concrete pad supporting Column 1, at grid cell E-13, is inaccessible and is estimated to exceed surface guidelines. The size of the affected floor area is approximately 5 feet by 8 feet for a total area of 40 square feet. Remedial Actions: The floor areas around and up to the concrete pad were decontaminated or removed. Contamination Levels: The estimated activity of this floor area is 5,245 dpm/100 cm^2. Data References: Surveys are described in "Direct Surface and Transferable Contamination Survey," BNI CCN No. D-28336 (1997).	Decontamination is not cost-effective as it would require removal of process column.

Location No. (Area)	Description[a]	Rationale for Residual Contamination Exceeding Criteria
LEC-15-1 (Area 15)	FLOOR UNDER TANK. Description: A large 20-foot-diameter process tank located near the south end of Area 15. The tank rests on what is presumably the original concrete slab. Remedial Actions: Surrounding floor was delineated and decontaminated where necessary. Contamination Levels: The floor underneath the tank is believed to have levels of contamination similar to those found on the surrounding floor at direct $\beta\gamma$ activity up to 27,000 dpm/100 cm^2 with the highest levels present west of the tank. Data References: IDM Survey 355.	Relocation of tank and two other columns judged not economically feasible at $375,000 and would have impacted owner operations.
LEC-20AE-1 (Area 20A East)	DRAINPIPE. Description: An abandoned drainpipe leading south from the center trench is present in the western trench. Historical drawings suggest it is a 4-inch diameter MED-era pipe. Pipe appears to run out of the building and likely leads to the sanitary sewer. Remedial Actions: The plug appeared to have been capped to prevent flow and trench removed. No further remedial actions implemented on drainpipe. Contamination Levels: The drainpipe was surveyed by TNU in 1996. Measurements were taken up to 22 feet from the trench with the maximum direct $\beta\gamma$ activity of 41,094 dpm/100 cm^2 measured at 12 feet from the trench. Data References: TNU Survey 129DT032, sheets 12900975.xls and 12900976.xls.	Removal of pipe would require excavation under north wall of Room 20B-1 and removal of footer of the south wall of the building, which would compromise the structural integrity of the building.
LEC-21-1 (Area 21)	SETTLING BASIN CONCRETE FLOOR BENEATH PIPES. Description: A former settling basin, used during MED operations, was buried beneath the slab within the current footprint of the Butler Building. Several water pipes ran through the basin and were supported in the west section by a tightly compacted rock and gravel mixture with concrete encasing the pipes on the top. The rock covers an area of 10 feet by 2 feet or a total of 20 ft^2. Remedial Actions: The fill material within the settling basin was excavated and removed. The concrete walls and floor of the basin were removed with the exception of the floor beneath the pipes and rock supporting the pipes. Contamination Levels: The concrete surface of the settling basin floor adjacent to the remaining rock which supports the pipes was surveyed with direct $\beta\gamma$ activity of 26,000 to 39,000 dpm/100 cm^2. Data References: IDM Survey 1185.	Removal of concrete and rock supporting water supply pipes may risk damage to the pipes.

Note:

a Additional details on the description and locations of each location exceeding the remedial action criteria can be obtained in the Section 4 text and summary figures of this report.

APPENDIX B

PROCESS PIPING RADIOLOGICAL INVESTIGATION

SUMMARY REPORT
FOR THE
PROCESS PIPING RADIOLOGICAL INVESTIGATION
PRAXAIR BUILDING 14

RECEIVED

JAN 1 2 1998

USACE Buffalo District
Tonawanda FUSRAP Office

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December 1997

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1.0 SITE AND PROJECT INFORMATION

1.1 Background Information

Building 14 (B14) of the Praxair facility, located in Tonawanda, NY was used for uranium separation processes during the 1940's for the Manhattan Engineering District (MED), the predecessor to the Atomic Energy Commission (AEC). This site is currently under the cognizance of Bechtel National, Inc. (BNI), the Department of Energy (DOE) prime contractor for the Formerly Utilized Sites Remedial Action Program (FUSRAP). IDM Environmental Corp. was contracted by BNI to decontaminate the radioactive contamination (BNI1993) in Building 14 on surfaces and structures to the criteria established in DOE 5400.5.

In prior site activities, contamination was detected within the low pressure air system associated with previous MED operations. This finding prompted an assessment of all process piping in B14 to support the building radiological release program. As part of this survey and decontamination program, process lines throughout B14 were evaluated and characterized for radioactive contamination. This report presents the results of the process piping survey and sampling investigation.

1.2 Historical Information

The Praxair facility was formerly owned and operated by Linde Air Products, formerly a subsidiary of Union Carbide Industrial Gases. From approximately 1943 to 1948, MED contracted Linde Air Products to perform uranium separation operations because of its expertise in producing uranium salts used in the manufacture of various ceramic products. B14 was used primarily for laboratory and pilot plant studies during the operations period. After uranium separation operations ceased, most of the associated systems and components of the operation were removed. Documentation is not available to determine exact locations of uranium processes and the associated process piping. Due to the nature of the operations, temporary systems are believed to have been installed and subsequently removed. Piping originally designed and used for a specific service may have been later modified to accommodate other services, such as changing a low pressure air system into a vacuum system or cross-connecting systems based on needs.

Insulation, most of which is asbestos bearing, has been repaired, removed or replaced with various modifications over the life of the building. The original process piping systems have been modified to support the changing needs of the occupants. The building is now a modern laboratory with typical utilities and service piping systems.

1.3 Scope of Project

The scope of this project was to investigate process piping located within B14 of the Praxair facility. The radiological investigation included sampling and HpGe gamma spectroscopy analysis of process piping debris, and direct contamination measurements of external and internal piping components. Based on the review of the

process piping system history, a site procedure (Attachment 1) was prepared to sample and survey representative process piping. Plan views of the Praxair site and Building 14 are shown as Attachment 2. Work performed for this investigation was performed in accordance with the IDM Site Specific Health & Safety Plan (IDMSHP).

2.0 Process Piping Radiological Investigation Approach

2.1 Survey Methodology

The methodology to obtain representative survey measurements and samples of the process piping began by prioritizing piping into two areas of potential contamination; *Group 1* categorized piping by assigning a high or low potential according to the radiological contamination conditions of the area in which they were installed, and *Group 2*, into high and low contamination potential based on historical information and the type of system (see Tables 2.1 & 2.2). Estimated quantities of each process piping system were generated for all areas in B14 and is presented as Attachment 6.

Table 2.1 Group 1 piping grouped by area contamination.

Higher Contamination Areas	Lower Contamination Areas
Areas 9, 12, 13, 14 North and South	Areas 2, 3, 4, 20A, 8, 10, 11, 15, 1st and 2nd floor offices, large hallway

Table 2.2 Group 2 piping grouped by characteristics and contamination potential.

Higher Potential for Contamination		Lower Potential for Contamination	
System	Comments	System	Comments
High Pressure Steam	Heating process systems, vacuum traps	Nitrogen Gas	Post MED, Pressurized
Low Pressure Steam	Heating process systems, vacuum traps	Natural Gas	Pressurized
Condensate Return	Part of low and high pressure steam lines	Oxygen	Post MED, Pressurized
Ventilation Systems	Overhead contamination indicates prior distribution of airborne contamination	Potable Water	Pressurized, washing effect
		Cooling Water Supply & Return	Pressurized, washing effect
		Hot Water Supply & Return	Pressurized, washing effect
		Electrical Conduit	Accessible for survey

The general survey and sampling procedure was as follows:

- Biased surveys were performed in areas where potential leakage was evident, indicated by discoloration and scale deposits on insulation and external surfaces.
- Process piping system insulation (typically ACM) was removed to investigate the exterior piping under the insulation where exterior insulation was found to be contaminated. All ACM removals were performed in accordance with (12NYCRR56).
- Prior radiation survey data and knowledge of the historical use of the area provided a basis for the location of internal measurements.
- Because of the uncertainty of the installation and removal dates, all ventilation systems were accessed and surveyed both externally and internally for radioactive contamination. Internal surveys were conducted at various points within the ventilation systems for fixed and removable contamination.
- A large area internal smear or sample was performed at each system breech point and the sample analyzed by HpGe gamma spectroscopy to determine isotopic uranium contamination concentrations (pCi or pCi/g).

3.0 Independent Verification Contractor (IVC)

Prior to the B14 process piping investigation, a meeting was held with the IVC (Lockheed Martin) management. The primary responsibility of the IVC is to provide QC verification and certification of B14 areas decontaminated and released by IDM for unrestricted use. The meeting discussed the plan for investigation of B14 process piping systems. All concerns were identified and resolved prior to investigation activities. The following are the primary issues that were agreed upon and completed by IDM and the IVC.

3.1 IDM and IVC agreed to perform inter-comparisons of portable radiation detection instrumentation efficiencies and response between the two agencies. This comparison was completed with acceptable agreement.

3.2 IDM agreed to open and survey each of the four high potential concern process piping types at a minimum of six locations within the building and at a minimum of three locations for each of the low potential concern process piping.

4.0 Radiological Survey Findings and Results

The following is a summary of the radiological surveys performed in support of the B14 process piping investigation. Results of field measurements are presented in Attachment 3. Radiation detection instrumentation utilized by IDM in performance of field surveys is shown in Attachment 5.

4.1 External Surfaces

4.1.1 No removable contamination was detected on any of process piping.

4.1.2 Fixed contamination was detected on electrical conduit and steam piping. All surfaces were decontaminated to less than guideline values.

4.1.3 Asbestos insulation (ACM) was originally contaminated in the Corridor, Large Hall and Areas 2, and 3. The ACM insulation was either decontaminated or removed.

4.1.4 Electrical conduit, steam and natural gas piping in the north end Corridor was originally contaminated with levels of from ≈ 500 to 1000 cpm (32000 to 64000 dpm/100cm2). All surfaces were decontaminated to within guideline values.

4.1.5 Non-insulated nitrogen pipe in the Large Hallway had levels of contamination up to ≈ 500cpm (32000 dpm/100cm2). All surfaces were decontaminated to within guideline values.

4.1.6 An external natural gas line in Area 14 SW was originally contaminated with levels of ≈ 300 to 1200cpm (19000 to 77000 dpm/100cm2). Decontamination is scheduled for that line as of this time.

4.1.7 A remnant process pipe located in the overhead of Area 3 and 4 was originally contaminated up to ≈ 400cpm (26000 dpm/100cm2) has been decontaminated to within guideline values.

4.1.8 Contaminated ACM insulation on steam piping (500cpm) was removed in Area 2.

4.1.9 Electrical conduit lines within various areas of B14 contaminated up to ≈1200cpm (77000 dpm/100cm2) were decontaminated to within guideline values.

4.1.10 A water heater in Area 15 was found to be contaminated up to a maximum of 1000cpm (64000 dpm/100cm2). The unit was decontaminated to within guideline values.

4.2 Internal Surfaces

Approximately 145 samples of piping internals were analyzed by low level gamma spectroscopy. All process pipe internal samples analyzed by low level gamma spectroscopy were evaluated for total Uranium activity concentration in pCi/g (for samples of residual dust or debris) or expressed as equivalent dpm/100cm2 for wipes of internal surfaces. The results of HpGe gamma spectroscopy analysis are presented in Attachment 4.

4.2.1 One internal debris/dust sample of a space heater intake plenum located in the overhead of Area 12 was determined at 88 pCi/g; the remaining surface

debris and dust was removed from the system.

4.2.2 The Corridor ventilation space heater was contaminated to a maximum of 500,000 dpm/100cm2. The space heater was removed and packaged for disposal.

5.0 Summary

During calendar year 1997, the process piping and ventilation systems within Praxair B14 were radiologically characterized by performance of surveys, samples and historical records review. Process piping and ventilation systems identified as being radiologically contaminated were then decontaminated or removed and packaged for disposal.

Final survey data demonstrate with a high degree of confidence (at the 95% confidence level) that no significant radioactivity attributable to the MED uranium processing operations remains on or within the investigated process pipe or ventilation systems of B14.

The final radiological status of the B14 process pipe and ventilation systems are such that overall residual activity from uranium operations is significantly less than the guideline values, does not pose a health and safety hazard to operating personnel, and the process piping and ventilation systems meet all requirements for release for unconditional use.

6.0 References

(IDM97) IDM Process Piping Investigation Procedure, dated 4/16/97.

(IDMSHP) IDM Site Specific Health & Safety Plan, Rev 1.7, dated 9/4/97.

(12NYCRR56) Asbestos Removal NY Code Rule 56

(BNI1993) Remedial Investigation (RI) Report.

B14 Process Piping Investigation

Attachment 1

Process Piping Investigation Procedure

B-11

Building 14 / Praxair
Process Piping Radiological Investigation

Date : April 16, 1997
Task Order # : 129-SC-563-023
Prepared : Mark Cafouras / Peter Biesiadecki

Purpose: IDM Radiological Investigation and Clearance of Building 14 Process Piping with the Independent Verification Contractor (IVC) concurrence to release from any future radiological concerns

References: *Prudent Practices for Handling Hazardous Chemicals in Laboratories*
IDM Procedure – Line Purge and Line Break Safety Procedure
IDM Lockout / Tagout Procedure
Applicable MSDS sheets for the appropriate process line gases
Praxair Hazardous Work Permit / Notification
IDM asbestos removal procedure
Code Rule 56: Requirements for Asbestos Sampling & Removal

Preliminary: IDM Management Safety consultation and review
Praxair approval for line valve isolations with field verification for lockout/tagout
IDM Site Safety review of IDM Task Hazard Analysis (THA) with site personnel
Radiation Work Permit preparation and safety review with workforce
Pre-job Briefing

Work Plan / Procedure for Process Piping Investigation

1.0 Introduction
The purpose of this procedure is to purge, survey, and sample the process piping in Bld 14 for radiological contamination both externally and internally for release to the Independent Verification Contractor from any radiological concerns.

2.0 BNI / Praxair Site Safety have been briefed and concurred on intended operations to isolate and survey the process piping. In each new area, IDM will communicate and brief BNI / Praxair on intended operations to coordinate safety / work operations with the Building 14 tenants. IDM will post the area to limit site personnel access during process survey operations. Praxair will generate and post their own Hazardous Work Permit to inform their personnel of intended operations.

3.0 Praxair will identify and sign-off the appropriate process system isolation valves to allow IDM to isolate the affected process system. IDM will maintain Positive control with Praxair concurrence by tagging the appropriate valves shut and the removal of the affected system operating hand-wheels during the process piping investigation.

4.0 IDM will generate a Task Hazard Analysis and Radiation Work Permit to identify various

process piping hazards including chemical and radiological concerns. A review with appropriate work personnel will be communicated with signoff at the pre-job briefing prior to the commencement of work. The affected area will be posted to limit access to appropriate personnel. Scaffolding and/or the Genie Lift will be built, inspected, and used to access the appropriate breech / vent points.

5.0 Process Piping is divided into 2 categories -High Potential and Low Potential from a radiological concern.

High Potential Lines include:
1. Low pressure air
2. High pressure steam
3. Low pressure steam
4. Steam Condensate

Low Potential Lines include:
5. Natural gas
6. Oxygen
7. Hot & Cold water
8. Nitrogen gas-various pressures

Additionally, Bld 14 'Areas' are divided into "High Profile" areas which include: "Areas" 12, 13, 14N, 14S, and Area 9 with others identified "Low Profile" areas unless otherwise identified.

Depending on accessibility, IDM's goal is 6 *internal* access survey points for Hi-potential process lines and 3 access points for Low-potential process lines in Building 14. Externally, all insulated process piping will be radiologically surveyed. When applicable, a certain percentage of insulated asbestos process piping insulation will be removed and externally surveyed at probable unions, drains, strainers to verify process system leaks and insure radiologically no contamination exists under the insulation following all applicable asbestos regulations. Furthermore, HVAC systems will be tagged, inspected and surveyed as required.

General Safety Precautions will include but not limited to the following for each area entered:

- After the Work Area Foreman has identified, tagged, and traced the appropriate process line to be breached & investigated, he is the *only* individual authorized to direct which valves / unions are to be opened and closed during the evolution.
- All personnel involved will know where appropriate emergency equipment (i.e. fire extinguishers), alarms, and appropriate emergency phone # etc. are located within each new work area entered.
- No smoking, open flames, sources of heat, or spark producing equipment will be allowed or operated during the following process line venting or re-assembly, notably natural gas and oxygen. Grounding straps will be used during venting operations to eliminate static- produced sparks. Personnel should ground tools to adjacent non-flammable metal piping prior to starting hazardous work. Soapy water & explosimeters are the preferred method for leak checking various unions / valves

during re-assembly.

- No oil or grease will be used on *any* process piping (i.e. oxygen) or oxygen tanks. This will include the use of new work gloves during disassembly and re-assembly by the workforce. Care will be exercised never to interchange oxygen valves, regulators, etc with any other intended use.
- Oxygen and Natural gas process lines will never be vented sequentially but preferably on different days.
- Extreme caution will be exercised when breaching steam systems due to burns and the prevalence of isolation valve leak-bye.
- The Radiation Work Permit will identify dressout requirements which may be changed by Site Safety based on the various chemical safety considerations of the process systems.

6.0 PROCESS PIPING PROCEDURE:

6.0.1 The internal radiological survey of Process piping in Bld 14 will require isolation and evacuation for access. Process piping with hazardous constituents (i.e. natural gas, oxygen, & nitrogen) will require venting and purging with inert nitrogen gas (or low pressure air as applicable for nitrogen) to an elevated area outside the exterior of the building (away from any personnel, air intakes into the bld, or sources of ignition) prior to breaching. After the Praxair authorized person has authorized and field verified the process line isolation valves to be shut, IDM will hang the approved tags on the process lines to be isolated and verify tagged shut isolation valves with the removal of the operating handle to maintain positive control.

6.0.2 IDM will start with non-hazardous process lines (hot/cold water & low pressure air) followed by steam and condensate as applicable to familiarize the work crews with the operations and safety procedures.

6.0.3 IDM will verify initial hazardous (natural gas, oxygen, & nitrogen) process piping conditions at the unions / valves with the explosimeter to ensure a non-hazardous conditions exists prior to start of work. A pressure test will be performed on the appropriate system via the system piping down-comers and a 2 stage gauged nitrogen gas cylinder (mounted and chained in a mobile cart) to test the integrity of the tagged isolation valves / system for leakage.

6.0.4 If successful, the appropriate process piping lines will be isolated and purged to remove their hazardous characteristics. All special safety precautions for Natural Gas, Oxygen, and Nitrogen will be followed during the procedure. Areas will be posted to eliminate flammability hazards, smoking, sparks, oxygen deficiency during all gas venting operations.

6.0.5 The systems (natural gas, oxygen, nitrogen) will be evacuated first slowly by natural venting, followed with purging (@ 5-10 psig > system pressure with nitrogen or compressed air as applicable) approximately 2 calculated volumes of gas to the outside atmosphere via a rubber air hose connected to an available system down-comer. The rubber vent hose will be grounded to earth ground. Two

combination LEL / Oxygen meters will be used for this purging- one in the area where personnel are working inside the building and the other monitoring the vented gas to the outside to verify when the process piping is fully evacuated and vented. Other low points and down-comers will also be required to be sequentially vented, to ensure removal of all hazardous constituents in the same manner. Other process piping lines (i.e. cold & hot water, steam) will be isolated, vented, and drained to Bld-14 drains prior to breech.

6.0.4 After the affected process line has been completed evacuated and verified by IDM site safety, the process line will be breached at available applicable access points including unions, strainers, and pipe caps with IDM site safety continuously monitoring for any hazardous conditions. RadCon will perform the internal survey / sampling of the internal breached areas. After completion of the radiological survey, the system will be reassembled and closed in preparation for returning to service.

6.0.5 A final pressure test will be performed before opening applicable isolation valves with bottled gas to verify system integrity and tested with soapy water at the breached sampling points. The oxygen lines will be purged and vented with bottled oxygen while the low pressure air will be tested and replaced with compressed air. The natural gas lines will not need to be purged. If successful and after authorization to remove the tagged isolation valves, the work area foreman will return the system to service.

Prepared By: Mark Cafouras, Ion Technology, Inc; Peter Biesiadecki, IDM Environmental, Inc — Date: 5/19/97

Reviewed / Approved By:

Charles W. Avery, IDM Site Superintendent — Date: 5/19/97

Joe Dinardo, IDM H & S Representative — Date 5/19/97

APPENDIX C

FIDLER MEASUREMENTS

Table C.1. FIDLER measurements with Detector A003Y at Building 14
(Data not normalized[a])

Area	North[b]	East[b]	Counts (1 min)	Date	Detector
8	0	5	12,352	4-15-97	A003Y
8	2	5	11,941	4-15-97	A003Y
8	4	5	12,561	4-15-97	A003Y
8	6	5	12,720	4-15-97	A003Y
8	8	5	11,450	4-15-97	A003Y
8	10	5	11,988	4-15-97	A003Y
8	12	5	8,900	4-15-97	A003Y
8	14	5	9,158	4-15-97	A003Y
8	4	1	12,308	4-15-97	A003Y
8	6	1	13,051	4-15-97	A003Y
8	8	1	12,245	4-15-97	A003Y
8	10	1	12,353	4-15-97	A003Y
8	12	1	11,047	4-15-97	A003Y
10	14	12	11,178	4-15-97	A003Y
10	0	10.5	11,517	4-15-97	A003Y
10	2	10.5	11,268	4-15-97	A003Y
10	4	10.5	12,062	4-15-97	A003Y
10	6	10.5	11,990	4-15-97	A003Y
10	8	10.5	11,086	4-15-97	A003Y
10	10	10.5	10,317	4-15-97	A003Y
10	1	1	8,527	4-15-97	A003Y
10	1	3	9,600	4-15-97	A003Y
10	1	5	9,787	4-15-97	A003Y
10	1	7	8,875	4-15-97	A003Y
11	5	7	10,127	4-15-97	A003Y
11	5	5	10,719	4-15-97	A003Y
11	5	3	10,164	4-15-97	A003Y
11	5	1	9,731	4-15-97	A003Y

Table C.1 (continued)
(Data not normalized[a])

Area	North[b]	East[b]	Counts (1 min)	Date	Detector
20B/20B-1	0	9	9,203	10-28-96	A003Y
20B/20B-1	0	8	8,807	10-28-96	A003Y
20B/20B-1	0	7	8,594	10-28-96	A003Y
20B/20B-1	0	6	6,801	10-28-96	A003Y
20B/20B-1	0	5	10,331	10-28-96	A003Y
20B/20B-1	0	4	9,862	10-28-96	A003Y
20B/20B-1	0	3	7,486	10-28-96	A003Y
20B/20B-1	0	2	9,916	10-28-96	A003Y
20B/20B-1	0	1	8,407	10-28-96	A003Y
20B/20B-1	0	0	8,396	10-28-96	A003Y
20B/20B-1	3	9	8,296	10-28-96	A003Y
20B/20B-1	3	8	6,974	10-28-96	A003Y
20B/20B-1	3	7	8,499	10-28-96	A003Y
20B/20B-1	3	6	9,180	10-28-96	A003Y
20B/20B-1	3	5	8,821	10-28-96	A003Y
20B/20B-1	3	4	8,801	10-28-96	A003Y
20B/20B-1	3	3	6,806	10-28-96	A003Y
20B/20B-1	3	2	9,253	10-28-96	A003Y
20B/20B-1	3	1	9,489	10-28-96	A003Y
20B/20B-1	3	0	9,212	10-28-96	A003Y
20B/20B-1	4	0	8,590	10-28-96	A003Y
20B/20B-1	4	1	9,284	10-28-96	A003Y
20B/20B-1	4	2	8,779	10-28-96	A003Y
20B/20B-1	4	3	8,183	10-28-96	A003Y
20B/20B-1	4	4	8,477	10-28-96	A003Y

[a]Measurements from Detector A003Y can only be compared with other measurements from the same detector.
[b]Meters north and east of southwest corner (N0, E0).

Table C.2. FIDLER measurements with Detector A005Y at Building 14
(Data not normalized[a])

Area	North[b]	East[b]	Counts (1 min)	Date	Detector
8	0	7	15,094	4-15-97	A005Y
8	2	7	13,837	4-15-97	A005Y
8	4	7	15,338	4-15-97	A005Y
8	6	7	14,472	4-15-97	A005Y
8	8	7	13,241	4-15-97	A005Y
8	10	7	12,877	4-15-97	A005Y
8	2	3	11,592	4-15-97	A005Y
8	4	3	14,447	4-15-97	A005Y
8	6	3	13,681	4-15-97	A005Y
8	8	3	11,130	4-15-97	A005Y
8	10	3	12,741	4-15-97	A005Y
8	12	3	11,464	4-15-97	A005Y
8	14	3	10,668	4-15-97	A005Y
10	0	12	12,460	4-15-97	A005Y
10	2	12	12,721	4-15-97	A005Y
10	4	12	13,681	4-15-97	A005Y
10	6	12	13,342	4-15-97	A005Y
10	8	12	12,062	4-15-97	A005Y
10	10	12	13,266	4-15-97	A005Y
10	2	8	12,704	4-15-97	A005Y
10	4	8	13,581	4-15-97	A005Y
10	6	8	13,841	4-15-97	A005Y
10	8	8	13,457	4-15-97	A005Y
10	10	8	13,121	4-15-97	A005Y
11	3	8	9,536	4-15-97	A005Y
11	5	8	11,008	4-15-97	A005Y
11	7	8	10,685	4-15-97	A005Y
11	9	8	10,145	4-15-97	A005Y

Table C.2 (continued)
(Data not normalized[a])

Area	North[b]	East[b]	Counts (1 min)	Date	Detector
20B/20B-1	1	9	10,451[c]	10-28-96	A005Y
20B/20B-1	1	8	8,051	10-28-96	A005Y
20B/20B-1	1	7	9,807	10-28-96	A005Y
20B/20B-1	1	6	7,486	10-28-96	A005Y
20B/20B-1	1	5	9,877	10-28-96	A005Y
20B/20B-1	1	4	10,112[c]	10-28-96	A005Y
20B/20B-1	1	3	7,070	10-28-96	A005Y
20B/20B-1	1	2	10,772	10-28-96	A005Y
20B/20B-1	1	1	10,909	10-28-96	A005Y
20B/20B-1	1	0	10,955	10-28-96	A005Y
20B/20B-1	2	0	10,508[c]	10-28-96	A005Y
20B/20B-1	2	1	10,386	10-28-96	A005Y
20B/20B-1	2	2	10,411[c]	10-28-96	A005Y
20B/20B-1	2	3	7,139	10-28-96	A005Y
20B/20B-1	2	4	9,797	10-28-96	A005Y
20B/20B-1	2	5	9,456	10-28-96	A005Y
20B/20B-1	2	6	6,964	10-28-96	A005Y
20B/20B-1	2	7	8,676	10-28-96	A005Y
20B/20B-1	2	8	8,739	10-28-96	A005Y
20B/20B-1	2	9	7,726[c]	10-28-96	A005Y
20B/20B-1	4	9	8,911[d]	10-28-96	A005Y
20B/20B-1	4	8	9,363	10-28-96	A005Y
20B/20B-1	4	7	9,810	10-28-96	A005Y
20B/20B-1	4	6	8,026	10-28-96	A005Y
20B/20B-1	4	5	9,588	10-28-96	A005Y

[a]Measurements from Detector A005Y can only be compared with other measurements from the same detector.
[b]Meters north and east of southwest corner (N0,E0).
[c]Near wall.
[d]Corner

APPENDIX D

CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TN 37831

December 30, 1996

Dr. W. Alexander Williams
Designation and Certification Manager
Office of Eastern Area Programs
Cloverleaf Building, (EM-421)
Department of Energy
19901 Germantown Road
Germantown, Maryland 20874-1290

Dear Dr. Williams:

Contract DE-AC05-96OR22464, Verification Surveys Conducted at Former Linde Site

In October 1996 personnel from the Oak Ridge National Laboratory conducted verification surveys at the former Linde site in Tonawanda, New York. A request was made for Oak Ridge National Laboratory to verify several areas in Building 14. All areas surveyed met Department of Energy cleanup criterion.

We have released Areas 20A East, 20B, 20B-1, and 20C as being below Department of Energy surface guidelines (see map). Additionally, areas in 20A East, where the concrete floor was removed, met approved Department of Energy guidelines for uranium soil contamination in the state of New York. A total of seven samples were taken from this area. However, we have not verified any other subsurfaces at the former Linde site.

Overall this particular project went quite well. The remediation contractor and technical support personnel worked together and did a good job of characterizing the areas and removing the contamination before the Oak Ridge National Laboratory verification team arrived.

If you have any questions please contact me at (423) 576-4108.

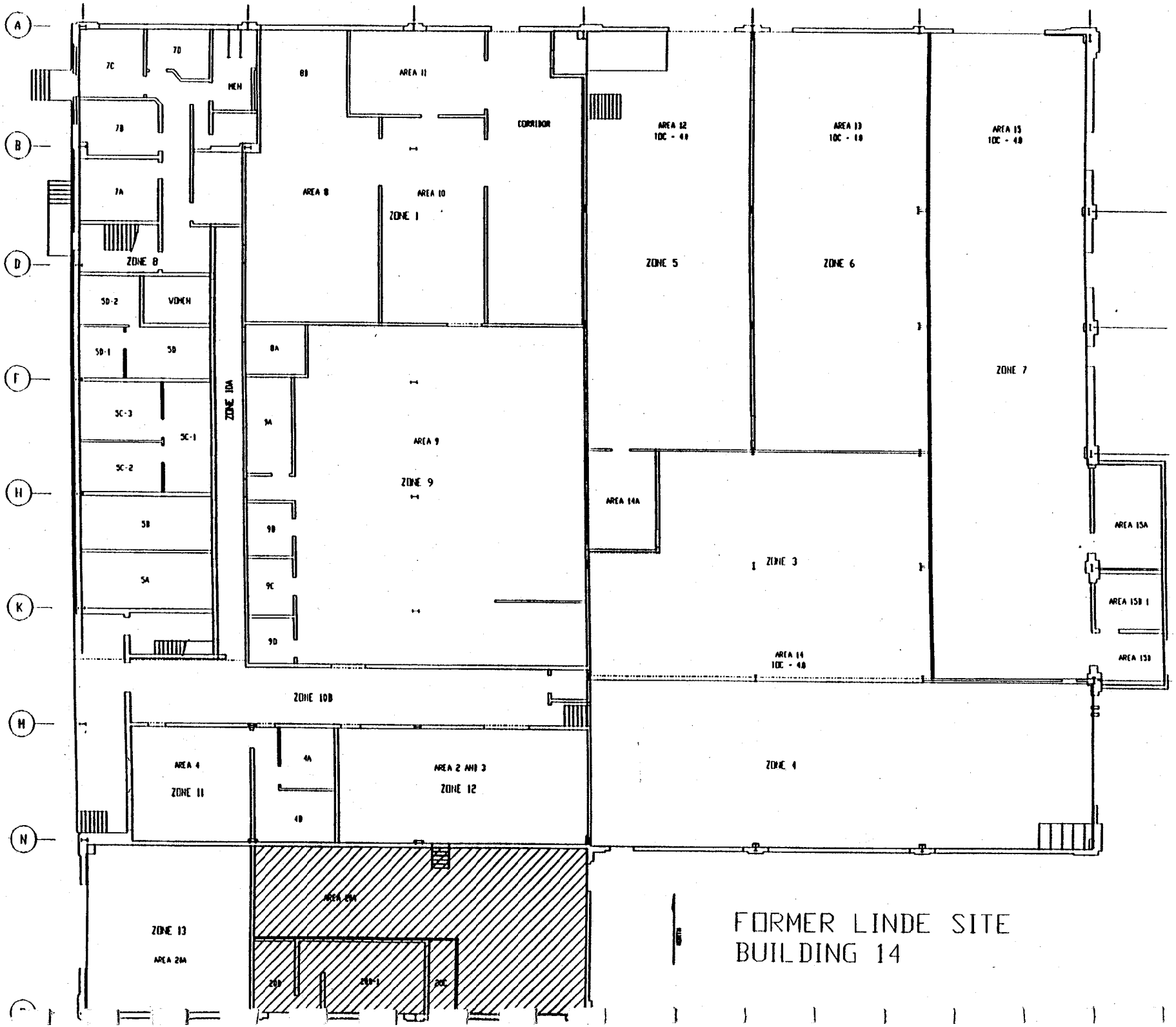
Sincerely,

S. P. McKenzie
Measurement Applications
and Development Group

SPM:lec

Enclosure(s): Former Linde Site Building 14

c: R. D. Foley
M. E. Murray
L. L. Baldy (BNI)
Rc-File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ZONE 12
ZONE 13
AREA 2BA
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20B-1
20C
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10C - 4.0
AREA 13
10C - 1.0
AREA 15
10C - 4.0
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ZONE 6
ZONE 7
AREA 14A
ZONE 3
AREA 15A
AREA 15B 1
AREA 15B
AREA 14
10C - 4.0
ZONE 4
FORMER LINDE SITE
BUILDING 14
D-4

Ort 5-8-97

AK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TN 37831-6420

PHONE: (423) 576-4108
FAX: (423) 241-5683
INTERNET: SPS@ornl.gov.

May 5, 1997

Dr. W. Alexander Williams
Designation and Certification Manager
Office of Eastern Area Programs
Cloverleaf Building, EM-421
Department of Energy
19901 Germantown Road
Germantown, Maryland 20874-1290

Dear Dr. Williams:

Contract DE-AC05-96OR22464, Verification of Building 14, Praxair Site

As a result of meeting with the Bechtel National, Incorporated, New York team, and IDM Environmental Corporation (the Turnkey Subcontractor for Building 14), we have chosen this form of communicating the results of our verification surveys in this building. This assists both Bechtel and IDM Environmental Corporation in their planning. Therefore, you will be receiving a series of letters clearing the areas that pass our Independent Verification surveys. During the week of April 14, an Independent Verification Contractor survey was conducted in certain areas in this building. The results are as follows:

1. We have declared the second floor as being below Department of Energy guidelines.
2. All above ground surfaces in areas 8, 10, and 11, are also released. No subsurface investigations have been conducted.
3. All surfaces above -1 foot of the wall/floor interface in area 12 were also released as below guidelines, with the exception of one "hot spot" on the lower horizontal surface, on the uppermost horizontal I-beam. Both Bechtel and IDM Environmental Corporation was made aware of this area and pending clean-up and survey of this area by Safety and Ecology Corporation, we would be willing to release this area. According to IDM Environmental Corporation the ledge that runs along the west wall and will be demolished with the floor (several areas above guidelines were found during a preliminary scan of the ledge).
4. Finally, in area 13, all surfaces above -1 foot of the floor/wall interface were declared below guidelines with the exception of an I-beam that runs along the west wall. Hot spots were found along the beam on the lower horizontal surface closest to the wall. This area will need further decontamination.

Please call S. P. McKenzie (423) 576-4108, if additional information is needed.

Sincerely,

S P McKenzie

Samuel P. McKenzie
Measurement Applications
and Development Group

SPM

c: S. K. Amrit, BNI
R. D. Foley
File-RC

out 7-31-97

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TN 37831-6420

PHONE: (423) 576-4108
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INTERNET: SP5@ornl.gov.

July 30, 1997

Dr. W. Alexander Williams
Designation and Certification Manager
Office of Eastern Area Programs
Cloverleaf Building, (EM-421)
Department of Energy
19901 Germantown Road
Germantown, Maryland 20874-1290

Dear Dr. Williams:

Status of Cleanup of Former Linde Site in Tonawanda, New York

This is the second letter in a series of updates concerning the status of the cleanup of the former Linde Site in Tonawanda, New York. We have chosen this method of notification to expedite the remediation process. Although the areas in building 14 were not initially prepared for our survey, we were able to complete our activities during this survey trip. Full reports will be prepared for each building after they are completed.

During the week of July 14, 1997, an Independent Verification Contractor (IVC) was conducted on certain areas in building 14, and the exterior of building 31. In addition, a verification survey was conducted on an above-ground tank near the former site of building 38. The results are as follows:

- We have verified the above-ground tank (metal surfaces only) as being below Department of Energy surface guidelines.
- The exterior of building 31 (exterior walls and roof) was also verified as not exceeding Department of Energy guidelines, with the exception of the area behind the transformer, as identified by Bechtel's radiological support subcontractor. The entire building is now verified, excluding the subsurface areas in and around the structure.
- The subsurface and remaining floor areas 12 and 13, of building 14, were throughly investigated and our results align fairly well with those from the turnkey subcontractor. A tentative hazard assessment on the soil underneath both the walls and remaining floor areas is being prepared. This assessment also includes the footer surfaces that were in the process of being remediated until the structural integrity came into question. Our verification survey was therefore limited to the areas not covered in the scope of the hazard assessment (i.e., the open excavated areas and the remaining floor surfaces). With the exception of a strip of soil in area 13 (which was subsequently remediated), all excavated areas are below Department of Energy soil guidelines for the state of New York. We also collected data on the areas to be included in the assessment so that we may be able to assist in the process.

If you have any questions or need additional information please call (423) 576-4108.

Sincerely,

Samuel P. McKenzie
Measurement Applications
and Development Group

SPM:lec

c: S. K. Armit, BNI R. D. Foley File-RC

out 10-28-97

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TN 37831

October 27, 1997

Dr. W. Alexander Williams
Designation and Certification Manager
Office of Eastern Area Programs
Cloverleaf Building, EM-421
Department of Energy
19901 Germantown Road
Germantown, Maryland 20874-1290

Dear Dr. Williams:

Contract DE-AC05-96OR22464, Independent Verification Survey on Building 14

During the week of September 15, an Independent Verification Survey was conducted on certain areas in Building 14, and a review of Post Remedial Action Data taken from the previously contaminated section on the exterior of Building 31. The results are as follows:

- Building 31 (all interior and exterior surfaces), with the exception of the subsurface, has been determined to be below Department of Energy clean-up guidelines.
- In Building 14 we have designated Areas 2, 3, 4, the hallway areas, all first floor offices (with the exception of 8A and 9A-D), and the Men's and Women's rest rooms as being below Department of Energy criterion.
- The corridor that separates Areas 10 and 11 from Area 12 was surveyed on a previous date, and is below Department of Energy clean-up criterion.
- We have reviewed the core sample results taken from Areas 8, 10, and 11, and conclude that the subsurface of these areas are below Department of Energy guidelines.

Sincerely,

Samuel P. McKenzie
Measurement Applications
and Develope Group

SPM:lec

c: S. Armit, BNI
R. D. Foley
File-RC

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE TN 37831

December 22, 1997

Mr. Tim Byrnes
CELRB-PP-PM
Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Byrnes:

Radiological Verification Surveys on Building 14

During the week of November 10, 1997, an Independent Verification Contractor (IVC) team from Oak Ridge National Laboratory, conducted radiological verification surveys on certain areas in building 14. The results are as follows:

1. Area 15 (all interior surfaces and the subsurface), with the exception of the surface beneath the large experimental tank, adjacent to the pit on the south side of the area, has been determined to be below remedial action guidelines.

2. Areas 15A, 15B, and 15B-1 (all interior surfaces and subsurfaces), has been determined to be below remedial action guidelines.

If you have any questions or need further assistance please call me at (423) 576-7584.

Sincerely,

R. D. Foley
Measurement Applications
and Development Group

RER:lec

c: S. Armit, BNI
S. P. McKenzie
R. E. Rodriguez
File - RC

File ext 2-2-98

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

OST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 30, 1998

Mr. Tim Byrnes
CELRB-PP-PM
Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Byrnes:

Independent Verification Survey of Praxair Building 14

During the week of January 12 an Independent Verification Survey was conducted on two areas in Building 14. Also, a review of the "Summary Report for the Process Piping Radiological Investigation Praxair Building 14," has been completed by the independent verification contractor. The results are as follows:

- Area 14 North, with the exception of the cross members associated with the crane rail, all surfaces above six inches from flool/wall interface have been determined to be below the clean-up guidelines as defined in the Department of Energy Order 5400 (wall surfaces to six inches from the floor will be remediated as part of the floor).
- Area 14 Southwest, accessible areas six inches from floor/wall interface up to approximately twelve feet along the south and west walls have also been determined to be below Department of Energy guidelines.
- Area 20A West was determined to be below Department of Energy Order 5400.5 guidelines via a review of data collected by the turnkey subcontractor.

We concur with the results of the summary of the process piping investigation in Building 14 and release this area as below Department of Energy clean up criterion for this site.

If you need additional information please contact me at (423) 576-7584.

Sincerely,

Ray D. Foley

R. D. Foley
Measurement Applications
and Development Group

RDF:lec

c: S. P. McKenzie
M. E. Murray
R. E. Rodriguez

NLT 3-18-98

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

March 16, 1998

Mr. R. J. Gibbs
Bechtel National, Incorporated
151 Lafayette Drive
Post Office Box 350
Oak Ridge, Tennessee 37831-0350

Dear Mr. Gibbs:

Independent Verification Survey for Building 14

During the week of March 2, 1998, an Independent Verification Survey (IVS) was conducted on the subsurface soils and bottom portions of the walls in area 14N and 14SW in Building 14.

The subsurface and remaining floor areas in 14N and 14SW were thoroughly investigated and our results align well with those of the subcontractor. Tentative supplemental standards for portions of the soil underneath both the walls and knee wall areas, are being developed. With the exception of the locations to be covered by supplemental standards, areas 14N and 14SW are verified not to have residual contamination above the guidelines, as defined in the Department of Energy (DOE) Order 5400.5. This closes out area 14N as the other portions were covered in a previous letter. Area 14SW has been verified to be below DOE guidelines with the exception of the overheads and walls above twelve feet. Cleanup activities on these surfaces will be conducted at a later date. I have attached two tables summarizing the radiological cleanup guidelines for unrestricted use as outlined in DOE Order 5400.5. If you have any questions call (423) 576-7584.

Sincerely,

Raymond Foley

R. D. Foley
Measurement Applications
and Development Group

RDF:lec

Attachment: Table 1; Table 2

c: S. P. McKenzie
M. E. Murray
R. Pilon, ACE
File-RC

Table 1. Applicable guidelines for protection against radiation adapted from DOE Order 5400.5
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
	Indoor gamma	
Gamma radiation	Indoor gamma radiation level (above background)	20 μR/h[a]
	Surface contamination	
Total residual surface contamination[b]	^{238}U, ^{235}U, U-natural (alpha emitters)	
	or	
	Beta-gamma emitters[c]	
	Maximum	15,000 dpm/100 cm^2
	Average	5,000 dpm/100 cm^2
	Removable	1,000 dpm/100 cm^2
	^{232}Th, Th-natural (alpha emitters)	
	or	
	^{90}Sr (beta-gamma emitter)	
	Maximum	3,000 dpm/100 cm^2
	Average	1,000 dpm/100 cm^2
	Removable	200 dpm/100 cm^2
	^{226}Ra, ^{230}Th, transuranics	
	Maximum	300 dpm/100 cm^2
	Average	100 dpm/100 cm^2
	Removable	20 dpm/100 cm^2
	Radionuclides in soil	
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m^2 area	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm-thick soil layers more than 15 cm below the surface
	^{226}Ra	
	^{232}Th	
	^{230}Th	
Derived concentrations	Total uranium	60 pCi/g[d]

Table 1 (continued)

Mode of exposure	Exposure conditions	Guideline value
	Soil hot spot criteria	
Guideline for non-homogeneous contamination (used in addition to the 100-m^2 guideline)[e]	Applicable to locations with an area ≤ 25 m^2, with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{1/2}$, where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m^2 area

[e]The 20 μR/h shall comply with the basic dose limit (100 mrem/year) when an appropriate-use scenario is considered.

[b]DOE surface contamination guidelines are consistent with *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material*, May 1987.

[c]Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr, ^{228}Ra, ^{223}Ra, ^{227}Ac, ^{133}I, ^{129}I, ^{126}I, ^{125}I.

[d]DOE guidelines for uranium are derived on a site-specific basis. A total uranium guideline of 60 pCi/g will be applied at the former Linde site. This corresponds to a ^{238}U concentration of ~30 pCi/g.

[e]DOE guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area (adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987).

Sources: Adapted from U.S. Department of Energy, DOE Order 5400.5, April 1990; U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987; and U.S. Department of Energy, *Radiological Control Manual*, DOE/EH-0256T Rev. 1, April 1994.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil near Tonawanda, New York

Type of radiation measurement or sample	Radiation level or radionuclide concentration	
	Range	Average
Gamma exposure rate at ground surface (μR/h)[a]	8–11	9
Concentration of radionuclides in soil (pCi/g)[a]		
^{238}U	0.8–1.1	1.0
^{226}Ra	0.7–1.1	0.9
^{232}Th	0.5–0.9	0.8

[a]Values obtained from four locations in the Tonawanda area.

Source: R. E. Rodriguez, M. E. Murray, and M. S. Uziel, *Results of the Radiological Survey at the Town of Tonawanda Landfill, Tonawanda, New York (TNY001)*, ORNL/RASA-92/12, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., October 1992.

Received 4-15-98 (lec)

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

April 15, 1998

Mr. Ray Pilon
CELRB-PP-PM
U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Pilon:

Contract DE-AC05-96OR22464, Independent Verification Interim Letter Reports for Building 14, Linde Site

At your request, copies of all interim letter reports issued at the conclusion of several Independent Verification Contractors surveys are enclosed. The enclosed email (November 19, 1997) was sent to cover work performed the week of November 10, 1997, on Building 14 at the Linde site. A formal letter report to cover this work will be sent at a later date, of which the email will serve as a basis to the formal letter.

If additional information is needed contact me at (423) 576-7584.

Sincerely,

Ray D. Foley

R. D. Foley
Measurement Applications
and Development Group

RDF:lec

Enclosures 7 (Bldg. 14 Letters)

c: S. P. McKenzie
R. E. Rodriguez
R. E. Swaja
File-RC

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

May 20, 1998

Mr. Robert J. Gibbs
Bechtel National, Incorporated
151 Lafayette Drive
Post Office Box 350
Oak Ridge, Tennessee 37831-0350

Dear Mr.Gibbs:

Contract DE-AC05-96OR22464, Building 14 Independent Verification Survey

An independent verification (IV) survey was conducted on walls and overhead structures in area 14SW, Building 14, during the week of May 4, 1998. This area of investigation was approximately twelve feet above the floor (all areas below this level were released earlier). This report does not cover the ceiling of the area. An additional area was surveyed, which was a stairway leading to the underground utility tunnels, adjacent to area 12.

The walls, piping, and other structures were thoroughly investigated and our results align well with those of the subcontractor. Tentative supplemental standards for portions of the lower horizontal I-beam surface, that is closest to the south wall, are being developed. With the exception of the ceiling and locations to be covered by supplemental standards, area 14SW is verified not to have residual contamination above the guidelines as defined in Department of Energy (DOE) Order 5400.5. The entrance stairway leading down to the utility tunnel, adjacent to area 12 was also surveyed and contamination above guidelines was detected. This elevated area was reported and additional decontamination was conducted. After additional decontamination the area was verified to be below the DOE order. The enclosed table summarizes the radiological clean-up guidelines for unrestricted use as outlined in DOE Order 5400.5.

If you have questions or need further information please call (423) 576-7584.

Sincerely,

Ray D. Foley

R. D. Foley
Measurement Applications
and Development Group

RDF:lec

Enclosures 1

c: S. P. McKenzie
M. E. Murray
R. E. Rodriguez
File-RC

AR 6-11-98

OAK RIDGE NATIONAL LABORATORY
ANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
R THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

June 10, 1998

Mr. Tim Byrnes
CELRB-PP-PM
U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Byrnes:

Contract DE-AC05-96OR22464, Independent Verification Survey on Building 14

During the week of June 1, 1998, an Independent Verification (IV) survey was conducted on the walls and certain overhead structures in areas 14SE, Building 14. This area of investigation began approximately one foot above the floor. Additionally, the overheads in area 9 were surveyed, as well as the ceiling in area 14SW.

The walls, piping, and part of the overhead structures in area 14SE were surveyed. This area is verified not to have residual contamination above guidelines defined in the Department of Energy (DOE) Order 5400.5. The exception is an area along the wall that leads to area 15. This area will be renovated and post remedial surveys will be conducted. The ceiling in area 14SW and the overheads and ceilings in area 9 were surveyed and both areas were verified to be below DOE guidelines. Enclosed is a table summarizing the radiological cleanup guidelines for unrestricted use as defined in DOE Order 5400.5.

If you have any questions or need additional information call (423) 576-7584.

Sincerely,

Ray D. Foley

R. D. Foley
Measurement Applications
and Development Group

RDF

Enclosures 1

c/enc: R. J. Gibbs, BNI
S. P. McKenzie
R. Pilon, USACE
File-RC

OAK RIDGE NATIONAL LABORATORY
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FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

July 7, 1998

Mr. Robert J. Gibbs
Bechtel National, Incorporated
151 Lafayette Drive
Post Office Box 350
Oak Ridge, Tennessee 37831-0350

Dear Mr. Gibbs:

Contract DE-AC05-96OR22464, Clarification Status of the Independent Verification of Building 14 Praxair Site

This correspondence is intended to clarify/update the status of the Independent Verification of Building 14 at the Praxair site. There are several areas that have been declared below Department of Energy (DOE) Guidelines as defined in DOE Order 5400.5. Included are the first and second floor offices, areas 2, 3, 4, 8, 10, 11, 13, 20A, 20A east, 20B, 20B-1, 20C, 21, the corridor, and stairways.

Areas 12 and 14 all have residual contamination in the soils beneath the walls that run along the west wall. Area 15 contains an area beneath a large experimental tank that was inaccessible and could not be surveyed. In addition, difficult to access metal surfaces in the overhead areas of area 14 (lower horizontal surfaces close to wall in area 14SW) are above DOE clean-up criterion. Survey activities are continuing in area 9 and 14 SE, and subsequent letters will address these areas.

Sincerely,

S. P. McKenzie
Measurement Applications
and Development Group

SPM:lec

Enclosures

c: R. D. Foley
M. E. Murray
File-RC

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

September 16, 1998

Mr. R. J. Gibbs
Bechtel National, Incorporated
151 Lafayette Drive
Post Office Box 350
Oak Ridge, Tennessee 37831-0350

Dear Mr. Gibbs:

Contract DE-AC05-96OR22464. Independent Verification Surveys of 9 Lab and 14SE of Building 14

During the week of July 6-13, 1998, Independent Verification Surveys (IV) were conducted in areas 9 Lab and 14SE of Building 14. The ceiling, exposed subsurface soils, and remaining floor areas of area 14SE were investigated. This area of investigation includes approximately one foot of the bottom of the wall. In addition the subsurface soils, walls, and remaining concrete floor surfaces were surveyed in area 9 Lab.

The exposed soils in areas 9 Lab and 14SE were scanned and soil samples were collected. The remaining concrete floor surfaces were also surveyed. After further decontamination efforts, review of the post remedial action radiological data supplied by the subcontractor, and additional data collected from the remediated areas collected by the independent verification contractor, these areas are verified not to have residual contamination above the guidelines as defined in Department of Energy (DOE) Order 5400.5. Walls in area 9 Lab were also scanned and after removal of additional contaminated material this area has also been verified not to have contamination above DOE guidelines. There is a portion of the subsurface in area 9 Lab containing a pipe that will be included in the request for supplemental standards, as it is above clean-up criterion. This email is not a verification statement and should not be used as one, since our soil samples have not been analyzed.

If you have any questions or need further information please call (423) 576-4108.

Sincerely,

S. P. McKenzie
Measurement Applications
and Development Group

SPM:lec

c: R. D. Foley
File-RC

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

September 21, 1998

Mr. R. J. Gibbs
Bechtel National, Incorporated
151 Lafayette Drive
Post Office Box 350
Oak Ridge, Tennessee 37831-0350

Dear Mr. Gibbs:

Contract DE-AC05-96OR22464, Clarification Status of the Independent Verification of Building 14, Praxair Site

This correspondence is to clarify our standing regarding areas remediated but not covered under previously issued correspondence. Portions of these areas were either omitted from earlier reports or additional decontamination was required. Area 21, which at one time housed underground sumps, has been decontaminated and falls below Department of Energy (DOE) guidelines for soil contamination as outlined in DOE Order 5400.5. The area was at one time enclosed and fell within the scope of this effort. The walls, steps, ceiling, and pipes associated with the stairwell in area 12, that leads to the utility tunnel, was also surveyed and is below DOE guidelines for surface contamination. The internal piping was cleared during the process piping investigations. However, the subsurface is not covered under this letter. Survey data collected by the subcontractor at an area along the wall between areas 14SE and area 15, have been released as falling below the DOE surface guidelines.

If you have any questions or need additional information call (423) 576-4108.

Sincerely,

S. P. McKenzie
Measurement Applications
and Development Group

SPM:lec

c: R. D. Foley
File-RC

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

October 23, 1998

Mr. Ray Pilon
CELRB-PP-PM
U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Pilon:

Contract DE-AC05-96OR22464, Clarification of Verification Activities Associated With Building 14, Praxair Facility

The purpose of this correspondence is to clarify any outstanding areas and misunderstood issues with respect to verification activities conducted in Building 14 at the Praxair facility. Initially, this type of correspondence served only as a vehicle to expedite the restoration/betterment activities that followed the remediation of parts of this building. They have never been intended as a final verification statement. A final, comprehensive verification report will be issued to cover all Oak Ridge National Laboratory (ORNL) activities in Building 14.

The ceiling in Area 14SE has been determined to fall below the surface guidelines as defined in Department of Energy (DOE) Order 5400.0. All soil samples have now been analyzed and the outstanding subsurface soils in Areas 9 and 14 fall below the site specific soil criterion of 60pCi/g total uranium. All surfaces (walls, stairs, floor, ceiling, and electrical conduits) associated with the stairwell leading to the utility tunnel in Area 12 have been verified as falling below the DOE surface guidelines. We are presently awaiting post remedial action surveys of the drain lines and sump location under the floor in this area.

If you have any questions or need more information please call (423) 576-4108.

Sincerely,

Sam P. McKenzie
Measurement Applications
and Development Group

SPM:lec

c: R. D. Foley
R. J. Gibbs, BNI
File-RC

D.t 11/4/98

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

November 4, 1998

Mr. Ray Pilon
CELRB-PP-PM
U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Pilon:

Contract DE-AC05-96OR22464, Radon Contamination Building 14, Praxair Facility

The purpose of this correspondence is to convey the results of our investigations for potential radon contamination in building 14, at the Praxair Facility. We are reporting our findings in picocuries per liter (pCi/l) and not working levels, because our detectors measure radon and not the daughters of radon. The numbers can be converted to working levels, taking into consideration a few basic assumptions.

If you have any questions or need additional information please call (423) 576-4108.

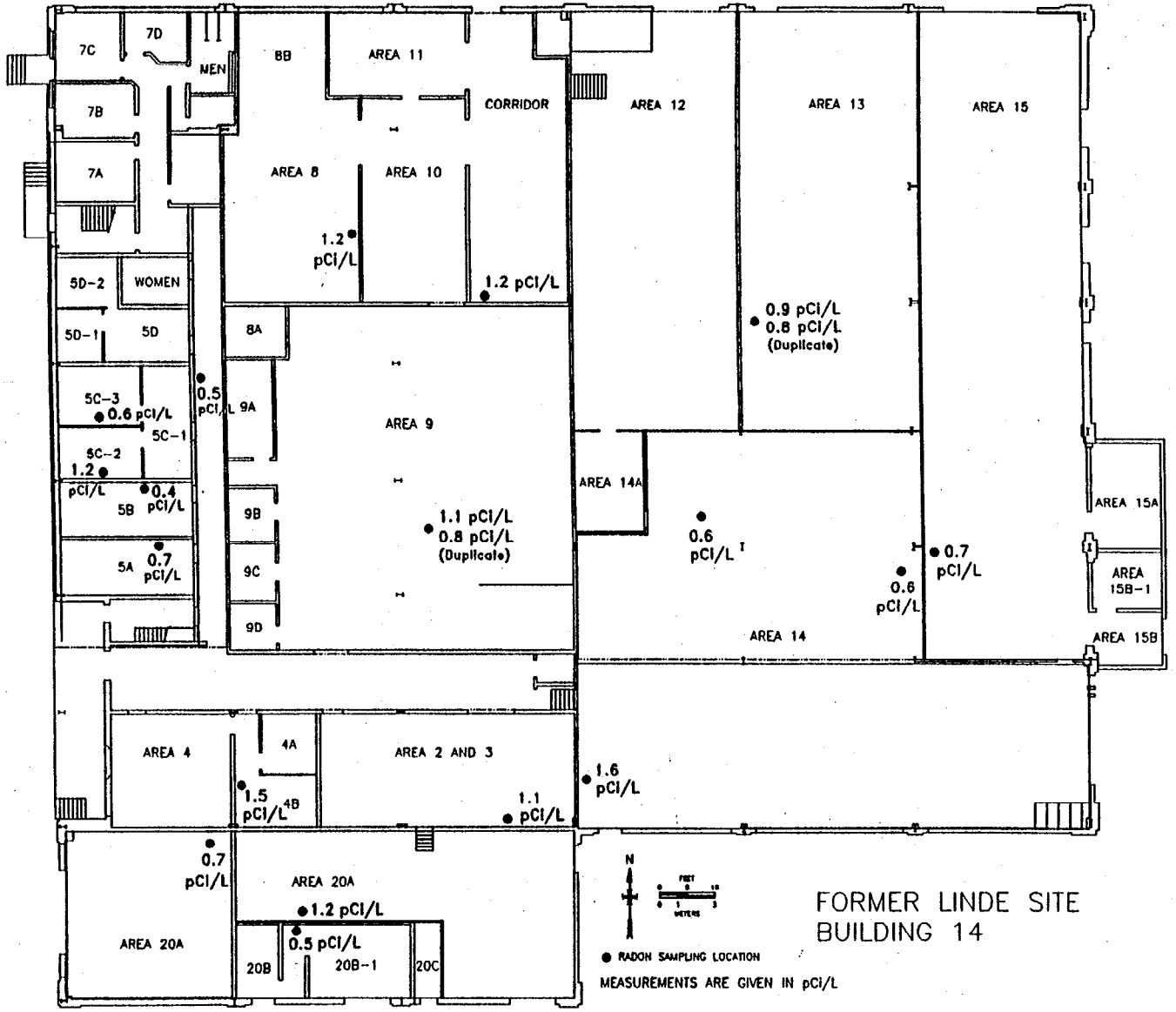
Sincerely,

S. P. McKenzie
Measurement Applications
and Development Group

SPM:lec

Attachment: 1 Drawing, Radon Sampling Location, Former Linde Site, Building 14

c: R. D. Foley
R. J. Gibbs, BNI
M. E. Murray
File-RC



FORMER LINDE SITE
BUILDING 14

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

November 10, 1998

Mr. Ray Pilon
CELRB-PP-PM
U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Pilon:

Contract No. DE-AC05-96OR22464, Radiological Data for Building 14 Praxair Site

The purpose of this correspondence is to convey the results of our evaluation of radiological data, taken by the subcontractor for Building 14, at the Praxair site. We agree with their findings (attached), that the surfaces of the sump located in the utility tunnel section of area 12, as well as the east and west drain lines leading into the sump, fall below the Department of Energy (DOE) criterion for radiological surface cleanup. The north drain line however, does exceed guidelines and further action will be necessary to resolve this portion of pipe. The remedial action survey of this sump area had not been received until recently. This sump area also falls below the DOE criterion for surface cleanup, and will be addressed in our verification report to be released subsequently.

If you have any questions or need additional information please call (423) 576-4108.

Sincerely,

S. P. McKenzie
Measurement Applications
and Development Group

SPM:lec

Attachment

c: R. D. Foley
R. J. Gibbs, BNI
M. E. Murray
File-RC

ION TECHNOLOGY, INC.
640 Maple Ave
Saratoga Springs, NY
(518) 584-0166

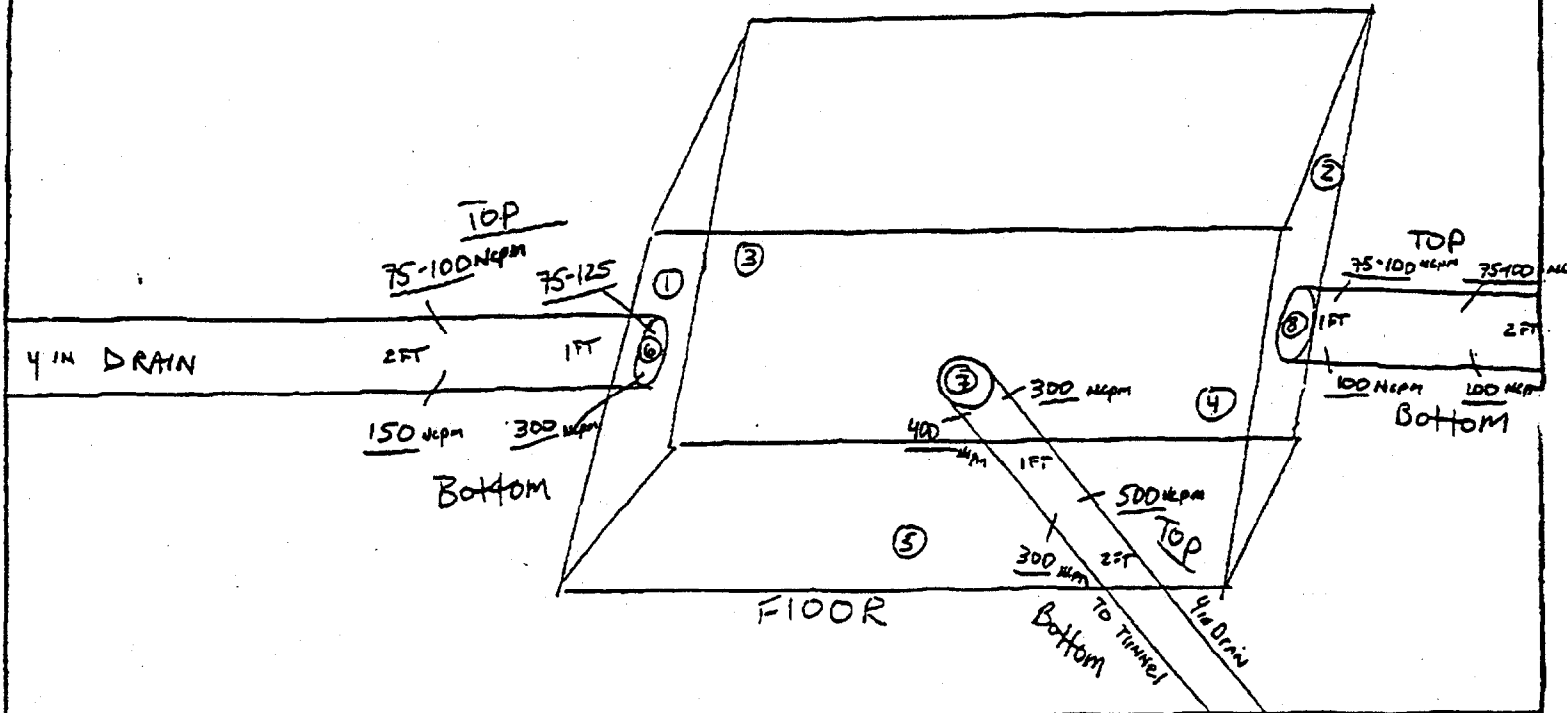
RADIOLOGICAL SURVEY

Project: PRAXAIR
Area: B14 A12 Sump

0225 } SEC
0226 } Surveys

Date/Time 9/23/97 /2100	Tech SMAILIDGE	Instrument/sn 2221
Location/ Purpose B-14 A-12 Sump pit AREA	Survey # 810	RWP# 01
VERIFICATION Survey		

AREA 12 Sump pit



Loc	Type	Description	Gross	α dpm	Gross	β dpm	Loc	Type	Description	Gross	α dpm	Gross	β dpm
1	S	EAST WALL	2	6	56	-14	E.WALL	D.P.	EAST WALL			50-250	
2		WEST WALL	0	0	69	31	W.WALL	D.P.	WEST WALL			50-180	
3		South WALL	4	12	77	59	↓	↓	↓			50-180	N/T
4		North WALL	1	3	916	124	S.WALL	D.P.	South WALL			90-260	
5		FLOOR	2	16	79	65	↓	↓	↓			90-260	
6		EAST PIPE	1	3	65	17	N.WALL	D.P.	North WALL			50-250	
7		North pipe	1	3	69	31	↓	↓	↓			50-250	A
8	↓	WEST PIPE	1	3	67	24	FLOOR	D.P.	FLOOR			75-275	
E.WALL	D.P.	EAST WALL	~~X~~	~~A~~	50-250	N/A	↓	↓	↓			75-275	

Type: s = smearable, dp = direct probe

Comments: (#) SMEAR LOCATION
D.P. READINGS @ CONTACT ALL READING N.C.P.M.

	BKD	EFF	MDA
Scalar S/N 91234			
CT= 1M1A DATE 9/23/97 α:	.13	.32	14
Tech SMAILRIDGE β:	60.2	.29	134

Review:

OAK RIDGE NATIONAL LABORATORY
MANAGED BY LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

January 13, 1999

Mr. Ray Pilon
CELRB-PP-PM
U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Pilon:

Contract No. DE-AC05-96OR22464, Post Remedial Action Report Review for Building 14

As you requested, members of the Measurement Applications and Development group, have reviewed the draft "Post Remedial Action Report for Building 14, Linde Site." This report was prepared by Bechtel National, Incorporated, dated November 1998.

In general we agree with the findings of this report. The data presented in this report agrees with our data within the bounds of radiological field survey techniques and instrument variation. However, there are a few comments we would like to make.

- The term "supplemental limits" is used several times in the document, but nowhere in the document are the "supplemental limits" stated that were used for areas not decontaminated and subsequently hazard assessed. We feel that these values should be included in the document. If different limits were used in different locations, these should also be stipulated.

- In the last paragraph of the executive summary, first line, it is stated that "the remedial action in Building 14 successfully identified all interior surfaces and sub-surfaces within the building footprint exceeding the remedial action criteria through an extensive delineation phase and review of previously collected delineation data." We take exception to the **"all"** in this statement. This is not to say the statement is incorrect, but based on many years of experience in this line of work, it has been our experience that small areas of contamination, both surface and sub-surface, can be overlooked. This building has had rooms added on and has undergone extensive remodeling since the Manhattan Project involvement was completed. This kind of action often covers up or makes inaccessible, small areas, which could contain some level of contamination. Due to the extensive radiological survey efforts expended in this building, we feel these areas are few and if they exist, would be small. If future maintenance or demolition activities were to inadvertently disturb these possibly existing areas, we feel that any personnel exposure would be very low and would not exceed exposure guidelines, because of the limited number and size of the areas involved. This statement refers only to those areas where contamination may be undiscovered, not to those areas where supplemental limits have been utilized or where suspected contamination may exist.

- The "Post Remedial Action Report," is a large and detailed document. It details both verbally and in drawings those areas still contaminated, where a hazard assessment has been utilized, using supplemental guidelines. We feel Figure 5-1 should be a large size color drawing i.e., an E-size, and the activity data should be included on the drawing and be furnished to the property owner for use by the Building 14 facility manager or maintenance personnel. Since the vast majority of the building is clean, the few areas containing or suspected to contain contamination exceeding guidelines, would be color coded for quick reference. The detailed report would still be available if work was going to be done in locations near known contamination.

- There appears to be a discrepancy in Figure 5-1. There are hazard assessed areas not depicted on the drawing. Example Area 12; south end of room on the east, south, and west walls. There is sub-surface contamination at the base of these three walls, which is not shown.

- There is also a contaminated structural beam in Area 14, which exceeds guidelines and was hazard assessed. The beam lies on the extreme western side of Area 14 and is parallel to the wall.

- Until all hazard assessed areas are approved, it is suggested that health physics coverage be provided for any work in these areas.

- There is a question concerning the legend in certain drawings. Example 4.3-1, "Contamination less than 1 meter on walls with a cross-hatched design and, "Contamination up to 1 meter on walls," with a double cross-hatch design. Basically, both say the same thing, so we suspect something has been left out. This legend and any other legends, should be reviewed and clarified.

- The "Post Remedial Action Report," states that some of the hazard assessed areas have been approved and others are pending. It is recommended the document be held until all areas are approved and the document rewritten to reflect these changes.

If you need additional information or have any questions please call me at (423) 576-7584.

Sincerely,

Ray D. Foley

Ray D. Foley
Measurement Applications
and Development Group

RDF:lec

c: S. P. McKenzie
M. E. Murray
R. E. Rodriguez
File-RC

DISTRIBUTION

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12. M. M. Bukhari, Bechtel National, Inc., FUSRAP Department, Oak Ridge Corporate Center, 151 Lafayette Drive, P.O. Box 350, Oak Ridge, TN 37831-0350

13–22. Raymond. L. Pilon, CELRB-PP-PM, U.S. Army Corps of Engineers, 1776 Niagara Street, Buffalo, NY 14207-3111

23–24. Office of Scientific and Technical Information, U.S. Department of Energy, P.O. Box 62, Oak Ridge, TN 37831-0062