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Results of the Independent Radiological Verification Survey of Remediation at Building 31, Former Linde Uranium Refinery, Tonawanda, New York (LI001V)

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MANAGED AND OPERATED BY
LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
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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 31 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 radioactive material was prevalent throughout the building and in some of the duct work. Decontamination consisted of removing surface contamination from floors, baseboards, and overhead areas; removing some air ducts; and vacuuming dust.

Building 31 at the former Linde site in Tonawanda, New York, was thoroughly investigated inside and outside for radionuclide residues. The verification team discovered previously undetected contamination beneath the concrete pad on the first floor and underneath floor tiles on the second floor. All suspect floor tiles were removed and any contamination beneath them cleaned to below guideline levels. The verification team also discovered elevated radiation levels associated with overhead air lines that led to the eventual removal of the entire air line and a complete investigation of the history of all process piping in the building.

Final verification surveys showed that residual surface beta-gamma activity levels were slightly elevated in some places but below U.S. Department of Energy applicable guidelines for protection against radiation (Table 1). Similarly, removable radioactive contamination was also below applicable guidelines. Exposure rates within the building were at typical background levels, and no consistently elevated indoor radon concentrations were measured. However, radionuclide analysis of subsurface soil from beneath the concrete floor on the ground level showed concentrations of ^{238}U and ^{226}Ra that exceeded applicable guidelines. At the time of this survey, there was no measured exposure pathway for this subslab contamination under current use scenarios, and there was low risk associated with this contamination if the concrete slab is not cracked or penetrated. However, any penetration of the concrete slab caused by renovations, repairs, demolition, or a naturally-occurring crack, would require further investigation and evaluation.

Analysis of the project management contractor's post-remedial action data and results of this independent radiological verification survey by ORNL confirm that all radiological measurements inside the building, on the exterior walls, and on the roof are below the limits prescribed by applicable guidelines for protection against radiation.

Results of the Independent Radiological Verification Survey of the Remediation at Building 31, Former Linde Uranium Refinery, Tonawanda, New York (LI001V)*

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 cannot be found, and the final radiological conditions of the site cannot 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. Only two points on roof vents in Building 31 showed radioactive contamination. According to the remedial investigation report, uranium dioxide was fluorinated to produce uranium tetrafluoride in Building 31. Since, the limited nature of contamination seemed inconsistent with the fluorination process used at that time and

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

the amount of contamination found in similar buildings at the Linde site, Building 31 was scheduled for further investigation and remedial action.

In 1995, Bechtel National, Inc. (BNI), the project management contractor designated by DOE, began remediation activities at Building 31. After BNI completed remediation in an area of the building, an independent verification survey of the remediated area was conducted by the Measurement Applications and Development Group of ORNL at the request of DOE's Office of Environmental Restoration. An independent verification contractor is 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 October 1995 to June 1998 at Building 31 at the former Linde Uranium Refinery. 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 31 at the Linde site.

SCOPE OF THE INVESTIGATION

The radiological verification investigation included the following:

- Systematic measurements using field instruments for detection of low-energy radiation (FIDLER) at 2-m intervals on the first floor and at 0.5-m intervals in selected areas of the second floor.*
- Collection and radiological analysis of soil samples from boreholes drilled through the concrete floor on the first floor of the building.
- Floor monitor surveys in areas where floor tiles had been removed, and beta-gamma scans of some other floor areas.
- Measurement of direct and transferable alpha and beta-gamma radiation levels at selected locations in the building.
- Thorough beta-gamma scans of the horizontal surfaces associated with interior overhead areas, including I-beams, cross ties, and wall/ceiling interfaces where contamination would most likely be concentrated.
- Thorough beta-gamma scans of the building interior baseboards (wall/floor interfaces), and verification of BNI wall survey data.
- Spot checks for contamination in additions and newly remodeled areas of the building.
- Measurement of indoor radon levels in several areas of the building.
- Radiological surveys of exterior walls, and examination of BNI roof survey data.
- Examination of post-remedial action data collected by BNI.

A radiological survey of exterior surface soil and grounds in the vicinity of Building 31 was not within the scope of this investigation. However, examination of the project management contractor's

*Floor grid size was selected based on suspected contamination, area, and time and cost considerations. The first floor covered a wide expanse and the survey crew was looking for large areas of soil contamination beneath the concrete, therefore, a 2-m grid was deemed sufficient. The second floor rooms were smaller and the survey crew was looking for small spots of contamination on the surface of the concrete beneath floor tiles in areas that had formerly been used as laboratories, therefore a 0.5-m grid was selected.

post-remedial action report is a required part of verification, and this activity will be completed as soon as the report becomes available.

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). Alpha radiation levels were measured with Bicron scaler/ratemeters connected to zinc sulfide scintillation probes.

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.)

FIDLER detection systems were used to measure the relative gamma fluence at the surface with the purpose of detecting gamma emitting radionuclide contamination beneath poured concrete floors on the first floor and beneath floor tiles on the second floor. 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 made at 2-m intervals on the first floor to ascertain that no large areas of soil contamination were present beneath the concrete slab. Similarly, FIDLER measurements were made at 0.5-m intervals in selected rooms and the hallway of the second floor to make certain that no contaminated spots were present on the surface of the concrete beneath floor tiles in former laboratory areas. Measurements in counts per minute were taken with three different instruments and then normalized such that the observed values would appear to have come from only a single detector.

Sixteen subsurface (from depth of 15 to 45 cm) soil samples were collected at 10 locations underneath the building by core drilling through concrete on the first floor. These biased samples* were collected at points representing a range (high to low) of subsurface radiation levels as indicated by

*Systematic subsurface soil sampling using preselected grid locations or random locations selected irrespective of FIDLER measurements was not conducted.

surface FIDLER measurements. Concentrations of ^{226}Ra, ^{232}Th, and ^{238}U were determined in soil samples using gamma spectrometry with hyper-pure germanium (HPGe) systems.

Floors in some 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; a man lift was used for the building exterior. Approximately 50% to 60% of the exterior wall area was surveyed between the ground and a height of 10 to 12 ft. Exterior wall surfaces more than 12 ft off the ground were spot checked for contamination.

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).

GAMMA AND ALPHA RADIATION LEVELS

Gamma exposure rates in Building 31 generally ranged from 8 to 13 μR/h, which is similar to typical background levels in the Tonawanda, New York, area (Table 2). Higher levels could be attributed to naturally occurring radioactive materials in brick and concrete. Direct alpha measurements were taken at numerous random locations throughout the building during all stages of remediation and verification. Final direct alpha measurements in all verified areas were well below applicable guideline values (Table 1).

FIDLER MEASUREMENTS

Results of FIDLER measurements on the surface of the first floor are shown on Fig. 3. Normalized measurements ranged from 3500 to 17,000 cpm. Discounting slightly increased readings due to the geometry of a corner/wall measurement, most of the higher measurements were concentrated in the east, and particularly the northeast, part of the building. This grouping of elevated FIDLER measurements suggested that subsurface contamination might be present beneath the concrete floor. Elevated FIDLER measurements were used to select locations for the collection of subsurface soil samples, which confirmed the presence of contamination. FIDLER measurements also confirmed that excessive beta-gamma emitting contaminants were not present on the surface.

Results of FIDLER measurements on the second floor are shown on Fig. 4. Normalized measurements ranged from 2700 to 13,000 cpm. Elevated FIDLER measurements on the tile and mastic material in rooms 214, 215, and 216 prompted further investigation. These rooms were used as labs during the time of the MED contract. Removal of tiles and analysis with a portable NaI gamma spectroscopy system indicated strong ^{226}Ra peaks in Room 215 and ^{238}U peaks in Room 216. This method identified contamination in excess of cleanup guidelines beneath the tiles. The tiles were removed and the contaminated areas remediated (see section on Beta-Gamma Activity Levels) by the BNI radiological support subcontractor. (The ^{226}Ra in Room 215 was later determined to be a component in the concrete.)

SOIL SAMPLES

Biased soil sample locations are shown in Fig. 5, and results of radiological analyses are listed in Table 3. Surface samples (0 to 15 cm) consisted of the concrete plugs, which were returned to the core holes. Concentrations of ^{238}U in subsurface soil (15–46 cm) ranged from 0.52 to 5.6 pCi/g at seven sample locations and from 40 to 230 pCi/g at the remaining three locations. Concentrations of ^{226}Ra in subsurface soil ranged from 0.53 to 6.2 pCi/g at seven sample locations and from 21 to 250 pCi/g at the remaining three locations. The same three sampling locations (VB15, VB19, and VB20) exceeded applicable guideline values for both ^{238}U and ^{226}Ra. All three sampling locations were located beneath Room 114. Typical background levels for ^{238}U and ^{226}Ra in the Tonawanda area (Table 2) were exceeded at sampling locations VB13, VB16, VB17, and VB18, which were located beneath rooms 110, 111, and 112. Concentrations of ^{232}Th in subsurface soil ranged from 0.22 to 3.0 pCi/g with one sample above typical background levels for ^{232}Th (Table 2), but all samples were well below applicable guideline values (Table 1) for this radionuclide.

SMEAR SAMPLE ANALYSIS

First floor smear sample locations are shown in Fig. 6, and second floor locations are shown in Fig. 7. Results of smear sample analysis are given in Table 4. No removable alpha or beta-gamma emitting material was measured in smear samples collected on the first floor. Before final remediation, second floor smear samples showed small amounts of removable alpha emitting material in samples VT1 and VT2 (Room 203), VT3 (Room 207), and VT19 (second floor hallway), and a small amount of removable beta-gamma emitting material in sample VT1 (Room 203). These areas were not verified below guidelines on the dates these smears were taken (See Table 5). More remediation was recommended and conducted in these rooms. The small amounts of removable radioactivity in smears VT5 (Room 205), VT12 (Room 215), and VT18 (Room 202) were well below guideline values. Based on these and other survey results, these rooms were verified below guidelines on the dates the smears were taken. After all remediation and verification activities were completed at Building 31, all removable radioactivity levels were well below applicable guidelines (Table 1).

BETA-GAMMA ACTIVITY LEVELS

Results of the surface beta-gamma scans of the floors, baseboards, walls, and overhead areas on both the first and the second floor are summarized in Table 5. Detailed survey drawings are on file. The term "verified below guidelines" is used in Table 5 to indicate that scan results showed total residual surface beta-gamma contamination below the applicable guideline limits listed in Table 1 for uranium (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 are classified as "needs further remediation" or "needs further investigation."

As indicated by Table 5, many areas of the building were scanned more than one time and on more than one date. When verification surveys indicated that applicable guideline values (Table 1) had not been achieved, additional remediation was required. Following the verification team's recommendation, tiles covering the floor in several rooms on the second floor were removed and subsurface areas remediated to ensure that no contamination remained below the tiles. The verification team's discovery of elevated radiation levels associated with air lines in rooms 105 and 102 led to the eventual removal of the entire air line and a complete investigation of the history of all process piping in Building 31. Some areas of Building 31 still have easily detectable radioactive materials remaining, but none of these areas exceed applicable guideline values for total residual surface contamination (Table 1).

A survey of Building 31 exterior walls revealed an area associated with a transformer that was above guidelines (Table 1). This area was remediated and resurveyed by the BNI radiological support subcontractor. With the exception of the transformer area, no elevated radioactivity levels were found during the survey of Building 31 exterior walls or during verification of roof survey data collected by BNI.

INDOOR RADON LEVELS

Six electret radon monitors were deployed for 7 days at four locations from March 17 to 24, 1998, and an additional four monitors were deployed for 31 days at four different locations from May 28 to June 29, 1998. The first four sampling locations are shown in Fig. 8. Sampling locations were selected to coincide with the highest subsurface soil radionuclide levels (Table 3 and Fig. 5) and the highest FIDLER measurements (Fig. 3). Results from all radon measurements are given in Table 6. One of the 7-day electrets showed radon concentrations of 5.2 pCi/L in Room 111. This is slightly above the EPA action level of 4 pCi/L. Two 31-day follow-up measurements in Room 111 showed concentrations of 0.5 and 0.8 pCi/L, which falls within the range of the other seven radon measurements (0.3 to 1.7 pCi/L) and well below the EPA action level.

SIGNIFICANCE OF FINDINGS

Prior to remediation, fixed alpha and beta-gamma emitting material was prevalent throughout Building 31 and in some of the duct work. Decontamination, performed by BNI and subcontractors under the direction of BNI, consisted of removal of surface contamination from floors, baseboards, and overhead areas; removal of some air ducts; 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 31 at the former Linde site in Tonawanda, New York, was thoroughly investigated inside and outside for radionuclide residues. Total residual surface activity levels were slightly elevated in some places but well below applicable guidelines for protection against radiation. Similarly, removable alpha and beta-gamma activity levels were also well below applicable guidelines. Exposure rates within the building were at typical background levels, and no consistently elevated indoor radon concentrations were measured. However, radionuclide analysis of subsurface soil from beneath the concrete floor on the ground level showed concentrations of ^{238}U and ^{226}Ra that exceeded applicable guidelines. At the time of this survey, there was no exposure pathway for this subslab contamination under current use scenarios, and there was low risk associated with this contamination if the concrete slab is not cracked or penetrated. However, any penetration of the concrete slab caused by renovations, repairs, demolition, or a naturally-occurring crack, would require further investigation and evaluation.

Analysis of the project management contractor's post-remedial action data and results of this independent radiological verification survey by ORNL confirm that all radiological measurements inside the building, on the exterior walls, and on the roof are below the limits prescribed by U.S. Department of Energy applicable guidelines for protection against radiation.

REFERENCES

DOE (U.S. Department of Energy). May 1978. *Radiological Survey of the Former Linde Uranium Refinery, Tonawanda, New York*, DOE/EV-0005/5, UC-70, U.S. Department of Energy, Division of Environmental Control Technology, Formerly Utilized MED/AEC Sites Remedial Action Program.

DOE (U.S. Department of Energy). September 1980. *A Background Report for the Formerly Utilized Manhattan Engineer District/Atomic Energy Commission Sites Program*, DOE/EV-0097.

DOE (U.S. Department of Energy). February 1993. *Remedial Investigation Report for the Tonawanda Site, Tonawanda, New York*, DOE/OR/21949-300, U.S. Department of Energy, Formerly Utilized Sites Remedial Action Program.

Myrick, T. E., et al. April 1987. *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab.

ORNL (Oak Ridge National Laboratory). January 1995. *Measurement Applications and Development Group Guidelines*, ORNL-6782, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab.

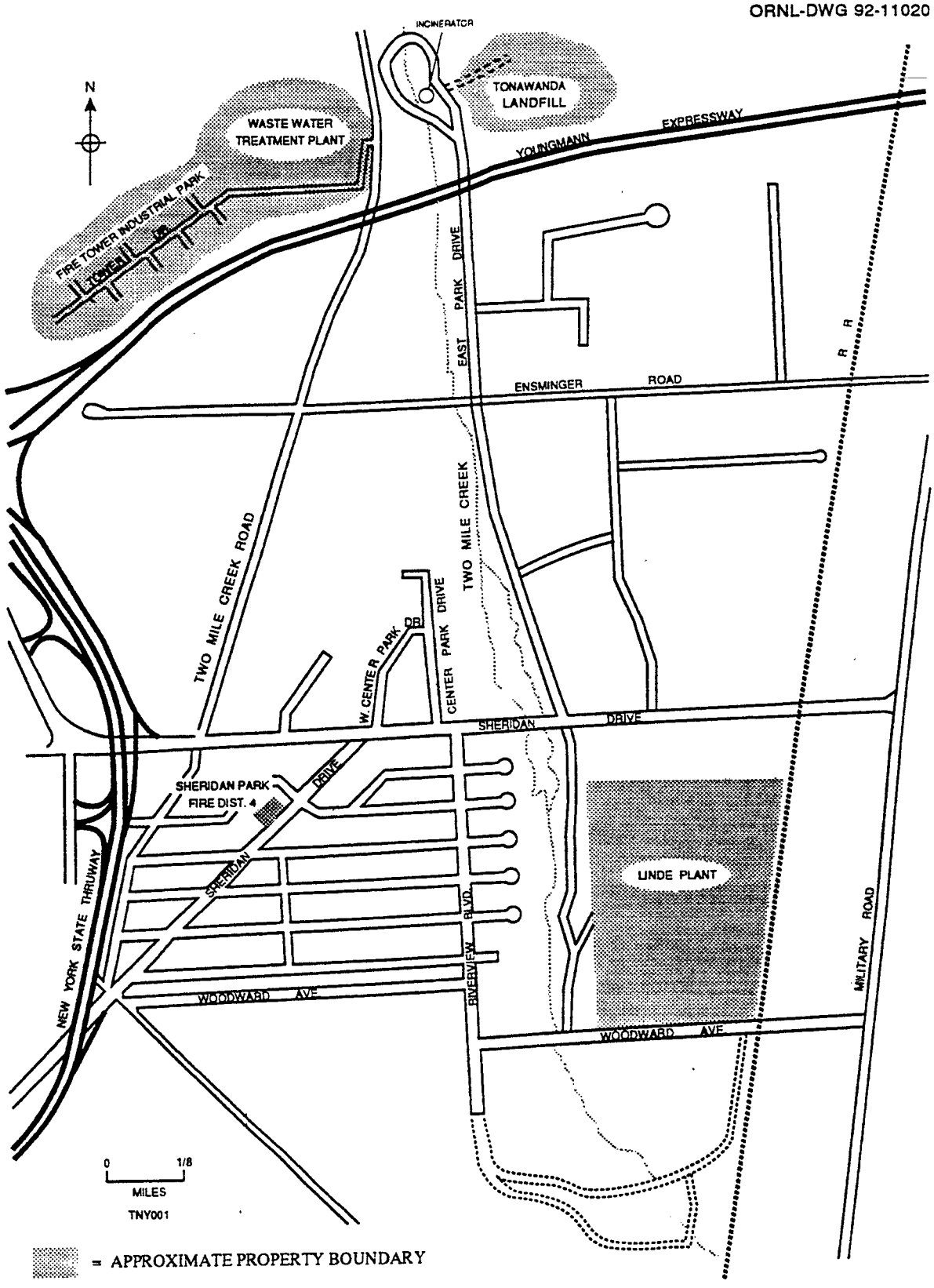

Fig. 1. Diagram showing general location of the former Linde site in Tonawanda, New York.

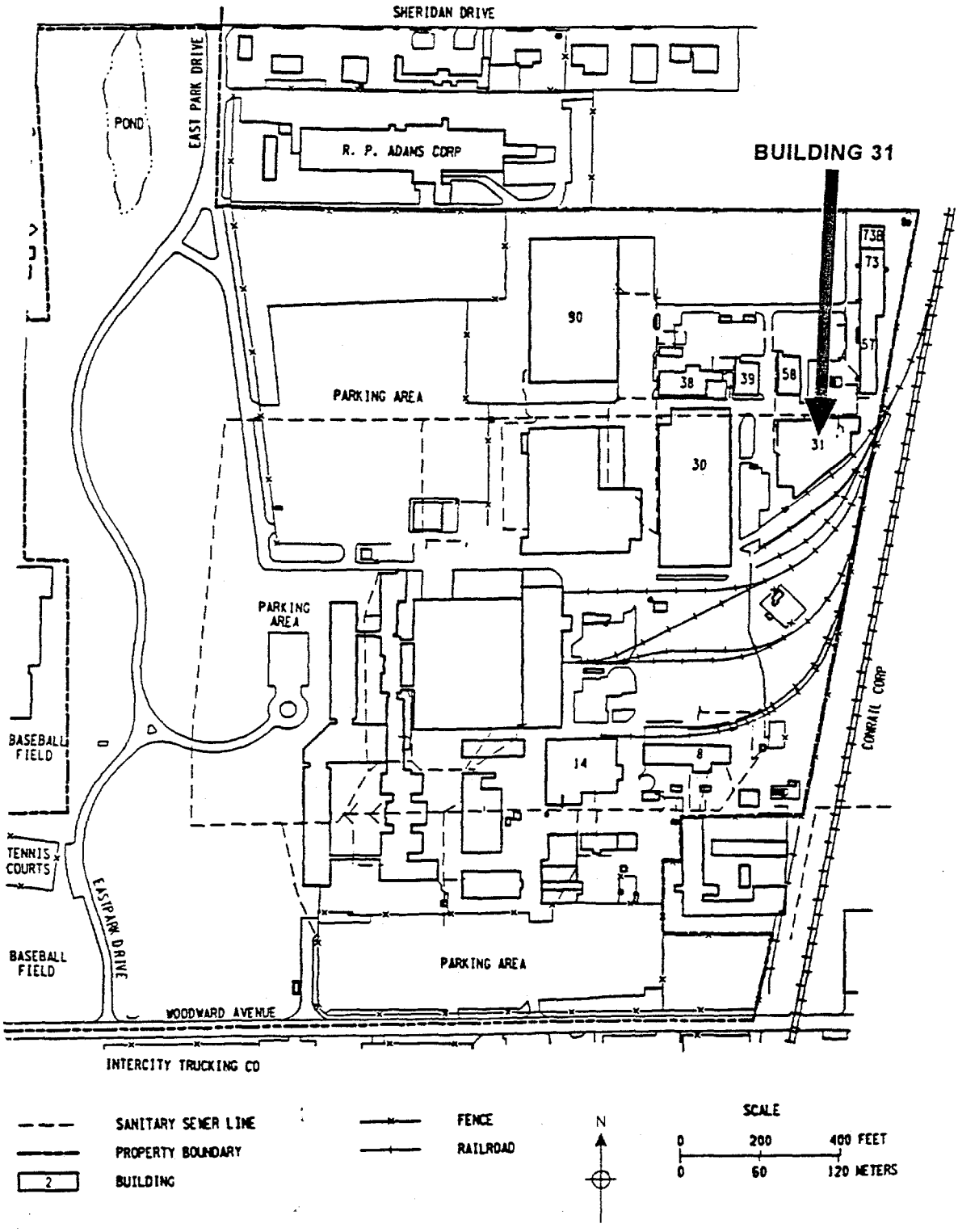

Fig. 2. Diagram showing general location of Building 31, at the former Linde site, Tonawanda, New York.

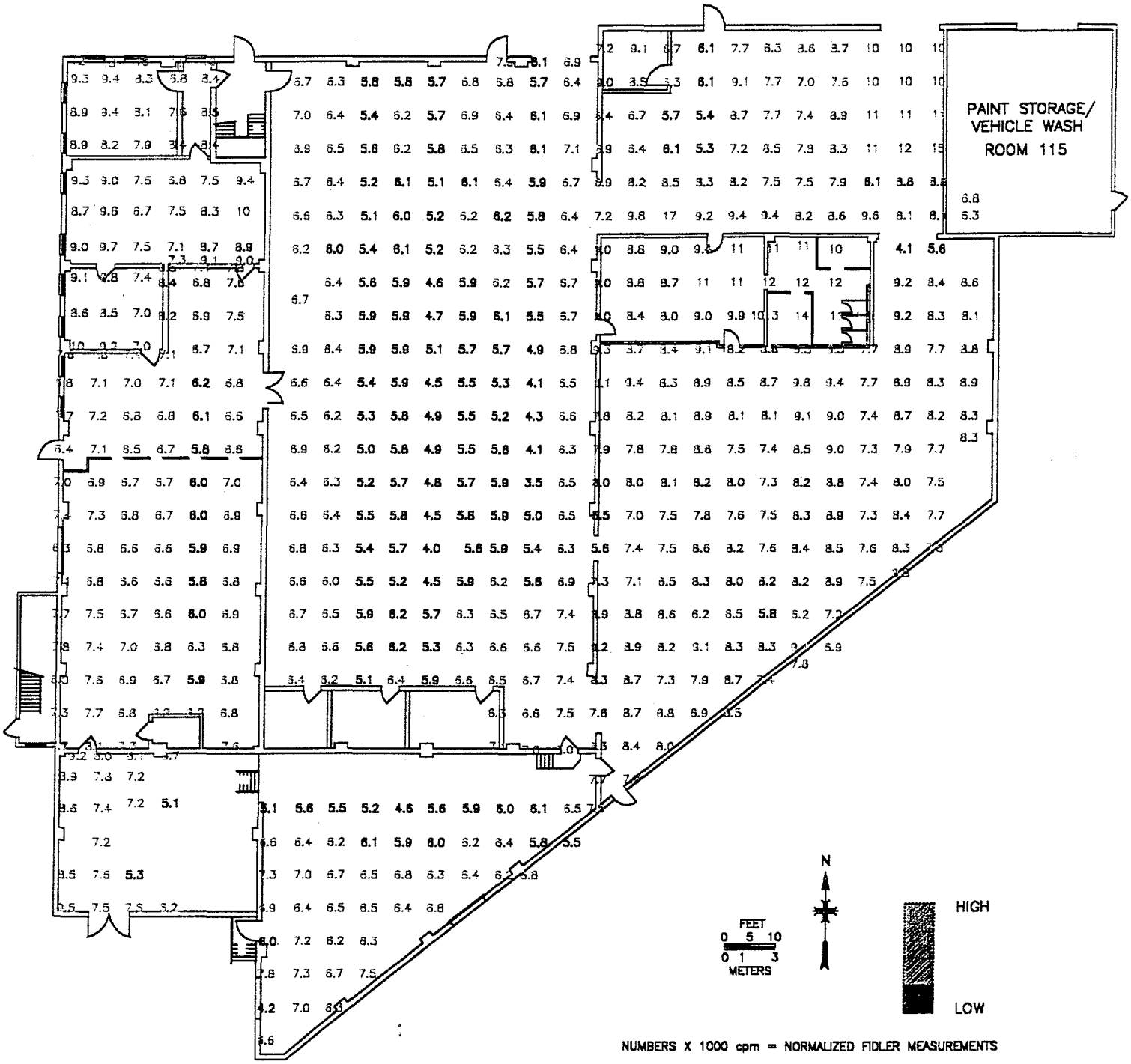

Fig. 3. Diagram showing first floor FIDLER measurements at Building 31.

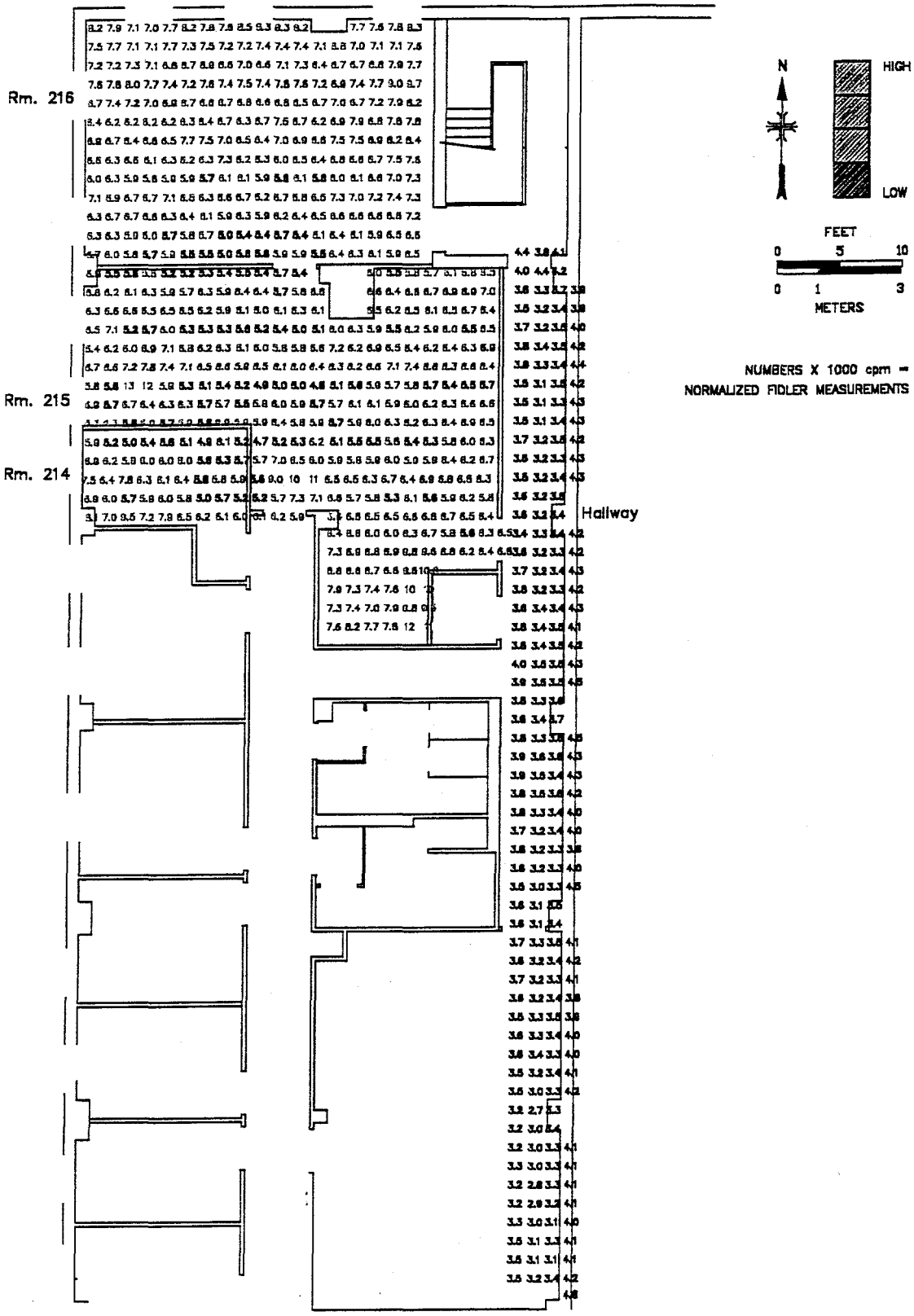

Fig. 4. Diagram showing second floor FIDLER measurements at Building 31.

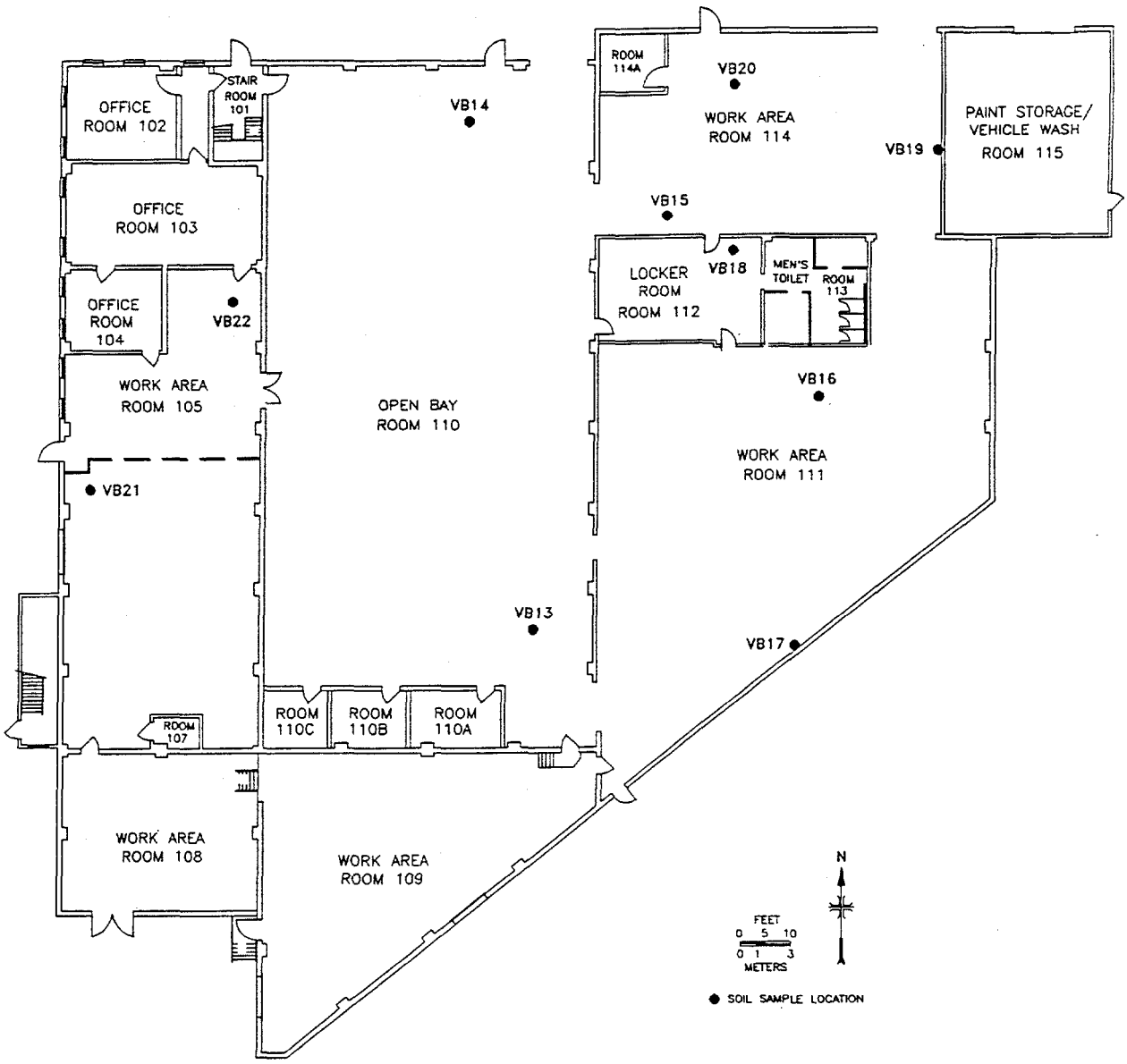

Fig. 5. Diagram showing location of biased soil samples collected underneath the first floor at Building 31.

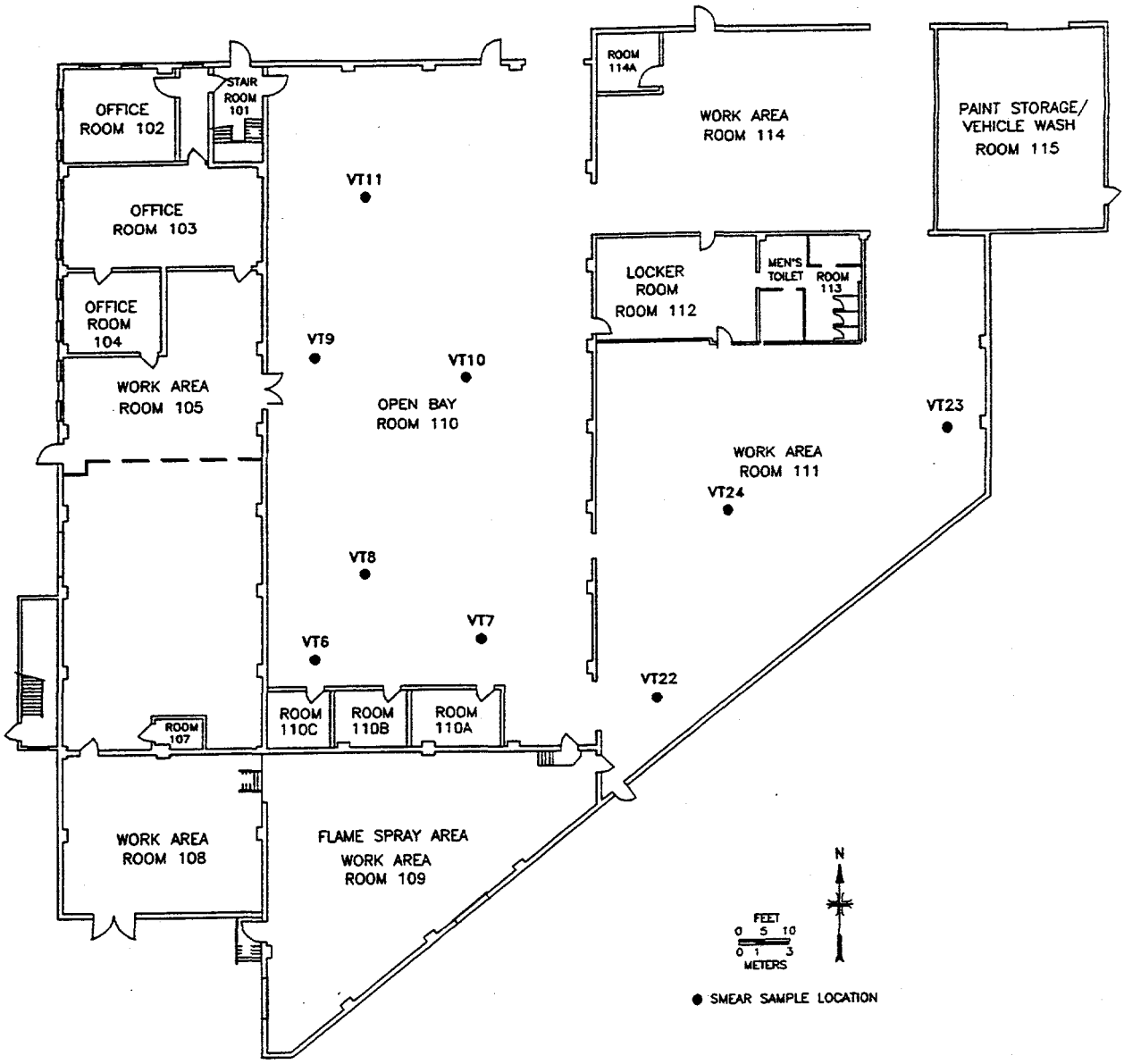

Fig. 6. Diagram showing first floor smear sample locations at Building 31.

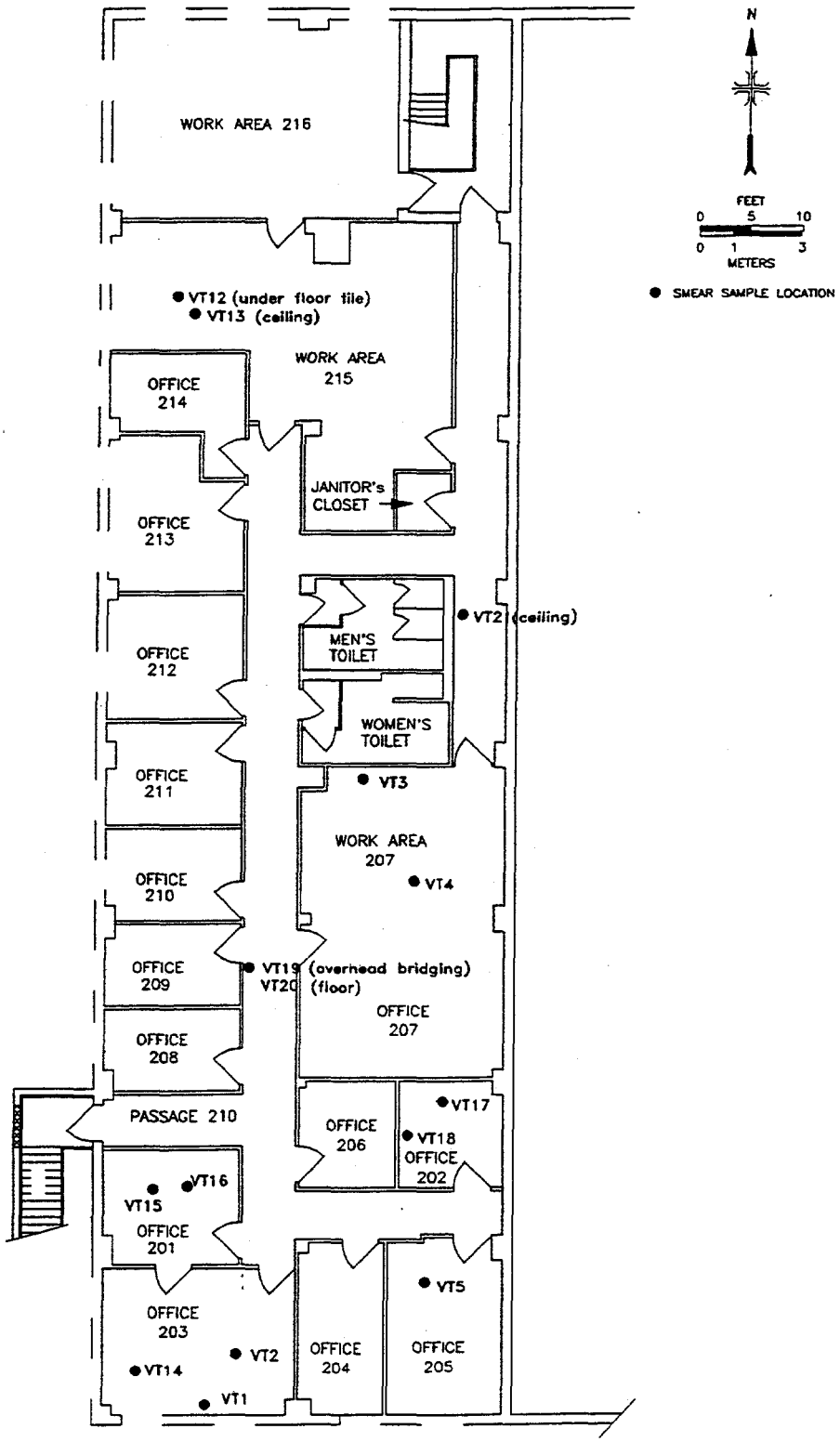

Fig. 7. Diagram showing second floor smear sample locations at Building 31.

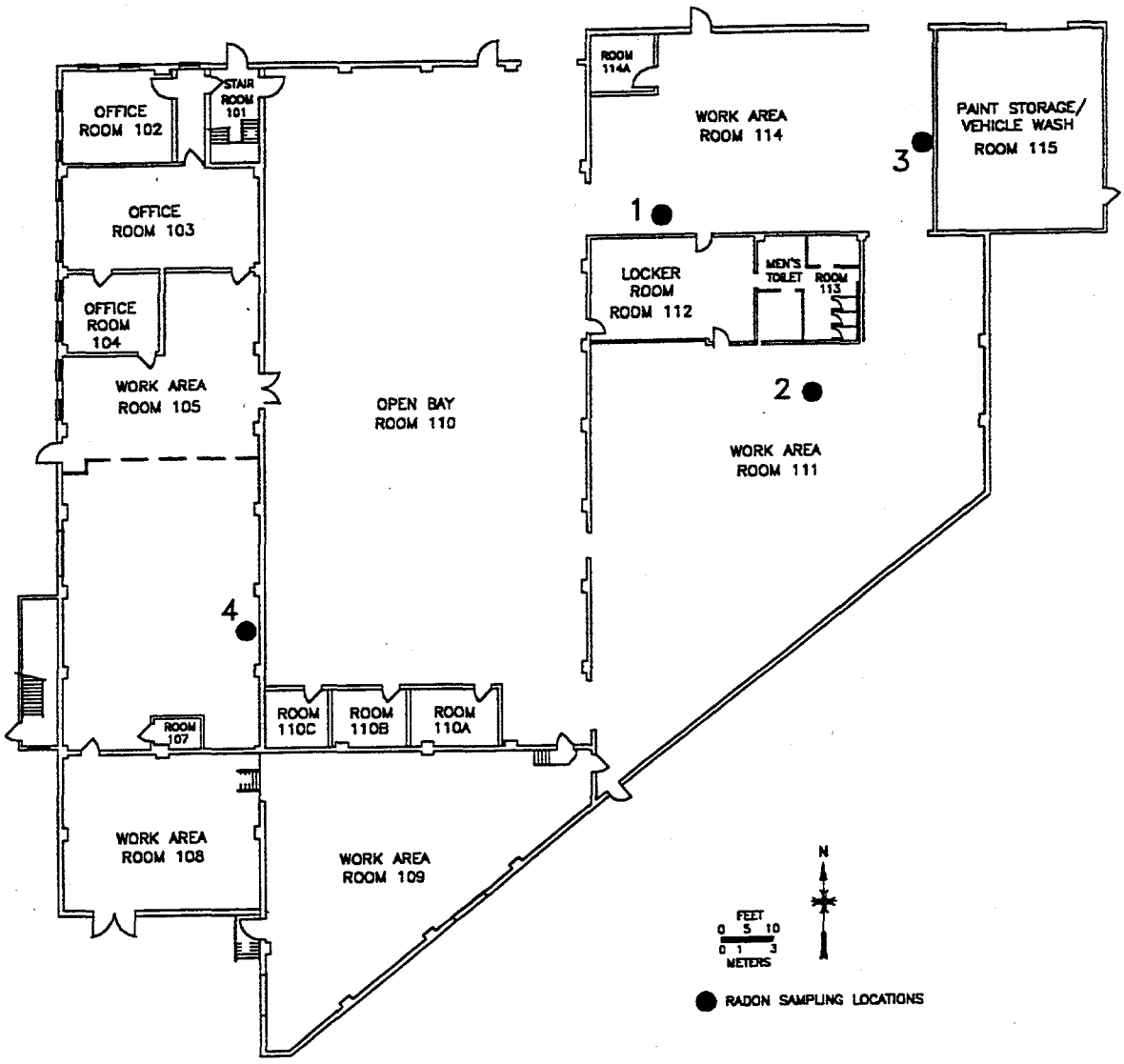

Fig. 8. Diagram showing 7-day radon sampling locations at Building 31.

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")	$G_A = G_t(100/A)^{1/2}$, where G_A = guideline for "hot spot" of area (A) G_t = guideline averaged over a 100-m^2 area

[a]The 20 $\mu R/h$ 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 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]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, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab.

Table 3. Concentrations of radionuclides in soil samples, Building 31, former Linde Uranium Refinery, Tonawanda, New York

Sample ID[a]	Grid Location	Depth[b] (cm)	Radionuclide concentration (pCi/g)[c]		
			^{238}U	^{226}Ra	^{232}Th
		Biased soil samples[d]			
VB13B	17N, 28E	15–30	1.7 ± 0.4	1.8 ± 0.2	0.94±0.1
VB13C	17N, 28E	30–38	1.2 ± 0.4	1.2 ± 0.2	0.73±0.1
VB14B	48N, 24E	19–30	0.95± 0.3	1.0 ± 0.1	0.41±0.09
VB14C	48N, 24E	30–46	1.4 ± 0.3	1.3 ± 0.2	0.50±0.1
VB15B	42N, 36E	20–33	41 ± 5	89 ± 1	1.3 ±0.2
VB16B	31N, 45E	13–28	3.8 ± 0.4	5.2 ± 0.3	1.1 ±0.1
VB16C	31N, 45E	28–43	4.1 ± 0.4	6.2 ± 0.4	1.3 ±0.2
VB17B	16N, 44E	15–30	5.6 ± 0.7	6.0 ± 0.4	0.97±0.1
VB17C	16N, 44E	30–46	4.9 ± 0.5	5.7 ± 0.4	1.3 ±0.2
VB18B	40N, 40E	15–30	5.3 ± 0.7	6.0 ± 0.3	0.79±0.08
VB18C	40N, 40E	30–46	5.0 ± 0.6	6.2 ± 0.5	1.0 ±0.2
VB19B	46N, 52E	30–46	230 ±50	250 ±20	3.0 ±0.6
VB20B	50N, 40E	15–30	40 ± 5	22 ± 1	0.41±0.2
VB20C	50N, 40E	30–43	40 ± 5	21 ± 1	1.1 ±0.2
VB21B	25.5N, 1.5E	15–30	1.2 ± 0.4	0.98± 0.1	0.22±0.06
VB22B	37N, 10E	18–33	0.52± 0.3	0.53± 0.1	0.23±0.06

[a]Sample locations are shown on Fig. 5.

[b]The first samples (A) from the hole (~0 to 15 cm) were concrete core plugs, which were returned to the hole.

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

[d]Biased samples were collected at points representing a range (high to low) of subsurface radiation levels as indicated by surface FIDLER measurements. No systematic soil samples were collected.

Table 4. Transferable alpha and beta-gamma measurements at Building 31, former Linde Uranium Refinery, Tonawanda, New York

Smear sample ID[a]	Location[a]	Date smear collected	Removable radioactivity (smears)	
			Alpha[b] (dpm/100 cm^2)	Beta-gamma[c] (dpm/100 cm^2)
		First floor		
VT6	15.3N, 15E Room 110, open bay, underside of beam	12-16-95	[0]	[-18]
VT7	16.5N, 25E Room 110, open bay, overhead	12-16-95	[1]	[24]
VT8	20.5N, 18E Room 110, open bay, ceiling vent housing	12-16-95	[2]	[-35]
VT9	33.4N, 15E Room 110, open bay, I-beam	12-16-95	[1]	[6]
VT10	32.4N, 24E Room 110, open bay, overhead beam	12-16-95	[0]	[-18]
VT11	43.4N, 18E Room 110, open bay, N-S I-beam	12-16-95	[2]	[53]
VT22	12.7N, 35.6E Room 111, overhead	12-17-95	[0]	[-6]
VT23	29N, 53E Room 111, overhead	12-17-95	[0]	[-59]
VT24	24N, 40E Room 111, overhead	12-17-95	[0]	[12]
		Second Floor		
VT1	0.0N, 3.1E Room 203, ceiling	11-2-95	100[d]	220[d]

Table 4 (continued)

Smear sample ID[a]	Location[a]	Date smear collected	Removable radioactivity (smears)	
			Alpha[b] (dpm/100 cm²)	Beta-gamma[c] (dpm/100 cm²)
VT2	1.5N, 4.0E Room 203, ceiling	11-2-95	33[d]	[12]
VT3	18.5N, 7.75E Room 207, ceiling	11-2-95	65[d]	[100]
VT4	15.4N, 9.25E Room 207, ceiling	11-2-95	[3]	[0]
VT5	3.7N, 9.5E Room 205, overhead	11-15-95	14[e]	[89]
VT12	33N, 2E Room 215, under floor tile	12-17-95	11[e]	[–35]
VT13	32.5N, 2.5E Room 215, ceiling	12-17-95	[0]	[–12]
VT14	1N, 1E Room 203, floor	12-17-95	[0]	[–6]
VT15	6.6N, 1.5E Room 201, floor	12-17-95	[0]	[–12]
VT16	6.5N, 2.5E Room 201, ceiling	12-17-95	[6]	[–18]
VT17	9N, 10E Room 202, floor	12-17-95	[0]	[–59]
VT18	8N, 9E Room 202, ceiling	12-17-95	12[e]	[18]
VT19	13N, 4.3E hallway overhead bridging	12-17-95	37[d]	[24]

Table 4 (continued)

Smear sample ID[a]	Location[a]	Date smear collected	Removable radioactivity (smears)	
			Alpha[b] (dpm/100 cm²)	Beta-gamma[c] (dpm/100 cm²)
VT20	13N, 4.3E hallway floor	12-17-95	[0]	[-12]
VT21	23.5N, 10.5E hallway ceiling	12-17-95	[0]	[0]

[a]Sample locations are shown on Fig. 6 (first floor) and Fig. 7 (second floor).
[b]MDA for alpha activity = 9 dpm/100 cm².
[c]MDA for beta activity = ~125 dpm/100 cm².
[d]Area not verified below guidelines on this date (See Table 5).
[e]Below guidelines (See Table 1).

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 5. Data from surveys of individual rooms during verification at Building 31, former Linde Uranium Refinery, Tonawanda, New York

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
			First floor			
101 stairway to 2nd floor & landing	2/8/96	Several areas elevated	Not applicable	Not applicable	One (~1 m^2) above guidelines. Located on landing at top of the first flight of stairs	Needs further remediation
101 stairway to 2nd floor & landing	2/9/96	Verified below guidelines	Not applicable	Not applicable		Verified below guidelines
102	1/11/96	Verified below guidelines[c]	Not applicable	*d*		Floor verified below guidelines
102	2/8/96	*d*	Not applicable	Generally 1400–2600. Pipe valve (east wall) needs to be removed (14,000 –29,000). Also, 9 ft of asbestos piping in question. Did integrated scan of asbestos piping later on this date and cleared (av 3800)		Needs further remediation
102	2/9/96	*d*	Not applicable	Portion of contaminated piping along west wall has been cleaned up. Pipe containing elevated pipe valve removed		Overhead verified below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
103	1/11/96 1/12/96	Verified below guidelines[c]	Not applicable	Some elevated areas. Bridging 3400–4900. I-beam 4900–6400. Spots on pipe 1000–2000	Elevated areas can be averaged and are below guidelines. Pipe later removed	Verified below guidelines
104	1/11/96 1/12/96	Verified below guidelines[c]	Not applicable	Some elevated areas. Generally 990–3400. Spots 1100–1500. I-beam 3400–7100	Elevated areas can be averaged and are below guidelines	Verified below guidelines
105	11/15/95	Verified below guidelines[c]	Not applicable	*d*		Floor verified below guidelines
105	2/7/96	*d*	Not applicable	Large room, 60% of area surveyed; ~1 m of 3-in. airline pipe elevated (7900–35,000)	Further investigation of overhead airline pipe showed that it was contaminated inside	Needs further investigation
105	2/8/96	*d*	Not applicable	Overhead scan completed		Discussion on pipe continuing
105	3/4/96	*d*	Not applicable	Contaminated pipe verified below guidelines; whole pipe eventually removed, removal completed May 1996		Overhead verified below guidelines
107	*e*	Verified below guidelines	Not applicable	Verified below guidelines	Verified by examination of fixed point measurement data collected by BNI	Verified below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
108 Flame Spray Area	2/9/96	Verified below guidelines[c]	Not applicable	Verified below guidelines	Verified by examination of BNI fixed point measurements and ORNL FIDLER measurements on floor	Verified below guidelines
109 Flame Spray Area	2/9/96	Verified below guidelines[c]	Not applicable	[Bkg]	Scanned 10% of area of walls and overhead. FIDLER measurements on floor	Verified below guidelines
110	11/15/95	Verified below guidelines[c]	Not applicable	*d*		Floor verified below guidelines
110 Open bay	12/16/95	*d*	Not applicable	[Bkg] [Bkg]–990 [Bkg] [Bkg]–1600 [Bkg]–1300 [Bkg] [Bkg] [Bkg] [Bkg]–1300 [Bkg] [Bkg]–2600 [Bkg] 2500–3400	14.6–17N, 12–16E 14.6–17N, 16–20E 14.6–17N, 22–31.4E 19.4–21.9N, 12–16E 19.4–21.9N, 16–19E 19.4–21.9N, 24–28E 19.4–21.9N, 28–31.5E 31.5–33.5N, 14–17.5E 31.5–33.5N, 17.5–21E 31.5–33.5N, 23.5–27E 42–44N, 17–20E 45–47N, 26–30E 39–43N, 18E × 3-in. wide truss	Overhead verified below guidelines Additional comment: also scraped away ~5% of the sprayed-on cellulose material covering trusses and bridges in order to scan underneath cellulose
110 Open bay	12/17/95	*d*	Not applicable	[Bkg]–1700	39.5–43N, 23.5–25E	Verified below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
Threshold leading to Open Bay	12/18/95	[Bkg]	Not applicable	*d*	Gamma levels 11–13 μR/h	Verified below guidelines
111	12/17/95	*d*	Not applicable	[Bkg]–1700 [Bkg]–1000 [Bkg]–1000 [Bkg]–1000 [Bkg] [Bkg]	14.7–11.7N, 36.5–34.5E 12–14N, 40–43E 29N, 50–55E 24N, 38–41E 24N, 54E (heater) 14N, 43E (heater)	Overhead verified below guidelines
111	12/18/95	[Bkg]–2100. 1-m^2 area on floor elevated but below guidelines (av 4700). Verified below guidelines[c]	Not applicable	*d*		Floor verified below guidelines
112	12/18/95	Verified below guidelines[c]	Not applicable	*d*	New walls and drop ceiling. Not necessary to survey	Verified below guidelines
113 Men's toilet	12/18/95	Verified below guidelines[c]	Not applicable	Verified below guidelines		Verified below guidelines
114	12/16/95 12/17/95	*d*	Not applicable	Verified below guidelines		Overhead verified below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
114	12/18/95	Verified below guidelines[c]	Not applicable	*d*		Floor verified below guidelines
114A	12/18/95	Verified below guidelines[c]	Not applicable	*d*	New walls and drop ceiling. Not necessary to survey	Verified below guidelines
115	*e*	Verified below guidelines	Not applicable	Verified below guidelines	New addition. All new materials. Verified by examination of fixed point measurement data collected by BNI	Verified below guidelines
			Second floor			
201	12/14/95	~1 m of tile removed. Generally 1900–6400. Spot 1500. Questionable, additional tiles need to be removed	Only existing baseboard on west wall. Elevated but below guidelines (4300–6400)	Elevated but below guidelines (3400–6400)	Floor questionable	Baseboards, overhead verified below guidelines
201	2/7/96	Elevated but below guidelines	*d*	*d*		Floor verified below guidelines
201	3/4/96	Tiles completely removed. All areas clean	*d*	*d*	Floor monitor used to survey area. Potentially elevated areas also checked with beta-gamma pancake detector	Verified below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
202	11/16/95	*d*	West baseboard over hot-spot criterion	*d*		Baseboard needs further remediation
202	12/14/95	Elevated but below guidelines (1300–6200)	East wall elevated but below guidelines (1900–6400)	[Bkg]		Verified below guidelines
203	11/2/95	Elevated. Needs further investigation (>4000)	Inaccessible	Several spots over		Needs further investigation
203	11/14/95	*d*	*d*	Verified below guidelines		Overheads below guidelines
203	12/14/95	5 tiles removed in SW corner ([Bkg]–9500); 5 more removed in NE corner (2200–5000). Measurements near guidelines	*d*	*d*	Floors questionable	Requested removal of additional tiles
203	12/15/95	Additional SW and NE corner tiles removed; SW corner av 3300. NE corner av 1600.	NE baseboard elevated and needs to be bounded and/or remediated (5200)	*d*	Additional tiles removed for this re-survey	NE baseboard needs further remediation

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
203	2/7/96	East edge of removed tiles above guidelines (5000–9000)	*d*	*d*	Additional tiles were removed in SW corner for this survey	Needs further remediation
203	2/8/96	*d*	East wall above guidelines. West wall near guidelines	*d*	East and west wall need further investigation	Needs further remediation
203	3/4/96	Tiles completely removed. All areas clean	Verified below guidelines	*d*	Floor monitor used to survey area. Potentially elevated areas also checked with beta-gamma pancake detector	Verified below guidelines
204	2/9/96	*d*	*d*	Trusses [Bkg]–4800. I-beam 4800–7800. Few spots 1800 on horizontal surface	Elevated areas ~7% total overhead area. Below guidelines when averaged	Overhead verified below guidelines
204	Near 2/9/96	Verified below guidelines	Verified below guidelines	*d*		Floor and baseboards verified below guidelines
205	11/15/95	[Bkg]–elevated (3100)	[Bkg]–elevated (3100)	Elevated but below guidelines (1900–6400)	7 ½ overhead trusses surveyed; smear VT5	Verified below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
206	11/2/95	Elevated but below guidelines (1800–3300)	[Bkg]–elevated (1200)	[Bkg]–elevated (2800)		Verified below guidelines
207	12/15/95	Elevated but below guidelines. Tiles removed: SW corner 900–2100; SE corner 1800–2700, 3000–4800, 3600–5700; NW corner [Bkg]–3600; NE corner [Bkg]–1800, [Bkg]–3600, [Bkg]–3600	East wall above guidelines. Corner against wall 22,000	*d*	Floor tiles removed in all 4 corners	Floor verified below guidelines. Baseboards need further remediation
207	1/10/96	*d*	Elevated but below guidelines. Average for each section: West 2400; South 1200, 2400; East 3300, 2600; North 1800	*d*		Baseboards verified below guidelines
207	2/9/96	*d*	*d*	Overheads need to be vacuumed		Overhead area needs remediation
207	3/5/96	*d*	*d*	Attempted to survey overhead area	Nuisance dust still present and needs to be removed	Overhead area needs remediation

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
207	3/7/96	*d*	*d*	Below guidelines when averaged. Elevated areas: (1) crossbeam range [Bkg]–8200, av 4400. (2) I-beam bottom surface 5200–8200, av 6700; top surface 1600–13,000, av 6700	Elevated surfaces of crossbeam and I-beam constitute <15% total overhead area. Below guidelines when averaged	Overhead verified below guidelines
208	11/2/95	[Bkg]	[Bkg]–elevated (4600)	Elevated but below guidelines (1800–3800)		Verified below guidelines
209	11/2/95	[Bkg]–elevated (1300)	[Bkg]–elevated (1000)	Elevated but below guidelines (2500–3300)	Spotty areas can be averaged	Verified below guidelines
Office 210	11/2/95	[Bkg]–elevated (1600)	[Bkg]–elevated (4800)	[Bkg]–elevated (1200); 1 spot (3800)	Spot below guidelines when averaged	Verified below guidelines
Passage 210	12/15/95	*d*	Not applicable	1400–5600 (av 3000)		Overhead verified below guidelines
Passage 210	2/8/96	Verified below guidelines	Not applicable	*d*	Stairway, steps, landings clean	Verified below guidelines
211	11/2/95	[Bkg]–elevated (4800)	Elevated but below guidelines (1800)	Elevated with spots that can be averaged (2400–5000)		Verified below guidelines
212	11/2/95	[Bkg]	[Bkg]	[Bkg]–elevated (1200)		Verified below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
213	11/2/95	[Bkg]	Above guidelines (9300–35,000)	Elevated spots that can be averaged (2300–4800)		Baseboards need further remediation
213	12/14/95	23 tiles removed; [Bkg]–elevated (2000)	[Bkg]–elevated (3500); W 1/3 of S baseboard above guidelines (29,000–59,000)	Elevated but below guidelines (1600–2000). Spotty areas (1800–2800) can be averaged	Overhead spotty areas contained in ~1 m total on horizontal surfaces & bridges	Below guidelines except for area on baseboard
213	Much later[e]	*d*	Baseboards clean; verified below guidelines	*d*		Baseboards verified below guidelines
214	1/11/96	Verified below guidelines[c]	[Bkg]	Overhead survey included (1) 3 joists running E-W, [Bkg]–2700; (2) 4 bridges, [Bkg]–1800; (3) conduit & sprinkler system, [Bkg]–1800; and (4) false ceiling [Bkg]		Verified below guidelines
215	12/15/95	[Bkg]– elevated (3800)	[Bkg]–elevated (2000)	Both horizontal surfaces of main I-beam above guidelines (4900–8000; 4900–32,000, av 20,000). Bridging and lower horizontal elevated but below guidelines (1600–8000, av 5000)	Overhead needs further remediation	Floor and baseboards below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
215	1/11/96 1/12/96	Verified below guidelines[c]	*d*	*d*		Floor verified below guidelines
215	3/4/96	*d*	*d*	Verified below guidelines		Overhead verified below guidelines
216	1/10/96	*d*	N (av 2800), S (av 3400), E (av 2800), & W (av 2500) elevated. E also had 2 spots (7800 & 2300) and strips (7900–20,000)	Average below guidelines but some residual contamination on S end of I-beam (~4900). Overhead bridging (av 2800)	Will check after further remediation	Needs further remediation
216	1/11/96 1/12/96	Contamination in excess of guidelines in both NE and NW area of room	*d*	*d*		Needs further remediation
216	3/4/96	Tiles completely removed. All areas clean	Verified below guidelines	Verified below guidelines	Floor monitor used to survey area. Potentially elevated areas also checked with beta-gamma pancake detector	Verified below guidelines
Men's toilet	11/2/95	[Bkg]	[Bkg]	[Bkg]; 1 spot below guidelines		Verified below guidelines
Women's toilet	11/2/95	Elevated (6300–8400)	[Bkg]	[Bkg]		Floor needs further remediation

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
Women's toilet	2/8/96	Elevated but below guidelines (1600–4900, av 3400)	*d*	*d*		Verified below guidelines
2nd floor hallway	12/15/95 12/16/95	Areas with floor tiles removed: N end E hallway 1400–5600; S end E hallway 1100–3800; middle E-W hallway 1100–2600; N end W hallway 1100–2300; middle W hallway [Bkg]–1700; S end W hallway (6 tiles) [Bkg]–2000; S end W hallway (18 tiles) 2600–5600; S E-W hallway [Bkg]–1400	*d*	[Bkg]–elevated but below guidelines. S E-W hallway overhead 1400–5600, av 3000. Spotty contamination on conduit in connecting hallway (6500–13,000, av 11,000)		Floor and overheads verified below guidelines except for conduit in connecting hallway
2nd floor hallway	1/9/96	*d*	Elevated but below guidelines. [Bkg] except for following: 2 spots (2000, 3800); 4 small strips (8000–13,000); other sections av 3500	*d*		Baseboards verified below guidelines
2nd floor hallway	2/7/96	Verified below guidelines[c]	*d*	Conduit had been removed		Floor and overhead verified below guidelines

Table 5 (continued)

Room No.[a]	Date of survey	Floor (dpm/100 cm^2)	Baseboards[b] (dpm/100 cm^2)	Overhead (dpm/100 cm^2)	Comments	Status
Back stairway Passage 210	2/8/96	Steps, landing, etc. [Bkg]	Not applicable	Not applicable		Verified below guidelines

[Bkg] = measurements not discernable from typical background levels.
BNI = Bechtel National Inc.
FIDLER = field instrument for the detection of low-energy radiation.
[a]Room numbers shown on Fig. 6 (first floor) and Fig. 7 (second floor).
[b]Baseboard refers to crack at wall-floor interface.
[c]Also see FIDLER measurements on Fig. 3 (1st floor) or Fig. 4 (2nd floor).
[d]Not surveyed this date.
[e]Date not specified.

Table 6. Results of radon measurements in indoor air at Building 31, former Linde Uranium Refinery, Tonawanda, New York

Electret serial number	Location in Building 31	Location number on Fig. 8[a]	Start date	Stop date	Total time (hours)	Radon concentration (pCi/L)
			7-day samples			
SO6203	Room 105 (southeast)	4	3-17-98	3-24-98	168	0.8
SO6196	Room 105 (southeast)	4	3-17-98	3-24-98	168	0.6
SO6163	Room 111	2	3-17-98	3-24-98	168	5.2
SR2906	Room 114 (south)	1	3-17-98	3-24-98	167.8	1.7
SO6158	Room 114 (east)	3	3-17-98	3-24-98	168	1.5
SO6141	Room 114 (east)	3	3-17-98	3-24-98	167.7	1.5
			31-day samples			
SR5117	Room 110 (west)	*b*	5-28-98	6-29-98	775.6	0.3
SO6169	Room 110 (east)	*b*	5-28-98	6-29-98	775.6	0.4
SR5179	Room 111	*b*	5-28-98	6-29-98	775.6	0.5
SR5144	Room 111	*b*	5-28-98	6-29-98	775.6	0.8

[a]Locations shown in Fig. 8.
[b]Monitor placed by Building 31 personnel. Exact location not recorded on data sheet.

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