

1. INTRODUCTION

Radian Corporation (Radian) was tasked by Los Alamos National Laboratory (LANL) under Contract No. 9-XQ3-1432E-J, Work Release 95-0017, to conduct a survey of TA-3-141. The purpose of the survey is to identify health and safety hazards, including chemical and physical hazards, of TA-3-141 so that contractors participating in the bid process or actual renovation/reconstruction activities may be better informed of the potential hazards. The building is being dismantled to prepare for the installation of a new beryllium processing system. As a result of surveys conducted during December 1995, beryllium, lithium, and uranium were identified as the primary contaminants of concern. Radiological contamination is also documented through surveys conducted by LANL between August 19 and October 14, 1995. Primary physical hazards identified include open/damaged electrical components, elevated work, and lockout/tagout requirements.

This report documents the chemical and physical hazards found in TA-3-141 through three major sources of information:

- a building survey conducted by Radian in accordance with the *Los Alamos National Laboratory Site Characterization for TA-3-141, Sampling and Testing Plan (S&T Plan)*, during December 1995;
- radiological survey conducted by LANL during 1995 for TA-3-141; and
- quarterly beryllium surveys conducted by LANL between July 19 and October 30, 1995, within the beryllium processing areas of TA-3-141.

This report constitutes Volume 2 of a two volume set. Volume 1 consists of chemical and physical hazard summaries organized by building areas, and Volume 2 presents all data evaluated for identifying the existence and locations of chemical and physical hazards, as well as the methodology used for obtaining the information. Volume 2 is presented in four sections, including this introduction, a description of the survey methodology used to locate hazards, a presentation of all data used for assessing hazards, and recommendations on how to best use the data.

TA-3-141 was used for powder metallurgy, and as a result, numerous types and kinds of metal powders have been handled in the building. Very fine to relatively course powders were handled in both the elemental and compound form. Due to the difficulty of retaining fine powders, it would be expected that metal powder contamination would be located throughout the building.

A plan view of the building is provided in Fig. 1.1. To assist in determining where contaminants may be located in the building, the building was divided into four areas: beryllium processing areas, radiological areas, general laboratory areas, and office areas. Due to the

similarities of nonradioactive materials handled in the radiological and general laboratory areas, these two areas were grouped together for the purposes of this study (i.e., radiological/general laboratory areas), except when discussing radiological contaminants.

To determine which objects/locations may be contaminated within each building area, the building areas were further divided into homogeneous areas (HAs): exhaust ventilation system, supply ventilation system, walls, rotating equipment, and miscellaneous horizontal surfaces. In addition, miscellaneous horizontal surfaces were sometimes divided into three additional categories, including surfaces higher than 6 ft, surfaces lower than 6 ft, and surfaces on equipment.

Because of the different types of materials that may be contaminated, different sampling techniques were necessary within the HAs. Materials requiring different sampling techniques include thin layers of accumulated dust (remove as wipe samples), paint (scrape off as bulk samples), oil stains (remove as wipe samples), gross quantities of dust (scoop up as bulk samples), and roofing material (cut and remove as bulk samples). Information is presented in this report according to building area, HA, and type of material.

The remainder of this introduction provides a general overview of the building and activities that have been conducted in it, a description of the various HAs that were sampled (i.e., ventilation systems and other HAs), and a discussion of the derivation of the levels of concern (LOCs) used for the various contaminants found in the building.

1.1 BACKGROUND AND HISTORY

The historical description of the facility presented in this report was determined through interviews with knowledgeable LANL personnel. TA-3-141 was first constructed in 1959 to support activities associated with the Rover Program and nuclear weapon components production. The original structure measured 102 × 62 ft, but it was later expanded to 102 × 164 ft during the early 1960s through an addition on the north side of the original structure. The Rover Program was the early development work for a nuclear rocket engine for deep space use. Components used in the nuclear rocket were made from many types of metals formed into numerous shapes.

Initially, the facility was used for producing one-of-a-kind metal parts for initial product development prior to scale-up, although the facility was also used for the entire production of some components. Various metal powders were the main ingredients used for these efforts. Powdered metal(s) were mixed with a binder (usually furfuryl alcohol) and then either rolled or pressed with such force to cause the powder to bind together. The shape thereby produced was then usually placed into an oven and sintered. After sintering, the material was placed in an oven at a temperature slightly below the melting point of the material, thereby causing it to bind together further, usually

with greater strength than if the material had been forged through traditional techniques. Much of this work was conducted under hoods to control the spread of contamination. Glove boxes were used mainly for reactive material to protect the workers and to maintain product purity.

In addition to rolling or pressing metal powders, the facility also used metal powder technology to coat metal onto other metal parts through the plasma arc furnace. Therefore, the major types of equipment used at the facility include rolling mills, manual and hydraulic presses, furnaces, glove boxes, and laboratory hoods.

Radiological materials in the form of thorium, depleted uranium, and enriched uranium were handled in Rooms 104, 126, 136, 148, and 150. Rooms 104 and 126 were outside the scope of the survey conducted by Radian. Much of the material handled in Room 136 was kept in glove boxes located along the north wall of this Room. These glove boxes were connected to the FE-10 exhaust ventilation system. The FE-10 exhaust ventilation system is not filtered and is still being used. The radiological area consisting of Room 150 is serviced by an exhaust ventilation system (i.e., labeled FE-6) that also services the east side of Room 148 and is connected to a baghouse located on the north side of the building.

Many of the furnaces used for firing the metal parts were located along the southern wall of Room 144. These furnaces were connected to the FE-9 exhaust ventilation system, which is not filtered and is still being used.

The Rover Program was phased out during the late 1960s. During this time and later into the 1970s and 1980s, the focus of the facility shifted toward research and development, although much effort was still given to the weapons program. Because of the wide range in products produced at the facility, most of the naturally occurring metals on the periodic chart have probably been used in the building. However, most metals were handled only in small quantities.

In 1987, a beryllium processing area was established in Rooms 136A, 139, and 141. When this area was established, the exhaust ventilation system was replaced for these rooms and is currently separated from the rest of the building. Air flowing through the dedicated exhaust system (i.e., new FE-1) passes through a high-efficiency particulate air (HEPA) bank of filters located just before the stack, which is located on the east side of the building. As part of this construction, a plaster board wall was built across Room 136 from north to south to divide this Room into 136 and 136A.

Room 136A is maintained under negative pressure relative to other building areas and can only be entered through an air lock. Room 139 is used as a change room for entering the beryllium areas, and Room 141 is used as a combination buffer zone/processing area between Rooms 136A and 139. There are two supply ventilation systems for the beryllium areas, the intake for one is located on the

roof and provides air for Rooms 139 and 141, and the other ventilation system is located on the west side of the building and supplies air for all three rooms plus Rooms 136 and 142.

There are six radiological controlled areas in the building, including Rooms 126, 136, 150, a flagged-off area located on the west side of Room 148, and two exhaust systems. Radiological contaminants that may be located in these areas include ^{235}U , ^{238}U , and ^{232}Th . The area on the west side of Room 148 is classified as a controlled area due to the presence of a metal rolling machine that was contaminated from rolling uranium. This rolling machine has not been used for uranium in its present location, but it has been used for other purposes (i.e., super conducting material production). It was originally located in Room 104. There is no exhaust ventilation system for this radiological area.

Based on interviews with knowledgeable LANL personnel, a list of elements used in the building was developed (see Table 1.1). LOCs established for these elements are discussed further in Sect. 1.4. The next two subsections describe the HAs developed for this survey.

1.2 VENTILATION SYSTEMS

The ventilation systems are used to control/eliminate contaminants in the building. Therefore, to estimate the quantity and locations of contaminants in the building, the processes where potential contaminants were handled and the ventilation systems need to be understood. Most of the discussion up to this point has been concerned with processes within the building. The remainder of this section focuses more on how these contaminants were controlled by the ventilation systems. To better understand the ventilation systems, the ventilation plan drawings included in Sect. 4 of this report may be consulted.

Exhaust Ventilation Systems. Only two of the exhaust ventilation systems are filtered. The concern with unfiltered exhaust systems (relative to building contamination) is the possibility for the reintroduction of the contaminants into the building through the intake of a nearby supply ventilation system and the contamination of the roof area through settled particulates. When discussing each exhaust ventilation system, its location relative to supply system intakes and the potential for the reintroduction of contamination are discussed.

There are six exhaust ventilation systems and six supply ventilation systems for the building. The six exhaust systems include old FE-1, new FE-1, FE-6, FE-9, FE-10, and FE-11. (Note: There are two more exhaust systems, FE-5 and FE-2; however, these systems are for recirculated cooling water systems for TA-3-141 air conditioning and are located immediately west of the building.)

Table 1.1. Powders handled in TA-3-141 in decreasing order of usage and potential hazard

Material	TLV (mg/m ³)	Density (g/mL)	Comment
Uranium	0.06 DAC	19.05	used extensively in radiological areas
Beryllium	0.002	1.85	negligible use except in beryllium areas
Lithium	1.0	0.84	usually used as LiH
Thorium ^{NS}	0.005 DAC	11.70	moderate to small use
Lead	0.05	11.34	small use
Nickel	1.0	8.90	moderate use
Graphite	2.0	2.25	used extensively
Tungsten	5.0	19.35	relatively significant use
Zirconium ^{NS}	5.0	6.49	significant use
Chromium	0.5	7.20	small use
Thallium	0.1	11.85	small use, may be absorbed through skin
Vanadium	0.05	5.96	small use
Cadmium	0.05	8.64	small use
Tantalum	5.0	14.4	significant use
Niobium	NA	8.57	significant use
Aluminum	10.0	2.70	used extensively
Molybdenum	5.0	10.20	small use (for plasma arc furnace)
Titanium	10.0	4.50	small use
Gadolinium ^{NS}	NA	7.90	small use
Antimony	0.5	6.68	negligible use
Arsenic	0.2	5.73	small use
Magnesium	10.0	1.74	small use
Boron	10.0	2.37	moderate use
Barium	0.5	3.51	negligible use
Copper	0.1	8.92	relatively significant use
Bismuth	10.0	9.80	negligible use
Europium ^{NS}	NA	5.24	negligible use
Germanium ^{NS}	0.6	5.35	negligible use
Tellurium ^{NS}	0.1	6.25	negligible use
Perchloric acid	NA	V	unknown use, concern is formation of perchlorates and explosive hazard
PCBs	0.5	V	unknown use, may be in lubricating oil
Silicates	NA	NA	small use (in the form of molydisilicate)

DAC = derived air concentration, based on ²³⁸U and ²³²Th

NA = not available

NS = non-standard analysis (not a standard ICP metal)

V = varies

The old FE-1 system was the original exhaust system used for the portion of the building constructed in 1959. This system is not filtered and currently services Rooms 104, 108, 126, and 130. A blanked-off portion of this system was also observed on the south wall of Room 136. Most of this system services the area of the building that was outside the scope of the survey conducted by Radian. However, one small lab hood located in Room 130 is serviced by this system. Small quantities of mercury have been handled in Rooms 130, 136, and 137. The closest supply intakes include HV-5 and HV-6, which are located on the roof approximately 70 and 80 ft away, respectively. The old FE-1 exhaust system is connected to a stack that rises ~ 15 ft above the roof of the building.

The new FE-1 exhaust ventilation system was built in 1987 exclusively for the beryllium processing area (i.e., Rooms 136A, 139, and 141). This system is HEPA filtered, and therefore, recontamination through a supply intake is highly improbable. The closest supply intakes include HV-5 and HV-6, which are both located on the roof approximately 50 ft away. The new FE-1 exhaust system is also connected to a stack that rises ~ 15 ft above the roof of the building.

The FE-6 exhaust ventilation system is located on the north side of the building and provides service for Rooms 148, 150, and the northwest corner of 144, although the system in Room 144 is currently blanked off. (Radiological material is handled in Room 150.) In addition, FE-6 was used to supply service to the northeast section of Room 144; however, this portion of the system is currently blanked off. FE-6 is connected to a baghouse located on the ground ~ 10 ft north of the building. After the air passes through the baghouse, it exits through a stack that rises ~ 15 ft above the roof of the building. The closest supply intake (HV-3) is located on the second floor north wall of the building and is ~ 25 ft south from the FE-6 exhaust stack.

The FE-9 exhaust ventilation system is located in the northwest quadrant of the building and provides service for Rooms 142 and 144. This system is not filtered, and gross contamination of a graphite-like material was noted in the ductwork and fanhouse during the December 1995 survey. This system exhausts through a stack located 25 ft south and 15 ft east from the northwest corner of the building. The closest supply intakes include HV-2, HV-3, and HVA-2, which are located 25, 45, and 60 ft away, respectively. Intakes for HV-2 and HVA-2 are on the second floor and face west. The HV-3 intake is on the second floor and faces north. All three intakes face away from the FE-9 exhaust stack. In addition, the FE-9 exhaust stack rises ~ 15 ft above the roof.

The FE-10 exhaust ventilation system is located near the center of the building and provides service for Room 136 where radioactive material was handled. This system is not filtered; however, very little gross contamination was noted in the ductwork near the fanhouse during the December 1995 survey. This system exhausts through a stack that rises ~ 15 ft above the surface of the roof near the center of the building. The closest supply intakes include HV-5, HVA-2, HV-6, and HV-2.

which are located 25, 40, 40, and 50 ft away, respectively. Intakes for HVA-2 and HV-2 face away from the FE-10 exhaust stack and are located on the second floor of the building facing west. Intakes for HV-5 and HV-6 are located on the roof of the building.

The FE-11 exhaust ventilation system is located entirely inside the building just above the ceiling for Room 130. FE-11 provides clean cool air for Room 106 and filters indoor air for this purpose. Because of FE-11's configuration, its potential for spreading contamination to other areas of the building is highly improbable. There are no supply intakes that could be impacted by this system.

Two other minor exhaust ventilation systems include FE-2 and FE-5. Both of these systems are for recirculating cooling water used for air conditioning in TA-3-141. There are no stacks or filtration systems associated with these two systems. If contamination was in the cooling water, these exhaust systems could potentially spread this contamination through water vapor lifted from the water. Both of these systems are located at ground level on the west side of the building. The cooling water is located ~5 ft below grade. HV-2, HVA-2, and HV-1 are located approximately 50, 20, and 20 ft away from FE-2, respectively, and HV-2, HVA-2, and HV-1 are located approximately 10, 30, and 80 ft away from FE-5, respectively. In all cases, the supply intakes are located on the second floor of the building facing west and are approximately 10 ft above FE-2 and FE-5.

Supply Ventilation Systems. There are six supply ventilation systems: HV-1, HVA-1, HV-2, HVA-2, HV-3, and HVA-3. The intake for HV-1 is located in Room 201 on the west side approximately 22 ft north from the southwest corner of the building. This system provides cooling and heating for Rooms 100, 102, 112, 113, 116, 117, and 126. Room 126 is outside the scope of this study, and the other rooms were classified as office areas (although Rooms 112, 113, and 116 are personnel change rooms) for the purposes of this study.

The intake for HV-2 is located in Room 248 on the west side approximately 105 ft north from the southwest corner of the building. This system provides cooling and heating for Rooms 136, 136A, 141, and 142. Rooms 136A and 141 are part of the beryllium processing area, Room 136 is a radiological area, and Room 142 is a small laboratory. Office areas were not served by this system.

The intake for HVA-1 is located on the roof of the building approximately 40 ft west and 50 ft north from the southeast corner of the building. This system provides cooling and heating for Rooms 102, 104, 106, 108, 113, 116, 130, 135, and 137. Rooms 104 and 108 are outside the scope of this study, Rooms 102, 113, 116, and 135 are classified as office areas (Rooms 113 and 116 are actually personnel change rooms), and Rooms 106, 130, and 137 are laboratory process areas.

The intake for HVA-2 is located in Room 248 on the west side approximately 70 ft north from the southwest corner of the building. This system provides cooling and heating for Rooms 133, 138, 140, and 146. All of these rooms are office areas.

The intake for HV-3 is located in Room 248 on the north side approximately 50 ft east from the northwest corner of the building. This system provides cooling and heating for Rooms 144, 148, and 150. All of these areas are laboratory processing areas. In addition, Room 150 is designated as a radiological area.

The intake for HVA-3 is also located on the roof of the building approximately 20 ft west and 80 ft north from the southwest corner of the building. This system provides service to Rooms 139 and 141, which are part of the beryllium processing area. However, during the December 1995 survey, this system was deactivated due to mechanical problems.

1.3 OTHER HOMOGENEOUS AREAS

Other HAs that were surveyed include walls, rotating equipment, and miscellaneous horizontal surfaces. It was anticipated that walls would have little or no contamination because of the inability of dust to collect on a vertical surface. Rotating equipment was established as a separate HA because of the larger volume of air that it is normally subjected to. In addition, the oil/grease often associated with this equipment provides a convenient collection point for dust in the air.

Miscellaneous horizontal surfaces were divided into three categories for further delineation (surfaces less than 6 ft, surfaces greater than 6 ft, and surfaces on active equipment). Surfaces located lower than 6 ft are normally subjected to more frequent cleaning by laboratory personnel due to their accessibility. Therefore, it was assumed that these areas would be less contaminated than surfaces higher than 6 ft. In addition, it was assumed that surfaces on equipment would have more contamination due to their proximity to areas where the contaminants were handled.

The majority of samples taken were wipe samples from the various HAs. Paint and roofing materials are two additional media that do not conveniently fit into these HAs. Therefore, results from sampling these media are presented separately. The primary anticipated concerns for paint were elevated concentrations of lead and possibly encapsulated contaminants (e.g., uranium). The primary anticipated concerns for roofing material were elevated concentrations of polychlorinated biphenyls (PCBs) in the tar paper and contaminants from the exhaust ventilation system stacks.

1.4 LEVEL OF CONCERN DETERMINATION

Before contamination in the HAs could be determined, LOCs had to be established for each toxic metal believed to be present. LOCs are needed to determine whether any discovered contamination is present in quantities large enough to warrant special consideration by the construction crew during reconfiguration. LOCs were first suggested in the S&T Plan. The primary purpose of establishing LOCs in the S&T Plan was to ensure that detection levels for the proposed sampling scheme were adequate. Therefore, the proposed LOCs were relatively conservative.

It is recommended that conservative LOCs also be used during initial phases of construction work. If personal monitoring demonstrates that the LOCs are too conservative, adjustments may be made at that time.

In addition to the level of concern (LOC), a definition for gross contamination was also established. The purpose of this distinction is that areas found contaminated above the LOC may or may not require respiratory protection, whereas grossly contaminated areas probably will require respiratory protection.

LOCs need to be established for surface contamination as well as bulk contamination. Bulk materials that were sampled during the toxic metal survey include dust from the ventilation systems, paint, and roofing material. Therefore, LOCs need to be established for:

- surface contamination,
- bulk dust,
- paint, and
- roofing material.

Surface Contamination. The LOCs proposed in the S&T Plan for surface contamination were based on an empirical comparison between surface concentrations and air concentrations of lead at a firing range¹ and the American Conference of Governmental Industrial Hygienists (ACGIH) published threshold limit values (TLVs) for various contaminants. Because of the relatively poor empirical correlation between surface contamination and air concentrations in the firing range study, the lowest ratio of air/surface concentration noted in the data was used along with a factor of safety of 100. As a result, the following formula was developed:

$$\text{Level of concern } (\mu\text{g}/\text{ft}^2) = \text{TLV } (\mu\text{g}/\text{m}^3) \times \frac{10 \text{ (correlation factor)}}{100 \text{ (factor of safety)}} \times 9.29 \text{ (100 - cm}^2/\text{ft}^2)$$

¹Caplan, K.J., *The Significance of Wipe Samples*, American Industrial Hygiene Association 54:70-75, February 1993.

This approach compared favorably with the beryllium action level established by LANL. Based on the formula above, an LOC of $1.9 \mu\text{g}/\text{ft}^2$ was calculated. The action level accepted by LANL is $2 \mu\text{g}/\text{ft}^2$. This same approach was used to determine LOCs for uranium and thorium except for two modifications. First, the derived air concentration (DAC) was used instead of the TLV, and secondly a smaller factor of safety was deemed necessary. The most conservative DAC was assumed for these radioisotopes, and the isotopes assumed present were ^{238}U and ^{232}Th . The DACs for these two radioisotopes are 2×10^{-11} and $5 \times 10^{-13} \mu\text{Ci}/\text{mL}$, respectively. When these numbers are converted to mass concentrations, the results are 0.06 and $0.005 \text{ mg}/\text{m}^3$, respectively.

A factor of safety of 10 was assumed adequate for these radioisotopes because the most conservative DAC was assumed and because of the ability to perform real-time monitoring while working around these contaminants. Using a factor of safety of 10 results in an LOC of $560 \mu\text{g}/\text{ft}^2$ and $46 \mu\text{g}/\text{ft}^2$ for uranium and thorium, respectively.

The primary exposure route of concern for most of the potential contaminants is their inhalation. However, a few of the TLVs (e.g., for thallium) are based on absorption through the skin.

A number of the potential contaminants in the building do not have published TLVs. This is probably because some are quite rare and others are only hazardous in gross quantities (i.e., as a nuisance dust). In some other cases, TLVs have been established for a compound that contains a certain element, but limits for the element itself have not been established.

A contaminant that occurs relatively frequently in the building that does not have a published TLV is lithium. A TLV has been established for lithium hydride, and lithium hydride is one of the major forms of lithium used at the facility. However, within a relatively short time (a few days) lithium hydride will react with moisture in the air and convert to lithium hydroxide. In turn, lithium hydroxide will react with carbon dioxide in the air over a long time (a few years) and convert to lithium carbonate. The primary concern with lithium hydride is its high corrosivity, and therefore, it has a relatively low TLV ($25 \mu\text{g}/\text{m}^3$). The primary concern with lithium hydroxide is also its corrosivity; however, it is much less corrosive than lithium hydride.

A TLV for lithium hydroxide has not been established; however, a similar compound, sodium hydroxide, has a TLV of $2000 \mu\text{g}/\text{m}^3$ as a ceiling limit. In addition, the United Kingdom has adopted a short-term exposure limit to lithium hydroxide of $1000 \mu\text{g}/\text{m}^3$. The reason for the short-term exposure limits versus long-term is that neither of these compounds demonstrates accumulative effects when exposures are small. This is because small doses are readily buffered by fluids in the body before any damage can be done. In consideration of these factors, it is recommended that a ceiling TLV of $1000 \mu\text{g}/\text{m}^3$ be assumed for lithium hydroxide.

The primary concern with lithium carbonate would be the effects of the lithium itself on the nervous system. Psychological symptoms from the ingestion of lithium may occur at dosages of 7 mg/kg². Assuming an average worker mass of 80 kg, a typical worker would have to inhale/ingest 560 mg of lithium to receive an effect. Assuming all inhaled lithium was absorbed, and assuming an inhalation rate of 8.5 m³/8 hours, lithium concentrations in the air would have to be 66,000 µg/m³ in order for a worker to receive an effect over an 8-hour day. Because this is such a large concentration, the nuisance dust effects (i.e., coughing) and nuisance dust TLV (10,000 µg/m³) would be realized before psychological symptoms would be noted.

Because of the relatively short time required for lithium hydride to change into lithium hydroxide, but the much larger time for lithium hydroxide to change into the carbonate form, it is prudent to base the LOC on lithium hydroxide for lithium found in the building. Therefore, the proposed TLV for lithium hydroxide (100 µg/m³) was used to calculate the LOC.

Areas with gross contamination are those areas where the need for respiratory protection is considered highly likely. Two factors were considered for defining grossly contaminated areas: the concentration of contamination in the dust and the quantity of dust present. As previously described, LOCs are relatively conservative as reflected in the large factor of safety that was adopted. The reason for a large factor of safety was the unknown variations in contaminant levels from one location to another and the inability to accurately reflect the quantity that could become airborne. Grossly contaminated areas require a much smaller factor of safety because it is assumed that respiratory protection would be used. Therefore, a factor of safety of 4 is suggested for defining grossly contaminated areas where the quantity of visible dust is small.

In areas where large quantities of dust are present, resuspension of particulates is more likely. For the purposes of this evaluation, large quantities of dust are defined as locations where visible dust accumulation appears to be greater than 1/8-in. deep. These areas would be considered grossly contaminated if any of the dust present contained contamination above the LOC.

Bulk Dust. The primary concern with bulk dust is inhaling the material if it becomes airborne. Therefore, to determine LOCs, it is necessary to estimate the quantity of dust that would be allowed in the air before respirators would be required.

A TLV for nuisance dust has been established at 10 mg/m³. Respirators are required should the dust level exceed this quantity. Contaminants will represent a certain percentage of this TLV based on their concentration in the dust. Therefore, it is possible to exceed a TLV for another

²Sax, N.I., *Dangerous Properties of Industrial Materials*, Van Nostrand Reinhold Co., New York, New York, 1979.

contaminant, even if the nuisance dust level is not exceeded. Another concern is that the contaminant's percentage within the dust may vary widely from one location to another.

Assuming a variation as high as 100-fold in the concentration of a contaminant from a particular HA, the LOC for a particular contaminant's concentration in dust is based on the following formula:

$$\text{Level of concern } (\mu\text{g/g}) = \frac{\text{TLV } (\mu\text{g}/\text{m}^3) \times 10^6 (\mu\text{g/g})}{10,000 (\mu\text{g}/\text{m}^3) \times 100 (\text{factor of safety})}$$

Where 10,000 $\mu\text{g}/\text{m}^3$ is based on the TLV for nuisance dust. Again, the DAC was used in place of TLV when determining LOCs with uranium and thorium with a factor of safety of 10. (See discussion on surface contamination).

Gross contamination with bulk dust is assumed present if the dust is greater than 1/8-in. deep and contains contaminants above the LOC. If the bulk dust is in a finer layer than 1/8-in., then gross contamination would be assumed not to be present unless the concentrations of contaminants are found at levels greater than 25 times the LOC (i.e., assumes factor of safety of 4, see discussion on surface contaminants).

Paint. Contaminants in paint are either part of the paint formulation or are encapsulated into the paint if a contaminated surface were painted. LOCs for contaminants in the paint formulation are based on the assumption that some of the paint will be removed through scraping or other abrasive processes. The primary concern with contaminants associated with paint would be their inhalation should they become airborne.

Assuming that the paint may become airborne, the same analysis applied to bulk dust is applicable here. Therefore, LOCs associated with the paint are the same as those established for bulk dust materials.

Because it is assumed that paint cannot be resuspended in the air easily (unless it is intentional), the only consideration for determining whether it is grossly contaminated is the concentration of contaminants associated with it. Therefore, paint is not considered grossly contaminated unless it contains contaminant concentrations greater than 25 times the LOC.

Roofing Material. The primary concern with contaminants associated with roofing material would be their absorption through the skin while handling these materials or surface dust that may become airborne when removing this material. The maximum quantity of material that could become airborne for this material is probably less than that established for the bulk dust; however, to be on the conservative side, the same maximum quantity of material that may become airborne used for the

bulk dust analysis is also applied here. Therefore, the same LOCs established for bulk dust are also considered when evaluating the roofing material analyses.

The same assumptions applied to gross contamination associated with paint also apply to roofing material. Therefore, gross contamination is assumed absent unless a sample containing 25 times the LOC for a particular contaminant was noted (see discussion on surface contamination for a more thorough discussion on the definition of gross contamination).

Based on the assumptions described above, the LOCs and gross contamination levels depicted in Table 1.2 were established for contaminants anticipated to be in TA-3-141.

Table 1.2. Levels of concern for contaminants in TA-3-141

Contaminant	Level of concern		
	Surface concentration (ug/ft²)	Material concentration (ug/g)	Gross contamination level (ug/ft²)
Aluminum	9300	10,000	230,000
Antimony	470	500	12,000
Arsenic	190	200	4800
Barium	470	500	12,000
Beryllium	1.9	2	46
Bismuth	9300	10,000	230,000
Boron	9300	10,000	230,000
Cadmium	46	50	1200
Cesium	1900	2000	48,000
Chromium	470	500	12,000
Europium	NA	NA	NA
Gadolinium	NA	NA	NA
Germanium	560	600	14,000
Graphite	1900	2000	48,000
Lead	46	50	1200
Lithium	930	1000	23,000
Magnesium	9300	10,000	230,000
Nickel	930	1000	23,000
Rubidium	NA	NA	NA
Tellurium	93	100	2300
Thallium	93	100	2300
Thorium	46	50	1200
Titanium	9300	10,000	230,000
Tungsten	4700	5000	120,000
Uranium	560	600	14,000
Vanadium	46	50	1200
Zirconium	4700	5000	120,000

NA = not available