

# ES&H manual

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## Environment, Safety, and Health

### Volume II

#### Part 14: Chemical

## Document 14.4

### Implementation of the Chronic Beryllium Disease Prevention Program Requirements

**Recommended for approval by the ES&H Working Group**

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**Implementation of the  
Chronic Beryllium Disease Prevention Program Requirements\***

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### Implementation of the Chronic Beryllium Disease Prevention Program Requirements

#### 1.0 Introduction

Beryllium metal, alloys, and compounds are widely used at LLNL and other Department of Energy (DOE) facilities because of the materials' nuclear properties as a moderator (i.e., reflector) of neutrons. Favorable mechanical properties have also resulted in beryllium's widespread use in the aerospace industry. Addition of 2% or less beryllium to copper forms an alloy with high strength and hardness—properties that have made the alloy useful in electronics, automotive, defense, and aerospace industries worldwide. Beryllium oxide (also known as beryllia) can be formed into beryllia ceramics, which have an exceptional combination of high thermal conductivity, electrical resistivity, and dielectric properties and which are used widely in electronics, laser, automotive, and defense applications.

Beryllium (atomic number 4) is a naturally occurring element. The commercially important ores are beryl ( $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$ ) and bertrandite [ $\text{Be}_4\text{Si}_2\text{O}_7(\text{OH})_2$ ]. The metal is silvery gray, has a low density ( $1.85 \text{ g/cm}^3$ ) and moderately high melting point ( $1287^\circ\text{C}$ ), and is relatively stable in air. Beryllium is commercially available as a metal [in massive form (i.e., "logs") or as sheets, foils, or powder], alloys (with copper, nickel, or aluminum), beryllia (as a powder or ceramic), or a large variety of other compounds.

Beryllium is naturally occurring in soils at both the LLNL main site and Site 300. The 1994 LLNL Environmental Report (UCRL-50027-94) reported the values shown in Table 1:

**Table 1. Beryllium concentrations in soils.**

Location	Median ( $\mu\text{g Be/g}$ )	Range ( $\mu\text{g Be/g}$ )
Livermore Valley soils	0.50	0.33–1.2
Livermore Water Reclamation Plant soils	0.64	0.46–0.78
Site 300 soils	1.5	0.68–42

The concentration of naturally occurring beryllium is variable. The average concentration in soil is about 6 parts per million (ppm), with a range of 0.1–42 ppm; humus soils show a concentration above the crustal average. The presence of beryllium in other geological materials shows similar variability: sandstones and limestones have a low concentration (<1 ppm), igneous rocks and shales a higher concentration (about

3 ppm). Beryllium ores may have a substantially higher concentration. For more details, see Wilbur (1980) and Rossman (1991), listed in Section 6.3.

Air samples taken at the LLNL main site and Site 300 perimeters indicate an average of approximately 0.09% of the Bay Area Air Quality Management District guideline of 10,000 pg/m<sup>3</sup>, as reported in the 1998 LLNL Environmental Report (UCRL-50027-98).

## 1.1 Goals

Controlling beryllium exposure has been a major interest of the DOE and its predecessor agencies. The first exposure standards were published by the Atomic Energy Commission in 1949 and were later adopted by the Occupational Safety and Health Administration (OSHA). DOE efforts to control and regulate exposure culminated in 10 CFR 850, *Chronic Beryllium Disease Prevention Program*, published in December 1999. The essential requirement of the rule is to establish a Chronic Beryllium Disease Prevention Program (CBDPP), whose ultimate goal is to eliminate chronic beryllium disease (CBD) from all DOE facilities by:

- Controlling exposures.
- Minimizing the number of workers exposed.
- Minimizing the opportunities for exposure.

Achieving this goal requires assessing operations that may result in exposure, identifying the population at risk, and establishing appropriate engineering, administrative, and personal protective equipment (PPE) controls to minimize the opportunities for exposure. The careful review and minimization of the potential exposures of visitors and other ancillary personnel shall be evaluated by the Responsible Individual. Visitors to beryllium work areas should be discouraged unless essential to the mission in question.

## 1.2 Applicability

This document applies to all work with “beryllium,” which means beryllium metal, as well as beryllium alloys and insoluble beryllium compounds that contain more than 0.1% beryllium. The following are exempt from the requirements of this document:

1. Beryllium articles that meet the definition of an article as defined by 29 CFR 1910.1200, i.e., a manufactured item that is formed to a specific shape or design during manufacture, that has end-use functions that depend in whole or in part on its shape or design during end use, and that does not release beryllium or otherwise result in exposure to airborne concentrations of beryllium under normal conditions of use. Therefore, beryllium articles are those items meeting this definition of an

article and whose surface contamination level is determined to be less than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ .

Invoking the article exemption requires a determination that the item in question cannot release a hazardous amount of beryllium under its intended use. Article status is documented with the label shown in Figure 5. See Section 3.14 for details.

2. Laboratory use of beryllium that meets the definition of laboratory use of hazardous chemicals. See Document 14.1, "LLNL Chemical Safety Management Program," in the *Environment, Safety, and Health (ES&H) Manual* for applicable controls. Medical surveillance shall be offered to laboratory workers as required by Document 14.2, "LLNL Chemical Hygiene Plan for Laboratories," in the *ES&H Manual*. Medical surveillance shall be the same as that offered for beryllium-associated workers. See Section 3.5.10 and Appendix B for details.
3. Appendix B applies only to LLNL employees.

This document applies primarily to beryllium-associated workers, who are defined as:

- Beryllium workers, i.e., workers who are currently assigned to beryllium work areas and are potentially exposed to beryllium.
- Workers whose work history shows past potential exposure.
- Workers receiving medical protection benefits.
- Workers exhibiting signs or symptoms of beryllium exposure.

All other workers who are not exposed to beryllium are subject only to the minimal training requirements specified in Section 3.5.9.

## 2.0 Hazards

Beryllium is potentially toxic in all forms. However, not all forms present the same level of hazard to workers.

There is a lack of consensus about whether the current exposure standard in 10 CFR 850 (i.e.,  $2 \mu\text{g Be}/\text{m}^3$ ) is adequate to protect workers. Although this issue was recognized during the rulemaking process for 10 CFR 850, it was also recognized that the scientific data needed to establish a different limit was lacking. The rule therefore establishes an action level (AL) that is one-tenth of this level, i.e.,  $0.2 \mu\text{g Be}/\text{m}^3$ . Therefore, work place levels shall be maintained below the AL and as low as practical. Visitors to beryllium work areas should be discouraged unless essential to the mission in question.

## 2.1 Acute Beryllium Disease

Acute beryllium disease is caused by dust or fumes of soluble beryllium salts (such as  $\text{BeF}_2$  or  $\text{BeSO}_4$ ), which are intermediaries in the extraction of beryllium hydroxide and the production of beryllium metal and oxide. This disease occurred almost exclusively among workers in such processes and in the production of phosphors for fluorescent lights in the 1930s and 1940s. Unlike CBD, acute beryllium disease is a chemical pneumonitis whose severity is determined by the magnitude of exposure. Acute beryllium disease is generally reversible.

## 2.2 Beryllium Sensitization and Chronic Beryllium Disease

Health effects from beryllium are caused by the body's immune system response to inhaled dust or fumes containing beryllium metal, alloys, or compounds. This immune system response to beryllium is similar to an allergic reaction and may evolve over many years, even decades. Early evidence of this reaction may be detected by a blood test [i.e., the beryllium lymphocyte proliferation test (Be-LPT)] before there is evidence of damage to the lungs. The Be-LPT is used as a screening test for early evidence that an individual may be at higher risk for beryllium disease based on reaction of the immune system to the metal. Positive test results indicate beryllium sensitization. Sensitization is not a disease. There is no impairment from, or symptoms of, sensitization itself.

The body's reaction may continue to progress and cause damage to the lungs. CBD is said to exist when there is evidence of harmful effects to the lungs, i.e., when healthy lung tissue becomes damaged and changes from functioning lung tissue to fibrotic tissue. Damage to the lungs may be detected early by biopsy before there are symptoms (e.g. shortness of breath). Damage (i.e., fibrosis) may progress to the point that symptoms are severe enough to disable or cause death. In summary, the health effects from beryllium may be clinically silent (i.e., without symptoms) or may progress to substantial impairment or death.

Detection and diagnosis of beryllium health effects are usually a two-step process. First, the Be-LPT is performed to determine whether a worker is sensitized. If the initial test result is confirmed to be positive on a repeat test, the worker is offered further tests, which include bronchoscopy and other medical tests that the examining physician deems necessary to determine whether lung damage or CBD exists.

Not all exposed workers develop sensitization or disease. Research suggests that a small percentage of the population may have a genetic predisposition to CBD. Once a worker becomes sensitized or is diagnosed with CBD, the process is not reversible. There is no cure for CBD. Early diagnosis and treatment of CBD are expected to reduce adverse health effects and improve a person's prognosis.

### 2.3 Skin and Implantation

Beryllium and its compounds can cause a variety of skin problems depending on the chemical form of beryllium and the type of exposure, as follows:

- Irritant dermatitis—Caused by contact with a soluble compound. Symptoms are inflammation, local edema (i.e., accumulation of excessive amounts of fluids), and transudation of serum (i.e., passage of serum through the skin).
- Allergic contact dermatitis—May occur within 6–15 days of exposure to dust, fumes, or mist. Symptoms include erythema (i.e., inflammatory redness) and varying degrees of edema; lesions may be present.
- Chemical ulcer or ulcerating granuloma—A persistent lesion that results from implantation of a beryllium crystal or metal under the skin. The lesion will not heal until the foreign body (i.e., beryllium) is removed.

A very small number of CBD cases have resulted from skin implantation; the typical effects are those noted above.

### 2.4 Cancer

The American Conference of Governmental Industrial Hygienists and the International Agency for Research on Cancer classify beryllium and its compounds as confirmed human carcinogens (classifications A1 and Group 1, respectively). These determinations are based on animal studies in which cancers were induced in laboratory animals dosed with beryllium and on human epidemiological studies of workers in beryllium plants that showed a slight increase in lung cancer incidence.

## 3.0 Controls

All beryllium work shall be controlled to minimize the number of workers and visitors exposed or potentially exposed and the opportunities for exposure. When beryllium needs to be used for an operation, controls shall be implemented in the following order of priority:

- Engineering controls.
- Administrative controls.
- PPE.

### 3.1 Chronic Beryllium Disease Prevention Program

LLNL's written program to implement the CBDPP [i.e., *LLNL Chronic Beryllium Disease Prevention Program* (UCRL-AR-144636, rev. 1.1)], required by 10 CFR 850, has been approved by DOE Oakland. Specific actions are required by the following other *ES&H Manual* documents as part of implementation:

- Document 2.2, "Managing ES&H for LLNL Work."
- Document 3.3, "Facility Safety Plans and Integration Work Sheets with Safety Plans."
- Document 10.2, "LLNL Health Hazard Communication Program."
- Document 11.1, "Personal Protective Equipment."
- Document 12.2, "Ventilation."
- Document 12.4, "Work Enclosures and Local Exhaust Systems for Toxic and Radioactive Materials."
- Document 12.5, "High-Efficiency Particulate Air (HEPA) Filter System Design for LLNL Applications."
- Document 21.2, "Onsite Hazardous Material Packaging and Transportation Safety Manual."
- Document 30.1, "Waste Minimization and Pollution Prevention."
- Document 32.1, "Managing Discharges to Water and Land."
- Document 32.4, "Discharges to the Sanitary Sewer System."
- Document 36.1, "Hazardous, Radioactive, and Biological Waste Management Requirements."

#### 3.1.1 DOE/NNSA Review of Beryllium Work Out of the Scope of the CBDPP

Appendix B of *LLNL Chronic Beryllium Disease Prevention Program* (UCRL-AR-144636-REV-1.1) lists specific approved operations. New work that is outside the operations listed in the CBDPP must meet the requirements of the *ES&H Manual* but shall not be conducted until the CBDPP is modified and approved.

Under 10 CFR 850, DOE/NNSA Oakland is permitted a 90-day review period, except in cases of emergency response. To allow for an appropriate period of time for review and approval the ES&H Team shall evaluate the work using the ISM processes against the *LLNL Chronic Beryllium Disease Prevention Program* and initiate the DOE review, if needed, before work is authorized.

### 3.2 Exposure Reduction and Minimization Program

When exposures as determined without accounting for respiratory protection equal or exceed the AL (see Section 3.3), a formal, operation-specific exposure reduction and minimization program shall be established. This operation-specific program, which is incorporated into the Laboratory's CBDPP and then approved by the DOE, shall include the following:

- Annual goals for exposure reduction and minimization.
- The rationale for the goals.
- Strategies for meeting the goals.
- Actions to be taken to achieve the goals.
- A means for tracking progress towards meeting the goals and demonstrating that the goals have been met.

When a formal exposure reduction and minimization program is required, the authorizing organization is responsible for developing the program in concert with the Hazards Control and Health Services Departments.

The following sections of this document shall be addressed as part of a formal exposure reduction and minimization program:

- Engineering controls (Section 3.4, "Engineering Controls").
- Periodic monitoring (Section 3.5.5, "Exposure Monitoring").
- Regulated areas (Section 3.5.7, "Beryllium Work Areas and Regulated Beryllium Work Areas").
- Warning signs (Section 3.5.8, "Labeling and Posting").
- Hygiene facilities and practices (Section 3.7, "Facilities and Equipment").
- Respiratory protection (Section 3.6.1, "Respiratory Protection").
- Protective clothing and equipment (Section 3.6.2, "Other Personal Protective Equipment").

Even when measurable exposures are less than the AL, steps shall be taken to reduce exposures further, if practical, although a formal program is not required. The controls in this document constitute the LLNL program to minimize worker exposure to beryllium.

### 3.3 Standards

The DOE, in 10 CFR 850, has established standards for beryllium airborne exposure and surface contamination allowable in DOE facilities. Additional standards are promulgated by OSHA, in 29 CFR 1910.1000, and are applicable to LLNL as Work Smart Standards. These exposure standards are listed in Table 2. The guidance provided in Appendix C is to be used for determining compliance with the standards. Sampling shall be conducted to ensure statistical confidence of at least 95% in meeting the standards.

**Table 2. Occupational exposure, housekeeping, and release standards.**

Standard	Limit	Source
<b>Personnel Exposure</b>		
Action level (8-hour, time-weighted average concentration)	0.2 $\mu\text{g Be}/\text{m}^3$ <sup>a</sup>	10 CFR 850.23
Permissible exposure limit (PEL) (8-hour, time-weighted average concentration)	2 $\mu\text{g Be}/\text{m}^3$ <sup>a</sup>	10 CFR 850.22, 29 CFR 1910.1000
PEL (acceptable ceiling concentration)	5 $\mu\text{g Be}/\text{m}^3$ <sup>b</sup>	29 CFR 1910.1000
PEL (peak above acceptable ceiling)	25 $\mu\text{g Be}/\text{m}^3$ , for no more than 30 minutes <sup>b</sup>	29 CFR 1910.1000
<b>Surface Contamination</b>		
(A) Housekeeping Maximum removable surface contamination for beryllium work areas	3 $\mu\text{g Be}/100 \text{ cm}^2$ <sup>c, d</sup>	10 CFR 850.30
(B) Release Criteria Maximum removable surface contamination for release to non-beryllium work areas	0.2 $\mu\text{g Be}/100 \text{ cm}^2$ <sup>d, e</sup>	10 CFR 850.31

<sup>a</sup> Measured without regard to the use of respiratory protection.

<sup>b</sup> For soluble compounds not subject to 10 CFR 850.

<sup>c</sup> At the end of operational periods.

<sup>d</sup> These are the units prescribed in 10 CFR 850; when expressed in the units typically used in analytical laboratory reports, these values are 0.03  $\mu\text{g Be}/\text{cm}^2$  and 0.002  $\mu\text{g Be}/\text{cm}^2$ , respectively.

<sup>e</sup> When there are visible accumulations of dust on accessible surfaces (for example, if a piece of equipment has been stored outdoors for an extended period of time), the release criteria are based on a bulk sample of the dust, and the applicable standard is the concentration of beryllium in the soil at the point of release [i.e., micrograms of beryllium per gram of soil ( $\mu\text{g Be}/\text{g}$ )].

**Action Level:** An AL of  $0.2 \mu\text{g Be}/\text{m}^3$  (8-hour, time-weighted average in air) has been established in 10 CFR 850.23. A goal of the LLNL CBDPP is to keep exposures as far below this level as practical.

**Permissible Exposure Limit:** The OSHA permissible exposure limit (PEL) of  $2 \mu\text{g Be}/\text{m}^3$  (8-hour, time-weighted average in air) has been adopted by the DOE in 10 CFR 850, and no worker shall be exposed at levels exceeding this limit. Any change in the OSHA PEL is automatically adopted in 10 CFR 850 and is also applicable to LLNL.

OSHA also established a maximum ceiling limit of  $5 \mu\text{g Be}/\text{m}^3$  and a peak (which is greater than the ceiling limit) of  $25 \mu\text{g Be}/\text{m}^3$ . These values are applicable to LLNL, but only for beryllium compounds (e.g., soluble beryllium compounds) that are not subject to 10 CFR 850.

**Housekeeping Standard:** Beryllium work areas shall be kept as clean as the nature of the work allows. However, during nonoperational periods, residual contamination shall be verified to be no greater than  $3 \mu\text{g Be}/100 \text{ cm}^2$  (this is the housekeeping standard). If contamination is found to be greater than this limit, then the area in question shall be recleaned and reevaluated to determine compliance with the housekeeping standard. See Section 3.8 for actions necessary for compliance with this standard.

**Release Standard for Contaminated Materials:** Material contaminated with beryllium may be released to non-beryllium work areas, provided that the material is first cleaned, the beryllium level is verified to be less than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ , and the material is labeled as required in Section 3.5.8 (Figure 3). The term “contaminated” means having removable surface contamination that is in excess of whichever of the following is higher:

- $0.2 \mu\text{g Be}/100 \text{ cm}^2$ .
- The concentration of beryllium in the soil at the point of release (when there is visible accumulation of debris).

**Environmental Standards:** The U.S. Environmental Protection Agency (EPA) has established the following limits:

- Maximum permissible air concentration level, which is  $0.01 \mu\text{g Be}/\text{m}^3$  averaged over a 30-day period (in 40 CFR 61.32, *Emission Standard*).
- Maximum contaminant level for beryllium in drinking water, which is  $4 \mu\text{g Be}/\text{L}$  (in 40 CFR 141.62).

However, the EPA has not yet set water quality criteria for beryllium in ambient water (40 CFR 131.38). The regulations specify that individual National Pollutant Discharge Elimination System permits shall address beryllium under the EPA’s narrative criteria for toxics. In addition, LLNL has established reuse criteria for soils generated and reused at LLNL (see Document 33.3, “Management of Soils and Debris,” in the *ES&H Manual*).

### 3.4 Engineering Controls

This section specifies the engineering controls applicable to the handling of beryllium and its compounds. Maintenance of systems used to control beryllium are subject to all the controls established in this document to minimize worker exposure to beryllium and to minimize opportunities for exposure.

Section 3.7, Facilities and Equipment, provides additional requirements for facility design and layout.

#### 3.4.1 Exhaust Ventilation

All repetitive indoor operations that may generate airborne beryllium equaling or exceeding the AL shall be enclosed and shall be equipped with local exhaust ventilation. Exhaust systems used to control beryllium work shall comply with Documents 12.2 and 12.4. The ES&H Team shall evaluate the systems' performance annually.

#### 3.4.2 HEPA Filtration

Required HEPA filter exhaust systems shall comply with Document 12.5 which implements "HEPA Filter and In-place Leak Testing Standard," (UCRL-AR-133354 rev 2). Required HEPA filter systems shall be visually inspected semiannually and be evaluated for performance annually.

Vacuums used for cleaning up beryllium contamination shall be equipped with HEPA filters. Such vacuums shall be labeled (see Section 3.5.8) and controlled and shall not be used for non-hazardous materials.

### 3.5 Administrative Controls

This section describes the administrative controls applicable to the handling of beryllium and its compounds.

#### 3.5.1 Population at Risk

The population at risk for beryllium sensitization or CBD is referred to as beryllium-associated workers. This population includes persons currently working with beryllium and potentially exposed to airborne beryllium (i.e., beryllium workers, defined below), persons formerly or currently potentially exposed, and individuals with signs or symptoms of beryllium sensitization or CBD.

A beryllium worker is a current worker who is regularly employed in an activity that can expose him or her to airborne beryllium. (Although not defined in 10 CFR 850, the

term “regular” is defined in this document to mean “customary, usual, or normal.” The intent of the definition is to include individuals assigned to work with beryllium or in beryllium work areas, not individuals who are present in a beryllium work area transiently or who work with beryllium irregularly or intermittently.) Although no exposure threshold is specified in 10 CFR 850, examples of situations that would classify someone as a beryllium worker include the following:

- Regularly working with beryllium in a process or operation that can produce airborne beryllium.
- Regularly working at tasks (regardless of the level of airborne concentration) such as:
  - Machining, milling, polishing, grinding, drilling, or welding beryllium.
  - Repairing or servicing equipment that has removable beryllium contamination exceeding release levels.
  - Maintenance of systems used to contain and control beryllium.
  - Working in an area where dispersible beryllium exceeding release levels is present.
  - Working with or handling contaminated items.
  - Other operations that disturb or abrade beryllium in a way that results in contamination exceeding release levels.

### **3.5.2 Visitors and Other Ancillary Personnel**

The Responsible Individual shall review and approve visitors and other ancillary personnel in beryllium work areas and shall inform such personnel of the hazards and controls of the area. Visitors to beryllium work areas should be discouraged unless essential to the mission in question.

### **3.5.3 Hazard Assessments**

All beryllium operations, unless exempt from this document, shall be reviewed with an Integration Work Sheet (IWS) as described in Document 2.2. [Work with beryllium shall not be considered as work commonly performed by the public. Such review shall take into consideration the following:

- The amount and nature of work to be performed, including preparation, maintenance, and cleanup.
- The amount of beryllium and chemical form to be used.
- The potential for aerosol production, including emergency response for spills and unplanned events.
- Historical air, swipe, or other data for similar operations.

- The number of workers involved.
- The number of co-located workers not involved in the work.

The hazard assessment that is performed as part of the IWS evaluation shall determine the controls (i.e., engineering, administrative, and PPE) necessary to keep airborne exposures below the AL and as low as practical. If there is a potential for airborne exposure to beryllium, then the Responsible Individual and the cognizant ES&H Team industrial hygienist shall arrange for exposure monitoring as required by Section 3.5.5 of this document. Respiratory protection requirements outlined in Section 3.6.1 shall be followed according to the workplace airborne beryllium concentration.

Welding or torch-cutting beryllium indoors, outdoors, or in a confined space is a presumptive task that may result in high exposures to airborne beryllium. Workers shall use local exhaust ventilation and airline respirators until personal air sampling conducted under worst-case conditions shows that exposures are within acceptable levels. Co-located workers who are not part of the operation shall be similarly protected.

In addition, all workers involved in a beryllium operation shall be evaluated to determine if they are beryllium workers. The operation shall be evaluated to determine if a regulated area is required; see Section 3.5.7 for specifics.

The basic principle for mitigating beryllium hazards is to establish controls to minimize both the number of workers exposed and the opportunities for exposure and to keep the exposure potential as low as practical.

### **3.5.4 Beryllium Inventories**

As part of the hazard assessment process, Responsible Individuals shall develop and maintain an inventory of beryllium, beryllium alloys, and beryllium compounds present in the facility. At the facility manager's discretion, UNCLASSIFIED (only) beryllium inventory information may be included in ChemTrack or obtained and tracked through some other means.

At a minimum, the inventory of beryllium, beryllium alloys, and beryllium compounds will be updated annually in each facility. In addition, whenever beryllium is brought into or taken out of a facility or removed from inventory because of use, workers shall notify their supervisors, who will then forward the inventory information to the Facility Manager. Individual inventories shall be provided to the facility manager, who prepares a consolidated inventory (in pounds) to the ChemTrack Operations Group in EPD for regulatory reporting purposes.

The inventory should have the following information (as appropriate):

- Product name, including form (e.g., beryllium foil)

- Manufacturer
- Building number
- Room number
- Sub-location (e.g., cabinet or other storage location)
- Quantity (i.e., weight of beryllium, beryllium alloy, or beryllium compound)
- Units
- Custodian's ID (i.e., employee number)
- Custodian's first and last name
- Custodian's telephone extension
- Container (if appropriate)
- Date

An inventory shall be sufficiently detailed to ensure the safety basis envelope of each facility where beryllium is used is not exceeded.

### **3.5.5 Exposure Monitoring**

#### **Initial Monitoring**

In areas that may have airborne beryllium, initial personal breathing zone sampling shall be conducted to determine workers' 8-hour, time-weighted average exposure. Sufficient numbers of samples shall be taken to adequately characterize exposures. Work supervisors, workers, and the ES&H Team shall cooperate to ensure that the ES&H Team receives the timely notification needed to conduct personnel sampling.

#### **Periodic Monitoring**

When personal exposures equal or exceed the AL, sampling shall be performed periodically, i.e., at least quarterly for routine operations. Infrequent operations, i.e., operations that occur less than quarterly, shall be sampled each time they are performed.

#### **Additional Monitoring**

When work operations, maintenance, or procedures change, or when there is any reason to believe that such a change has occurred, additional monitoring shall be conducted.

### 3.5.6 Safety Documents

Before beginning any work involving beryllium, the work shall be authorized by an IWS. An activity's IWS shall be revised and reapproved if changes in operations increase the level of hazard or introduce new hazards.

In addition to an IWS, a safety plan is required for all beryllium operations that have the potential for producing airborne beryllium. A safety plan that is consistent with Document 2.2 shall provide specific controls to keep airborne beryllium at levels less than the AL and as low as practicable. A Hazard Assessment and Control (HAC) form is used to document the use of respirators and other PPE in accordance with the requirements of Document 11.1. A HAC form is used for work when a safety plan is not required.

### 3.5.7 Beryllium Work Areas and Regulated Beryllium Work Areas

A beryllium work area is any defined area (e.g., shop, laboratory, or other facility) that is subject to 10 CFR 850, i.e., that does not fall under the laboratory-use exemption (see Section 1.0), and where beryllium (other than beryllium articles) is handled, used, or worked. (Beryllium articles are those items meeting the OSHA definition of an article and whose surface contamination level is determined to be less than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ .) Measured or potential airborne exposures are to be less than the AL of  $0.2 \mu\text{g Be}/\text{m}^3$  as an 8-hour, time-weighted average. A beryllium work area may be either temporary or permanent, depending on the nature of the specific work. A beryllium work area shall be posted with the sign shown in Figure 1 in Section 3.5.8.

A regulated beryllium work area is any area (e.g., shop, laboratory, or other facility, including outdoor locations) that is subject to 10 CFR 850, i.e., that does not fall under the laboratory-use exemption, and where beryllium is handled, used, or worked and measured airborne exposures equal or exceed the AL. A regulated beryllium work area may be either temporary or permanent, depending on the nature of the specific task or effectiveness of controls. Significant requirements of a regulated beryllium work area are:

- A manner of demarcation from the rest of the workplace that adequately alerts workers to the boundaries. (See Figure 2 in Section 3.5.8.)
- Access that is limited to authorized persons.
- A log of all entrants that shows each entrant's name, employee number, date, time in, time out, and work activity.
- Dedicated change rooms for workers to change into and store personal clothing and clean protective clothing and equipment.
- Dedicated showers and handwashing areas. (Workers are required to shower at the end of the shift.)

Additional requirements for regulated areas are specified by 10 CFR 850 and are addressed in the following sections of this document:

- Section 3.2, "Exposure Reduction and Minimization Program."
- Section 3.5.5, "Exposure Monitoring."
- Section 3.5.8, "Labeling and Posting."
- Section 3.6.1, "Respiratory Protection."
- Section 3.6.2, "Other Protective Equipment."

A regulated beryllium work area reverts to a beryllium work area when personal air samples determine that exposures are less than the AL.

### 3.5.8 Labeling and Posting

All access points to a beryllium work area shall be demarcated with a sign having, as a minimum, the wording shown in Figure 1. Earlier versions of such signs having the same wording may be used if legible.

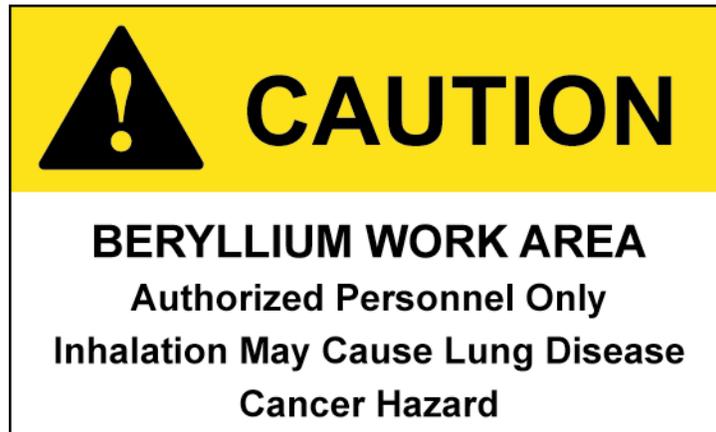
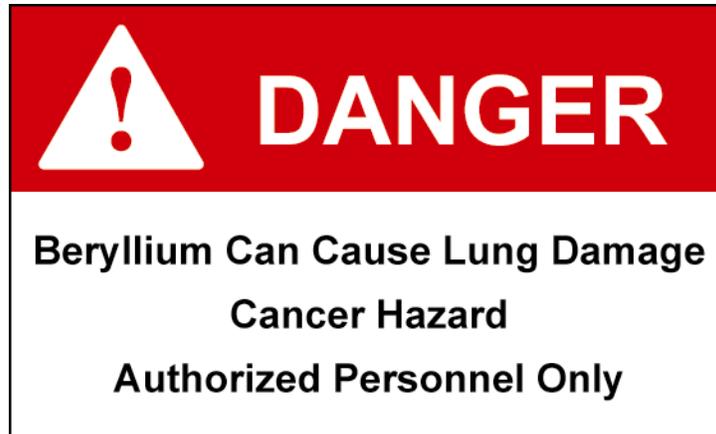


Figure 1. Access posting for entrance to beryllium work areas.

All access points to a regulated beryllium work area shall be demarcated, as required by 10 CFR 850, with a sign having, as a minimum, the wording shown in Figure 2.



**Figure 2.** Access sign for regulated beryllium work areas.

All containers of beryllium, beryllium compounds, or beryllium-contaminated clothing, equipment, waste, scrap, or debris shall be labeled, as required by 10 CFR 850, with a sign having, as a minimum, the wording shown in Figure 3. In addition, labeling shall also conform to the requirements of the LLNL Health Hazard Communication Program, as specified in Document 10.2.



**Figure 3.** Label for containers of beryllium or items contaminated with beryllium.

Items made of beryllium, beryllium alloys, or beryllium compounds that do not meet the definition of beryllium articles shall be labeled as indicated in Figure 4. When such a label affects the performance of the item or interferes with a process (e.g. machining or cleaning), the label shall be positioned so that the information is readily apparent to the user or shall be included in the work documentation.

 <b>CAUTION</b>		
<b><u>Beryllium Material</u></b>		
<b><u>Contamination Level:</u></b>		
<input type="checkbox"/> Not Determined		
<input type="checkbox"/> Swipe Results		
Sample No.	Sample Date	Sample Result
_____	_____	_____
<b><u>Controls:</u></b>		
<input type="checkbox"/> Handle Only in an Approved Beryllium Work Area		
<input type="checkbox"/> Releasable $\leq 0.002\mu\text{g}/\text{cm}^2$		

**Figure 4.** Label for beryllium items.

Beryllium articles, although exempt from the requirements of 10 CFR 850, should be labeled, when feasible, to alert users to the presence of beryllium. Labels may be affixed to storage containers or enclosures for parts. The label shown in Figure 5 may be used for this purpose.



**Figure 5. Label for beryllium articles.**

Areas where beryllium metal, alloys, or compounds are stored shall be posted prominently with the sign shown in Figure 6:



**Figure 6. Beryllium storage area sign.**

### 3.5.9 Training

All persons working at LLNL (e.g., UC/LLNL employees, subcontract workers and assigned to LLNL) shall be trained in the hazards of, and controls for, working with beryllium. The level of training is dependent on a worker's exposure potential. Details are listed in Table 3.

**Table 3. Required training.**

Course	Target Audience	Repeat Frequency
HS4258-W, "Beryllium Awareness"	Required for all workers at LLNL, except beryllium workers or beryllium-associated workers	One time only
HS4258-R, "Beryllium Awareness-Refresher"	Required for all workers at LLNL, except beryllium workers or beryllium-associated workers	Every 2 years following HS 4258
HS-4257-R, "Beryllium Safety Training"	Required for beryllium-associated workers, except beryllium workers	Every 2 years
HS4256, "Beryllium Worker Training"	Required for beryllium workers	Every 2 years
HS4610-CBT, "Basic Air Purifying Respirator Training"	Persons required or choosing to use air purifying respirators	Annually
HS4620-CBT, "Basic Air-Supplied Respirator Training"	Persons required to use air supplied respirators	Annually
HS4630-S, "SCBA - Interspiro/Spiromatic-Specific" <sup>a</sup>	Persons required to use SCBAs	Annually

<sup>a</sup> Self-contained breathing apparatus.

Visitors and other ancillary personnel in beryllium work areas shall be briefed on area specific hazards, including beryllium, and controls by the Responsible Individual or designee.

Retraining for beryllium workers and beryllium-associated workers is required every 2 years or sooner if a worker's performance in work involving beryllium indicates that he or she has not retained the required proficiency.

When respirators or other PPE is required, training shall be conducted as required by Document 11.1.

### 3.5.10 Medical Surveillance

All workers identified as beryllium-associated workers shall be offered beryllium medical surveillance in accordance with 10 CFR 850. The Health Services Department provides medical surveillance only for UC employees at no charge and at convenient times to accommodate their work schedules. All other workers are offered medical surveillance through their employers. Participation in the medical program is voluntary, i.e., subject to a worker's consent to specific medical tests.

The Responsible Individual shall identify beryllium workers on the IWS (see Section 3.5.3) and ensure that Hazards Control and Health Services Departments are on distribution. The payroll supervisor shall also ensure that medical surveillance is offered

to beryllium-associated workers. These departments jointly develop and maintain a list of eligible beryllium-associated workers. The list is updated at regular intervals as new beryllium-associated workers are identified in the field and as others leave LLNL service. The Hazards Control Department and other LLNL departments, as necessary, provide the Health Services Department and employers of subcontract workers with information about exposure and industrial hygiene sampling as needed to direct and coordinate the Beryllium Medical Surveillance Program. Such information includes baseline inventories, hazard assessment and exposure monitoring data, and the identity and nature of activities covered under the CBDPP. The Health Services Department's ES&H Team clinicians make field visits to beryllium operations areas to familiarize themselves with the nature of beryllium work activities and exposure potential.

Medical evaluations are provided to beryllium-associated workers (who include beryllium workers). Beryllium workers are offered annual medical exams and testing. All other beryllium-associated workers are offered evaluations every 3 years. Medical evaluations include assessment of clinical history and exposure history, as well as an exam that emphasizes the respiratory system, skin, and eyes. Workers are offered the Be-LPT, spirometry test, and other tests. Examination and tests are offered with workers' consent, which is documented on the standardized DOE consent form. Information on the risk and benefits of any clinical tests is provided prior to those tests. The Health Services Department (in the case of UC employees) and employer-designated medical surveillance providers (in the case of nonUC employees) also provide clinical evaluation to any worker who may have been exposed to beryllium in an unplanned incident. Workers also receive a written summary of the clinical evaluation, as well as any recommendations, within 10 working days of receipt of the results by the Health Services Department.

LLNL employees may exercise the multiple-physician review option, which is specified in 10 CFR 850 and which can include review of initial medical findings by a second physician. Workers also receive a written summary of the clinical evaluation, as well as any recommendations, within 10 working days of receipt of the results by the Health Services Department.

If a worker is determined, by the Be-LPT, to be sensitized, then sensitization is reported through the standard OSHA injury reporting process. The medical removal option is discussed in detail in Appendix B.

Counseling is available through the Health Services Department (in the case of UC employees) and employer-designated medical surveillance providers (in the case of nonUC employees) for sensitized and CBD workers to assist those workers with concerns regarding their medical treatment, psychological concerns, workers' compensation, and the health risks of continued beryllium exposure. Sensitized workers are offered regular, comprehensive medical evaluations by a specialist to detect the early signs of CBD.

Records are maintained according to the standards specified in 10 CFR 850.39, and worker confidentiality is preserved to the extent afforded by law. The results of clinical evaluations of UC employees are stored in the Health Services Department's medical records. Records of subcontractor employees, including the results of analysis, shall be released to the Health Services Department for retention. All records are kept either for a minimum of 75 years or according to the LLNL record-retention schedule.

Worker exposure data and group sensitization data are regularly reviewed collaboratively by the Health Services and Hazards Control Departments and analyzed to establish a prevalence rate and thereby identify work groups who are at risk for sensitization. Health Services Department procedures are in place to protect the confidentiality of individual workers. The results of such analyses are also used to identify additional work groups who are in need of surveillance or exposure controls.

A worker who begins voluntary participation in the medical program is identified as a beryllium-associated worker and shall continue to be offered beryllium medical surveillance for the duration of his or her employment at LLNL.

### **3.5.11 Beryllium Registry**

Under 10 CFR 850, DOE has established a registry of beryllium-associated workers and requires LLNL to transmit the following information semiannually for each beryllium-associated worker (including those who are subcontract workers) in the registry:

- A unique identifier
- Year of birth
- Gender
- Site identifier
- Job history
- Medical screening test results
- Exposure measurements
- Results of referral for specialized medical evaluations

Each record in the registry is identified by a unique identifier, which serves to link the record to a specific individual while maintaining confidentiality. The pairing of unique identifiers with specific workers is known only to the LLNL Medical Director and individuals designated by him or her as having a need to know such information.

In addition, see Appendix B for LLNL's medical protection requirements for current and prospective beryllium workers.

### 3.6 Personal Protective Equipment

The hazard assessment (see Section 3.5.3) shall determine and document the necessary PPE. The use of personal protective equipment protection is required when worker exposure equals or exceeds, or potentially equals or exceeds, the AL.

PPE shall be provided to any beryllium-associated worker, regardless of the level of exposure, whenever he or she requests it. Beryllium-contaminated PPE shall be handled in accordance with Document 11.1. Containers of contaminated PPE shall be labeled in accordance with Section 3.5.8 (Figure 3).

#### 3.6.1 Respiratory Protection

For beryllium work that involves unknown exposures and that has a potential for airborne exposure, respiratory protection shall be used until at least one of the following conditions is satisfied:

- Personal samples have been taken, and exposures for worst case conditions are known to be less than the AL.
- The work has been evaluated and compared to other, similar work in which exposures are known to be less than the AL.
- The work has been evaluated, compared to other, related work (in which exposures are known to be less than the AL), and determined to have less exposure potential.

All workers requiring or wanting to use respiratory protection shall follow the requirements of Document 11.1. Respiratory protection shall be chosen by the ES&H Team industrial hygienist in accordance with Table 4 and shall be documented on a HAC form.

**Table 4. Required respiratory protection.**

Exposure <sup>a</sup>	Required Respirator
<0.2 µg Be/m <sup>3</sup>	None
<2.0 µg Be/m <sup>3</sup> (<10 × AL)	Half-mask, negative-pressure respirator with P100 filter
<10 µg Be/m <sup>3</sup> (<50 × AL)	Full-face, negative-pressure respirator with P100 filter or half-mask PAPR <sup>b</sup> with P100 filter
<20 µg Be/m <sup>3</sup> (<100 × AL)	Full-face PAPR with P100 filter
<200 µg Be/m <sup>3</sup> (<1000 × AL)	Supplied-air, full-face respirator operated in pressure demand mode
>200 µg Be/m <sup>3</sup> , unknown concentration, or	Full-face SCBA in positive pressure mode

firefighting	
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<sup>a</sup> "Exposure" means measured exposure or potential for exposure at the indicated level.

<sup>b</sup> Powered, air-purifying respirator.

### 3.6.2 Other Personal Protective Equipment

The use of other PPE (e. g., gloves, lab coats, or coveralls), as determined by the ES&H Team industrial hygienist, is required when:

- Airborne exposures to beryllium equal or exceed the AL.
- Surface contamination exceeds, or is presumed to exceed, the housekeeping standard (i.e., 3 µg Be/100 cm<sup>2</sup>).

All workers required or wanting to use PPE shall follow the requirements of Document 11.1, which requires that the selection of PPE be documented. The processes of Document 2.2 shall also be followed.

### 3.7 Facilities and Equipment

Facilities used for beryllium work should be designed to minimize the spread of beryllium aerosols and to minimize beryllium contamination and opportunities for beryllium exposure. Therefore, such facilities have the following features:

- Beryllium work areas that are at negative pressure relative to non-beryllium work areas (e.g., beryllium machine shops).
- Building components (e.g., floors and walls) that are nonporous (for ease of decontamination), to the extent feasible.
- A facility layout that enables non-beryllium workers to enter and pass between non-beryllium work areas in the facility without entering a beryllium work area.
- Eyewashes and safety showers shall be provided where operations are done routinely in which eye or skin contact with dust or splinters is possible. Requirements for training the users of eyewashes/safety showers are found in Section 3.1.3 of Document 10.2 (for non-laboratory situations), and Section 3.2.6 of Document 14.2 (for laboratory situations). Requirements for the testing of safety showers/eyewashes are specified in Appendix B of Document 14.1. Engineering specifications are found in LLNL Facility Standard PEL-M-11610, "Emergency Eyewash & Shower Units."

When a regulated beryllium work area needs to be established (see Section 3.5.7), the change room and showers should be located as close as possible, and preferably adjacent, to the regulated area or located in such a manner that beryllium contamination

is not spread throughout the facility or to other workers. The ES&H Team industrial hygienist can provide specific guidance.

### 3.8 Housekeeping

Beryllium work areas shall be kept as clean as the nature of the work allows during operational periods. The work area shall be cleaned at the conclusion of work. [The interior of a system (e.g., enclosure, glove box, chamber, or ventilation system) designed to contain beryllium contamination is not subject to this cleaning and sampling requirement.] Cleaning shall use techniques (e.g., wet methods or HEPA vacuuming) that do not produce airborne dust. Equipment used for cleaning beryllium-contaminated areas shall not be used for nonhazardous materials. Such equipment shall be labeled as beryllium contaminated using the label shown in Figure 3.

During nonoperational periods, beryllium work areas shall have residual surface contamination verified to be less than  $3 \mu\text{g Be}/100 \text{ cm}^2$  based on a routine sampling protocol that meets Appendix C guidelines. Sampling shall be conducted as often as necessary to ensure 95% confidence in meeting the housekeeping standard.

A nonoperational period is defined, based on the nature of the work, as the period commencing at either of the following:

- For ongoing, routine operations (i.e., production-type activities)—The end of the work shift or shifts, if work extends over one more consecutive shifts.
- For specific jobs (i.e., non-production or isolated activities)—The conclusion of the work, even if the work extends over 2 or more days. For long-term operations, the first definition applies.

### 3.9 Shipment and Receipt of Potentially Beryllium-contaminated Items

Operations involving shipment or transfer of potentially beryllium-contaminated items are subject to all the controls established in this document to minimize worker exposure to beryllium and to minimize the opportunities for exposure.

Classified beryllium parts shall be handled in accordance with this section when there is a potential for exposure to beryllium. See *MDD Procedures Manual*, Section 302.17, "Beryllium," UCRL-MA-124100 (UCNI), *Materials Management Material Control and Accountability Manual*, Volume A, "Material Control and Accountability Plan;" and *Safeguards and Security Program Guide* for specific requirements for classified parts.

Prior to shipment or transfer, potentially beryllium-contaminated items shall be cleaned to the extent practical taking into consideration the nature of the item and its subsequent use. Shipment and receipt of an item that is potentially contaminated with

beryllium, or that has uncharacterized beryllium contamination, shall be handled to minimize the potential for exposure to airborne beryllium. The surface criteria standards listed in Table 2 in Section 3.3 of this document shall apply, except when:

- The item is too fragile to be swiped.
- Swiping of the item's surface would render the item unsuitable for experimental or investigative work.
- The item is composed of beryllium that may be released when handled or manipulated.

Transfer (i.e., movement of an item within the geographically contiguous property owned by, or under the control of, LLNL) shall comply with Document 21.2.

Shipment (i.e., movement of beryllium on public roads) shall comply with 49 CFR 100-199, "Research and Special Programs Administration, Department of Transportation." Assistance is available from the Hazardous Material Packaging and Transportation and Safety Office. The following beryllium-specific controls apply to preparation for shipment, actual shipment, and receipt of a potentially beryllium-contaminated item:

### **Preparation for Shipment**

The Responsible Individual shall

- Document the shipment, including swipe results, if done, on the Equipment/Property Release Form as required by Document 21.5, "Requirements for Transfer of Equipment and Property for Repair, Reuse, Maintenance, Storage, Excess, or Scrap," in the *ES&H Manual*.
- Verify whether swiping the surface would render the item unsuitable for its intended purpose or investigation. (This fact shall be included with the shipping documents.)
- Ensure that swipes are taken to determine the level of contamination. If the item is not to be swiped, the item shall be assumed to be contaminated.
- Ensure that the item is properly packaged for shipment, storage, or transfer.
- Ensure that the item is enclosed in a sealed, impermeable bag or container to prevent the release of beryllium dust during handling and transportation.
- Ensure that the bag or container shall be labeled using the label shown in Figure 3 or 4 (as appropriate), as required by Section 3.5.8.

## Shipment

The Responsible Individual shall

- Inform the recipient, in writing, of the level of beryllium contamination or that the item has an uncharacterized level of contamination.
- Obtain, from the recipient, a written statement acknowledging the uncharacterized level of contamination and accepting the shipment in this state. (This written statement shall be included with the Equipment/Property Release Form.)

## Receipt

A bag or container having a potentially beryllium-contaminated item inside shall be opened only in an area that has suitable controls for beryllium work, as authorized in an approved IWS. In the absence of appropriate shipping documentation, beryllium-containing items shall be assumed to be contaminated.

Acquisition of beryllium or beryllium-contaminated items from other DOE contractor facilities is subject to 10 CFR 850.31(c) and shall

- Not have removal contamination in excess of 3  $\mu\text{g}/100\text{ cm}^2$ .
- Be labeled in accordance with Figure 3 (or equivalent).
- Be enclosed in sealed, impermeable bags or containers.

Purchase of beryllium is subject to approval of the Hazards Control Department. The authorized approver is noted in the Procurement & Materiel Department's Controlled Items List, which is available at the following Internet address:

<http://www-r.llnl.gov/pm/html/trrinfo.html>

### 3.10 Storage

Beryllium shall be stored to minimize potential opportunities for personnel exposure to airborne dust. The requirements and guidelines for beryllium storage are as follows:

- Areas where beryllium is stored shall be prominently posted (see Figure 6).
- Containers of beryllium, beryllium compounds, or beryllium alloys shall be labeled as required by Section 3.5.8.
- Beryllium parts or other items should be stored in containers and labeled, when appropriate.

### 3.11 Waste

Operations (i.e., waste handling or decontamination activities) involving beryllium waste are subject to all the controls established in this document to minimize worker exposure to beryllium and to minimize opportunities for exposure.

#### 3.11.1 Waste Handling

All beryllium waste and beryllium-contaminated waste shall be handled by the generator (i. e., the worker or the Responsible Individual) according to the requirements applicable for all hazardous waste as required by Document 36.1. In addition, all beryllium waste and beryllium-contaminated waste shall be labeled using the label shown in Figure 3.

*Waste Acceptance Criteria* (UCRL-MA-115877, Rev. 2) provides summary requirements on waste management to comply with state and federal regulations and DOE Orders.

#### 3.11.2 Wastewater Discharges

Liquid wastes generated during operations involving beryllium need to have authorization from the Water Guidance and Monitoring Group (in the Environmental Protection Department) prior to being discharged to the sanitary sewer. All discharges to the sanitary sewer shall follow Documents 32.1 ,” and 32.4. Wastewater with a pH that is less than 5 or greater than 10 shall not be discharged to the sanitary sewer.

#### 3.11.3 Waste Minimization

All beryllium work shall be conducted according to waste minimizing principles of the waste minimization program, detailed in Document 30.1.

### 3.12 Emergency Response

Unplanned events (e.g., accidental exposure, spills, loss of containment, and fire) involving beryllium particulates or liquids shall be promptly cleaned up using the appropriate PPE selected with assistance from the Hazards Control Department. See Table 5 for emergency response actions to take in the event of a beryllium accident.

Emergency response to an unplanned event with a potential for beryllium exposure constitutes beryllium work and is subject to this document.

The hazard assessment required by Section 3.5.3 of this document shall include an evaluation of the airborne beryllium exposure that could result from the potential failure of control and containment. The Responsible Individual shall:

- Ensure that a written emergency plan is prepared with the advice of the ES&H Team. The plan shall specify appropriate actions to be taken and PPE to be used in the event of a breach of control or containment. This document shall be included with the IWS, Facility Safety Plan (FSP), or IWS with Safety Plan.

**Table 5. Beryllium emergency response actions.**

Event	Action
Eyes	If beryllium powder or chips get into eyes, do not rub them. Flush eyes with water for at least 15 minutes, lifting the upper and lower eyelids frequently to ensure complete washing. Have someone else dial 911 for the emergency dispatcher. Report to the Health Services Department.
Skin	If beryllium powder or chips come in contact with an open wound in skin, flush the wound with water for 15 minutes, then report to the Health Services Department.
Inhalation	If beryllium dust is inhaled, or believed to have been inhaled, report immediately to the Health Services Department. Have someone else notify the Hazards Control Department.
Spills	If beryllium powder is spilled, evacuate and isolate the area. Move upwind, if possible, and wear an air-supplied respirator or a cartridge respirator equipped with a high-efficiency cartridge or the equivalent. If practical, wet down the spill with water and cover it with sand, a tarpaulin, or some other suitable material. Dial 911 for the emergency dispatcher. The Hazards Control Department specifies the procedures and PPE to be used in cleanup and decontamination.

- Ensure that workers are familiar with those actions.
- Call 911 if the size of the spill exceeds
  - The ability of personnel to handle the spill.
  - The scope of preplanning.

The ES&H Team shall be notified of any exposure or unplanned release of beryllium. A spill of even a small amount of beryllium powder is an event of significant exposure potential and requires the assistance of the ES&H Team.

Upon the completion of spill cleanup, verification of residual contamination is required. The criteria for beryllium work areas ( $<3 \mu\text{g Be}/100 \text{ cm}^2$ ) and non-beryllium work areas ( $<0.2 \mu\text{g Be}/100 \text{ cm}^2$ ), as appropriate, shall be met (see Section 3.3 of this document).

### 3.13 Decontamination for Reuse, Disposal, or Excess

#### 3.13.1 Equipment

Equipment to be reused for non-beryllium work, excessed, or disposed of shall be decontaminated to the extent practical taking into consideration its end use or disposition. Equipment to be released to the general public or non-beryllium areas of DOE contractor facilities shall meet the release criteria (see Section 3.3); equipment to be released to other beryllium work areas of DOE contractors shall meet the housekeeping standard (see Section 3.3).

Release of equipment to the general public or non-beryllium areas of DOE contractor facilities is conditional on the recipient's commitment to implement controls to prevent foreseeable beryllium exposure considering the nature of the items and their foreseeable use.

The disposal and excessing of potentially beryllium-contaminated equipment shall be handled in accordance with this document and Document 21.5.

#### 3.13.2 Facilities

Facilities or work areas to be removed from beryllium controls shall be cleaned to the release or housekeeping standard, as appropriate for subsequent use, and contaminated equipment shall be cleaned, removed, or enclosed to prevent exposures.

The shutdown and transfer of beryllium work areas shall be handled in accordance with this document and Document 12.7, "Shutdown or Transfer of Facilities, Operations or Associated Equipment," in the *ES&H Manual*.

### 3.14 Beryllium Article Exemption

Under 10 CFR 850.2 (Applicability), articles are exempt from the requirements of the rule. The term "article," as used in the exemption, has a meaning that is subject to specific criteria derived from the OSHA Hazard Communication Standard (i.e., 29 CFR 1910) and from interpretations in OSHA Compliance Instruction CPL 2-2.38D. An article is a manufactured item that:

- Is formed to a specific shape or design during manufacture.
- Has end-use functions that depend in whole or in part on its shape or design during end use.
- Does not release beryllium or otherwise result in exposure to airborne concentrations of beryllium under normal conditions of use.

The following three examples illustrate the differences between items that can be considered articles and items that cannot:

1. **Example of a nonexempt item.** A piece of beryllium stock that is to be machined into a part is not an article because (1) it is not in its finished form, (2) its use is dependent on that form, and (3) machining the piece will produce beryllium particulates in potentially hazardous quantities.
2. **Example of a nonexempt item.** A finished part that has gone through the final cleaning step of its manufacturing process is swiped and found to have a residual surface contamination of less than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ . However, further handling or use (e.g., abrading the surface or exposing the object to an environment that results in removable oxidation, but not including operations that do not abrade the surface) results in removal beryllium surface contamination greater than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ . The part is no longer an article and is subject to the rule. Beryllium metal or beryllium–copper alloy objects are expected to meet this criteria; beryllium oxide objects may not meet the criteria, although the determination depends on use.
3. **Example of an exempt item.** A finished part that has gone through the final cleaning step of its manufacturing process is swiped and found to have residual surface contamination of less than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ , and further handling will not abrade the part's surfaces, i.e., there will be no removal beryllium surface contamination exceeding  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ . This part is an article and is exempt from the rule.

Before a beryllium item is considered an article, the following process shall be implemented:

1. The item shall be assumed to be contaminated until surface contamination is determined.
2. Swipes shall be taken by the ES&H Team to determine surface contamination and a report provided to the RI.
3. If swipes reveal contamination that is less than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ , the article or its container shall be labeled as an article with the date of the sampling and sample numbers (see Figure 5). If labeling of the article or its container would be inappropriate, then a record of the results of swiping shall be maintained with other documents for the work process.
4. If swipes reveal contamination that is greater than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ , the part may be re-cleaned and surface contamination reevaluated. If the results are less than  $0.2 \mu\text{g Be}/100 \text{ cm}^2$ , the part shall be labeled as an article (see Figure 5).

Equipment that is purchased for LLNL use and that has internal beryllium components does not require further evaluation. The components are assumed to be articles unless worked on by LLNL personnel, at which point the components are subject to the controls of this document.

## 4.0 Responsibilities

All workers and organizations responsible for the safe handling of beryllium and its compounds shall refer to Document 2.1, "Laboratory and ES&H Policies, General Worker Responsibilities, and Integrated Safety Management," in the *ES&H Manual* for a list of general responsibilities. This section describes specific responsibilities of LLNL organizations and workers who perform beryllium-related work.

### 4.1 Workers

Workers involved in work with beryllium shall:

- Take the appropriate courses specified in Table 3.
- Comply with all requirements of an activity's IWS and safety plan.
- Notify the Responsible Individual whenever beryllium or beryllium-containing items are brought into the work area so that appropriate evaluation can be conducted.
- Follow the procedures specified in this document for all purchases of beryllium.
- Wear the provided PPE.
- Complete the Beryllium Occupational History Questionnaire. (The questionnaire is available from the Health Services Department and from the area ES&H Team.)

### 4.2 Responsible Individuals and Work Supervisors

Responsible Individuals, principal investigators, and work supervisors shall ensure that:

- A complete ES&H evaluation (using an IWS and including review by the ES&H Team) for all beryllium work, including experimentation, cleaning of beryllium-contaminated equipment or parts, and dismantling of equipment, is conducted as described in Document 2.2 before starting the work.

- A safety plan is prepared for all uses of beryllium that may result in any airborne concentration of beryllium or for any operation indicated by an ES&H evaluation as requiring a safety plan.
- Beryllium work areas and regulated beryllium work areas are established, as appropriate.
- The ES&H Team is notified prior to the initiation of beryllium operations, so that personal air sampling to evaluate worker exposure to beryllium can be performed.
- The ES&H Team is notified of new beryllium operations.
- Workers take the courses specified in Table 3 before beginning beryllium work that could result in an airborne exposure. The courses are offered by the Hazards Control Department.
- Workers comply with all requirements of an activity's IWS or safety plan and follow the controls specified in this document.
- Access to beryllium work areas is limited to authorized workers and visitors essential to the mission; non-essential visitors should be discouraged.
- The storage, handling, and disposal of beryllium meet the requirements of this document and other requirements in the *ES&H Manual*.
- Shipping or transfer of beryllium meet the requirements of this document and any other applicable document in the *ES&H Manual*.
- A beryllium inventory is conducted, kept current, and provided to the facility manager.
- Inform the technical release representative of all purchases involving beryllium and of the presence of beryllium in items.
- All engineering controls (i.e., ventilation and HEPA filtration) function properly.
- PPE is provided to workers who may be potentially exposed to levels of beryllium equaling or exceeding the AL or who may be involved in work with uncharacterized exposures.
- Workers fill out the Beryllium Occupational History Questionnaire. (A new questionnaire shall be completed each time work assignments change.)
- A formal exposure reduction and minimization program is developed by the impacted program with the assistance of the Hazards Control and Health Services Departments in the event that exposures equal or exceed the AL.

- Beryllium workers and beryllium-associated workers are identified and reported to the payroll supervisor, to the Chemical and Biological Safety Section of the Hazards Control Department, and to the Health Services Department at least annually.
- The presence of visitors and other ancillary personnel in beryllium work areas is approved.
- Approved visitors and other ancillary personnel are briefed on hazards and controls in beryllium work areas.
- Payroll supervisors are notified of training and medical surveillance for assigned workers.
- Control of SRD beryllium parts meets the requirements of the Materials Management classified parts procedures.
- Ensure that beryllium processing and control equipment is properly maintained.
- Replace beryllium warning signs that have been removed or defaced.

#### 4.3 Payroll Supervisors

Payroll supervisors are responsible for ensuring that:

- Beryllium medical surveillance is offered to identified workers. This may be accomplished by contacting either the Health Services Department point of contact for beryllium surveillance or the Health Services Department clinician assigned to the supervisor's ES&H Team. A list of points of contact and ES&H Team clinicians is available at the Health Services Department's Web site:

<http://www-r.llnl.gov/healthserv/>

- Workers take the appropriate courses specified in Table 3.
- The payroll organization is responsible for ensuring its assigned responsibilities in Appendix B are followed.

#### 4.4 Hazards Control Department

The Hazards Control Department shall:

- Review beryllium IWSs and safety plans.
- Analyze the hazards of all beryllium operations, evaluate the hazards to workers, and document hazard assessments.

- Evaluate new beryllium work against the CBDPP and initiate DOE review, if needed.
- Conduct initial and periodic monitoring (i.e., personal air sampling) of beryllium operations when required.
- Perform periodic sampling of surface contamination in beryllium work areas.
- Maintain the industrial hygiene portion of LLNL's entries in the DOE beryllium registry.
- Provide training identified in Table 3.
- Assist an impacted program in development of a formal (i.e., written) exposure reduction and minimization program when measured exposures equal or exceed the AL.
- Provide timely personnel exposure monitoring data to the Health Services Department and to employers of subcontract workers.
- Work closely with the Health Services Department to review group exposure and group sensitization data.
- Review all subcontractor contracts for compliance with 10 CFR 850.
- Take swipe samples on equipment to determine the level of surface contamination.
- Inform the authorizing organization and facility management of the need to establish beryllium work areas or regulated beryllium work areas.

#### **4.5 Health Services Department**

The Health Services Department shall:

- Offer baseline and periodic medical surveillance examinations for beryllium workers and beryllium-associated workers who are UC employees.
- Recommend temporary or permanent removal from beryllium work (if needed), including medical restrictions, and advise management of medical removal issues.
- Provide counseling for UC employees who are diagnosed as being sensitized to beryllium or having CBD.
- Provide training in the medical issues of beryllium sensitization and disease, the potential consequences of beryllium sensitization, and medical removal.

- Maintain the medical portion of LLNL's and subcontractors' entries in the DOE beryllium registry.
- Assist in development of a formal (i.e., written) exposure reduction and minimization program when exposures equal or exceed the AL.
- Work closely with the Hazards Control Department to analyze group exposure and sensitization data.
- Perform group analyses of beryllium medical surveillance data.

#### **4.6 Environmental Protection Department**

The Environmental Protection Department shall:

- Participate in the hazard review to evaluate environmental contamination levels, permit requirements, National Environmental Policy Act declarations, and other environmental issues during the experiment design phase.
- Specify, in conjunction with the ES&H Team industrial hygienist, the requirements for the packaging of beryllium waste or beryllium-contaminated equipment for shipping and disposal.
- Assist authorizing organizations with the removal and disposal of packaged beryllium or beryllium-contaminated waste.
- Properly manage beryllium-contaminated equipment for disposal.
- Maintain beryllium inventory data.

The Environmental Protection Department is not normally involved in the evaluation of potentially contaminated surplus equipment unless the equipment is to be sold as scrap, recycled, or managed as waste.

#### **4.7 Materials Management Section**

The Materials Management Section is responsible for maintaining a database of SRD classified parts and establishing procedures for the control of such parts owned by LLNL. Individuals performing programmatic work are assigned responsibility for the control of beryllium SRD classified parts and must meet the requirements of both the Materials Management classified parts procedures and this document.

#### **4.8 Technical Release Representatives and Other Personnel Who Purchase Beryllium**

Refer all requests for beryllium to the Hazards Control Department for review and approval prior to placing an actual order. Controls for purchasing beryllium are given in the Controlled Items List, available at the following Internet address:

<http://www-r.llnl.gov/pm/trr/html/controlitem.html>

#### **4.9 Facility Managers**

Facility managers (or designees) shall:

- Be aware of locations where beryllium work is done.
- Provide a consolidated beryllium inventory for all facilities under their responsibility to the Environmental Protection Department.
- Assure that all facility maintenance work involving beryllium work areas and related equipment has been appropriately evaluated to establish proper workplace controls before work begins.
- Maintain copies of inspection records, survey reports, and assessment findings related to beryllium in their facilities.
- Respond to incidents involving beryllium release.
- Assist in limiting access to regulated beryllium work areas, if established.
- Call the area ES&H Team health and safety technician for assistance upon learning of a potential or actual beryllium problem.
- Call the area ES&H Team to collect a sample for analysis in the event of a spill involving an unknown material.
- Ensure that safe working conditions are provided for building occupants.

#### **4.10 Human Resources Department**

The Human Resources Department is responsible for assisting program management in finding alternate work assignments for workers who have been recommended for temporary or permanent removal from beryllium work.

## **5.0 Work Smart Standards**

10 CFR 850, *Chronic Beryllium Disease Prevention Program*.

29 CFR 1910.252(c)(8), *Beryllium*.

29 CFR 1910, Subpart H, *Hazardous Materials*, 1910.101 to 1910.120, January 1999.

29 CFR 1910, Subpart I, *Personal Protective Equipment*, 1910.132-1910.138, as of July 1, 2000.

29 CFR 1910, Subpart Z, *Toxic and Hazardous Substances*, 1910.1000 to 1910.1450 Appendix B, January 1999.

29 CFR 1926, Subpart D, *Occupational Health and Environmental Control*, 1926.50 to 1926.66, January 1999.

49 CFR 100–199, *Research and Special Programs Administration*, DOT (offsite).

ACGIH, *Industrial Ventilation: A Manual of Recommended Practice*, 23rd edition, 1998.

ACGIH, *TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents*, 2002 (excluding Biological Exposure Indices, TLVs for Physical Agents, and Biologically Derived Airborne Contaminants).

ANSI Z358.1-1990, *Emergency Eyewashes and Showers* (testing frequency for emergency showers to be monthly, rather than weekly as required by this standard).

DOE O 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, Attachment 2, "Contractor Requirement Document," Sections 1–11, 13–18 (delete item 18.a), 19 (delete item 19.d.3), and 22.

UCRL-AR-130204, *On-site Packaging and Transportation Safety Standard*, 1999.

UCRL-AR-133354, *HEPA Filter and In-place Leak Testing Standard*, Rev. 2, April 2003.

## 6.0 Resources for More Information

### 6.1 Contacts

See the ES&H Contact List.

### 6.2 Applicable Lessons Learned

For lessons learned applicable to beryllium, refer to the following Internet address:

[http://www-r.llnl.gov/es\\_and\\_h/lessons/lessons.shtml](http://www-r.llnl.gov/es_and_h/lessons/lessons.shtml)

### 6.3 Other Sources

29 CFR 1910, Subpart G, *Occupational Health and Environmental Control*.

63 FR 66940, *Notice of Proposed Rulemaking*, 10 CFR 850, December 3, 1998.

64 FR 68854, *Preamble to Final Rule*, 10 CFR 850, December 8, 1999.

*Defense Programs Beryllium Good Practices Guide*, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-ID-127871.

DOE G 440.1-3, *Implementation Guide for Use with DOE O 440.1, Occupational Exposure Assessment*, July 21, 1997.

DOE G 440.1-7, *Implementation Guide for Use with DOE N 440.1, Interim Chronic Beryllium Disease Prevention Program*, July 11, 1997.

DOE G 440.1-7A, *Implementation Guide for Use with 10 CFR 850, Chronic Beryllium Disease Prevention Program*, January 4, 2001.

DOE N 440.1, *Interim Chronic Beryllium Disease Prevention Program*, July 15, 1997.

DOE, Chronic Beryllium Disease Prevention Program Web site:  
<http://tis-nt.eh.doe.gov/be/>

DOE Oakland, letter from Camille Yuan-Soo Hoo to L. Lynn Cleland. (For more information, contact the Hazards Control Department.)

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 58, "Beryllium, Cadmium, Mercury, and Exposures in the Glass Manufacturing Industry," (1993). Available at the following Internet address:  
<http://193.51.164.11/monoeval/crthall.html>

Leidel, Nelson A., Kenneth A. Busch, and Jeremiah R. Lynch, "Occupational Exposure Sampling Strategy Manual," U.S. Department of Health, Education, and Welfare, Publication 77-173, January 1977.

MDD Procedures Manual, Section 302.17, *Beryllium*. Available at the following Internet address:

<http://www-r.llnl.gov/pm/mdd/html/mddpol.html>

Mulhausen, John R. and Joseph Damiano, "A Strategy for Assessing and Managing Occupational Exposures," 2nd Edition, AIHA Press, Fairfax, VA 1998.

OSHA Directive CPL 2-2.38D, "Inspection Procedures for the Hazard Communication Standard," March 20, 1998.

Rossmann, Milton D., Preuss, Otto P., Powers, Martin B., *Beryllium: Biomedical and Environmental Aspects*, Williams & Wilkins, Baltimore, 1991.

*Safeguards and Security Program Guide*. Available at the following Internet address:  
<http://www-security.llnl.gov/SSDPub/SSGuide/SSG01.ncl>

UCRL-50027-94, *Environmental Report 1993*, 1994.

UCRL-50027-98, *Environmental Report 1998*, 1999.

UCRL-AR-144636-REV-1.1, *LLNL Chronic Beryllium Disease Prevention Program (CBDPP)*, Implementation of 10 CFR 850, Revision 1.1, August 15, 2003.

UCRL-MA-115877, *Waste Acceptance Criteria*, Rev. 2, November, 2003.

UCRL-MA-124100 (UCNI), *Materials Management Material Control and Accountability Manual*, Volume A, "Material Control and Accountability Plan."

Wang, Z., White, P. S., Petrovic, M., Tatum, O. L., Newman, L. S., Maier, L. A., Marrone, B. L., "Differential Susceptibilities to Chronic Beryllium Disease Contributed by Different Glu<sup>69</sup> HLA-DPB1 and -DPA1 Alleles," *Journal of Immunology*, 1999, 163: 1647-1653.

Wilbur, C. G., *Beryllium—A Potential Environmental Contaminant*, Springfield, IL, Charles C. Thomas, Publisher. 1980.

## Appendix A

### Acronyms, Terms, and Definitions

Accepted applicant	A person who has accepted an offer of employment at LLNL but who has not yet entered active duty as a beryllium worker as defined by 10 CFR 850. For purposes of this appendix, an accepted applicant is not a current LLNL or UC employee.
Action level (AL)	The level of airborne concentration of beryllium that is established pursuant to 10 CFR 850.23 and that, if equaled or exceeded, requires the implementation of worker protection provisions specified in that section. The AL is 0.2 $\mu\text{g Be}/\text{m}^3$ averaged over 8 hours.
AL	See "Action level."
Authorized person	Any person required by work duties to be in a regulated area.
Be-LPT	See "Beryllium lymphocyte proliferation test."
Beryllium	Elemental beryllium and any insoluble beryllium compound or alloy that contains 0.1% beryllium or greater and that may be released as an airborne particulate.
Beryllium article	A manufactured item that is formed to a specific shape or design during manufacture, that has end-use functions that depend in whole or in part on its shape or design during end use, and that does not release beryllium or otherwise result in exposure to airborne concentrations of beryllium under normal conditions of use. Further information, including examples, is provided in Section 3.14 of this document.

Beryllium-associated worker	<p>A current worker who is or was exposed or potentially exposed to airborne concentrations of beryllium at a DOE facility, including:</p> <ol style="list-style-type: none"> <li>(1) A beryllium worker.</li> <li>(2) A current worker whose work history shows that the worker may have been exposed to airborne concentrations of beryllium at a DOE facility, including workers who self-identify as having past exposure.</li> <li>(3) A current worker who exhibits signs or symptoms of beryllium exposure.</li> <li>(4) A current worker who is receiving medical removal protection benefits.</li> </ol>
Beryllium emergency	<p>Any occurrence (including, but not limited to, equipment failure, container rupture, or failure of control equipment or operations) that results in an unexpected and significant release of beryllium at a DOE facility.</p>
Beryllium lymphocyte proliferation test (Be-LPT)	<p>A screening test to measure an individual's immune system sensitivity to beryllium metal.</p>
Beryllium work	<p>An activity, taken for or by DOE at a DOE facility, that can expose workers to airborne beryllium—including, but not limited to, design, construction, operation, maintenance, or decommissioning—and that may involve one DOE facility or operation or a combination of facilities and operations. This term is synonymous with "beryllium activity," used in 10 CFR 850.</p>
Beryllium work area	<p>Any area in which beryllium use may result in personnel exposure; areas with beryllium articles only (as defined by OSHA in 29 CFR 1910.1200) are not included this definition.</p>
Beryllium worker	<p>A current worker who is regularly employed in a DOE beryllium activity. At LLNL, this term indicates any worker assigned to a beryllium work area or a regulated beryllium work area.</p>

Breathing zone	A hemisphere forward of the shoulders, centered on the mouth and nose, with a radius of 6 to 9 inches.
CBD	See "Chronic beryllium disease."
CBDPP	Chronic Beryllium Disease Prevention Program.
Chronic beryllium disease	A disease of the lungs caused by the body's immune system and characterized by progressive scarring of the lungs.
Confirmed positive	Positive result based on analysis of two separate blood samples (Be-LPT or an equivalent test).
Contaminated	Presence of beryllium surface contamination in excess of 0.2 $\mu\text{g Be}/100\text{ cm}^2$ or, when the visible accumulation of dust is present, in excess of the concentration (in $\mu\text{g Be}/\text{g}$ of soil) of beryllium in soil at the point of release.
DOE	Department of Energy.
DOE contractor	Any entity under contract with DOE (or its subcontractor) that has responsibility for performing beryllium activities at DOE facilities. Includes LLNL and its subcontractors.
DOE facility	Any facility operated by or for DOE. Includes LLNL.
HEPA	High-efficiency particulate air (filter).
High-efficiency particulate air (HEPA) filter	A filter that traps and retains at least 99.97% of 0.3 $\mu\text{m}$ monodispersed particles.
Immune response	The series of cellular events by which the immune system reacts to challenge by an antigen.
Medical Director	The physician responsible for the overall direction and operation of the site occupational medicine program. This position is referred to as the Site Occupational Medical Director in 10 CFR 850.

Medical removal protection benefits	The employment rights established by 10 CFR 850.35 for beryllium-associated workers who voluntarily accept temporary or permanent medical removal from beryllium areas following a recommendation by the Medical Director.
Non-beryllium work area	Workplaces where there is no beryllium to result in an exposure; beryllium articles may be present in such areas.
Nonoperational period	A period defined, based on the nature of the work, as the period commencing at either of the following: <ul style="list-style-type: none"> <li>• For ongoing, routine operations (i.e., production-type activities)—The end of the work shift or shifts, if work extends over one more consecutive shifts.</li> <li>• For specific jobs (i.e., non-production or isolated activities)—The conclusion of the work, even if the work extends over 2 or more days. For long-term operations, the first definition applies.</li> </ul>
OSHA	Occupational Safety and Health Administration.
PAPR	Powered, air-purifying respirator.
PEL	See “Permissible exposure limit.”
Permissible exposure limit	For beryllium, the PEL is 2 µg Be/m <sup>3</sup> averaged over 8 hours.
Personal sample	An air sample taken in a worker’s breathing zone (a hemisphere forward of the shoulders with a radius of approximately 6–9 inches) to evaluate a worker’s exposure to airborne beryllium.
PPE	Personal protective equipment.
Regulated beryllium work area	An area, demarcated by the responsible employer, in which the airborne concentration of beryllium equals or exceeds, or can reasonably be expected to equal or exceed, the action level.

Removable contamination	Beryllium contamination that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing.
Responsible employer	<ol style="list-style-type: none"> <li>(1) For DOE contractor employees, the DOE contractor office that is directly responsible for the safety and health of DOE contractor employees while performing a beryllium activity or other activity at a DOE facility.</li> <li>(2) For DOE employees, the DOE office that is directly responsible for the safety and health of DOE Federal employees while performing a beryllium activity or other activity at a DOE facility.</li> <li>(3) Any person acting directly or indirectly for either of the above offices with respect to the terms and conditions of employment of beryllium-associated workers.</li> </ol>
SCBA	Self-contained breathing apparatus.
Shipment or shipping	Movement of an item over public roads.
Transfer	Movement of an item within the geographically contiguous property owned by, or under the control of, LLNL.
Unique identifier	The part of a paired set of labels, used in records that contain confidential information, that does not identify individuals except by using the matching label.
Visitor	A person who is not assigned to a beryllium work area but has an irregular or intermittent need to be in that area
WAL	Work authorization level.
Worker	A person who performs work for or on behalf of DOE, including a DOE employee, an independent contractor, a DOE contractor or subcontractor employee, or any other person who performs work at a DOE facility.
Worker exposure	The exposure of a worker to airborne beryllium that would occur if the worker were not using respiratory protective equipment. This is synonymous with "exposure."

## Appendix B

### Medical Protection Requirements for Current and Prospective Beryllium Workers

#### B.1 Summary

LLNL recognizes the need for medical safeguards for beryllium workers at its facilities. LLNL offers medical examination and evaluation for LLNL employees and undertakes notification procedures in beryllium work areas and regulated beryllium work areas in support of workplace safety and health. LLNL strives to inform all employees in beryllium work areas and regulated beryllium work areas that exposures to airborne levels of beryllium, including those less than regulatory limits, may trigger sensitization among some individuals and that such sensitization has, in some cases, led to CBD. Programs and services offered to LLNL employees include tests for beryllium sensitivity and CBD, a medical examination program, and management assistance in seeking alternative assignments, when appropriate. The medical surveillance and notification requirement applies to current and prospective LLNL employees. Testing for beryllium sensitivity is recommended for employees assigned to beryllium work areas or regulated beryllium work areas.

#### B.2 Beryllium Sensitivity Tests

LLNL offers all LLNL workers who are beryllium-associated workers periodic tests for beryllium sensitivity. The tests are offered as a medical examination (either initial or periodic) that includes the Be-LPT or other blood tests for beryllium sensitivity as designated by the LLNL Medical Director. Workers who are, or may become, beryllium-associated workers are encouraged to accept either the Be-LPT or an equivalent designated test. Such workers shall be asked to acknowledge receiving information concerning beryllium sensitization and disease and being offered the beryllium sensitization test. The Health Services Department informs each individual of the test results, including the risks associated with developing CBD, if sensitivity to beryllium is shown. Test results are treated as confidential medical information and are released only with the individual's consent (consistent with current LLNL requirements) or as required by law, including 10 CFR 850 (Chronic Beryllium Prevention Program). Testing for beryllium sensitivity is recommended for all LLNL employees who are beryllium-associated workers and for any LLNL and UC employees transferring to an assignment in a beryllium work area or regulated beryllium work area.

The Be-LPT or equivalent test is offered as a part of a preplacement medical examination for new hires (i.e., accepted applicants) prior to beginning an assignment in a beryllium work area or regulated beryllium work area.

### **B.3 Reassignment Options**

Described below are LLNL workers' options for reassignment from beryllium work.

#### **B.3.1 Temporary Reassignment**

The LLNL Medical Director (or designee) may recommend to the individual, in a written medical opinion based on one or more positive Be-LPT results, CBD diagnosis, an examining physician's recommendation, or any other signs or symptoms that the Medical Director deems medically sufficient, that he or she be temporarily removed from beryllium exposure. When such a determination is made, the employee is offered temporary reassignment (pending a final medical determination) to a non-beryllium worker position with equivalent employment benefits, pay, and other terms and conditions of employment. The Medical Director shall provide the worker a copy of 10 CFR 850, its preamble, and other appropriate information regarding beryllium exposure in discussing the benefits of removal.

The worker may also be offered the option of continuing to work in the current position with beryllium. If the worker chooses to do so, he or she shall sign an acknowledgement of disclosure of health effects, and his or her participation in ongoing medical surveillance, as determined by the Medical Director, shall be mandatory. If a worker who has been confirmed positive for beryllium sensitivity chooses to be placed in an alternative assignment, LLNL management will use its best efforts, working with the worker's organization and with the Health Services and Human Resources Departments, to identify an alternative work assignment. If no temporary reassignment can be found, the worker shall maintain equivalent employment benefits, pay, and other terms and conditions of employment, as specified in 10 CFR 850.35, until a position becomes available or for 1 year, whichever comes first.

#### **B.3.2 Permanent Reassignment**

The Medical Director or designee shall make a recommendation to the individual, in writing, regarding permanent removal for individuals with beryllium-related conditions. If a final medical determination for permanent medical removal has been made, alternate placement shall be made in the same manner as temporary medical removal. If a position is not available, permanent medical removal protection benefits expire after 2 years. The worker shall also have the option of continuing in his or her original position. A worker who chooses to do so shall sign an acknowledgement of disclosure of health effects, and agreement to participate in ongoing medical surveillance, as determined by the Medical Director, shall be mandatory.

### **B.3.3 New Hires from Outside LLNL**

New hires (i.e., accepted applicants) who have a confirmed positive sensitivity test have the option of accepting the beryllium assignment or having the employment offer withdrawn and applying for open, non-beryllium work positions through the LLNL employment process. If a new hire has a confirmed positive sensitivity test and decides to accept the beryllium work assignment, the applicant shall sign, prior to beginning the assignment, an acknowledgment form that the Medical Director has provided the worker a copy of 10 CFR 850 and other appropriate information regarding the health effects of beryllium exposure. The signed form shall be included with his or her medical record. Participation in the medical surveillance program shall be mandatory.

### **B.3.4 Other LLNL or UC Employees**

Internal LLNL transferees or UC employees who have a confirmed positive sensitivity test have the option of accepting the beryllium work assignment, remaining in the current position, or applying for another non-beryllium position within LLNL. If an internal LLNL transferee or UC employee assigned to a beryllium work area or regulated beryllium work area decides to continue in the beryllium work assignment, the employees shall sign, as a condition of continuation in the assignment, an acknowledgment form that the Medical Director has provided the worker, along with a copy of 10 CFR 850 and other appropriate information regarding the health effects of beryllium exposure. The signed form shall be included with his or her medical record. Participation in the medical surveillance program shall be mandatory.

## **B.4 NonLLNL and NonUC Employees**

The safety of work done by subcontract workers shall be managed as required by Document 2.5, "Procured Services ES&H Program," in the *ES&H Manual*. All subcontractors and other nonLLNL organizations providing workers in a beryllium work area or regulated beryllium work area shall be notified of the beryllium hazard in such workplaces. LLNL also recommends that subcontractors and other nonLLNL organizations use medical surveillance programs similar to those used at LLNL. The Health Services Department is available as an advisory resource in addressing the workplace health and safety concerns of subcontractors and other nonLLNL organizations. Laboratory programs or facilities utilizing subcontract workers or other nonLLNL employees in a beryllium work area or regulated beryllium work area shall notify the appropriate ES&H Team of the nonLLNL employees' impending work. The ES&H Team industrial hygienist then performs a hazard assessment and, in conjunction with the appropriate program manager or facility point of contact (FPOC), makes a case-by-case decision regarding the monitoring of the work conducted by the subcontract workers or other nonLLNL employees.

## **B.5 Responsibilities**

This section lists organizations' responsibilities regarding medical protection.

### **B.5.1 Health Services Department**

Health Services Department is responsible for:

- Providing medical surveillance examinations.
- Providing results of medical examinations to workers,
- Recommending temporary or permanent removal, as appropriate, from beryllium work.
- Providing necessary information to affected workers so they can make an informed decision concerning reassignment (current employees) or employment (prospective new hires), if necessary.

### **B.5.2 Payroll Organizations**

The payroll organization is responsible for ensuring that the requirements in this appendix are followed. The requirements apply whether an individual works for a short time or indefinitely in a beryllium work area or regulated beryllium work area. These requirements include ensuring:

- Medical surveillance exams are offered to workers.
- Information on beryllium hazards is provided to workers.
- Assisting in alternate placement, if appropriate.

### **B.5.3 ES&H Team Industrial Hygienists**

ES&H Team industrial hygienists are responsible for performing hazard assessments and air monitoring of beryllium work areas.

### **B.5.4 Human Resources Department**

The Human Resources Department is responsible for assisting program management in finding alternate work assignments.

## Appendix C

### Statistical Analysis of Beryllium Data

#### C.1 General

The use of a statistics-based sampling protocol to characterize worker exposures to airborne beryllium is required by 10 CFR 850, as is routine surface sampling to verify compliance with the housekeeping standard. The rule is performance based and does not prescribe statistical protocols. General guidance is provided in DOE G 440.1-7A, "Implementation Guide for use with 10 CFR 850, Chronic Beryllium Disease Prevention Program," which states:

Sampling activities should include a sufficient number of samples to ensure at least a 95 percent confidence level that the results represent the sample population.

Although numerous publications about statistical data analysis and quality control are available, the following two references are widely used for industrial hygiene sampling:

- Nelson A. Leidel, Kenneth A. Busch, and Jeremiah R. Lynch, "Occupational Exposure Sampling Strategy Manual," U.S. Department of Health, Education, and Welfare, Publication 77-173, January 1977.
- John R. Mulhausen and Joseph Damiano, "A Strategy for Assessing and Managing Occupational Exposures," 2nd Edition, AIHA Press, Fairfax, VA 1998.

The following guidance can be used for initial and periodic air sampling, for establishing and disestablishing regulated areas, and for routine surface sampling for housekeeping.

#### C.2 Suggested Protocol

The following is a suggested protocol:

1. Using the hazard assessment described in Section 3.5.3, identify:
  - The similar exposure group [i.e., process, job, task, agent (i.e., beryllium) and specific population at risk].
  - The appropriate standard for airborne exposure or surface contamination.

2. Conduct a sampling campaign.
  - (a) Determine the number of samples to take.
  - (b) Take the samples.
  - (c) Determine the data distribution (e.g., normal or log normal) and calculate the appropriate descriptive statistics.
  - (d) Compare the results with the appropriate standard.