



Chronic Beryllium Disease Prevention Program

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Executive Summary

Beryllium is an element with various industrial uses that is classified as a suspected human lung carcinogen (exposure to beryllium particles can cause chronic beryllium disease [CBD]).

Beryllium has been used at SLAC alloyed with copper to shield beam line electrical contacts from stray radiofrequency components, as beryllium oxide ceramics in klystron windows, in pure form as short sections of beam pipe, and in an alloy for tools.

The purpose of this SLAC Chronic Beryllium Disease Prevention Program is to meet the requirements of Title 10, *Code of Federal Regulations*, “Energy”, Chapter 3, “Department of Energy”, Part 850, “Chronic Beryllium Disease Prevention Program” ([10 CFR 850](#)) by

- Minimizing the use of materials containing beryllium by substituting other materials
- Providing guidance for minimizing potential worker exposure to beryllium during handling or use
- Outlining medical monitoring and surveillance of workers potentially exposed to beryllium
- Providing job specific safety procedures for beryllium use that could generate dusts, mists, or fumes

This program covers the handling, machining, and use of beryllium and medical monitoring and surveillance of workers potentially exposed to beryllium.

The requirements of this program apply to workers handling, machining, and using beryllium and their supervisors; the Industrial Hygiene Group, Field Services, Occupational Health Center, and Human Resources departments; and the SLAC Local Safety Committee and legal counsel.

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Acronyms

Be-LPT	beryllium lymphocyte proliferation test
CBD	chronic beryllium disease
CFR	<i>Code of Federal Regulations</i>
DOE	United States Department of Energy
EDM	electrical discharge machine
ESH	environment, safety, and health
FSD	Field Services Department
HEPA	high efficiency particulate air
MSDS	material safety data sheet
OSHA	federal Occupational Safety and Health Administration
PEL	permissible exposure limit
SOMD	site occupational medical director
SSO	DOE SLAC Site Office

1 Introduction

Beryllium is an element (atomic number four), that is silver-grey in color and occurs naturally in some minerals. Beryllium has a high melting temperature. One pound of beryllium can absorb as much heat as five pounds of copper, which makes beryllium a useful material for aerospace and defense. It has various industrial uses and, since the 1950s, many products and processes contain forms of beryllium and its alloys.

Beryllium is classified as a suspected human lung carcinogen by the US Department of Health and Human Services' [National Toxicology Program](#) and the World Health Organization's [International Agency for Research on Cancer](#).

During machining or other working processes¹, small particles and chips of insoluble beryllium-containing material can break off and spread through the air in the work area unless ventilation and other controls are used.

The federal Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for beryllium is 2 micrograms/cubic meter. The goal at SLAC is to control worker exposures below a level ten times lower than this limit.

1.1 About Chronic Beryllium Disease

Exposure to beryllium particles can cause chronic beryllium disease (CBD). In two to five percent of people exposed, inhalation of the beryllium particles (aerosolized beryllium) can trigger an allergy-like sensitivity. This immunological reaction can eventually result in scarring of the lungs, shortness of breath, coughing, fatigue, weight loss, and (ultimately) respiratory failure. CBD can take 10 to 15 years to develop after the initial exposure.

1.2 Purpose

The purpose of the SLAC Chronic Beryllium Disease Prevention Program is to

- Minimize the use of materials containing beryllium by substituting other materials
- Provide guidance for minimizing potential worker exposure to beryllium during handling or use
- Outline medical monitoring and surveillance of workers potentially exposed to beryllium
- Provide job specific safety procedures for beryllium use that could generate dusts, mists, or fumes
- Meet the requirements of Title 10, *Code of Federal Regulations*, “Energy”, Chapter 3, “Department of Energy”, Part 850, “Chronic Beryllium Disease Prevention Program” ([10 CFR 850](#))

1 In this document, the term *machining* will be used to encompass machining, metalworking, cutting, punching, shearing, electrical discharge machine (EDM) cutting, and other forms of operations that may result in beryllium dust.

1.3 Scope

This program covers the handling, machining, and use of beryllium and medical monitoring and surveillance of workers potentially exposed to beryllium.

1.4 Applicability

The requirements of this program apply to workers handling, machining, and using beryllium and their supervisors; the Industrial Hygiene Group, Field Services, Occupation Health Center, and Human Resources departments; and the SLAC Local Safety Committee and legal counsel.

1.5 Standards

This program is designed to meet the requirements of the following:

- Title 10, *Code of Federal Regulations*, “Energy”, Chapter 3, “Department of Energy”, Part 850, “Chronic Beryllium Disease Prevention Program” ([10 CFR 850](#))
- Title 29, *Code of Federal Regulations*, “Labor”, Chapter 17, “Occupational Safety and Health Administration, Department of Labor”, Part 1910, “Occupational Safety and Health Standards”
 - Subpart H, “Hazardous Materials”, Section 120, “Hazardous Waste Operations and Emergency Response” ([29 CFR 1910.120](#))
 - Subpart I, “Personal Protective Equipment”, Section 132, “General Requirements” ([29 CFR 1910.132](#))
 - Subpart Z, “Toxic and Hazardous Substances”, Section 1200, “Hazard Communication” ([29 CFR 1910.1200](#))

2 Beryllium at SLAC

2.1 Uses

Beryllium copper is occasionally cut at SLAC in small-scale operations. SLAC has monitored industrial processes for airborne beryllium since the 1970s and has retained employee medical pre-placement exams and records since 1965.

Beryllium has been used at SLAC

- In the form of copper alloy (2% beryllium) to shield beam line electrical contacts from stray radiofrequency components (beryllium copper sheet material has been sheared, punched, and cut by electrical discharge machine [EDM])
- As beryllium oxide ceramics in klystron windows. The ceramics are used for the thermal conductive properties.
- In pure form as short sections of beam pipe. (These were not machined or manufactured at SLAC.)
- In non-magnetic tools. A small amount of beryllium is used to produce hardened copper alloy. (These tools were not machined or manufactured at SLAC.)

Through the rest of this document, the word *beryllium* will be used to represent all forms of the mineral found at SLAC.

2.2 Approved Operations

Currently approved beryllium operations at SLAC are listed in Table 1.

Table 1 Approved Beryllium Operations at SLAC

Operations	Location	Required Controls
Electrical discharge machine cutting of beryllium copper sheet	Machine Shop Building 25	<ul style="list-style-type: none"> ▪ Warning sign ▪ Glove and eye protection ▪ Respiratory protection ▪ Tyvek coveralls ▪ Air sampling ▪ Hand washing ▪ Proper cleanup and disposal of scrap materials ▪ Medical surveillance
Punching, cutting and shearing of beryllium copper parts	Machine Shops Buildings 25, 26, and 44	<ul style="list-style-type: none"> ▪ Warning sign ▪ Glove and eye protection ▪ Respiratory protection ▪ Tyvek coveralls ▪ Air sampling ▪ Hand washing ▪ Proper cleanup and disposal of scrap material ▪ Medical surveillance

The required controls are detailed in Appendix C.

2.3 Future Operations

New projects that involve beryllium machining must be approved by the SLAC Industrial Hygiene Group (within FSD) and may only be conducted after the SLAC Chronic Beryllium Disease Prevention Program has been updated and approved by Department of Energy (DOE) SLAC Site Office (SSO).

3 Implementation Plan

3.1 Performance Goals

The SLAC ESH performance goals for beryllium exposures are as follows:

- To maintain worker exposure below the action level of 0.2 micrograms per cubic meter (calculated as an 8-hour time weighted average).
- To maintain the current low volume of work with beryllium materials.

Any operation that produces airborne beryllium levels above this level will be controlled, contracted out, or discontinued. SLAC will attempt to keep the number of workers who perform beryllium machining to a minimum.

The Industrial Hygiene staff of FSD will meet with the site occupational medical director (SOMD), all supervisors of beryllium operations, and any interested personnel to analyze monitoring activities, hazards, medical surveillance, exposure reduction and minimization actions, and occurrence reporting data. This meeting will occur annually.

3.2 Records and Program Documentation

SLAC will establish and maintain beryllium inventory records, hazard assessments, exposure measurements, exposure controls, and medical surveillance. This information will be maintained in the Occupational Health Center and Field Services Department for a minimum of 75 years.

If SLAC ceases to be involved in the beryllium program (for example, if all beryllium machining is stopped and SLAC has no remaining workers who previously were exposed to beryllium), all records pertaining to the program will be sent to the DOE or its designee.

Records will be maintained in an electronic format and will be transmitted to the DOE, as required by the [10 CFR 850](#).

SLAC will replace employee names and social security numbers with coded information, to protect employee privacy of all transmitted data.

SLAC will provide the results of assessments of beryllium operations to managers, planners, worker protection staff, workers, medical staff and labor organizations representing-beryllium associated workers who request such information.

The SLAC Local Safety Committee will notify labor organizations that represent employees who machine beryllium of intended changes in and updates of this program. The SLAC Human Resources Department and legal counsel will bargain on this program (if needed) during the contract negotiations.

A copy of this Chronic Beryllium Disease Prevention Program document will be delivered at least annually to the DOE SLAC Site Office. (This requirement is generally met by maintaining the program document on the SLAC web site at <http://www-group.slac.stanford.edu/esh/documents/beryllium.pdf>)

3.2.1 Inventory Requirements

An inventory of all beryllium materials to be machined will be maintained by the ESH Field Services Department (FSD). The inventory will not include beryllium that is manufactured off-site and has end use functions at SLAC that do not release airborne beryllium (such as a copper-beryllium wrench).

The beryllium inventory will consist of the following data:

- Department
- Locations (including building number and room)
- Point of contact
- Quantity of material in size or weight
- Contents of material (for example, “pure beryllium” or “2% beryllium and 98% copper”)
- Intended machining use

A beryllium inventory form must be submitted from every shop that machines beryllium. Supervisors will obtain a copy of the form (Appendix A) from FSD. After the form is completed, it will be returned to FSD. See Appendix B for current contact information.

3.3 Training

Personnel who conduct approved beryllium machining operations (as outlined in this document) must be current for ESH Course 296, Beryllium Safety Training ([ESH Course 296](#)). This course includes the potential health hazards associated with occupational exposure to beryllium, including copies of this document, information about potential risks to family members, and details of the medical surveillance program. (See Section 3.2 for recordkeeping information, and Section 4.1 for medical surveillance information.)

The OSHA hazard communication standard ([29 CFR 1910.1200](#)) requires employers to provide all employees with information on the physical and health hazards of chemicals (beryllium is included as a chemical for this purpose) and safe handling precautions. It also requires employers to establish a hazard communication program that includes guidance for labeling containers, completing material safety data sheets (MSDS), and developing training programs. SLAC conforms to this standard.

All SLAC personnel will be provided training on the subject of beryllium hazards and controls as part of ESH Course 219, Employee Orientation to Environment, Safety, and Health (EOESH) ([ESH Course 219](#)).

4 Protective Measures

4.1 Medical Surveillance

The site occupational medical director (SOMD) will offer medical surveillance to all employees designated by the SLAC industrial hygienist based on occupational air monitoring results. Employees with a history of machining beryllium metal at SLAC will be contacted by the industrial hygienist (ext. 4105) to coordinate medical surveillance. Employees with a history of machining beryllium outside of SLAC are required to contact the SOMD to determine medical surveillance requirements. Medical surveillance for beryllium will be provided as specified in [10 CFR 850](#).

The SLAC Occupational Health Center will use the protocol in Appendix D, which describes the elements of the medical surveillance that will be offered to employees who machine beryllium. Each employee exposed to beryllium who chooses to participate in the medical surveillance will receive a written medical opinion containing the results of all tests, an explanation of any abnormal finding, and recommendations for additional testing (if any). This will be done within 10 working days after the SOMD receives the results of the medical tests or procedures. The SLAC Field Services Department will provide hazard assessments and exposure monitoring data to the SOMD.

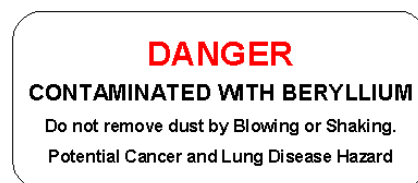
Currently existing required procedures for working with beryllium are listed and defined in Appendix C, including detailed information on air sampling.

4.2 Personal Protective Equipment

Respirators and Tyvek coveralls are required for the operations listed in Section 2.2. SLAC employees who machine beryllium will use a respirator and disposable Tyvek coveralls in compliance with the SLAC respiratory protection and personal protective equipment programs (ESH Manual [Chapter 29, “Respiratory Protection”](#) and [Chapter 19, “Personal Protective Equipment”](#)). See Appendix C for additional controls.

4.3 Housekeeping of Beryllium-related Equipment

Surfaces of beryllium-related equipment will be cleaned to less than 3 micrograms of removable beryllium per 100 square centimeters. Equipment that exceeds this amount will have the following label posted:



Delicate beryllium-containing items such as experimental foils of less than 100 microns thickness will have this label attached at all times including when transferred off site due to their potential for breakage during handling.

4.4 Salvage of Beryllium-related Equipment

SLAC will not salvage beryllium-associated equipment until surfaces have been cleaned to the lowest level practicable and testing shows surface contamination does not exceed 0.2 micrograms per 100 square centimeters.

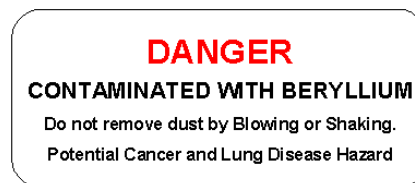
4.5 Subcontractors

No subcontractors are authorized to perform machining operations on beryllium materials at SLAC.

4.6 Waste Disposal and Minimization

SLAC workers who perform machining operations with beryllium copper metal must minimize the amount of waste produced (such as by cutting sheets in such a way to maximize use of the sheet). Beryllium waste must be disposed of in sealed, impermeable bags, containers, or enclosures to prevent the release of beryllium dust during handling and transportation. Any waste container or bagged waste must be labeled as beryllium waste.

Beryllium warning signs will be added to all containers of beryllium-containing waste. If beryllium surface contamination is present, the following warning label will be posted:



4.7 Emergency Procedures

SLAC emergency response personnel must be immediately informed, via ext. 5555 (650-926-5555), of any emergency involving beryllium.

SLAC's emergency responders will respond in accordance with [29 CFR 1910.120](#).

Cleanup and disposal of beryllium, including decommissioning operations, will be supported by the SLAC Industrial Hygiene and Waste Management groups and will comply with the requirements of [10 CFR 850](#).

Appropriate response where air exposure is possible includes self contained breathing apparatus and exposure barrier personal protective equipment. Where damage to beryllium components inside of vacuum systems occurs, those systems are to remain closed until proper work planning and controls are prepared with the assistance of the ESH beryllium program manager.

5 Related Documents

The following table lists documents related to this program.

Table 2 Related Documents

Title	Document Number	Originating Unit	URL
ESH Chapters / Programs			
Chapter 3, "Medical"	SLAC-I-720-0A29Z-001	Occupational Health Center	http://www-group.slac.stanford.edu/esh/medical/chapter/
Chapter 5, "Industrial Hygiene"	SLAC-I-720-0A29Z-001	FS	http://www-group.slac.stanford.edu/esh/hazardous_substances/industrial_hygiene/
Chapter 19, "Personal Protective Equipment"	SLAC-I-720-0A29Z-001	FS	http://www-group.slac.stanford.edu/esh/general/ppe/
Chapter 29, "Respiratory Protection"	SLAC-I-720-0A29Z-001	FS	http://www-group.slac.stanford.edu/esh/hazardous_substances/respirator/
Other SLAC			
ESH Course 219, Employee Orientation to Environment, Safety, and Health (EOESH)	ESH Course 219	ESH	https://www-internal.slac.stanford.edu/esh-db/training/slaonly/bin/catalog_item.asp?course=219
ESH Course 296, Beryllium Safety Training	ESH Course 296	FS	https://www-internal.slac.stanford.edu/esh-db/training/slaonly/bin/catalog_item.asp?course=296
ESH Course 407ME, Beryllium Baseline Exam	ESH Course 407ME	FS	https://www-internal.slac.stanford.edu/esh-db/training/slaonly/bin/catalog_me_item.asp?course=407ME
Medical Surveillance Programs		Occupational Health Center	https://www-internal.slac.stanford.edu/esh-db/training/slaonly/bin/catalog_me_index.asp
Other			
Chronic Beryllium Disease Prevention Program		US Department of Energy, Office of Health, Safety and Security	http://www.hss.energy.gov/healthsafety/wshp/be/
National Toxicology Program		US Department of Health and Human Services	http://ntp.niehs.nih.gov/
International Agency for Research on Cancer.		World Health Organization	http://www.iarc.fr/

B Contact Information

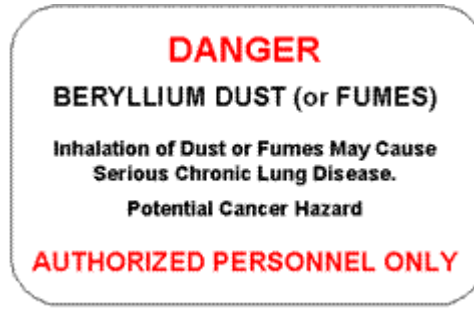
The ESH Industrial Hygiene Group is available to answer any questions regarding beryllium.

Primary	John Shepardson E-mail: johnds@slac.stanford.edu Phone: ext. 4105 Mailstop: 84
Backup	Phil Hoyt E-mail at: phoyt@slac.stanford.edu Phone: ext. 4276 Mailstop: 84
Other ESH resources	ESH Contacts, http://www-group.slac.stanford.edu/esh/about_esh/contacts.htm

C Definitions of Required Procedures

The following are detailed definitions of the procedures required to be in place during the operations listed in Section 1.

Warning Sign The work areas in Table 1 must be posted with the following sign while work is being performed on beryllium:



Respiratory Protection	A respirator is required for all approved beryllium operations authorized by this chapter. A half mask or full faced respiratory with P-100 cartridges will be utilized in accordance with the requirements of ESH Manual Chapter 29, "Respiratory Protection"
Tyvek Coveralls	Disposable Tyvek coveralls, available in SLAC Stores, are required for beryllium machining.
Hand Washing	Sinks must be available to personnel in or near the workplace. Workers must wash hands before eating, drinking, or leaving the workplace.
Proper Cleanup	Surface contamination levels will be routinely measured on all equipment associated with beryllium machining. Surface contamination levels of a maximum of 3 micrograms per 100 square centimeters will be maintained by surface cleaning. Compressed air will not be used for surface cleaning. No tools (such as a HEPA vacuum) will be used to clean beryllium contamination from machinery at SLAC. A tacky oiled cloth will be used to clean machine surfaces and must be disposed of as hazardous waste. Workers removing gloves should turn them inside out and deposit them in the beryllium waste container. Tyvek coveralls will be discarded as beryllium waste at the end of the work shift. No brushing or shaking of the coveralls or gloves will be allowed. Only disposable protective coveralls and gloves will be used for these operations.
Air Sampling	Trained personnel must conduct regular air samples to evaluate personal breathing zone concentrations with high accuracy. Since SLAC rarely conducts shearing or EDM cutting, 100% of these operations will be sampled by an industrial hygienist. All air sampling will be conducted to determine 8-hour time weighted averages as required by 10 CFR 850. All employees affected will be notified in writing of monitoring results within 10 working days after receipt of monitoring results. If the workers exposure is equal to or above the action level, the notice will include a statement that the action level has been exceeded, corrective actions being taken, and notification of the DOE and the SOMD within 10 working days. All air sampling procedures will be have an accuracy of +- 25% with a 95% confidence level. Air sample media will be analyzed by a laboratory accredited by the American Industrial Hygiene Association.

D Beryllium Medical Surveillance Procedure

The SLAC Occupational Health Center will offer employees who machine beryllium, or who have machined beryllium in the past, to

- Place the employee(s) name in the Medical Surveillance List
- Contact the employee(s) in writing to notify them of medical surveillance and to call the Occupational Health Center for appointment for a physical examination

The surveillance will consist of the following measures.

Topic	Requirement
Baseline Medical Evaluation	Questionnaire or medical exam for beryllium health surveillance Respiratory questionnaire Questionnaire and medical exam for respirator users Information and consent for Be-LPT testing Spirometry or pulmonary function test A physical examination with emphasis on respiratory system, skin, and eyes Chest x-ray (anterior-posterior) interpreted by a NIOSH B-reader or a board-certified radiologist (unless a baseline chest x-ray is already on file) will be offered A Be-LPT will be offered Any other tests deemed appropriate by the examining physician for evaluating beryllium related health effects
Periodic Evaluation	Questionnaire or medical exam for beryllium health surveillance Respiratory questionnaire Questionnaire and medical exam for respirator users Spirometry or pulmonary function test Any other tests deemed appropriate by the examining physician for evaluating beryllium related health effects
Chest X-ray	A chest x-ray will be offered every five years
Emergency Evaluation or Physical Examination	Will be provided to employee who has had an accidental or emergency exposure to beryllium. This includes the following: <ul style="list-style-type: none"> ▪ Questionnaire or medical exam for beryllium health surveillance ▪ Respiratory questionnaire ▪ Questionnaire and medical exam for respirator users ▪ Spirometry or pulmonary function test ▪ Any other tests deemed appropriate by the examining physician for evaluating beryllium related health effect
Referrals	Employee will be referred out to a pulmonary or respiratory disease specialist for abnormal findings

Topic	Requirement
Medical Removal	<p>The site occupational medical director (SOMD) will</p> <ul style="list-style-type: none">▪ Provide a consultation with the employee to advise regarding risks of continued exposure to beryllium, and answer any questions that the employee might have▪ Provide the employee a copy of 10 CFR 850 or the SLAC Chronic Beryllium Disease Prevention Program▪ Based on positive Be-LPT results, chronic beryllium disease diagnosis can remove a worker from beryllium exposure and recommend reassignment▪ Will be offer temporary medical removal from exposure to beryllium pending a final medical determination of whether the worker should be removed permanently.▪ Obtain a signed document that employee has been advised to accept a medical removal from beryllium exposure
Return to Work (after medical removal)	Employee can be returned to work if the SOMD determines that continued removal is no longer necessary to protect the workers' health.