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Government Responses to Beryllium Uses and Risks

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Contents

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Over the last 50 years, federal policymakers and scientists have attempted to both capitalize on the advantages of beryllium and address health and environmental risks. Beryllium is a strong and lightweight metal that generates and reflects neutrons, resists corrosion, is transparent to X-rays, and conducts electricity. It is also a hazardous substance.

Among the organizations that have played key roles in responding to the risks associated with beryllium are the Departments of Defense, Energy, and Labor. The Departments of Defense and Energy are the federal agencies that have most commonly used beryllium. Defense procures components containing beryllium for a variety of weapon systems from private contractors. Energy operates federal facilities (including nuclear weapons production facilities) that use beryllium, and it has responsibility for protecting federal and contract workers at these facilities. Energy has identified at least 17 facilities that use or have used beryllium, and it estimates that about 20,000 current and former workers at these facilities were exposed or potentially exposed to beryllium from the 1940s to the present. The Department of Labor's Occupational Safety and Health Administration has overall responsibility for protecting the health and safety of workers in most workplaces throughout the United States, including those that use beryllium.[1]

This report responds to your request for information on beryllium as a hazardous material and on the health and safety controls over its use. As agreed with your offices, this report (1) provides information on beryllium's uses and risks and (2) describes selected key events that illustrate the evolution of the federal government's response to risks posed by beryllium. To respond to the second question, we identified and summarized key events from the 1960s through the 1990s involving actions by the Departments of Defense and Energy and the Occupational Safety

[1] Defense uses of beryllium (primarily through its contractors) and Energy's beryllium vendors are subject to Occupational Safety and Health Administration (OSHA) standards. Energy's recent rule covering its facilities adopts OSHA's permissible exposure limit.

and Health Administration. Appendix I describes the objectives, scope, and methodology for this review.

Results in Brief

Lightness, strength, and other attributes have made beryllium useful in a wide array of products, such as aircraft, spacecraft, X-ray equipment, and nuclear weapons. However, beryllium is considered hazardous. Health effects from high exposure to beryllium particles were first noted in the early 20th century. Beginning in the 1940s, scientists linked exposure to beryllium with an inflammatory lung condition now called chronic beryllium disease, which can be debilitating and, in some cases, fatal. Today, questions remain about the level of exposure that poses a risk and exactly how chronic beryllium disease develops. In the 1950s, studies showed that beryllium caused cancer in laboratory animals. National and international organizations now consider beryllium a human carcinogen. The magnitude of the risk from current occupational exposure levels is not known, but may be minimal.

From the 1960s to the 1990s, Defense, Energy, and the Occupational Safety and Health Administration took a number of actions to assess and to respond to risks associated with exposure to beryllium. In reviewing selected key events, we noted that the agencies took the following steps to reduce risks from exposure to beryllium: discontinued testing of rocket propellant containing beryllium, assessed beryllium exposure standards, limited worker exposure to beryllium, established health surveillance measures, and proposed compensation for workers who have chronic beryllium disease. The key events are as follows:

- Defense discontinued testing beryllium in rocket fuel by 1970, due in part to concerns about meeting air quality requirements.
- The Occupational Safety and Health Administration proposed a more stringent worker exposure standard for beryllium in 1975 based on evidence that it was carcinogenic in laboratory animals. The proposal generated concerns about the technical feasibility of the proposal, impact on national security, and the scientific evidence supporting the proposed change. According to Occupational Safety and Health Administration officials, the agency discontinued its work on the proposal in the early 1980s in response to other regulatory priorities such as lead, electrical hazards, and occupational noise. In 1998, the agency announced that it would develop a comprehensive standard for beryllium by 2001.

- Energy improved working conditions at its facilities and implemented medical testing for its current and former workers during the 1980s and 1990s after new cases of chronic beryllium disease were identified during the 1980s. From 1984 through 1999, 149 Energy workers have been diagnosed with definite or possible chronic beryllium disease.
- In 1999, Energy issued a rule that established new worker safety controls, such as increased use of respirators and assessing hazards associated with work tasks, for its facilities that use beryllium. Energy also proposed a compensation program for Energy workers affected by chronic beryllium disease, which has been introduced as legislation in the Congress.

The Departments of Defense, Energy, and Labor provided written or oral comments on our report and generally concurred with the information presented. They suggested technical changes, and Labor officials also emphasized that the hazard information bulletin on beryllium cited in the body of this report was a significant effort to protect worker health.[2]

Beryllium Uses and Risks

In the 1920s and 1930s, beryllium was used for a variety of purposes, including as an additive for alloying with copper and other metals in manufacturing, as an ingredient in fluorescent lamps, and for other purposes. Today, beryllium is used in nuclear reactor and weapons parts; aircraft, spacecraft, and missile structures and parts; military vehicle structures and parts; electronics; auto parts; lasers; X-ray equipment; dental prosthetics; and other consumer products. In some of these products, substitutes for beryllium can be used (e.g., titanium, stainless steel, and some forms of bronze and aluminum). However, Energy and Defense officials state there is no substitute for beryllium in key nuclear components or in weapons for which lightweight and strength are critical.

According to U.S. Public Health Service reports, people are exposed to extremely low levels of naturally occurring beryllium in the air, in many foods, in water, and in soil. The highest exposures to beryllium tend to occur in the workplace. Occupational exposure to beryllium occurs when it is extracted from ore; when the ore is processed into beryllium metal; and

[2] An OSHA bulletin titled *Preventing Adverse Health Effects from Exposure to Beryllium on the Job* was issued in September 1999. The bulletin cautioned that the current permissible exposure limit may not be adequate to prevent the incidence of disease, and it recommended measures to reduce exposures.

when this metal is made into parts (e.g., machined, welded, cut, or ground). Today, beryllium is used in many applications outside of the Defense and Energy industries.

Health effects from high exposure to beryllium particles were first noted in the early 20th century. Beginning in the 1940s, scientists linked exposure to beryllium with an inflammatory lung condition now called chronic beryllium disease, which is often debilitating and, in some cases, fatal.

Research on the biomedical and environmental aspects of beryllium is extensive.[3] According to the National Jewish Medical and Research Center (a nonprofit institution devoted to respiratory, allergic, and immune system diseases), beryllium primarily affects the lungs. The disease occurs when people inhale beryllium dust, and it can develop even after workers have been out of the beryllium industry for many years. There are three main types of adverse health effects associated with beryllium exposure:

- Chronic beryllium disease is caused by an allergic-like reaction to beryllium. Even brief exposure to very low levels can lead to this disease, which often has a slow onset and involves changes to lung tissue that reduce lung function. The first evidence of what was to be called chronic beryllium disease was identified in 1946. More recent studies indicate that reaction to beryllium depends on the type of beryllium and the work task.[4] According to the National Jewish Medical and Research Center, the disease occurs in 1 to 16 percent of exposed people, with the level of exposure that poses risk and the precise mechanisms of disease not yet well characterized.
- Acute beryllium disease (symptoms lasting less than 1 year) results from relatively high exposure to soluble beryllium compounds (i.e., compounds that can be at least partially dissolved). This disease usually has a quick onset and resembles pneumonia or bronchitis. High exposures may also cause skin lesions. The earliest cases of this disease involved severe overexposure to beryllium that affected the lungs and

[3] A database sponsored by Energy contains over 2,500 citations (dating up to 1994) on biomedical and environmental aspects of beryllium, and more studies exist. For example, although Energy's database contains only 20 citations identified as relating to beryllium use in propellants or rocket fuel, databases maintained by Defense and the National Aeronautics and Space Administration contain more than 350 additional studies on rocket fuel issues alone.

[4] For example, the size of beryllium particles has been identified as a possible factor in toxicity, and machining tasks have been associated with higher rates of disease.

skin of fluorescent light workers in the 1930s. It is now rare due to improved industrial protective measures designed to reduce exposure levels.

- National and international organizations have identified beryllium metal and compounds as carcinogenic to humans. Studies involving workers in plants with high exposures during the 1940s showed subsequent increases in mortality. The magnitude of the risk from current occupational exposure levels is not known, but may be minimal.

Key Events in the Federal Response to Beryllium Risks

The following illustrative key events involving Defense, Energy, and the Occupational Safety and Health Administration (OSHA) document concerns and actions taken regarding beryllium exposure risks. The events include (1) Defense's decision to discontinue testing beryllium in rocket fuel by 1970, (2) OSHA's efforts in the 1970s and since 1998 to lower the exposure limits, (3) Energy's steps to improve working conditions and medical screening in the 1980s and 1990s, and (4) Energy's 1999 rule on beryllium worker safety.

Defense Discontinued Testing of Beryllium Rocket Propellant

Defense discontinued testing of rocket propellant containing beryllium by 1970 due to the potential risk of public exposure to hazardous levels of beryllium particles released in rocket exhaust. According to an August 1969 Air Force report,[5] the Air Force and the Advanced Research Projects Agency began development of beryllium rocket propellant in 1959. Experiments in the 1960s showed that rocket payloads could be increased 10 to 30 percent by using beryllium powder in propellant. Research and development efforts later expanded to include other Defense agencies and the National Aeronautics and Space Administration.

As military and civilian agencies experimented with beryllium in rocket fuel, they also pursued concerns about beryllium's potential risks. For example, an August 1962 manufacturer's internal memorandum stated that officials planned a visit from the Navy propellant plant at Indian Head, Maryland, to discuss health and safety concerns in handling beryllium powders at a test facility for solid fuel propellants. When testing began to involve firing large rocket motors that would release potentially hazardous

[5] *Review of Toxicity Aspects of Beryllium Propellant*, The Aerospace Corporation (San Bernardino, California: Aug. 8, 1969).

levels of beryllium particles into the air, concerns expanded to include the general population in the vicinity of test facilities.

In 1966, the U.S. Public Health Service[6] requested the National Academy of Sciences-National Research Council[7] to study the toxicity and hazards of beryllium propellant and its compounds and to recommend air quality criteria. The resulting March 1966 council report[8] recommended a range of less stringent limits for atmospheric contamination.[9] The U.S. Public Health Service concluded that releases of any form of beryllium above 75 micrograms per cubic meter of air could be hazardous, and it did not adopt the council's recommendation to change the release limit.

According to a 1985 Air Force report,[10] as a result of the U.S. Public Health Service decision, all beryllium propellant and motor testing has been discontinued since 1970.[11] Following the U.S. Public Health Service decision, Defense issued a directive in 1967 that in effect curtailed open-air

[6] The U.S. Public Health Service is part of the Department of Health and Human Services, the major health agency of the federal government. During the time of the request, the Service was part of the Department of Health, Education, and Welfare. Part of its mission is to control and prevent disease and conduct and fund biomedical research.

[7] The National Academy of Sciences, a private and nonprofit organization composed of scholars, is engaged in scientific and engineering research for the purpose of furthering knowledge and advising the federal government. The National Research Council, the principal operating agency for the National Academy of Sciences, provides services to the government, the public, and the scientific and engineering community.

[8] *Air Quality Criteria for Beryllium and Its Compounds*, Committee on Toxicology and the Advisory Center on Toxicology, National Academy of Sciences-National Research Council (Washington, D.C.: Mar. 1, 1966).

[9] At that time, the U.S. Public Health Service was responsible for such standards. The 1966 Academy report stated that, for intermittent rocket firings totaling up to 1 hour during any 2 weeks, releases of forms of beryllium oxide believed less toxic could total as much as 1,500 micrograms per cubic meter. Forms believed more toxic were limited to a peak of 75 micrograms per cubic meter in such circumstances.

[10] *Beryllium Propellant Feasibility Study* (Revised), Jet Propulsion Laboratory (Pasadena, California: Jan. 1985), p. 4.

[11] According to an August 1969 Air Force Systems Command report, a key document in the decision to discontinue testing was "Control of Air Pollution Associated with Beryllium Enriched Propellants," a memorandum from the Director for Defense Research and Engineering to the Assistant Secretary of the Air Force (Research and Development) dated November 20, 1967. It directed that all open-air rocket firings be within the lowest proposed limits or that firings be made within protected facilities or outside the continental United States.

firing of beryllium-fueled rocket motors. The directive required that the release of beryllium in all open-air firings fall within the 75 microgram contamination limit, that exhaust from rocket motors be filtered to meet the 75 microgram limit, or that firings be conducted outside the continental limits of the United States. According to the August 1969 Air Force report, this directive severely limited development of beryllium-fueled rocket motors. The report also indicated that the 75 microgram contamination limit could not be met, the equipment needed to filter exhaust to meet the 75 microgram limit was not available, and firing at remote locations was expensive. The Environmental Protection Agency, which is today responsible for air quality standards, continues to limit such releases to the 75 microgram level.

OSHA Actions to Revise Exposure Standards

In 1971, OSHA adopted a beryllium standard developed by the American National Standards Institute to control exposure to beryllium in the workplace.[12] OSHA subsequently began efforts to determine whether this standard should be revised. Officials at OSHA believed a change in the standard was warranted because of research conducted by the National Institute for Occupational Safety and Health, a component of the Center for Disease Control under the Department of Health, Education, and Welfare at the time.[13] This research concluded that beryllium exposure caused cancer in animals and likely posed a similar risk to humans. OSHA policy at the time required that once a toxic material was confirmed as carcinogenic in animals, it should be treated as posing a carcinogenic risk to humans and employee exposure should be reduced to the lowest level feasible. OSHA's proposal would have cut the permissible exposure limit in half.[14]

[12]The American National Standards Institute is a private organization that facilitates the development of voluntary standards by consensus. The standard for industrial exposure set a permissible exposure limit of 2 micrograms per cubic meter of air based on an 8-hour time weighted average, with a ceiling concentration of 5 micrograms per cubic meter for 30 minutes.

[13] Currently the National Institute for Occupational Safety and Health is part of the Centers for Disease Control and Prevention under the Department of Health and Human Services.

[14] In addition to reducing the permissible exposure limit from 2 to 1 micrograms per cubic meter, OSHA proposed reducing a ceiling concentration of 5 micrograms per cubic meter from 30 to 15 minutes and added requirements such as employee exposure measurements, medical surveillance, compliance procedures, and protective equipment.

In a 1975 Federal Register notice outlining its proposal, OSHA cited several issues raised by the revised standard, including OSHA's decision to treat beryllium as a substance that posed a carcinogenic risk to humans based on laboratory animal data, the technical feasibility of achieving the proposed exposure limits, and the method of monitoring airborne concentrations of beryllium. It solicited comments from the public and received about 150 written comments and 40 requests for a public hearing. As a result, from August through September 1977, OSHA held an informal rulemaking hearing and heard testimony from 46 individuals representing business, government, labor, and academia. Some commenters questioned whether there was sufficient scientific evidence to support a revision, whether employers (particularly beryllium producers) could comply with lower exposure limits with existing technology, and whether the cost of complying with the proposed standard was excessive.

In 1978, while government panels[15] were considering the sufficiency of scientific evidence, the Secretaries of Energy and Defense questioned the impact of the proposed standard on the continued production of beryllium, which was important for national defense. August 30, 1978, letters from the Secretary of Energy to the Secretary of Labor and the Secretary of Health, Education, and Welfare noted that the proposed standard would place a heavy burden on the two primary beryllium producers in the United States, who might stop producing beryllium. Specifically, the letter stated that "Clearly, cessation of beryllium metal and/or beryllium oxide production is unacceptable and would significantly degrade our national defense effort." The Secretary agreed that workers' health was paramount, but believed that the scientific questions warranted an independent peer review. The Secretary of Defense—in November 1978 letters to the Secretary of Labor and the Secretary of Health, Education, and Welfare—echoed the Energy Secretary's concerns about national security and the scientific evidence.

The first government panel reviewed human cancer studies, but documents did not show whether or how the panel's review was concluded. The Secretary of Health, Education, and Welfare formed a second panel in 1978 to address three questions. The questions were as follows: (1) Are the

[15] The first panel (generally called the Beryllium Review Panel) included six members from Department of Health, Education, and Welfare's National Institute for Occupational Safety and Health, and its Center for Disease Control. The panel was active from March to September 1978. The second panel (generally called the Health, Education, and Welfare Beryllium Review Panel) met during early October 1978 and included seven members from five academic and two government institutions.

animal studies credible in showing beryllium carcinogenicity in at least two species? (2) Is beryllium-copper alloy a carcinogen? (3) Is there evidence indicating that beryllium is a carcinogen in man?

The second panel's consultants generally agreed that (1) beryllium was an animal carcinogen, (2) no good information existed on cancer involving beryllium-copper alloy, and (3) epidemiological evidence was suggestive of an association between beryllium exposure in the workplace and human lung cancer (however, the data were only suggestive because of alternative explanations for this association). In a 1978 report to the Secretary of Health, Education, and Welfare, the U.S. Surgeon General and the Assistant Surgeon General, who oversaw the panel and reviewed the scientific evidence, stated that the conclusion that beryllium was an animal carcinogen required the Department of Health, Education, and Welfare to recommend standard setting and that more definitive answers were needed regarding the last two questions.

Representatives from Defense, Energy, and OSHA met to discuss the proposed OSHA standard in 1979. Concerns included national security, technical feasibility, and the scientific evidence. OSHA continued its efforts to finalize the standard and prepare a draft rule at least through July 1980. According to OSHA officials, work was discontinued in the early 1980s because of other regulatory priorities such as lead, electrical hazards, and occupational noise.

In 1998, OSHA announced that it was developing a comprehensive standard on occupational exposure to beryllium. In its announcement, the agency cited evidence of chronic beryllium disease associated with beryllium exposure below the 2 microgram limit, a new beryllium sensitivity[16] test, and conclusions that beryllium is a human carcinogen. Officials from OSHA expect to propose a standard in 2001.

To develop information for this standard, OSHA contracted with a private firm and has obtained preliminary data on industries that use beryllium. It also issued a hazard information bulletin[17] on beryllium exposure in September 1999 to alert employers and employees about the potential

[16] In this report, sensitivity and sensitization have the same meaning.

[17] OSHA issues hazard information bulletins to provide information and guidance to affected workers on new or misunderstood health and safety hazards when they arise.

hazards of beryllium and to provide guidance on work practices needed to control exposure.

Energy Improved Working Conditions and Medical Screening Following New Disease Cases in the 1980s

Two Energy facilities that have large numbers of beryllium-related workers are the Rocky Flats Environmental Technology Site in Golden, Colorado, and the Oak Ridge Y-12 Plant in Oak Ridge, Tennessee. Rocky Flats produced beryllium metal parts for nuclear weapons from 1958 through 1989, but no longer has any production role and is expected to be closed. Some workers at Rocky Flats may encounter beryllium during the environmental cleanup process at the facility. The Y-12 Plant produces nuclear weapons parts from beryllium powder and has other roles in the nuclear weapons program that may expose workers to beryllium. Overall, as of March 2000, Energy had identified at least 17 facilities that use or have used beryllium. Energy's preliminary estimate is that about 20,000 current and former workers at its facilities were exposed or potentially exposed to beryllium.[18]

According to Energy documents, from the 1970s through 1984, the incidence of chronic beryllium disease appeared to significantly decline at Energy facilities. This apparent reduction, along with the long latency period for the disease, led Energy to assume that chronic beryllium disease was occurring only among workers who had been exposed to high levels of beryllium decades earlier, such as in the 1940s. However, in 1984 a new case of chronic beryllium disease was diagnosed in a worker employed in 1970 at Energy's Rocky Flats facility. Several additional cases were diagnosed among Rocky Flats workers in the following years, raising questions about the adequacy of worker protection measures. In response, Energy investigated the working conditions at Rocky Flats and made improvements to ventilation in 1986 and also improved working practices. Energy also instituted medical screening programs for beryllium workers at risk of developing chronic beryllium disease, making use of new medical

[18] Los Alamos National Laboratory in New Mexico is now responsible for producing a small number of the beryllium metal parts that Rocky Flats used to produce. Energy workers were exposed to beryllium at several additional facilities where nuclear weapons research and development, production, maintenance, or testing occurred. In addition, Energy conducts many scientific research activities, such as investigation of the basic nature of matter and atoms. Some Energy research laboratories use beryllium or beryllium parts. For example, several nuclear reactors that are used for scientific research contain beryllium parts called reflectors. Workers at Energy facilities may also be exposed to beryllium during environmental cleanup and decontamination of buildings.

advances such as a new blood test. In addition, Energy improved its practices for monitoring worker exposure.

Energy's Actions at Rocky Flats

After the new case of chronic beryllium disease was diagnosed in June 1984, Energy's Albuquerque Operations Office, which oversaw Rocky Flats, conducted an investigation of working conditions at the plant's beryllium machine shop to identify factors contributing to the disease case. The investigation, reported in October 1984, identified ventilation problems in the beryllium machine shop and hazards from performing certain operations outside of ventilation hoods, which are designed to collect and filter out airborne beryllium particles. The investigation also found that the affected worker had repeatedly been exposed to beryllium at levels greater than the permissible exposure limit of 2 micrograms per cubic meter of air (averaged over an 8-hour period).

During the 1984 investigation, the Rocky Flats facility began taking air samples from workers' "breathing zones" for the first time, using sampling devices placed on workers' shirts or lapels. Previously, the facility had used "area monitoring," in which sampling devices were placed on beryllium machines or other fixed locations in the work area. Exposure levels measured by personal breathing zone sampling were generally found to be higher than those measured by area samplers. Several reasons could account for the differing monitoring results, according to a 1996 research study and Energy officials. Fixed area monitors were not always well-placed to represent workers' breathing zones.[19] Also, fixed area monitors placed on or near machines may not capture exposures resulting from the use of hand-held tools or poor work practices, such as shaking out cloths used to clean machines.

Following the investigation, Rocky Flats remodeled the ventilation system, eliminated most operations outside ventilation hoods, improved procedures for cleaning tools and work areas, increased respirator use, and improved worker safety training. For example, starting in 1984, respirators were required to be worn in the Rocky Flats beryllium machine shop. According to officials, workers exposed above the permissible exposure limit during the 1984 through 1989 era would have been protected by respirators. Energy officials indicated that this was an especially important

[19]Anthony E. Barnard, Janet Torma-Krajewski, and Susan M. Viet, "Retrospective Beryllium Exposure Assessment at the Rocky Flats Environmental Technology Site," *American Industrial Hygiene Association Journal* (Sept. 1996).

interim corrective measure prior to completion of the remodeling project in September 1986. In addition, Rocky Flats hired a health and safety consulting firm to test the effectiveness of its remodeling by conducting "before-and-after" personal breathing zone monitoring. According to the consultant's study, samples taken in September and October 1986 (after the ventilation remodeling) showed lower average exposure levels and fewer samples were over exposure limits than was the case before the remodeling.

A second evaluation at Rocky Flats was conducted by the National Institute for Occupational Safety and Health, at the request of a union's local chapter. This evaluation, which was completed in May 1986 before the ventilation remodeling was completed, concluded that a health hazard existed from overexposure to beryllium in the beryllium machine shop. The Institute recommended that Rocky Flats routinely use personal breathing zone sampling, conduct all beryllium machining under exhaust ventilation, and conduct medical monitoring of beryllium-exposed workers.

Improved Medical Testing

During the late 1980s, medical advances allowed for earlier and easier detection of chronic beryllium disease and sensitivity to beryllium. Beryllium sensitivity is an immune system reaction, similar to an allergic reaction, which can occur in some persons exposed to beryllium and that indicates an increased risk of developing chronic beryllium disease. A blood test for sensitivity, known as the beryllium lymphocyte proliferation test, was refined during the late 1980s. Another new diagnostic device, the flexible bronchoscope (a tubular lighted device), provided a less invasive means for examining the lungs for signs of chronic beryllium disease.

Energy and the National Jewish Medical and Research Center first began using the newly developed blood test on a trial basis to identify workers' sensitivity to beryllium at Rocky Flats in 1987. Beginning in 1991, Energy established medical screening programs for many additional current and former Energy employees, using this blood test. For those identified as having sensitivity to beryllium, Energy offered follow-up medical exams to determine whether chronic beryllium disease was present. Medical testing was provided in phases, due to the funding levels available, according to an official in Energy's Office of Occupational Medicine and Medical Surveillance. Specifically, blood testing for current and former Rocky Flats workers began on a routine basis in 1991, for current Oak Ridge workers in 1991, for former Oak Ridge workers in 1993, and for former workers at several other facilities where workers could have been exposed to beryllium in 1996 and 1997.

From 1984 through December 31, 1999, a total of 13,770 current and former workers (or about 69 percent of the estimated 20,000 workers who may have been exposed to beryllium) had been screened for definite or possible chronic beryllium disease. Through this testing, 149 Energy workers have been diagnosed with chronic beryllium disease. The Assistant Secretary for Environment, Safety, and Health states that of the 149 workers, 89 have been diagnosed with chronic beryllium disease and another 60 have clinical findings presumed to be due to chronic beryllium disease. An additional 299 workers were identified as having sensitivity to beryllium; 219 of these workers do not have chronic beryllium disease; and 80 workers had yet to complete clinical evaluations to determine whether or not they have the disease. Energy plans to continue offering testing to additional former workers.

Improved Exposure Monitoring

During the 1990s, Energy also expanded the use of personal breathing zone monitoring at its facilities. For instance, the Y-12 Plant at Oak Ridge took only 148 personal breathing zone samples prior to 1990, but took 1,448 personal breathing zone samples from 1990 through 1996. According to plant officials, beginning in January 1998 and continuing through fiscal year 1999, the Y-12 Plant sampled every beryllium worker on every shift and reported the results back to the workers the following day. More than 7,900 personal breathing zone samples were collected during this period, according to the plant's Industrial Hygiene Manager. The purposes of this monitoring effort were to make workers more aware of safety practices through immediate feedback, to identify any practices needing improvement, and to address the monitoring requirements stated in a 1997 Energy notice on chronic beryllium disease prevention (described below). The Industrial Hygiene Manager for the Y-12 Plant told us that the plant plans to continue using personal breathing zone sampling routinely, sampling every worker in some locations and using a statistically based sampling approach in locations where more extensive data have already been gathered.

Energy Established a Rule on Beryllium Worker Safety in 1999 and Proposed a Beryllium Worker Compensation Program

Energy issued a rule in December 1999 establishing regulations to reduce beryllium exposure levels among its workforce, to reduce the number of workers exposed to beryllium, and to provide medical testing for exposed and potentially exposed workers.[20] This rule on chronic beryllium disease prevention applies to federal, contractor, and subcontractor employees at Energy facilities where there is actual or potential exposure to beryllium.[21] Energy has identified 17 facilities affected by the rule. These facilities have a total of about 8,100 workers who currently are associated with beryllium activities. According to officials in Energy's Office of Environment, Safety, and Health, each Energy facility is currently evaluating how it is affected by the new requirements in the rule. This review may result in identifying additional facilities that are affected by the rule. Several actions by Energy, such as a survey of its facilities to identify those with beryllium uses, preceded development of the final rule. In addition, in November 1999, the Secretary of Energy announced a legislative proposal to provide compensation for Energy workers who have contracted chronic beryllium disease or beryllium sensitivity.

Steps Preceding Issuance of Energy's Rule

In 1996, Energy surveyed the contractors that manage and operate its facilities concerning the extent of beryllium usage and the estimated numbers of workers exposed to beryllium. Following the survey, in July 1997, Energy issued a notice to its offices requiring the development and implementation of programs to minimize workers' exposure to beryllium and to minimize the incidence of chronic beryllium disease. The Secretary of Energy stated that the programs were to be followed until an Energy rule on beryllium could be promulgated. The notice required that the programs include measures to monitor and reduce workers' exposures to beryllium. For example, Energy facilities were to assess the hazards associated with each beryllium-related task. The contractors at these facilities were also required to offer voluntary medical testing for beryllium sensitivity to their current workers. Seventeen Energy facilities developed chronic beryllium disease prevention programs in response to the notice.

Energy's Rule on Chronic Beryllium Disease Prevention

Energy's December 1999 rule on chronic beryllium disease prevention includes a number of provisions designed to reduce beryllium exposure

[20] 64 Fed. Reg. 68854 (Dec. 8, 1999).

[21] The rule does not apply to Energy's beryllium vendors, which are regulated by OSHA. It also does not apply to certain Energy laboratory operations that are regulated under an OSHA rule for laboratories.

among its workers. First, the rule adopts OSHA's permissible exposure limit (currently 2 micrograms per cubic meter averaged over an 8-hour period) or a more stringent limit that may be promulgated by OSHA in the future. Second, the rule establishes an action level that is one-tenth of the permissible exposure limit,[22] at which level certain controls must be implemented. Controls required when exposure reaches the action level include using respirators and protective clothing, periodically monitoring beryllium levels, setting annual goals for exposure reduction, and limiting work area access to authorized personnel. The rule requires that periodic monitoring occur at least quarterly and that facilities use personal breathing zone monitoring. In addition, some controls are required for any beryllium work, regardless of the exposure level. These include assessing hazards before beginning work tasks involving beryllium, providing safety training to workers, and providing respirators to any beryllium worker who requests one.

Energy's rule includes two other types of beryllium limits. First, the rule establishes limits for beryllium particles on surfaces such as floors, tables, and the exterior of machinery. Surface sampling must be conducted routinely, and specified housekeeping methods must be used to keep beryllium dust below the limits. Second, the rule sets limits called release criteria for beryllium-contaminated equipment or items. One limit is set for releasing equipment and items to other facilities that perform beryllium work. A second, more stringent level is set for releasing equipment and items for reuse outside of Energy facilities or in non-beryllium areas of Energy facilities.

Energy's rule requires that medical surveillance be provided, on a voluntary basis, to all current workers with known or potential exposure to beryllium. Beryllium workers' annual health evaluations are to include blood tests for beryllium sensitivity and a physical examination emphasizing the respiratory system. These health evaluations are to be provided at no cost to workers. If medical opinions so indicate, employers at Energy facilities must offer to remove workers from beryllium work and exposure. Individuals removed from beryllium work must be provided the opportunity to transfer to other work for which they are qualified or can be trained in a short period. If a position is not available, employers must provide such workers with their normal earnings, benefits, and seniority for up to 2 years.

[22] The action level is 0.2 micrograms per cubic meter averaged over an 8-hour period.

Worker Compensation Proposal

In November 1999, the Administration transmitted a legislative proposal to the Congress to provide compensation for current and former Energy workers with chronic beryllium disease.[23] The proposal covers employees of Energy and its predecessor agencies, Energy contractors and subcontractors, and beryllium vendors who sold beryllium to Energy. According to Energy officials who helped develop the proposal, employees of beryllium vendors were included because (1) Energy's contracts with vendors through the early 1960s generally required them to apply the same worker safety provisions that Energy used in its own facilities and (2) the vendors manufactured beryllium parts to government specifications and for the sole use of the government. Affected workers would be eligible to receive reimbursement for medical costs, assistance for impairment or vocational rehabilitation, and compensation for lost wages. Workers with sensitivity to beryllium could also be reimbursed for medical costs involved in tracking their condition. In an announcement regarding this proposal, the Secretary of Energy noted that the proposal would reverse Energy's past practice of opposing and litigating most worker health compensation claims. The Administration's proposed legislation was introduced in the House and the Senate in November 1999. Two other bills concerning compensation for beryllium workers have also been introduced in the House and are pending.

Agency Comments and Our Evaluation

We provided the Departments of Energy, Labor, and Defense with a draft of this report for their review and comment. They generally agreed with the information in the report and provided technical changes, which we incorporated as appropriate. Energy's written comments are in appendix II. An official of the Office of the Deputy Under Secretary of Defense for Environmental Security orally concurred with the information in our report and suggested changes to clarify data on air monitoring and medical testing. An official of Labor's Occupational Safety and Health Administration orally concurred with the information in our report and suggested changes to clarify terminology and to expand data on beryllium as a human carcinogen.

[23] The proposal also addressed compensation for several other groups of Energy workers.

We are sending copies of this report to the Honorable William S. Cohen, Secretary of Defense; the Honorable Bill Richardson, the Secretary of Energy; the Honorable Alexis Herman, the Secretary of Labor; and other interested parties.

If you have any questions about this report, please call the contacts listed in appendix III.

David R. Warren, Director
Defense Management Issues

List of Congressional Requesters

The Honorable Robert F. Bennett
The Honorable Mike DeWine
The Honorable John McCain
United States Senate

The Honorable Christopher Shays
Chairman, Subcommittee on National Security,
Veterans' Affairs, and International Relations
Committee on Government Reform
The Honorable Tim Holden
The Honorable Paul E. Kanjorski
The Honorable Marcy Kaptur
The Honorable Jim Kolbe
House of Representatives

Objectives, Scope, and Methodology

Our objectives were (1) to provide information on beryllium uses and risks and (2) to describe selected key events that illustrate the evolution of federal government responses to risks. More specifically, we were asked to examine key events at the Departments of Energy and Defense and at Labor's Occupational Safety and Health Administration.

To obtain information on beryllium uses and risks, we reviewed documentation such as agency studies and reports and interviewed officials at Energy, Defense, Labor, and the Occupational Safety and Health Administration headquarters. We reviewed current and archived data and reports from the U.S. Public Health Service; the National Jewish Medical and Research Center, Denver, Colorado; Brush Wellman, Inc. (one of two producers of beryllium in the United States) headquartered in Cleveland, Ohio; and the Lovelace Respiratory Research Institute, Albuquerque, New Mexico.

We selected key events during the 1960s through 1990s involving Energy, Defense, and Labor to illustrate agency responses to beryllium uses and risks. For each event, we screened current and archived records for documentation such as agency hearing records, studies, correspondence, and reports; we interviewed agency officials to identify agency positions; and we followed up on agency officials' interviews with other parties, to ensure the accuracy of our report.

- For Energy, we contacted headquarters staff in the Offices of Environment, Safety, and Health; the General Counsel; Defense Programs; Science; and Nuclear Energy, Science, and Technology; and field staff from Defense facilities, including Rocky Flats, Colorado; Oak Ridge Y-12 Plant, Tennessee; Los Alamos National Laboratory, New Mexico; and Lawrence Livermore National Laboratory, California. We obtained data on exposure sampling; working conditions; medical screening efforts; workplace controls; policy, practices, and procedures; and the rule, proposed legislation, and associated history.
- For Defense overview information, we contacted staff from the Deputy Under Secretary of Defense for Environmental Security; the military service headquarters; the U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, Maryland; the Navy Environmental Health Center, Norfolk, Virginia; the Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis, Brooks Air Force Base, Texas; and selected subordinate commands. Regarding beryllium rocket fuel, we also visited the Air Force Research Laboratory, Edwards Air Force Base, California. We obtained background

information from the headquarters of the National Aeronautics and Space Administration, its Langley Research Center, and the Chemical Propulsion Information Agency, Columbia, Maryland.
- For Labor, we interviewed current and former staff from the Department of Labor's Occupational Safety and Health Administration and the Department of Health and Human Services' National Institute for Occupational Safety and Health. We obtained and examined the complete transcript of the August-September 1977 informal hearing on beryllium, as well as key documents available from hearing records and related archive files.

This report was reviewed for classification by an authorized derivative classifier at Energy and was determined to be unclassified. We conducted our review from June 1999 through April 2000 in accordance with generally accepted government auditing standards.

Comments From the Department of Energy

Department of Energy
Washington, DC 20585

April 27, 2000

David R. Warren
Director, Defense Management Issues
National Security and International Affairs Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Warren:

In response to your April 7, 2000, request to the Secretary of Energy, the Office of Environment, Safety and Health has reviewed the draft General Accounting Office report, RCED-HEHS-00-92, "OCCUPATIONAL SAFETY AND HEALTH: Government Responses to Beryllium Uses and Risks" (GAO Code 709457.) The Office of Environment, Safety and Health has no essential comments requiring a reply from the General Accounting Office prior to the publication of the report. We found the report to be accurate. However, we are enclosing suggested comments for your consideration.

If you have any questions, please contact Ms. Lesley Gasperow, Director, Office of Budget and Administration, on 301-903-5577.

Sincerely,

David Michaels, Ph.D, MPH
Assistant Secretary
Environment, Safety and Health

Enclosure

GAO Contacts and Staff Acknowledgments

GAO Contacts

Charles Patton, Jr., (202) 512-8412
Uldis Adamsons, (202) 512-4289

Acknowledgments

In addition to those named above, Bruce Brown, Rachel Hesselink, Arturo Holguin, Robert Kigerl, Lori Rectanus, Ronni Schwartz, George Shelton, and Glen Trochelman made key contributions to this report.

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