



Beryllium-Associated Worker Registry Dashboard, (2021)

Welcome to the Beryllium-Associated Worker Registry (BAWR) Dashboard, developed by the *Oak Ridge Institute for Science and Education (ORISE)* [<https://orise.ornl.gov/>] BAWR project team, under a contract with the U.S. Department of Energy (DOE). The BAWR program began in 2002, and since its inception has tracked, monitored, and analyzed data on workers exposed to beryllium and produced annual reports and summary data tables for more than 30 active and inactive DOE sites throughout the United States. The first Registry publication reported data for 12,267 workers through 2005. In 2021, the Registry has grown to more than 44,000 workers (including those at inactive reporting organizations such as Rocky Flats and some retrospective data provided prior to the 2002 start date of the Registry).

This BAWR Dashboard for 2021 is the continued presentation of the BAWR data on an annual basis. As a means of providing a better user experience with this tool, the BAWR program has transitioned from presenting data in a paper-based annual report to an interactive digital format, or a Dashboard. This transition from paper to digital format is intended to allow for interaction with and visualization of data contained in the Registry. The BAWR Dashboard contains the same sections of data, graphs, tables, and figures as the paper-based annual reports but is presented within the Dashboard format.

Enhancements to facilitate the user experience include topical sections and tabs, navigation features such as mouse-overs with data details, and other helpful functions that allow users to quickly examine information. Users are able to explore the standard metrics and results of data analyses for the BAWR through an interrelated series of graphics and tables to provide a comprehensive overview of Registry demographics, health monitoring, and exposure activities.

Some helpful hints for the best experience as you explore the Dashboard:

- To interact with the data explorer, hover over any of the graphics on the screen and click on your selection for more information.
- Once the selected graphic is open, roll the cursor over data to enable a pop-up screen with more detailed information.
- When you have completed your review of the graphic, please click on the 'x' button located in the upper right-hand corner of the graphic.
- More information is provided in the Help section of the Dashboard.
- A PDF of the Dashboard is available for download, located at the bottom of the navigation bar on the left.

If you have any comments, questions, or suggestions concerning this tool, please contact Dr. Linh Duong, DOE EHSS-13 Office of Domestic and International Health Studies, at Linh.Duong@hq.doe.gov or BAWR@ornl.gov.

DOE Mission & BAWR Initiative

DOE Mission

Introduction

The *U.S. Department of Energy (DOE)* [<https://www.energy.gov/>] is responsible for protecting the health and safety of DOE workers, contractors, and subcontractors. The Office of Environment, Health, Safety and Security (EHSS) provides the federal-level leadership and strategic vision necessary to establish clear expectations for health, safety, environment, and security programs. In support of this mission, the *Office of Health and Safety (EHSS-10)* [<https://www.energy.gov/ehss/health-and-safety>] collects, analyzes, and disseminates data and performance indicators, such as beryllium health and exposure information for individuals potentially at risk for chronic beryllium disease due to their work at DOE facilities.

The DOE Beryllium-Associated Worker Registry (BAWR) is a complex-wide internal program to help DOE conduct and improve its Chronic Beryllium Disease Prevention Program (CBDPP), the purpose of which is to protect workers from the adverse health effects of exposure to beryllium. The *U.S. Code of Federal Regulations (CFR) Title 10, part 850 Chronic Beryllium Disease Prevention Program (10 CFR 850)* [<https://www.energy.gov/ehss/chronic-beryllium-disease-prevention-program-10-cfr-850>] requires DOE sites to inventory and assess beryllium exposure hazards and transmit all records generated as required by this rule to DOE. Established in 2002, the BAWR is the repository for these data and contains information from more than 30 DOE facility reporting organizations, both active and inactive. Data from the BAWR and the annual summary reports were included in the Federal Register on June 7, 2016, in support of proposed amendments to 10 CFR 850. These recent proposed changes to the rule, reflecting DOE's goals to achieve aggressive reduction and minimization of worker exposures to airborne beryllium, will further strengthen the current CBDPP, worker protection programs, and reporting of affected workers.

Background

The Department of Energy and Department of Defense (DOD) have historically been some of the largest users of beryllium. Since the early 1940s, many thousands of workers at DOE and DOD plants or facilities have worked with beryllium and had the potential for exposure. These U.S. Departments have also been among the most involved in the study of beryllium and its possible health effects, and DOE took steps to initiate a comprehensive beryllium worker health program. Following years of aggressive data collection and analysis of beryllium activities, exposure measurements, and disease occurrence, a public notice of intent to establish a chronic beryllium disease prevention program was published in 1998 (*63 FR 66940* [<https://www.govinfo.gov/content/pkg/FR-1998-12-03/pdf/98-30277.pdf>]). Within the notice of intent, DOE requested comments, data, and any other relevant information from the public and industry for consideration in developing the beryllium worker health program. Following receipt and consideration of numerous comments and other relevant information, DOE published the final rule of 10 CFR part 850 CBDPP in 1999. DOE issued a comprehensive implementation guide (DOE G 440.1-7) to assist line managers in meeting responsibilities required by the CBDPP in 1997 and updated it in 2001 (*DOE G 440.1-7a* [<https://www.directives.doe.gov/directives-documents/400-series/0440.1-EGuide-7a>]). In 2006, DOE published *10 CFR 851* [<https://www.energy.gov/gc/10-cfr-851-worker-safety-and-health-program>], a final rule establishing and implementing a formal worker safety and health program (WSHP) which also included some updating of the CBDPP. The WSHP, including the amendments to the CBDPP Rule, went into effect in 2007.

BAWR Initiative

The U.S. Department of Energy (DOE) *Beryllium-Associated Worker Registry* [<https://orise.ornl.gov/health-surveillance/information-systems/data-registries.html#bawr>] (BAWR) was established to meet the requirements of 10 CFR 850 enacted in December 1999 and has been in operation since 2002. It is a collection of health and exposure information of individuals potentially at risk for chronic beryllium disease (CBD) due to their work at DOE-owned or leased facilities.

The DOE Office of Domestic and International Health Studies [<https://www.energy.gov/ehss/domestic-health-studies-and-activities>] supports the operation of a surveillance registry of current workers who are exposed to beryllium in their current job or may have been

exposed to beryllium in the past from work conducted at a DOE site. Data reported electronically to the BAWR are analyzed and summarized to help DOE accomplish several goals. One goal of the Registry is to determine the incidence and prevalence of beryllium sensitization and CBD. The data are analyzed to help better understand CBD and to identify those at risk. Another goal is to monitor and evaluate the effectiveness of DOE's Chronic Beryllium Disease Prevention Program. A third goal is to provide data and analyses to help answer questions posed by DOE Headquarters (and other agencies) regarding, for example, the effects of lowering established personal exposure limits.

Regulations, Standards, and Specifications

Code of Federal Regulations 10 Part 850

Title 10, Code of Federal Regulations, part 850 (10 CFR 850) [<https://www.ecfr.gov/current/title-10/chapter-III/part-850>], "Chronic Beryllium Disease Prevention Program," requires U.S. Department of Energy (DOE) sites to inventory and assess beryllium exposure hazards to determine whether workers are at risk for chronic beryllium disease (CBD). Sites that determine workers are at risk due to ongoing or past work must implement CBD prevention programs that include reporting health and exposure data to the DOE Beryllium-Associated Worker Registry (BAWR). Health data are collected through the operation of medical surveillance programs for current workers. Exposure data are collected through the operation of industrial hygiene programs at sites that have continuing beryllium operations.

Standards and Specifications

Beryllium-Associated Worker Registry Data Collection and Management Guidance, DOE-STD-1187-2019

[<https://www.standards.doe.gov/standards-documents/1100/1187-astd-2019>] is a technical standard that provides acceptable methods for compliance with the requirements of Title 10 Code of Federal Regulations, Part 850.39 (*10 CFR 850.39*

[<https://www.govinfo.gov/content/pkg/CFR-2017-title10-vol4/pdf/CFR-2017-title10-vol4-sec850-39.pdf>]) "Recordkeeping and Use of Information." It should be used by responsible employers subject to the requirements of 10 CFR 850 "Chronic Beryllium Disease Prevention Program" to guide their submission of information to the DOE BAWR. Use of this standard promotes consistent reporting and efficient analysis and dissemination of information to those who need to know. It supersedes DOE-STD-1187-2007, dated June 2007.

Beryllium Lymphocyte Proliferation Testing (BeLPT) Technical Specification, DOE-SPEC-1142-2019

[<https://www.standards.doe.gov/standards-documents/1100/1142-dspec-2019>] is a specification for BeLPTs used for detecting whether an individual has developed a sensitization to beryllium and for clinical evaluation and diagnosis of patients for CBD (a lung biopsy is needed to fully establish the presence of CBD). This specification should be used in all contracts with laboratories for the purchase of BeLPT services. It supersedes DOE-SPEC-1142-2001, dated May 2001.

Executive Summary

Significant Findings

The U.S. Department of Energy (DOE) Chronic Beryllium Disease Prevention Program (CBDPP) and Beryllium-Associated Worker Registry (BAWR) have been essential in raising awareness of and increasing vigilance in ensuring accountability for workers' health and for a workplace that limits harmful exposure to airborne beryllium. The BAWR remains a valuable occupational health program.

The BAWR 2021 Dashboard provides a summary of data collected by DOE-affiliated reporting organizations through the end of the 2021 calendar year.

During the 2021 calendar year, important findings from the BAWR are:

- Registry data show that the DOE CBDPP has resulted in increased vigilance and decreasing exposure to beryllium which has helped to reduce the number of beryllium sensitization (BeS) and chronic beryllium disease (CBD) cases over time. The yearly average for workers developing sensitization, whose first abnormal Beryllium Lymphocyte Proliferation Test (BeLPT) results were reported between 2001 and 2010, was 35. This rate dropped to an average of 7.8 from 2012–2021. For workers later diagnosed with CBD, the yearly averages dropped from 9 to less than 1 per year for the respective time frames.
- Prevention programs screen nearly 4 times as many workers for BeS than are monitored for exposure to beryllium.
- While health monitoring for BeS appears vigorous, industrial hygiene programs have historically submitted fewer exposure sampling measurements to the BAWR each year. However, in Calendar Year 2021 there was a slight increase in the number of records reported to the Registry (see the “DOE-wide Trend in Reported Exposure Sampling for 2012–2021” graph in the Exposure Monitoring Activities tab of the Data Metrics and Results section).
- Due to BeS and CBD observed in workers without exposure monitoring data (i.e., over two-thirds of total cases), sites may need to review and update exposure sampling plans to be more proactive identifying cases. For example, recent cases include workers whose jobs had no expected risk for exposure. For BeS and CBD cases that do have exposure sampling reported, the amount of data prior to their diagnosis date (i.e., having data for monitoring conducted earlier than their date of sensitization or CBD diagnosis) is very limited.
- Significant delays in reporting impact the BAWR analyses and the conclusions drawn from them. Data submitted with missing required values (such as first hire on site date, 8-hour time weighted average, actual exposure level, first beryllium job start date, or job title) also limit BAWR analyses and make it difficult to identify potential problem areas or those warranting further investigation.
- Analyses of the data from the BAWR yielded no statistical correlation between the incidence of BeS/CBD and the percent of exceedances among exposure sampling results submitted to the Registry. The lack of correlation could be due to sensitization and CBD cases associated with past work locations or conditions rather than the environment currently monitored. However, it is also possible that the exposure monitoring programs are missing sources of exposure.
- Reporting organizations with low exposure monitoring results and high sensitization or CBD rates should further investigate cases to determine if there is a possibility of ongoing exposures.

Summary of Findings, 2021

The Beryllium-Associated Worker Registry (BAWR) 2021 Dashboard provides a summary of cumulative data collected by the U.S. Department of Energy (DOE)-affiliated reporting organizations through the end of the Calendar Year 2021 (CY2021). The Oak Ridge Institute for Science and Education (ORISE) Data Center in collaboration with DOE's Office of Health and Safety developed the analyses and statistics presented within this report. The report provides an overview of Registry demographics and health monitoring and exposure activities, highlighting changes over the last reporting period. In brief:

Registry Demographics

- The Registry includes 27 active reporting organizations during the CY2021 reporting period. There were no changes in reporting organizations for CY2021.
- There were 11 changes in data coordinators in CY2021. The Registry includes 44,926 workers among the active reporting sites.
- The majority of the workers in the Registry are males over 50 years of age (54% of workers). The number of workers increased by 3,004 (from 41,922 workers in CY2020 to 44,926 workers in CY2021).

Health Monitoring

- Participants' medical surveillance programs screened a total of 7,982 workers for beryllium sensitization (BeS) in CY2021, which included 1,277 new workers with BeS test results reported to the Registry.
- The Registry has a total of 544 BeS workers and 155 workers diagnosed with chronic beryllium disease (CBD). The Registry reported 2 new BeS and 0 CBD cases in CY2021.
- The majority of BeS workers and CBD cases are associated with Y-12 and Hanford.
 - 27% of BeS workers are associated with employment at Y-12 and 23% of BeS workers are associated with Hanford. 40% of CBD cases are associated with Y-12 and 22% of CBD cases are associated with Hanford.
- The majority of BeS workers and CBD cases are associated with work histories involving crafts and line operators.
 - Crafts work histories are associated with 106 (20%) BeS workers. Line operators account for an additional 90 (17%) BeS workers. Crafts work histories are associated with 37 (24%) CBD cases. Line operators account for 23 (15%) CBD cases.

Exposure Monitoring

- The Registry received data for 3,396 air monitoring samples for 734 workers in CY2021.
- Of the samples measured in CY2021, approximately 91.1% had non-detectable results. Only 0.2% of the samples exceeded the 8-hour time weighted average (TWA) action level of 0.2 $\mu\text{g}/\text{m}^3$. Y-12 and Pantex reported the largest number of samples exceeding the action level with 64% of the reported exceedances.
- The highest 8-hour TWA level measured during CY2021 was 6.609 $\mu\text{g}/\text{m}^3$ at Pantex among production technicians. This was lower than the highest reported measurement in CY2020 which was 17.34 $\mu\text{g}/\text{m}^3$ at Y-12 among machinists.

Health and Exposure Monitoring Comparisons

- Site medical programs screen a greater proportion of workers for beryllium sensitization (BeS) than are monitored for exposure to airborne beryllium. This may be due to some extent from monitoring for the onset of BeS and chronic beryllium disease (CBD) in workers no longer performing beryllium-related work; workers moving between sites/contractors; the discovery of legacy beryllium in poorly documented areas; and the use of swipe sampling results, not required for the Registry.
- 67% of workers identified as BeS do not have exposure monitoring results submitted to the Registry.
- 20% of CBD cases have exposure records dated earlier than their reported date of CBD diagnosis.
- Of those with exposure monitoring, 39% of workers only have exposure monitoring results after identification as BeS.

Accomplishments

The U.S. Department of Energy (DOE) Beryllium-Associated Worker Registry (BAWR) is a centralized repository for the collection and analyses of beryllium exposure data since 2002. The program was mandated by *U.S. Code of Federal Regulations (CFR) Title 10, part 850 Chronic Beryllium Disease Prevention Program (10 CFR 850)* [<https://www.govinfo.gov/app/details/FR-1999-12-08/99-31181>] (published December 8, 1999) when DOE required sites, on an ongoing basis, to monitor and assess beryllium exposure hazards and transmit associated records containing health and exposure data to the BAWR. Since that time, the Registry has grown significantly, both in the numbers of included organizations and the longitudinal nature of the data, making it a valuable and unique resource for DOE, the sites overseen by the DOE Chronic Beryllium Disease Prevention Program (CBDPP), and even other agencies.

The BAWR accomplishments to date highlight the importance and contributions made by this program in partnership with the DOE CBDPP:

Chronic Beryllium Disease Prevention Program

- The results of the BAWR data analyses indicate that the CBDPP has resulted in decreased exposure to beryllium which has helped to reduce the number of beryllium sensitizations (BeS) and chronic beryllium disease (CBD) cases over time.
- The yearly average for workers developing sensitization, whose first abnormal Beryllium Lymphocyte Proliferation Test (BeLPT) results were between 2001 and 2010, was 35. This rate dropped to an average of 7.8 from 2012 to 2021.
 - For workers later diagnosed with CBD, the yearly averages dropped from 9 to less than 1 per year for the respective time frames. The CBDPP and the BAWR have been critical in reducing CBD among workers and remain valuable occupational health programs.
- The data in the BAWR have been used by both the DOE Office of Inspector General and by the reporting organizations to investigate the effectiveness of sites' beryllium protection and prevention programs or follow-up to assure that recommendations from audits have been implemented. The BAWR has also provided special analyses for individual reporting organizations to help with quality assurance of their data and to prepare for internal or external audits. This cumulative data resource has proven to be more comprehensive and accurate than individual sites' records, as well as designed to provide easy comparisons between the health and exposure information.

BAWR Data Used in Support of 10 CFR 850 Amendments

- Data from the BAWR were included in the Federal Register on 7 June 2016, in support of proposed amendments to 10 CFR 850. These proposed changes to the rule, reflecting DOE goals to achieve aggressive reduction and minimization of worker exposures to airborne beryllium, will further strengthen the current CBDPP, worker protection programs, and reporting of affected workers. As part of the justification for lowering DOE established personal exposure limits (PELs), BAWR data was analyzed to determine the effects of the current cutoff of 2.0 $\mu\text{g}/\text{m}^3$ and played a critical role in lowering it to several levels between 1.0 and 0.33 $\mu\text{g}/\text{m}^3$.
- Data from the BAWR were also used by DOE staff working on updates to the rule to monitor reporting organizations by geographic location and account for reporting organizations (and changes in numbers of workers), which had been combined when contracts were rebid and/or organization names had changed.

Improved Algorithms for Earlier Identification of Affected Workers

- Staff from Oak Ridge Institute for Science and Education (ORISE) and the BAWR have provided input to the revised algorithm, based on blood BeLPT results, for determining BeS. The new algorithm will lead to, in many cases, earlier identification of affected workers.
- To determine the differences between algorithms, the current and the proposed algorithm were modeled for comparison. ORISE Beryllium Laboratory staff later provided expert testimony at the public hearings for revisions to 10 CFR 850 regarding the importance of adding an additional 3 borderlines criteria to the methodology, and the BAWR and Beryllium Laboratory provided supporting data.

Cross-Agency Data Sharing

- Results from BAWR analyses to study the effects of lowering DOE established personal exposure limits (PELs) were shared by DOE with the Occupational Safety and Health Administration (OSHA). The BAWR is the only source for these cumulative data for DOE-affiliated sites.
- Raw exposure data from the BAWR were requested and used by OSHA in evaluating lowering their permissible exposure limit (PEL) to 0.2 $\mu\text{g}/\text{m}^3$. ORISE staff created and provided a de-identified file for OSHA with a limited number of fields to protect workers' identities.

Subject-Matter Expertise – Specifications, Standards, and Studies

- As subject matter experts with regard to beryllium, worker health, and interpretation of BeLPT results, ORISE staff played a major role in assisting DOE in revising the Beryllium Lymphocyte Proliferation Testing (BeLPT) Technical Specification, *DOE-SPEC-1142-2019* [<https://www.standards.doe.gov/standards-documents/1100/1142-dspec-2019>]. This specification had not been updated since 2001.
- ORISE staff with decades of experience with the BAWR, provided substantial input in guiding updates to the BAWR Technical Standard, which had not been updated since 2007. The *DOE-STD-1187-2019 Technical Standard* [<https://www.standards.doe.gov/standards-documents/1100/1187-astd-2019>] was completed in late 2019.
- Studies using BAWR data have provided a better understanding of impacts on worker health. Studies that combined data from the BAWR with data from the former DOE Illness and Injury Surveillance Program (IISP) include:
 - *Illness Absences Among Beryllium Sensitized Workers* [<https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2014.302132>] (American Journal of Public Health, Janice Watkins, et. al., September 2014).
 - Y-12 American Recovery and Reinvestment Act (ARRA), workers hired after January 1, 2009, analyses of exposures and health data for the cohort (Paul Wambach, White Paper, July 2011).
- ORISE, in cooperation with DOE and National Jewish Health, continue to evaluate studies regarding beryllium test results, latency from first BeS to disease onset, and evidence of a dose-response relationship between beryllium exposure and disease outcomes. The data in the BAWR are of interest with regard to discovering more about how these are correlated. Some examples include:
 - *Clinical and laboratory factors contributing to uninterpretable beryllium lymphocyte proliferation tests (BeLPT)* [<https://pubmed.ncbi.nlm.nih.gov/29574954/>] (American Journal of Industrial Medicine, Derek Smith, et. al., March 2018).
 - *Exposure and genetics increase risk of beryllium sensitization and chronic beryllium disease in the nuclear weapons industry* [<https://pubmed.ncbi.nlm.nih.gov/21460389/>] (Occupational and Environmental Medicine, Michael Van Dyke, et. al., November 2011).

Improvements to Data Quality

- Because of the regular and required electronic reporting of data to the BAWR, the BAWR has been used as justification by the reporting organizations for streamlining their processes by developing new systems, infrastructure, and/or procuring new software. Over time, data have improved dramatically, as evidenced by decreasing error rates in the data condition reports. There is a continued effort made by BAWR and DOE staff to improve data quality, notably securing complete worker rosters and work history data.
- DOE and ORISE staff have worked together to help assure that once 10 CFR 850 is updated and published, the BAWR's Technical Standard is specifically cited as containing the guidance and elements required to satisfy mandatory reporting. DOE and ORISE staff worked together to help assure the BAWR's Technical Standard is specifically cited as the guidance and elements required to satisfy mandatory reporting in current updates to 10 CFR 850. This effort will ensure sites do a better job of complete and accurate reporting and correction of errors. As a result, the BAWR will be an even more robust resource to better understand the relationship between beryllium exposure and disease outcomes, in order to protect worker health.

Limitations to Data Interpretation

Due to limitations associated with data submitted to the Beryllium-Associated Worker Registry (BAWR), caution should be exercised in the conclusions drawn from data analyses results and data summarizations. Caveats to consider when interpreting the data presented in the BAWR Dashboard are discussed below:

Absence of Personally Identifiable Information

The Registry does not contain PII (personally identifiable information) on workers. Each reporting organization is free to choose its own encryption algorithm to assign a unique identifier for a given worker. While this approach ensures the protection of the individual's privacy, it restricts the Registry's ability to determine when a given worker moves from one reporting organization to another.

Need for Updated Exposure Sampling Plans

Reporting of air monitoring samples have declined each year. Due to beryllium sensitization (BeS) and chronic beryllium disease (CBD) observed in workers without exposure monitoring data, reporting organizations may need to review and update exposure sampling plans. In contrast, health monitoring for BeS appears to be robust, although additional medical follow-up of CBD cases would be useful.

Absence of Worker Morbidity and Mortality Data

Morbidity and mortality data are not reported by sites to the BAWR. However, the Registry does capture health outcome information on workers' development of beryllium sensitization (BeS) or chronic beryllium disease (CBD). The clinical criteria and incidence rules for the case definition of BeS is one of the following:

- Individual must have 2 abnormal blood tests, or
- 1 abnormal and 2 borderline blood tests, or
- An abnormal bronchoalveolar lavage BeLPT (Beryllium Lymphocyte Proliferation Test), or
- Clinical evaluation with a diagnosis of BeS.

The current diagnostic algorithm used in the identification of cases is limited because of the time lapse between meeting any one of the above criteria to a time when the worker may already be experiencing health effects. When 10 CFR 850 (<https://www.ecfr.gov/current/title-10/chapter-III/part-850>) is updated and published, revisions to the current algorithm for determining BeS will result in earlier dates of BeS for many workers, providing more timely identification and subsequent medical follow-up or appropriate work restrictions.

- Cause of death is not available to the Registry, which prevents further analyses focused on estimation of mortality risk from particular causes.

Incomplete Worker Rosters

Reporting organizations are not required to submit data on the total number of workers for each reporting year. Additionally, it is difficult to ensure that each reporting organization has submitted a complete roster of workers with potential beryllium exposure due to current or past work locations or activities. The number of workers tested using the beryllium lymphocyte proliferation test, therefore, is the denominator in many of the analyses and calculated rates of beryllium sensitization or chronic beryllium disease.

Inability to Confirm First Date of Hire

The Registry cannot always confirm the date of first hire because some organizations define the date of first hire as the date of first hire by the current (sub)contractor, and this date overwrites the previous date of first hire by a former contractor. Resetting this date negatively impacts the Beryllium-Associated Worker Registry analyses to examine latency from possible exposure to development of sensitization to disease onset.

Duplication of Worker Counts

Although most workers represented in the figures and tables are unique cases, there is potential duplication of workers and counts. This issue can arise when a worker moves from one reporting organization to another and is assigned a new identifier based on a different encryption algorithm. Although the number of workers in this category is believed to be small, given the absence of personally identified information on individuals, we cannot be absolutely certain that the total numbers of individuals shown in figures and tables represent unique individuals. We have used this approach to err on the side of protecting the workers' privacy.

Data Reporting Delays

Significant delays in reporting impact the Beryllium-Associated Worker Registry (BAWR) analyses and conclusions drawn from them. Such delays also impact the ability to identify problems and defer refinement of protocols.

Timely and complete reporting of exposure monitoring data is necessary to characterize beryllium-related work at a site and analyze workers' actual exposure levels and time weighted averages. Timely and complete reporting of beryllium sensitization (BeS) and chronic beryllium disease (CBD) cases (and their related work history) is critical to identifying problems, assessing the effectiveness of CBD Prevention Programs, and refining protocols.

In recent years, reporting organizations observed BeS among security guards, administrative personnel, and field engineers. These workers had no expected exposure, are not covered in sites' industrial hygiene sampling plans, and did not use personal protective equipment. These cases highlight the importance of proactive hazard assessments and sampling approaches. Timely reporting of data is critical to earlier identification of potential work areas or sources of beryllium exposure, particularly locations or work activities not anticipated to be significant sources of beryllium exposure.

There are reasons contributing to delayed reporting of data:

- Turnover in data coordinators often results in the need for additional training and subsequent delays in data submissions. Therefore, significant data coordinator turnover can impact the timely acquisition of data and subsequent reporting of results.
- Exposure monitoring records for previous monitoring years are sometimes received late. This results in a delay in data collection and an impact on data analysis. For example, of the 3,396 exposure records submitted to BAWR during the Calendar Year 2021 (CY2021), 3,185 had monitoring dates in CY2021 and 211 records were for monitoring years prior to CY2021. Some of these records for prior monitoring years include higher-than-average exposure levels which can significantly impact trend analysis. As the number of annual exposure records has decreased in recent years, the impact of these records on BAWR analyses has increased.

There have been delays in reporting of BeS and CBD cases, most often for those cases where workers did not hold beryllium-related jobs. Therefore, several years elapsed before beryllium was identified as a factor. As a result, workers were enrolled in medical surveillance programs, or were referred to a pulmonary laboratory, for further testing and evaluation.

Data Metrics & Results

BAWR Reporting Sites and Target Population

Beryllium-Associated Worker Registry (BAWR) Reporting Organizations are owned by the U.S. Department of Energy (DOE)-operated facilities with current workers who:

- Have been exposed, or have had the potential for exposure, to airborne concentrations of beryllium due to their work at the present or a previous DOE site;
- Self-identify and indicate a history of possible exposure; or
- Exhibit symptoms of beryllium exposure, or are receiving medical removal protection benefits.

The site's Chronic Beryllium Disease Prevention Program (CBDPP) may also include other workers in the BAWR reporting for their site, as appropriate. Subcontractors who are not included under the main site's CBDPP must have their own CBDPP and report data separately. The 10 CFR 850 (<https://www.ecfr.gov/current/title-10/chapter-III/part-850>) contains further information on beryllium and beryllium-associated workers, and which organizations should have CBDPPs.

Active BAWR Reporting Organizations

Through the 2021 calendar year, the BAWR received data from the following 27 DOE-affiliated reporting organizations:

- Ames Laboratory (AMES)
- Argonne National Laboratory (ANL)
- Brookhaven National Laboratory (BNL)
- DOE Oak Ridge Office (DOE-ORO)
- East Tennessee Technology Park (ETTP)
- Fermi National Accelerator Laboratory (Fermi)
- Golden SVCS, LLC (GSVCS)
- Hanford Site (HAN)
- Idaho National Laboratory (INL)
- Kansas City National Security Campus (KCNSC)
- Knolls Atomic Power Laboratory (KAPL)
- Lawrence Berkeley National Laboratory (LBNL)
- Lawrence Livermore National Laboratory (LLNL)
- LLNL Clean Harbors Environmental Services (LLNL CHES)
- LLNL North Wind (LLNL NW)
- Los Alamos National Laboratory (LANL)
- LANL N3B (LANL N3B)
- Nevada National Security Site (NNSS)
- Oak Ridge National Laboratory (ORNL)
- Pacific Northwest National Laboratory (PNNL)
- Paducah Site (PADUCAH)
- Pantex Plant (PTX)
- Sandia National Laboratories (SNL)
- Savannah River Site (SRS)
- SLAC National Accelerator Laboratory (SLAC)
- Y-12 Atkins Nuclear Secured (Y-12 ANS)
- Y-12 National Security Complex (Y-12)

All 27 active reporting organizations collected health data through the operation of their medical surveillance programs.

Twenty-five (25) organizations conducted exposure sampling through their industrial hygiene programs. Golden SVCS, LLC (GSVCS) and DOE Oak Ridge Operations (DOE-ORO) do not submit exposure sampling data since their workers are in the BAWR due to prior work at another DOE site and have no potential for exposure.

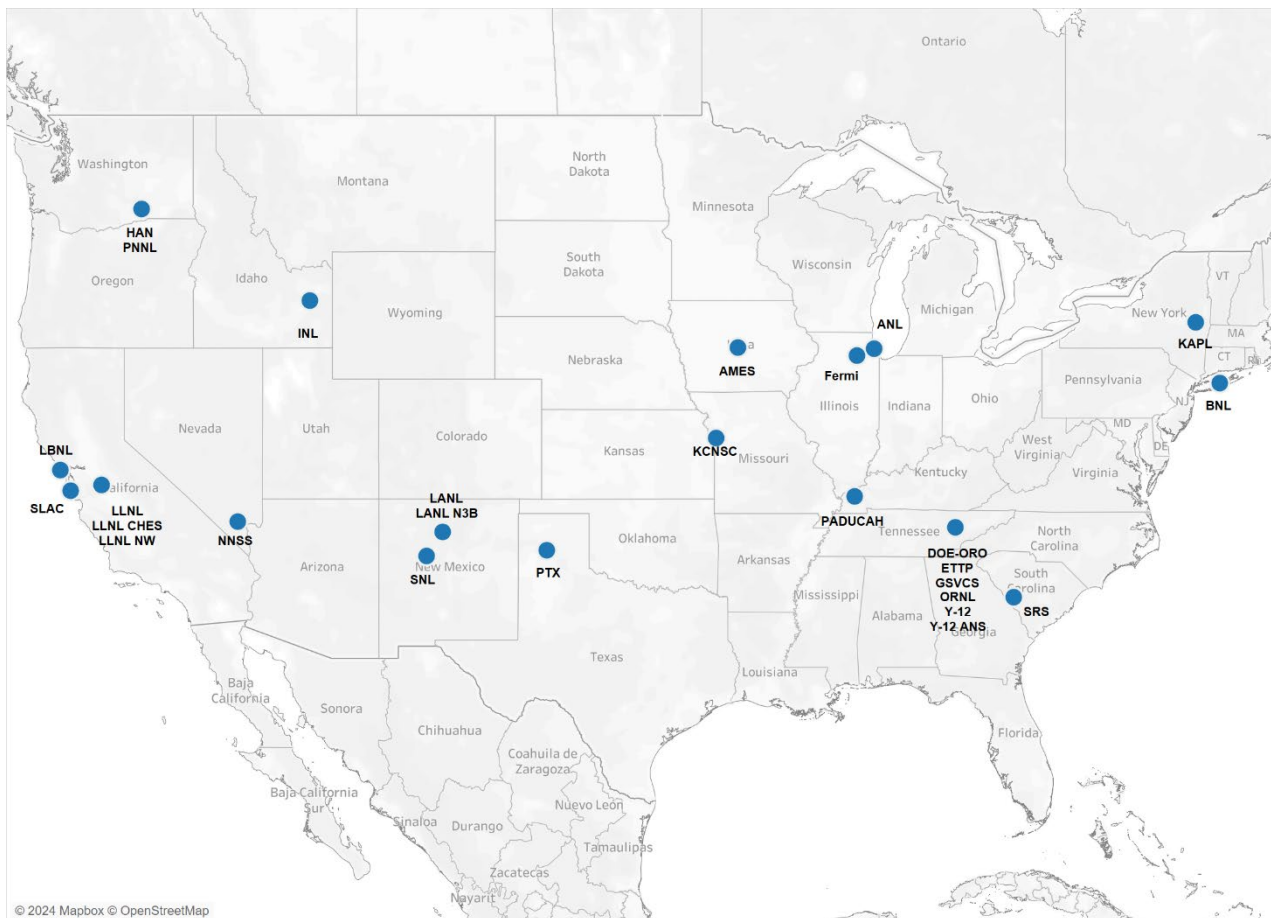
Inactive BAWR Reporting Organizations

There are 9 reporting organizations that previously participated in the program, but due to contract changes or work completion, no longer submit data. The previously submitted data from these organizations, referred to as inactive reporting organizations, remain in the BAWR.

The inactive reporting organizations are:

- Advanced Mixed Waste Treatment Project (AMWTP)
- LLNL Boston University (LLNL BU)
- LLNL Envirocon, Inc. (LLNL ENVC)
- National Strategic Protective Services, LLC for ETTP and ORNL (NSPS)
- Rocky Flats Closure Project (RF)
- Southwestern Power Administration (SWPA)
- Wackenhut Security Services, Inc. for ETTP, ORNL, and Y-12 (WSI)
- Y-12 Navarro Research and Engineering (Y-12 NRE)
- Y-12 URS Corporation (Y-12 URS)

Geographical Locations for 27 Active BAWR Reporting Organizations (2021)



[Click here for List of Acronyms](#)

This map shows the geographical locations of the 27 DOE-affiliated actively reporting organizations within the continental US.

Infographic Details

Ames Laboratory (AMES)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
48	48	2	0	12

Argonne National Laboratory (ANL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
425	193	3	0	23

Brookhaven National Laboratory (BNL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
82	56	1	0	48

Fermi National Accelerator Laboratory (Fermi)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
29	21	0	0	23

Richland Area Reporting Locations

Hanford Site (HAN)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
19,241	11,014	123	34	2,225

Pacific Northwest National Laboratory (PNNL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
444	405	10	0	56

Idaho National Laboratory (INL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,516	502	3	0	371

Knolls Atomic Power Laboratory (KAPL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
78	39	0	0	39

Los Alamos Area Reporting Locations

Los Alamos National Laboratory (LANL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
5,394	3,883	33	8	951

LANL N3B Project (LANL N3B)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
107	97	0	0	19

Lawrence Berkeley National Laboratory (LBNL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
37	26	2	0	8

Livermore Area Reporting Locations

Lawrence Livermore National Laboratory (LLNL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
3,027	1,979	72	4	328

LLNL Clean Harbors Environmental Services (LLNL CHES)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
49	38	0	0	1

LLNL North Wind (LLNL NW)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
26	26	0	0	0

Kansas City National Security Campus (KCNSC)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,399	1,299	41	14	190

Nevada National Security Site (NNSS)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,398	1,243	23	6	297

Oak Ridge Area Reporting Locations

DOE Oak Ridge Office (DOE-ORO)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
98	99	1	0	0

East Tennessee Technology Park (ETTP)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,377	1,084	6	4	496

Golden SVCS, LLC (GSVCS)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
7	6	1	0	0

Oak Ridge National Laboratory (ORNL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,065	989	21	0	318

Y-12 National Security Complex (Y-12)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
3,734	3,060	146	62	1,414

Y-12 Atkins Nuclear Secured (Y-12 ANS)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
47	46	0	0	29

Paducah Site (PADUCAH)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
357	279	6	0	90

Pantex Plant (PTX)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
2,263	2,123	27	15	592

Sandia National Laboratories (SNL)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
669	663	1	1	156

Savannah River Site (SRS)

Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,921	874	22	6	206

SLAC National Accelerator Laboratory (SLAC)

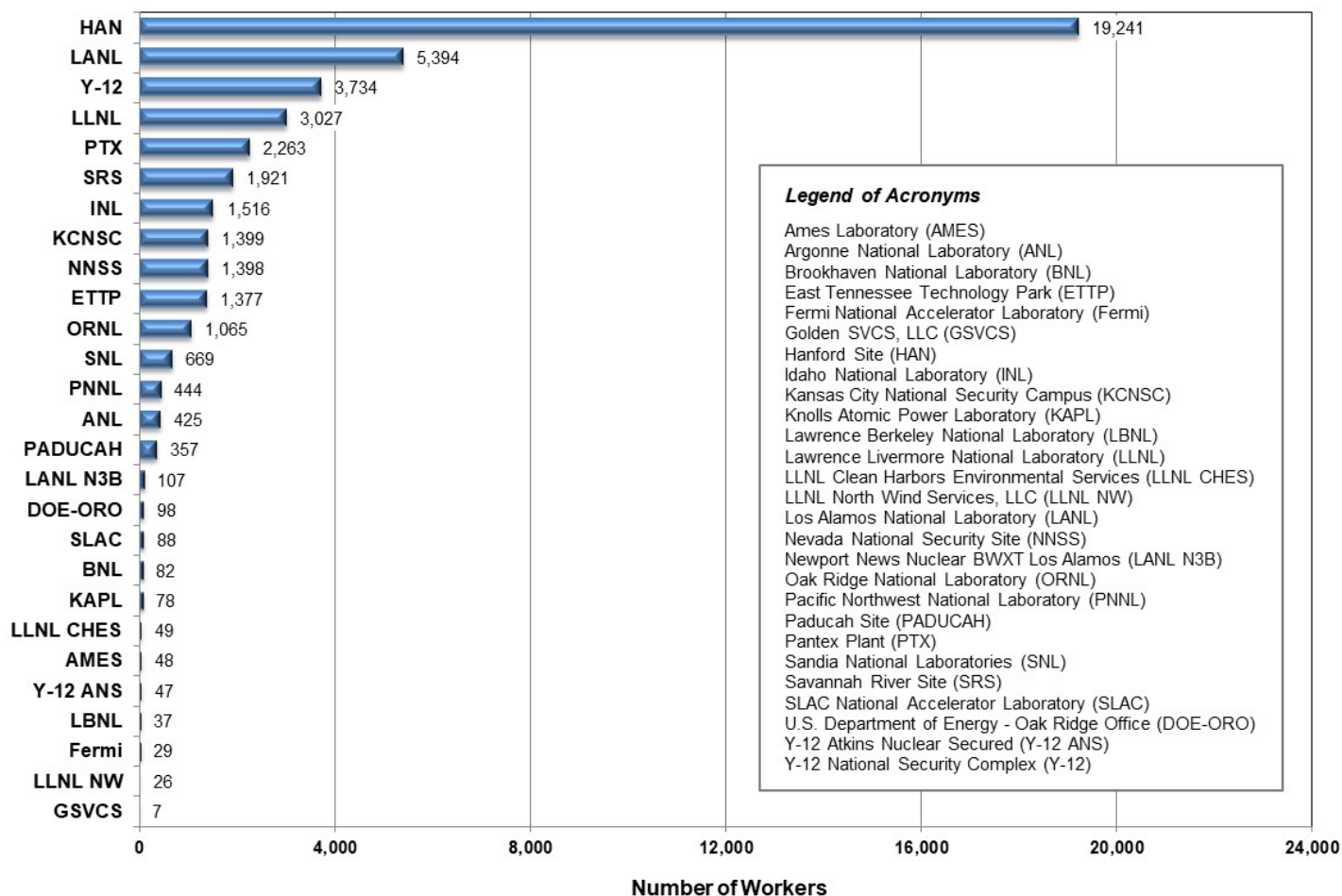
Number of Workers:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
88	49	0	1	26

Data Coordinator Changes by Reporting Organization (2014–2021)

Each reporting organization designates a data coordinator who is responsible for coordinating activities at the site related to data collection, timely submittal of data, and responding to inquiries from the U.S. Department of Energy (DOE) Program Manager and the Oak Ridge Institute for Science and Education Data Center as outlined in the DOE technical standard, DOE-STD-1187-2019. The following table shows that there were 12 data coordinator changes in Calendar Year 2021.

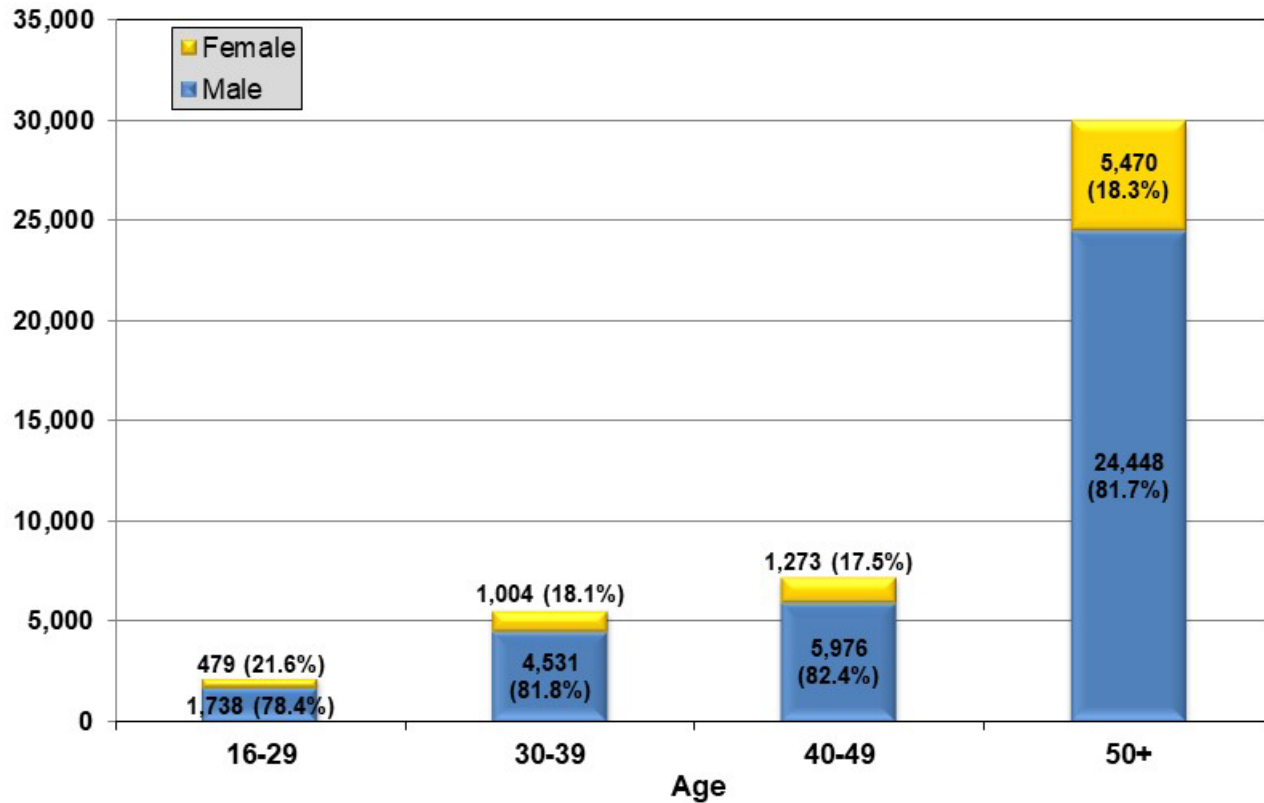
Year	Number (%) of Reporting Organizations	Total Data Coordinator Changes	Organizations with ≥ 2 Data Coordinator Changes in Same Year
2014	10 (37%)	15	5
2015	6 (22%)	9	3
2016	6 (22%)	7	1
2017	5 (19%)	7	2
2018	7 (27%)	9	2
2019	11 (41%)	12	0
2020	4 (15%)	5	1
2021	11 (41%)	12	1

Changes in data coordinators often result in the need for additional training and subsequent delays in data submissions. Therefore, significant data coordinator turnover can impact the timely acquisition of data and subsequent reporting of results.

Workers reported to the BAWR by Reporting Organization (2002–2021) *

* Some reporting organizations have provided data that predate the 2002 start date of the Registry.

This figure shows the cumulative numbers of beryllium-associated workers reported to the Beryllium-Associated Worker Registry (BAWR) by reporting organization. Through Calendar Year 2021 (CY2021), there were 44,926 workers in the cumulative roster as compared to 41,922 workers in the cumulative roster through CY2020, for an increase of 3,004 workers. Hanford site has 19,241 workers in the roster, constituting the largest number (46%) in the cumulative roster.

Gender and Age Distribution for Workers (2002–2021) *

* Some reporting organizations have provided data that predate the 2002 start date of the Registry.

Workers are predominantly male (approximately 82%) and greater than 50 years old (54%). This chart excludes 17 workers (<0.1%) for whom demographic data were not available.

Health Monitoring Results

Sites' health clinics collect medical surveillance data on workers identified by their beryllium rosters. These data sets contain beryllium-related health monitoring information and the results of any specialized medical testing. The Site Occupational Medical Director determines the content and frequency of surveillance evaluations and tests based on policies, standards, and the worker's health and work history. The most vital information collected and reported on an annual basis are the number of workers monitored for beryllium sensitization (BeS) using the beryllium lymphocyte proliferation test (BeLPT), the number of new BeS cases identified, and the number of new cases of chronic beryllium disease (CBD).

Some workers in the roster may decline testing for sensitizations. As a result, no records will be available for individuals who refuse this diagnostic evaluation. Some workers may have testing done independently (for example, as part of a former worker program), and in these cases results may be unavailable for Registry reporting unless the worker releases their evaluation report, and it becomes part of the organization's electronic medical records. Also, advanced medical testing results when workers are referred (after findings suggestive of possible CBD) to a pulmonary medicine or other specialized clinic for follow-up diagnosis and care may not be reported and/or can be difficult to collect.

Sensitization and CBD Screening

The cumulative number of workers with BeLPT screening results submitted to the Beryllium-Associated Worker Registry (BAWR) through Calendar Year 2021 (CY2021) was 30,141. When compared with the 29,688 workers screened through CY2020, this corresponds to an additional 453 workers tested.

There was a total of 544 sensitized workers included in the BAWR, and medical staff diagnosed 155 as having CBD through CY2021. BeS and CBD are mutually exclusive categories, i.e., if a person who is BeS receives a CBD diagnosis, the person's diagnosis moves to the CBD category and is no longer counted in the BeS category.

Number and Proportion of Workers undergoing BeLPT Testing and Diagnosed with BeS or Diagnosed with CBD by Reporting Organization (n=30,141) (2002–2021) *

Reporting Organization	No. Workers with BeLPT Results	No. Sensitized Workers	No. Workers with CBD
HAN	11,014	123 (1.1%)	34 (0.3%)
LANL	3,883	33 (0.8%)	8 (0.2%)
Y-12	3,060	146 (4.8%)	62 (2.0%)
PTX	2,123	27 (1.3%)	15 (0.7%)
LLNL	1,979	72 (3.6%)	4 (0.2%)
KCNSC	1,299	41 (3.2%)	14 (1.1%)
NNSS	1,243	23 (1.9%)	6 (0.5%)
ETTP	1,084	6 (0.6%)	4 (0.4%)
ORNL	989	21 (2.1%)	0 (0.0%)
SRS	874	22 (2.5%)	6 (0.7%)
SNL	663	1 (0.2%)	1 (0.1%)
INL	502	3 (0.6%)	0 (0.0%)
PNNL	405	10 (2.5%)	0 (0.0%)
PADUCAH	279	6 (2.2%)	0 (0.0%)
ANL	193	3 (1.6%)	0 (0.0%)
DOE-ORO	99	1 (1.0%)	0 (0.0%)
LANL N3B	97	0 (0.0%)	0 (0.0%)
BNL	56	1 (1.8%)	0 (0.0%)
SLAC	49	0 (0.0%)	1 (2.0%)
AMES	48	2 (4.2%)	0 (0.0%)
Y-12 ANS	46	0 (0.0%)	0 (0.0%)
KAPL	39	0 (0.0%)	0 (0.0%)
LLNL CHES	38	0 (0.0%)	0 (0.0%)
LBNL	26	2 (7.7%)	0 (0.0%)
LLNL NW	26	0 (0.0%)	0 (0.0%)
Fermi	21	0 (0.0%)	0 (0.0%)
GSVCS	6	1 (16.7%)	0 (0.0%)
Totals	30,141	544 (1.7%)	155 (0.5%)

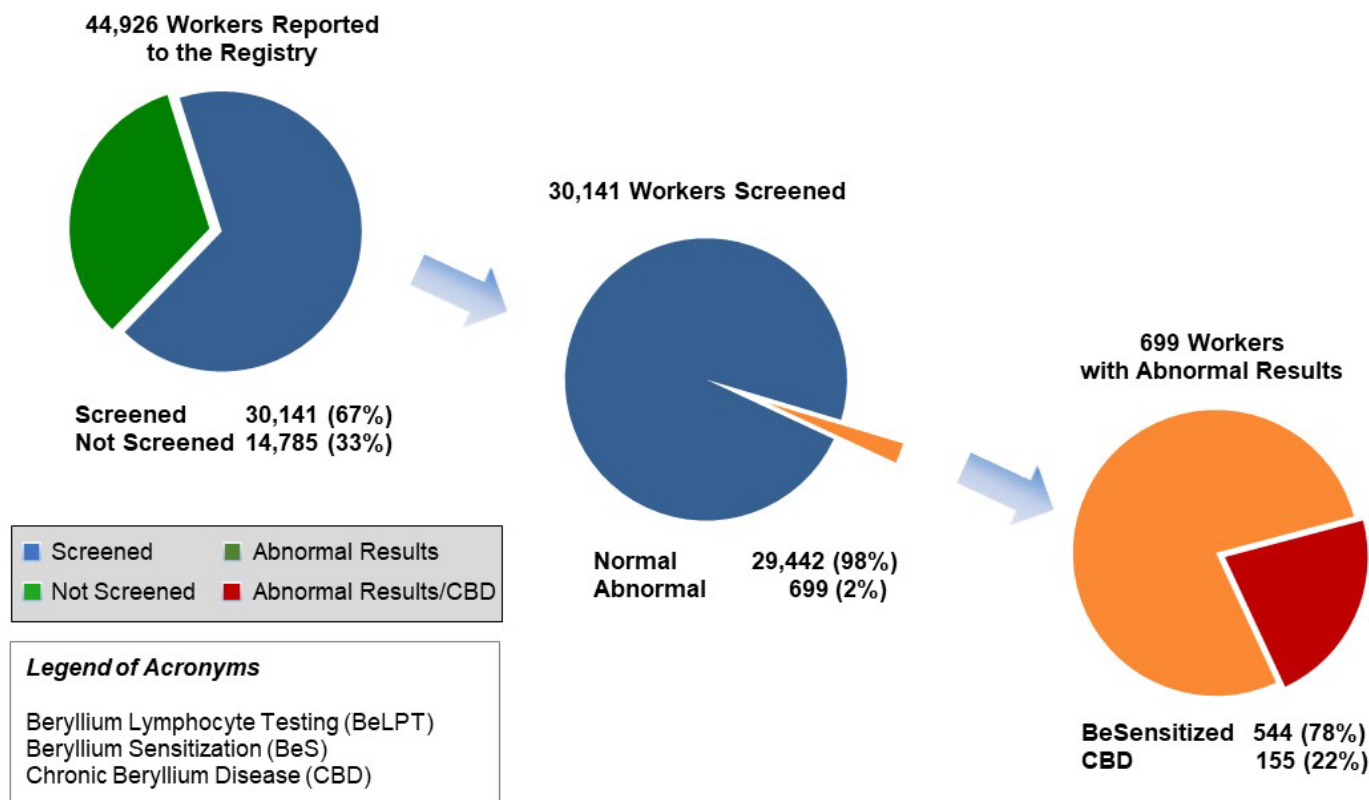
[Click here for List of Acronyms](#)

* Some reporting organizations have provided data that predate the 2002 start date of the Registry.

This table provides the numbers of beryllium-associated workers with Beryllium Lymphocyte Proliferation Testing (BeLPT) test results submitted to the Beryllium-Associated Worker Registry each year, and the total number of beryllium-sensitized (BeS) workers increased by 2 through Calendar Year 2021 (CY2021) (544 total BeS cases reported). The newly reported BeS cases were from 2 reporting organizations (1 at HAN and 1 at GSVCS). One case reported the date of sensitization in CY2020, and the second case was reported in CY2021.

Twenty (20) of the reporting organizations have BeS workers and 11 have workers who have been diagnosed with chronic beryllium disease (CBD).

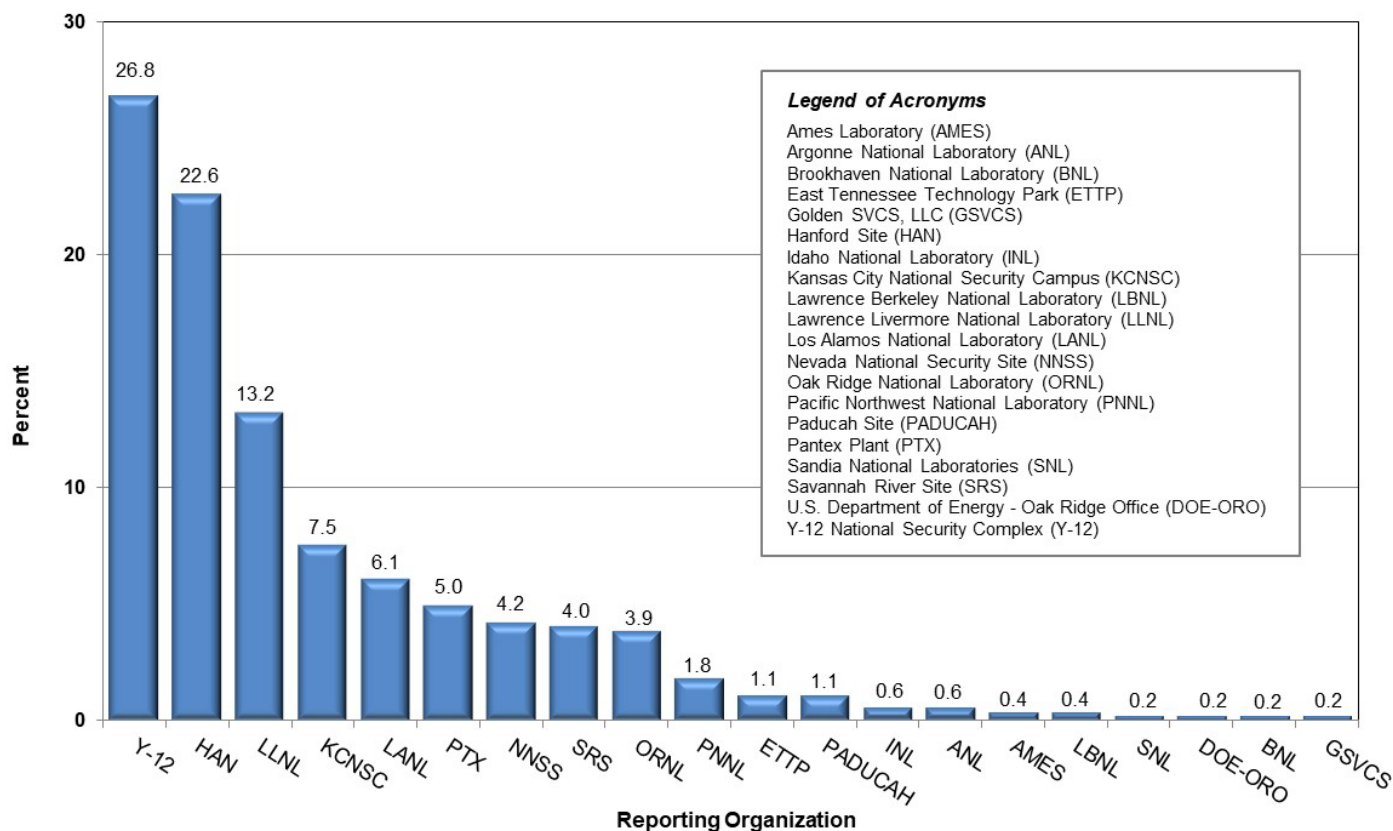
Number and Percent Proportion of Workers Undergoing BeLPT Testing, and Yielding Abnormal BeS or CBD Results (n=44,926) (2002–2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the Registry.

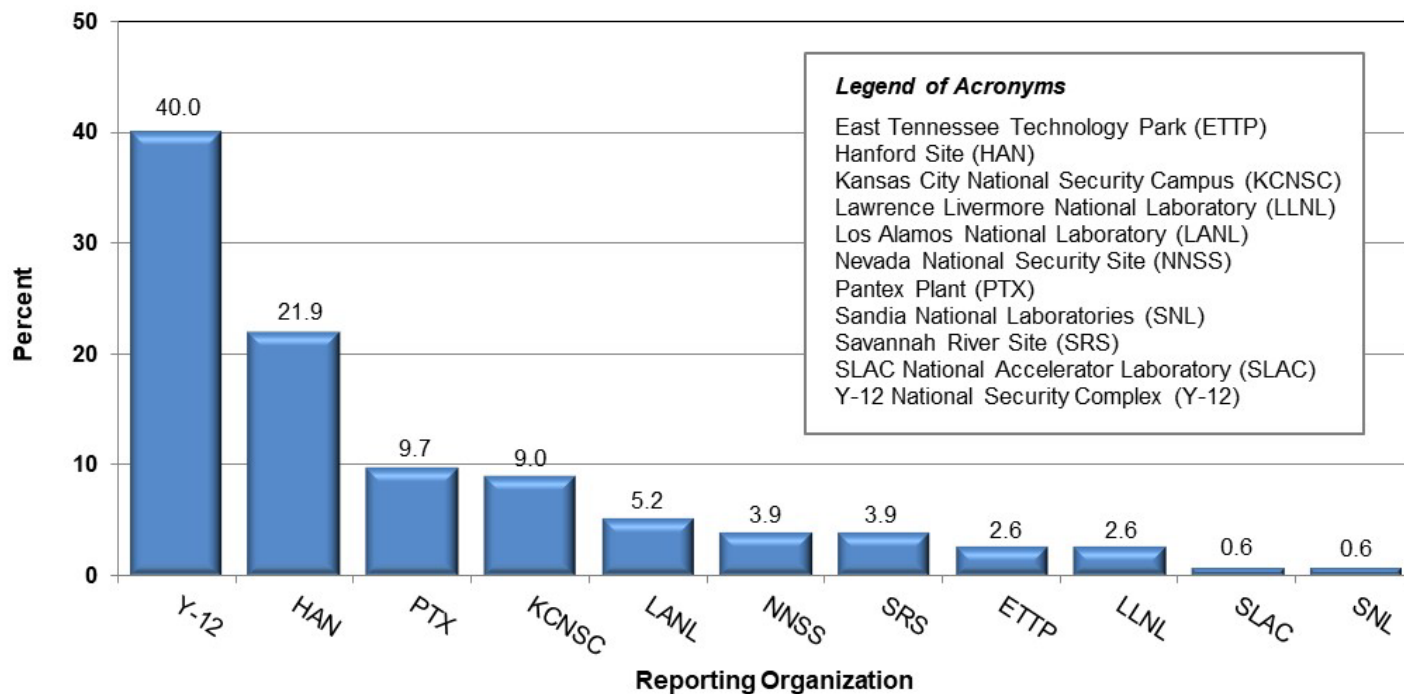
This figure depicts the numbers and percentages across the U.S. Department of Energy (DOE) complex of workers screened using the BeLPT and among those workers having abnormal results, how many are sensitized or have developed CBD. Comparison with previous years' reports show that these DOE-wide percentage distributions have remained consistent.

Percent Proportion of Workers Diagnosed as BeS by Reporting Organization (n=544) (2002–2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the Registry.

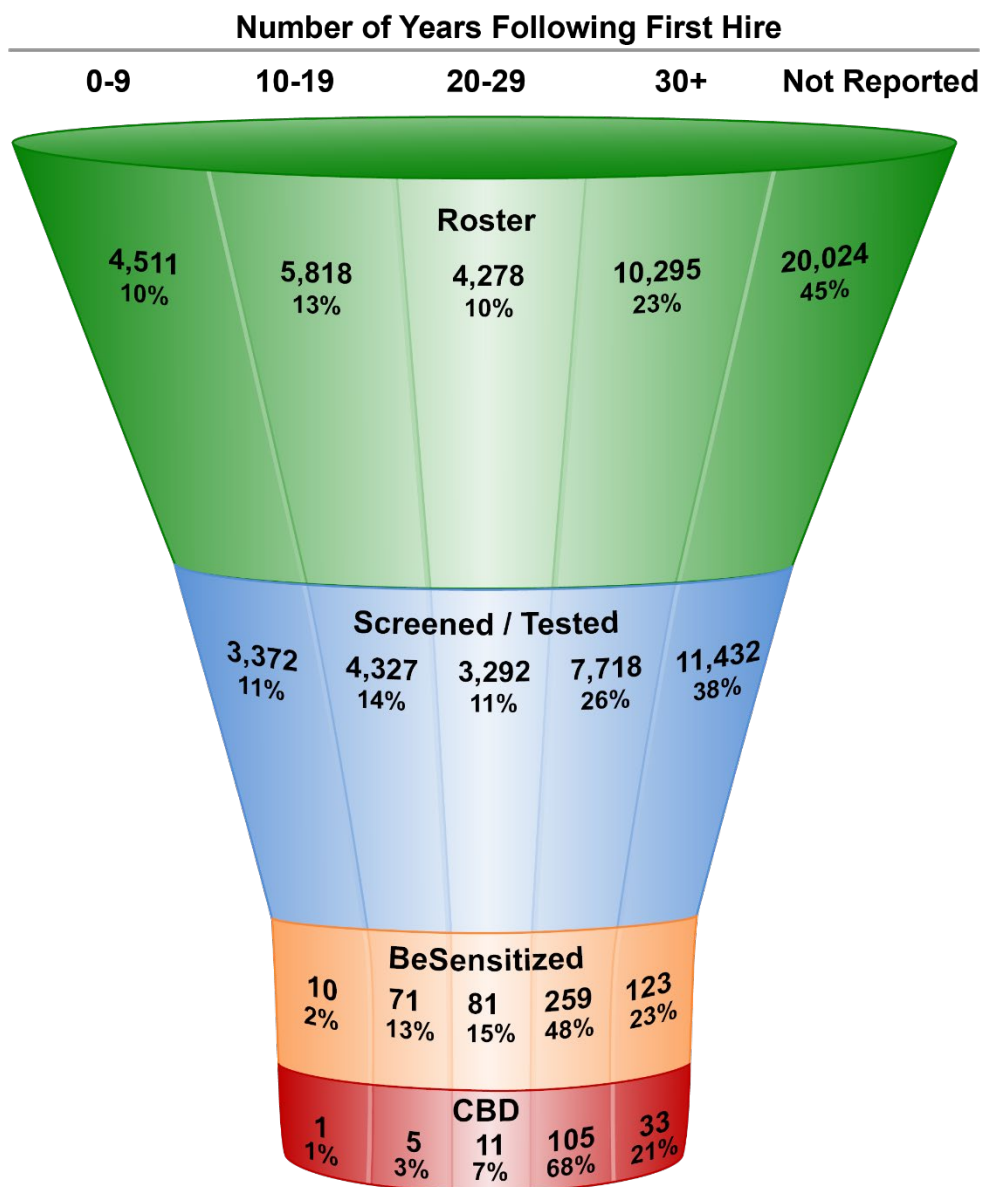
This figure presents the distribution in percent of beryllium sensitization (BeS) cases by reporting organization. Of the 20 reporting organizations, about 50% of total BeS cases are associated with the Y-12 and HAN sites.

Percent Proportion of Workers Diagnosed as CBD by Reporting Organization (n=155) (2002–2021) *

* Some reporting organizations have provided data that predate the 2002 start date of the Registry.

This figure presents the distribution in percent for the 11 reporting organizations with workers diagnosed with chronic beryllium disease (CBD). Approximately 62% of total CBD cases are associated with the Y-12 and HAN sites.

Number and Percent of Workers Categorized by Number of Years Following Hire Date, Undergoing BeLPT and Diagnosed with BeS or Diagnosed with CBD (n=44,926) (2002–2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the Registry.

This figure shows the number of beryllium-associated workers categorized by years following first hire, undergoing Beryllium Lymphocyte Proliferation Testing (BeLPT) tests. This includes roster total, those screened, and those with beryllium sensitization (BeS) or chronic beryllium disease (CBD).

Number of Workers Undergoing BeLPT and Diagnosed with BeS or Diagnosed with CBD (n=30,431) (2002–2021) *

This table provides the numbers of beryllium-associated workers with Beryllium Lymphocyte Proliferation Testing (BeLPT) test results submitted to the Beryllium-Associated Worker Registry each year, and the year of first positive or abnormal BeLPT result for those who were beryllium-sensitized (BeS) or diagnosed as having chronic beryllium disease (CBD). First positive or abnormal BeLPT result is an important medical surveillance sentinel, resulting in earlier or more frequent repeat testing, hence, earlier diagnosis, earlier work restrictions, and more successful treatment. It is also a criterion for eligibility for compensation and payment of medical expenses under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA). Two (2) abnormal BeLPT results or 1 abnormal and 2 borderline BeLPT results are required to categorize a worker as BeS. Since a worker may choose not to have repeat BeLPT measurements, may change work and have long lags between measurements, or may not test abnormal for a period of time, the year of first BeLPT provides a more reliable metric than the year a worker becomes BeS.

Year of BeLPT Result	No. Workers Tested	No. Sensitized Workers	No. Workers with CBD
<2000	708	34	11
2000	1,629	29	17
2001	3,236	43	17
2002	3,968	42	16
2003	3,968	12	6
2004	3,814	14	3
2005	5,115	28	6
2006	4,860	46	9
2007	4,578	49	5
2008	5,072	30	7
2009	6,219	52	2
2010	6,892	36	2
2011	7,920	23	0
2012	6,172	5	0
2013	5,574	8	0
2014	6,008	10	1
2015	6,049	13	0
2016	6,060	2	0
2017	6,683	11	0
2018	6,768	11	2
2019	7,044	6	0
2020	7,280	10	0
2021	7,982	2	0
Year Not Reported	0	28	51

*The number of "Workers Tested" includes all testing with results of Normal, Negative, Borderline, Positive, Abnormal, and Unsatisfactory. Workers tested periodically are included in each year they were tested. Data capture includes prior to the year 2002.

Number and Percent Proportion of Workers with Abnormal BeLPT Results BeS or CBD Results (n=30,431) (2002–2021) *

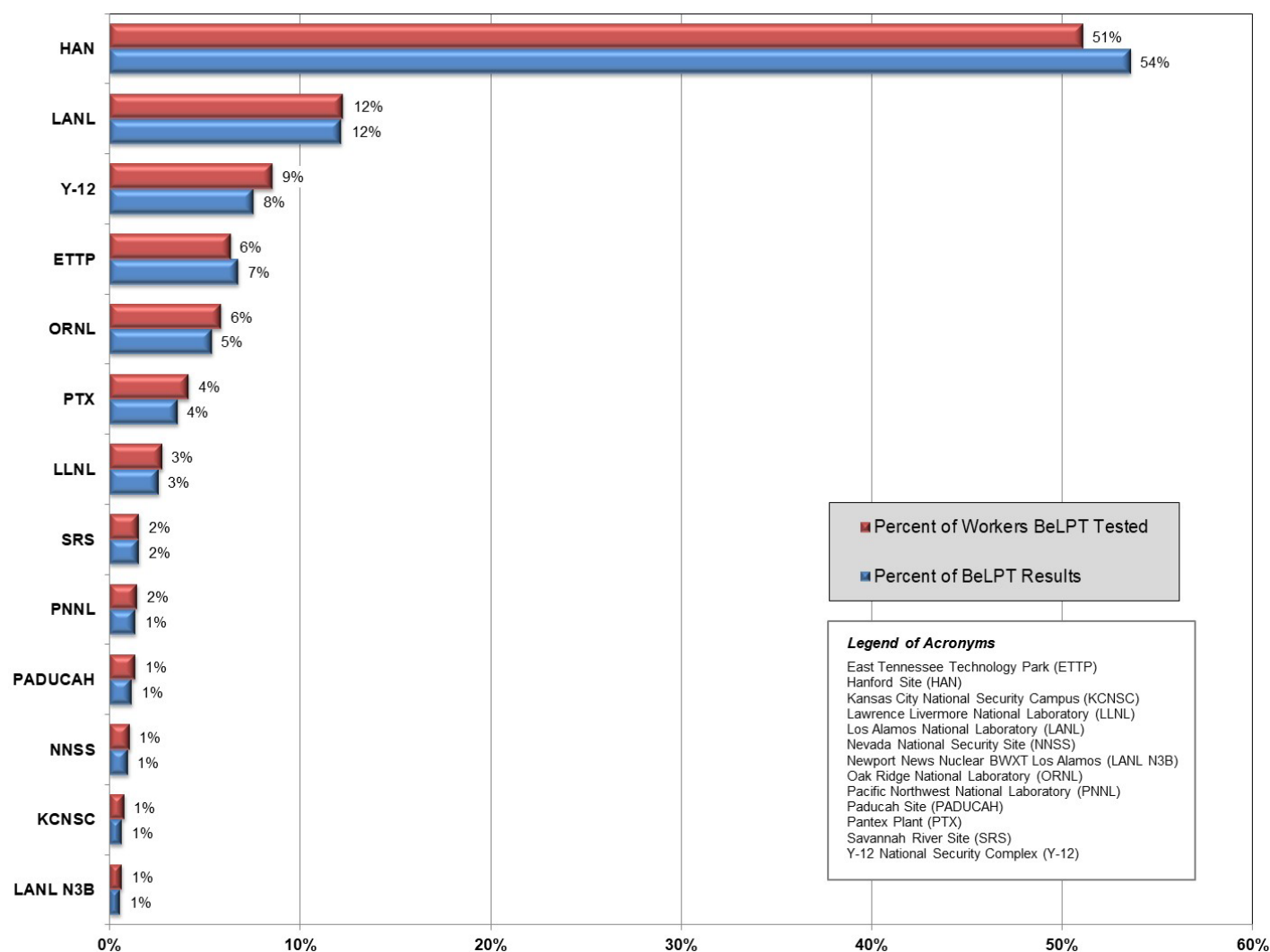
The yearly average for workers developing sensitization, whose first abnormal Beryllium Lymphocyte Proliferation Test (BeLPT) results were between Calendar Year 2001 (CY2001) and CY2010, was 35. This rate dropped to an average of 7.8 from CY2012 to CY2021. These results provide evidence that programs are serving to improve worker protection and reduce the risk of chronic beryllium disease (CBD).

This table lists beryllium-sensitized (BeS), or CBD diagnosed workers, through CY2021 grouped by their work history activity, which is a high-level rollup of job function. Based on the data submitted through CY2021 and as presented in the table, the majority of both reported BeS (37%) and CBD cases (39%) occurred among the broad occupational groups of Crafts and Line Operators.

Work History Activity	Workers with BeLPT Results (n=30,431)	No. Sensitized Workers (n=544)	Beryllium Sensitization (%)	No. Workers with CBD (n=155)	Chronic Beryllium Disease (%)
Management	1,906	46 (1.9%)	8%	10 (0.4%)	6%
Administrative Support	1,121	33 (2.6%)	6%	11 (0.9%)	7%
In-House Professionals	1,907	43 (1.9%)	8%	14 (0.6%)	9%
Field Professional	2,582	49 (1.4%)	9%	8 (0.2%)	5%
Technical Support	4,117	73 (1.5%)	13%	15 (0.3%)	10%
Service	1,676	33 (2.0%)	6%	12 (0.7%)	8%
Security and Fire	1,600	26 (1.4%)	5%	9 (0.5%)	6%
Crafts	5,382	106 (1.7%)	20%	37 (0.6%)	24%
Line Operators	3,116	90 (2.2%)	17%	23 (0.6%)	15%
Guests	88	1 (0.7%)	<1%	0 (0.0%)	0%
Unknown	749	14 (1.2%)	3%	11 (0.8%)	7%
Not Reported	6,187	30 (1.7%)	6%	5 (0.2%)	3%
Totals	30,431	544 (1.7%)	–	155 (0.5%)	–

* Some reporting organizations have provided data that predate the 2002 start date of the Registry.

Comparison of the Number and Percent Proportion of Workers Undergoing BeLPT to the Number of Workers with BeLPT Results by Reporting Organization (n=6,888) (2021)



This figure compares the percent of Beryllium Lymphocyte Proliferation Testing (BeLPT) tests conducted to the number of workers tested for each reporting organization in 2021. Workers may be BeLPT tested multiple times in a year if they have abnormal or borderline results. Therefore, the number of BeLPT tests conducted are higher than the number of workers tested.

Exposure Monitoring Results

The Beryllium-Associated Worker Registry receives beryllium work history and exposure data. The submission contains information about all activities with the potential for beryllium exposure including where the beryllium-associated worker currently works or previously worked, and the exposures associated with those activities. Reporting organization staff collect retrospective work history information through questionnaires and interviews with the worker or from records if accessible. This information includes location, organization, and job title for workers who work directly with beryllium, work in areas of potential beryllium exposure even if not working directly with beryllium, and activities with potential casual exposure to beryllium, such as working near an area where others are working directly with beryllium.

Exposure Monitoring Trends - Workers

The cumulative number of workers monitored through Calendar Year 2021 (CY2021) was 7,918 compared to 7,545 workers monitored through CY2020 as reported in the Beryllium-Associated Worker Registry 2020 Dashboard. This equates to an increase of 373 workers monitored for exposure to beryllium through CY2021.

Fifteen (15) reporting organizations provided exposure monitoring results with monitoring dates in CY2021. Organization-specific totals for a given year may change from totals in previous annual reports due to late reporting and/or corrections.

Number and Percent of Workers Monitored by Reporting Organization (unique workers n=3,911) (2012–2021) *

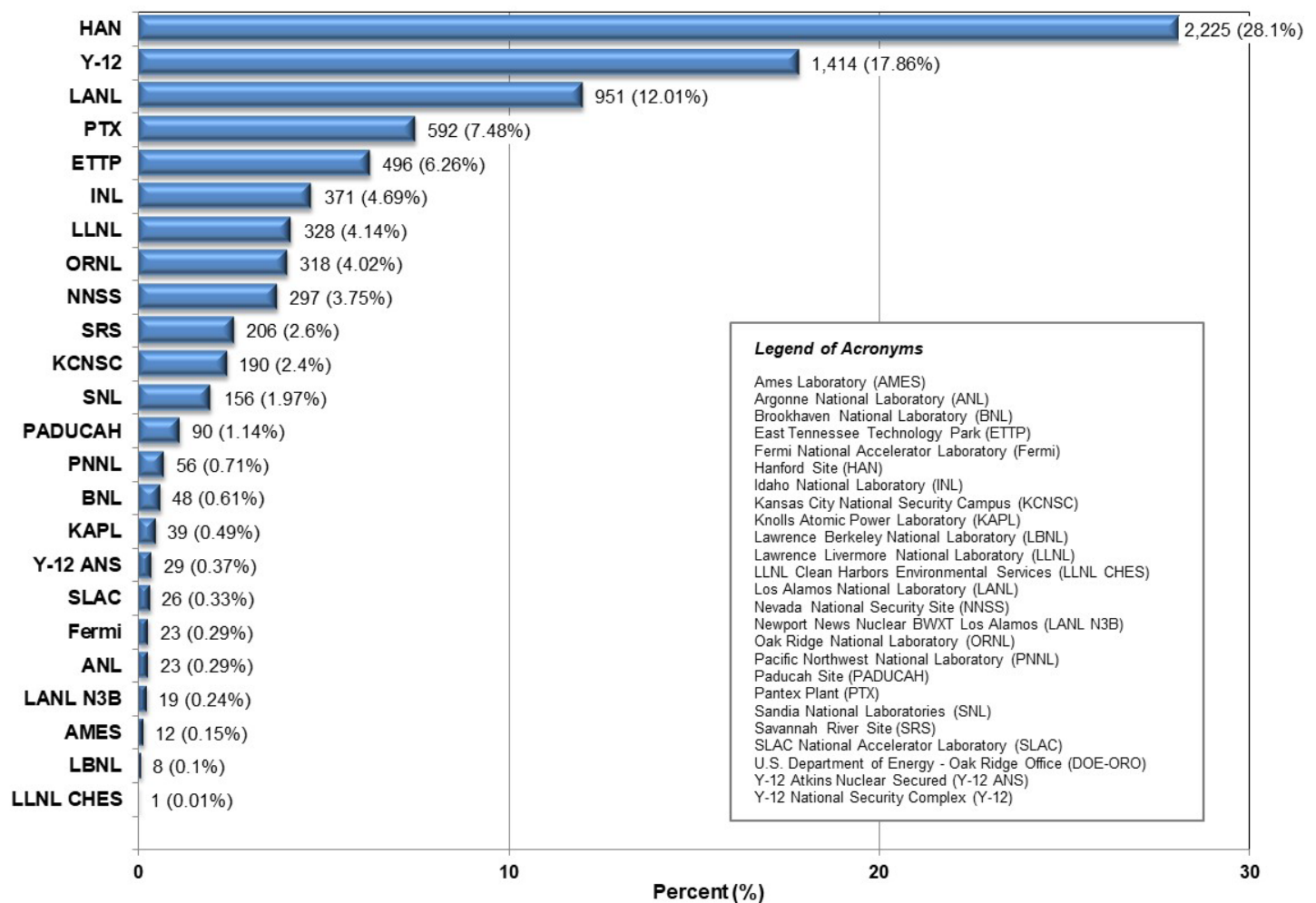
Reporting Organization	2012 n=826	2013 n=787	2014 n=833	2015 n=712	2016 n=696	2017 n=731	2018 n=682	2019 n=730	2020 n=704	2021 n=734
AMES	-	-	2 (0.2%)	-	-	-	-	5 (0.7%)	-	-
ANL	-	-	-	-	-	-	-	-	-	-
BNL	18 (2.2%)	-	2 (0.2%)	3 (0.4%)	4 (0.6%)	4 (0.5%)	1 (0.1%)	-	-	-
ETTP	3 (0.4%)	9 (1.1%)	2 (0.2%)	-	2 (0.3%)	-	-	8 (1.1%)	85 (12.1%)	151 (20.6%)
Fermi	-	-	1 (0.1%)	-	-	-	-	-	-	-
GSVCS	-	-	-	-	-	-	-	-	-	-
HAN	249 (30.1%)	287 (36.5%)	325 (39%)	290 (40.7%)	265 (38.1%)	359 (49.1%)	244 (35.8%)	301 (41.2%)	211 (30%)	202 (27.5%)
INL	5 (0.6%)	42 (5.3%)	45 (5.4%)	55 (7.7%)	45 (6.5%)	31 (4.2%)	62 (9.1%)	43 (5.9%)	36 (5.1%)	1 (0.1%)
KAPL	4 (0.5%)	3 (0.4%)	2 (0.2%)	-	-	-	-	-	2 (0.3%)	-
KCNSC	43 (5.2%)	27 (3.4%)	18 (2.2%)	9 (1.3%)	9 (1.3%)	7 (1%)	3 (0.4%)	2 (0.3%)	4 (0.6%)	2 (0.3%)
LANL	45 (5.4%)	34 (4.3%)	87 (10.4%)	32 (4.5%)	64 (9.2%)	49 (6.7%)	83 (12.2%)	97 (13.3%)	89 (12.6%)	47 (6.4%)
LANL N3B	-	-	-	-	-	-	-	10 (1.4%)	7 (1.0%)	2 (0.3%)
LBNL	-	1 (0.1%)	3 (0.4%)	-	-	-	-	-	-	-
LLNL	59 (7.1%)	34 (4.3%)	25 (3%)	32 (4.5%)	21 (3%)	19 (2.6%)	16 (2.3%)	16 (2.2%)	3 (0.4%)	6 (0.8%)
NNSS	22 (2.7%)	14 (1.8%)	17 (2%)	5 (0.7%)	5 (0.7%)	1 (0.1%)	4 (0.6%)	15 (2.1%)	-	-
ORNL	46 (5.6%)	61 (7.8%)	24 (2.9%)	20 (2.8%)	15 (2.2%)	11 (1.5%)	7 (1%)	10 (1.4%)	14 (2.0%)	28 (3.8%)
PADUCAH	5 (0.6%)	4 (0.5%)	5 (0.6%)	-	-	13 (1.8%)	15 (2.2%)	5 (0.7%)	12 (1.7%)	6 (0.8%)
PNNL	-	1 (0.1%)	19 (2.3%)	7 (1%)	10 (1.4%)	8 (1.1%)	19 (2.8%)	9 (1.2%)	-	4 (0.5%)
PTX	51 (6.2%)	23 (2.9%)	21 (2.5%)	20 (2.8%)	52 (7.5%)	27 (3.7%)	34 (5%)	27 (3.7%)	43 (6.1%)	26 (3.5%)
SNL	17 (2.1%)	3 (0.4%)	5 (0.6%)	16 (2.2%)	10 (1.4%)	8 (1.1%)	3 (0.4%)	9 (1.2%)	7 (1.0%)	6 (0.8%)
SRS	10 (1.2%)	1 (0.1%)	5 (0.6%)	2 (0.3%)	3 (0.4%)	6 (0.8%)	4 (0.6%)	3 (0.4%)	6 (0.9%)	4 (0.5%)
Y-12	245 (29.7%)	238 (30.2%)	221 (26.5%)	206 (28.9%)	181 (26%)	178 (24.4%)	174 (25.5%)	156 (21.4%)	166 (23.6%)	233 (31.7%)
Y-12 ANS	-	-	-	15 (2.1%)	10 (1.4%)	10 (1.4%)	13 (1.9%)	14 (1.9%)	19 (2.7%)	16 (2.2%)
Y-12 NRE	4 (0.5%)	5 (0.6%)	4 (0.5%)	-	-	-	-	-	-	-
Totals	826 (100%)	787 (100%)	833 (100%)	712 (100%)	696 (100%)	731 (100%)	682 (100%)	730 (100%)	704 (100%)	734 (100%)

[Click here for List of Acronyms](#)

* Some reporting organizations have provided data that predate the 2002 start date of the Registry

An industrial hygienist monitored exposure for workers by reporting organization at least once in each year for the past 10 years (i.e., between 2012 and 2021).

Number and Percent Proportion of Workers Undergoing Beryllium Exposure Monitoring by Reporting Organization (n=7,918) (2002-2021) *

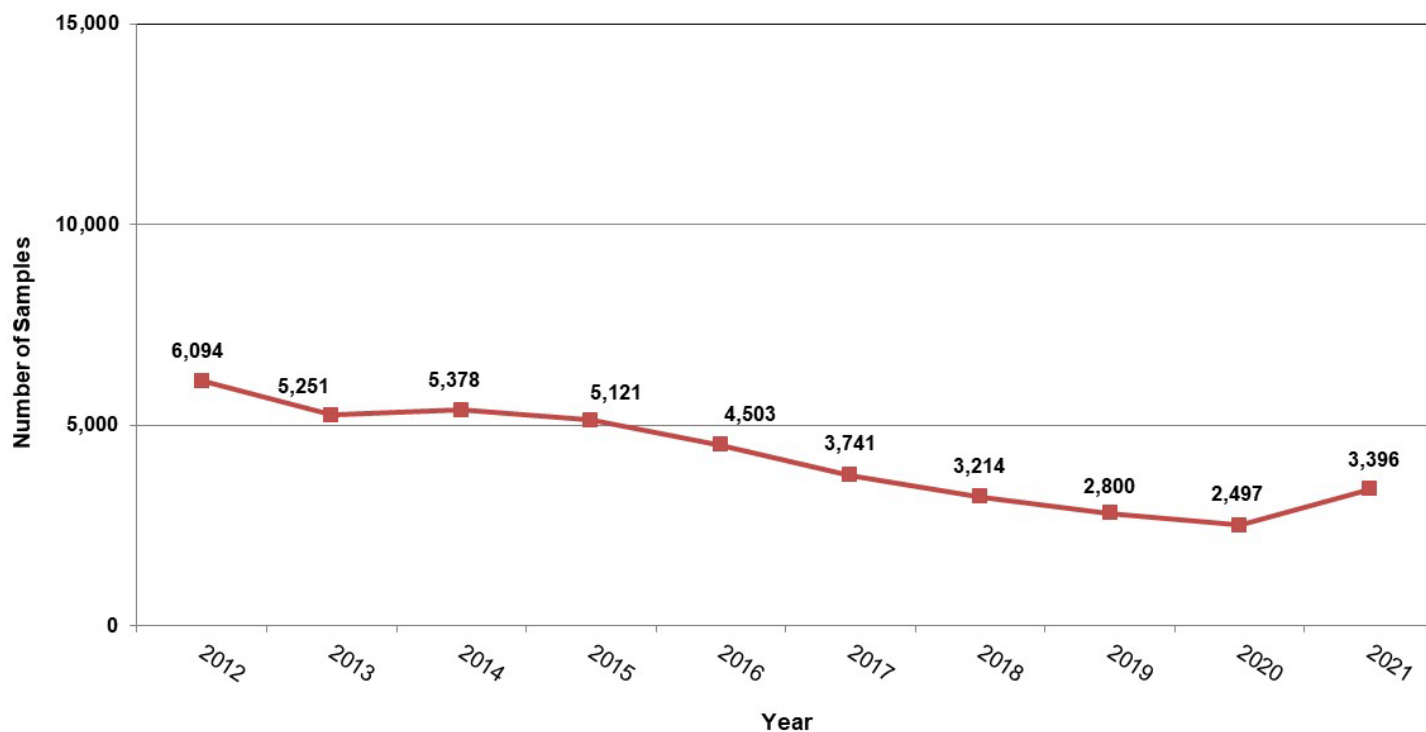


* Some reporting organizations have provided data that predate the 2002 start date of the registry.

This figure displays the cumulative 7,918 beryllium-associated workers monitored for beryllium exposure in Calendar Years 2002–2021 by reporting organization.

Exposure Monitoring Trends - Samples

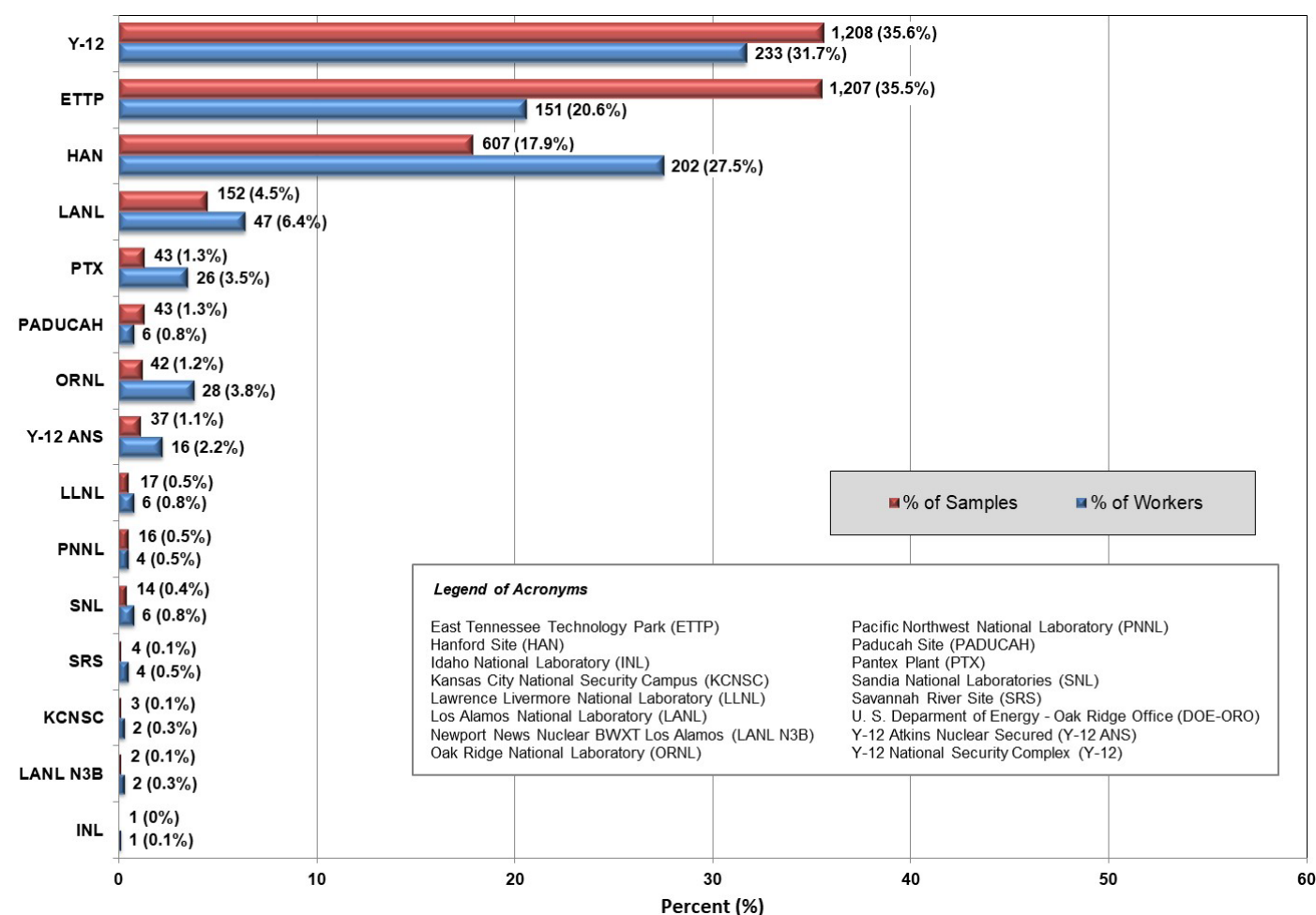
Number and Percent Proportion of Exposure Sample Results by Year (N=41,995) (2012–2021) *



The numbers of exposure sampling results in the Beryllium-Associated Worker Registry (BAWR) by year monitored for each of the past 10 years are shown in the line chart.

As can be seen, the numbers have steadily declined in recent years. The reporting organizations that collected and submitted exposure monitoring sample data show a downward trend which, in some cases, impact the analysis and interpretation of results in BAWR. The small sample size reduces accuracy and causes higher variability in the statistical models used for the BAWR analyses. In Calendar Year 2021, there was a slight increase in the number of exposure records submitted. It remains to be seen whether this is year to year variable or an upwards trend.

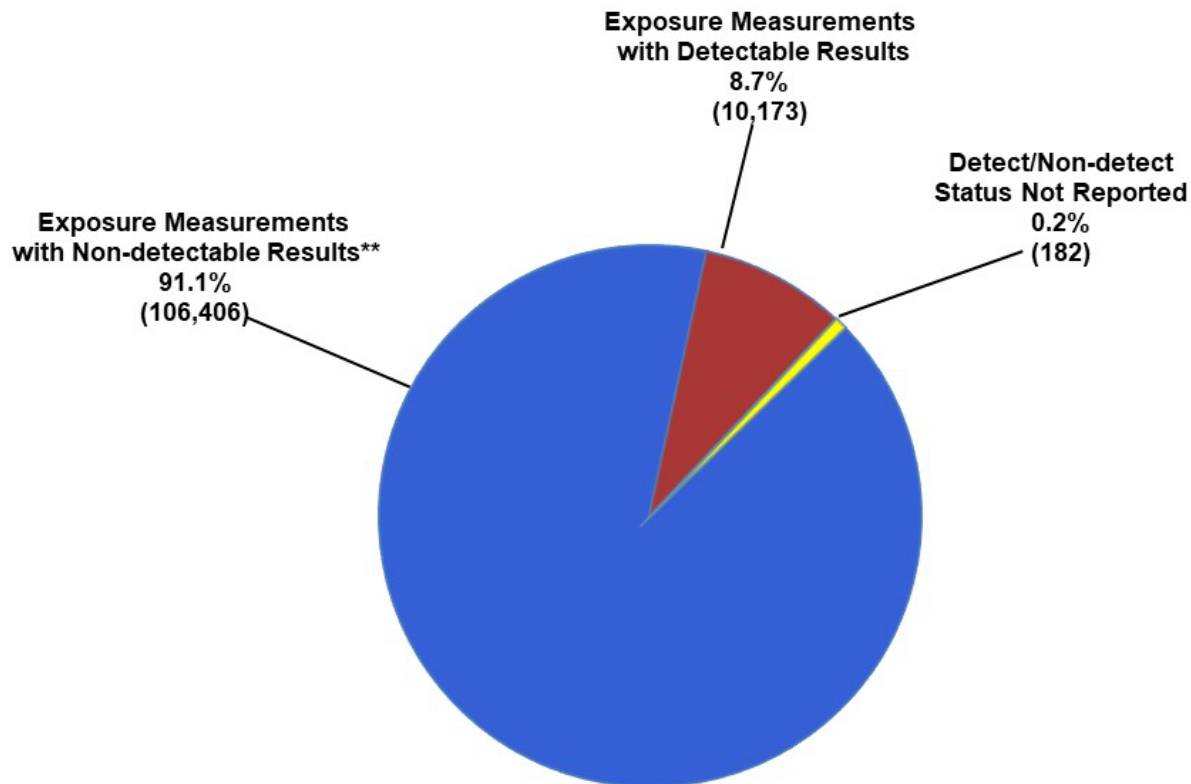
Comparison of the Number and Percent Proportion of Exposure Samples to Workers with Exposure Sampling Results by Reporting Organizations (n=3,396) (2021)



This graphic illustrates the distribution of exposure samples and workers monitored across 15 reporting organizations during 2021. Similar to the beryllium screening results, most workers monitored for beryllium exposure have multiple exposure measurements throughout the year. The frequency of monitoring is dependent on the worker's specific type of work and their employer's monitoring schemes.

Reporting organizations submitted a total of 116,761 exposure measurements to the Beryllium-Associated Worker Registry (BAWR) through Calendar Year 2021 (CY2021). This equates to an additional 3,396 exposure sampling results collected and submitted to the 113,505 total through CY2020. Of these, 211 sampling results submitted to BAWR in CY2021 were sampling data for years prior to CY2021. Broken down further, 1 record was for CY2018 and the remaining records (210) were for CY2020.

Number and Percent Proportion of Non-Detectable Results Exposure Measurements, Detectable Exposure Measurement Results and Exposure Measurement Status Not Reported (N=116,761) (2002–2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the registry.

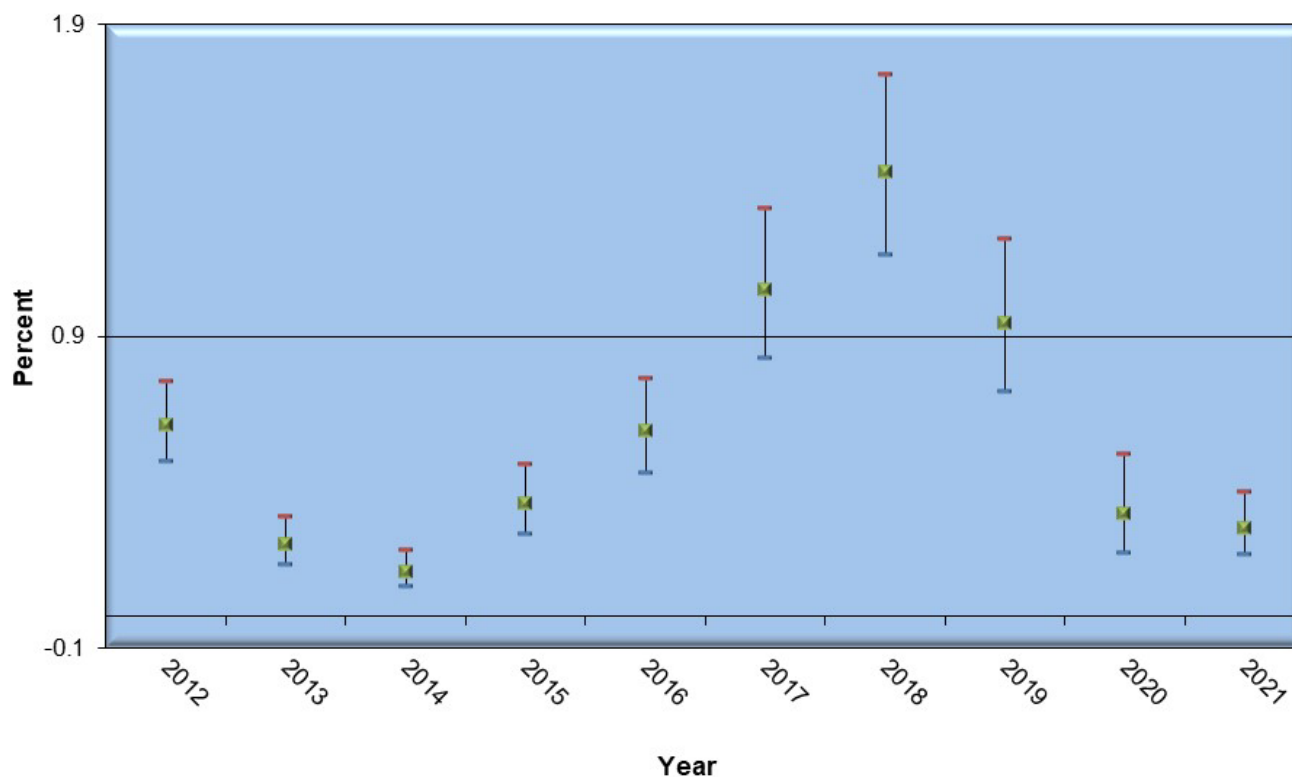
** Non-detectable indicates that analysis results were reported as less than the laboratory's reporting limit.

Of the 116,761 exposure monitoring records submitted to the Registry through Calendar Year 2021 (CY2021), 91.1% have “non-detectable” results, indicating that the sample analysis results were less than the laboratory’s reporting limit. The reporting limit can vary from sample to sample because of differing flow rates of the sampling equipment used and because of the presence of other materials on the sample that can interfere with the analysis. Reporting limits typically vary from 0.01 to 0.05 $\mu\text{g}/\text{m}^3$, which is one-twentieth to one-quarter of the action level of 0.2 $\mu\text{g}/\text{m}^3$.

In comparison, 113,505 cumulative exposure monitoring results were submitted through CY2020, for an increase through CY2021 of 3,256 records (including those monitoring dates in CY2020 and earlier). This 3,256 increase in sampling results is higher than the 2,600 increase in records between CY2019 and CY2020 and higher than the 3,048 increase in records submitted between CY2018 and CY2019.

Trends in Exposure Levels

Percent of 8-hour time weighted average (TWA) Exceeding Action Level $0.2 \mu\text{g}/\text{m}^3$ by Year (2012–2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ based on 95% Confidence Limits.

This figure shows the percent of DOE-wide 8-hour time weighted average (TWA) personal exposure monitoring results that exceeded the action level of $0.2 \mu\text{g}/\text{m}^3$ in each of the 10 years from Calendar Year 2012 (CY2012) to CY2021.

Infographic Details

2012

Upper confidence limit for F: 0.8
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.6
Lower confidence limit for F: 0.5

2013

Upper confidence limit for F: 0.3
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.2
Lower confidence limit for F: 0.2

2014

Upper confidence limit for F: 0.2
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.1
Lower confidence limit for F: 0.1

2015

Upper confidence limit for F: 0.5
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.4
Lower confidence limit for F: 0.3

2016

Upper confidence limit for F: 0.8
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.6
Lower confidence limit for F: 0.5

2017

Upper confidence limit for F: 1.3
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 1.0
Lower confidence limit for F: 0.8

2018

Upper confidence limit for F: 1.7
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 1.4
Lower confidence limit for F: 1.2

2019

Upper confidence limit for F: 1.2
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.9
Lower confidence limit for F: 0.7

2020

Upper confidence limit for F: 0.4
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.3
Lower confidence limit for F: 0.2

2021

Upper confidence limit for F: 0.4
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.3
Lower confidence limit for F: 0.2

Summary Statistics for 2012–2021 8-Hour Time Weighted Average Exposure Monitoring Results *

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	10-year Summary
Number of reported monitoring results	6,042 (13.9%)	5,220 (12%)	5,336 (12.3%)	5,065 (11.6%)	4,461 (10.3%)	3,405 (7.8%)	3,159 (7.3%)	2,789 (6.4%)	2,495 (5.9%)	4,534 (10.7%)	42,506 (100%)
Number of detected values	302 (16.5%)	215 (11.8%)	175 (9.6%)	154 (8.4%)	241 (13.2%)	175 (9.6%)	240 (13.1%)	168 (9.2%)	69 (3.8%)	69 (3.8%)	1,808 (100%)
Percent non-detects	95	95.9	96.7	97	94.6	94.9	92.4	94	97.2	98.5	95.7
Number of individuals monitored	822 (19.8%)	782 (18.8%)	823 (19.8%)	711 (17.1%)	694 (16.7%)	730 (17.6%)	683 (16.4%)	801 (19.3%)	691 (17.6%)	844 (21.5%)	3,929 (100%)
Arithmetic mean (EX) (µg/m³)	0.032	0.004	0.002	0.014	0.016	0.842	0.369	0.166	0.022	0.389	0.029
Lower confidence limit of EX (µg/m³)	0.015	0.003	0.002	0.005	0.008	0.128	0.101	0.039	0.003	0.010	0.021
Upper confidence limit of EX (µg/m³)	0.068	0.006	0.003	0.039	0.031	5.521	1.353	0.712	0.154	14.428	0.040
Observed 95th percentile of data (µg/m³)	0.007	0.005	0.004	0.004	0.005	0.006	0.020	0.011	0.001	<0.1	0.005
95% upper tolerance limit of the 95th percentile (µg/m³)	0.017	0.015	0.017	0.017	0.020	0.020	0.030	0.026	0.011	0.011	0.017
Largest value (µg/m³)	4.013	0.804	0.876	1.847	8.865	87.419	16.712	23.084	17.340	6.609	87.419
Percent exceeding 0.2 µg/m³ (F)	0.6	0.2	0.1	0.4	0.6	1.0	1.4	0.9	0.3	0.3	0.5
Lower confidence limit for F	0.5	0.2	0.1	0.3	0.5	0.8	1.2	0.7	0.2	0.2	0.5
Upper confidence limit for F	0.8	0.3	0.2	0.5	0.8	1.3	1.7	1.2	0.5	0.4	0.6

* Many individuals were monitored in more than 1 year. The total number of individuals measured at least once in the 10-year period from CY2012 through CY2021 is 3,911. Some reporting organizations have provided data that predate the CY2002 start date of the registry. Percent exceeding 0.2 µg/m³ based on 95% Confidence Limits.

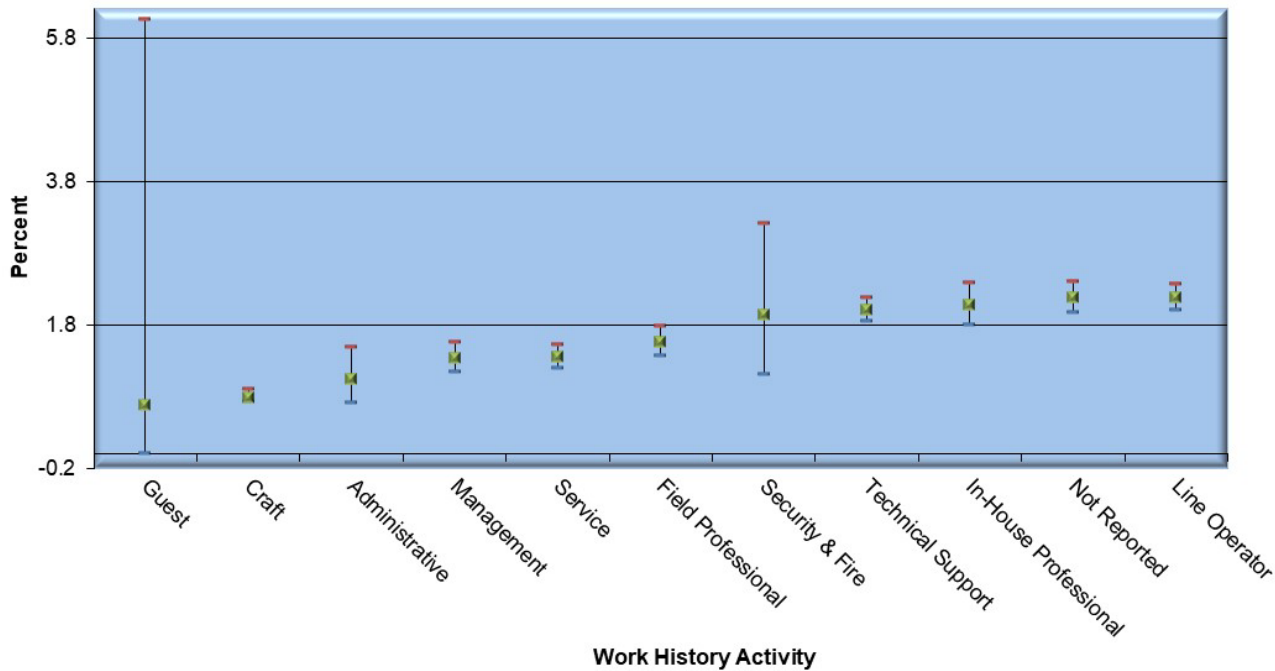
The detailed data presented in the table above provide additional summary statistics for the DOE-wide 8-hour TWA results for each of the past 10 years. The very high percentage of non-detected results from workplaces compliant with the $0.2 \mu\text{g}/\text{m}^3$ action level points to the need to develop more sensitive exposure monitoring methods to support estimates of individuals' actual exposure levels.

These statistical methods accommodate the high percentage of non-detect results (left censored) in these data sets. These analyses exclude non-detected values greater than $0.2 \mu\text{g}/\text{m}^3$. For details, see “*Statistical Methods and Software for the Analysis of Occupational Exposure Data with Non-Detectable Values* [<https://info.ornl.gov/sites/publications/Files/Pub57493.pdf>]” Frome EL and Wambach PF, ORNL/TM-2005/52.

Totals for an individual year may vary from previous reports due to late reporting and/or corrections. The data reported in the Beryllium-Associated Worker Registry indicate that the chronic beryllium disease prevention programs operated at DOE sites have continued to maintain a high level of compliance with the 10 CFR 850 action level of $0.2 \mu\text{g}/\text{m}^3$ over the past 10 years.

Exceedances Observed through 2021

Percent of 8-hour time weighted average (TWA) Exceeding Action Level $0.2 \mu\text{g}/\text{m}^3$ by Work History Activity (2002–2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ based on 95% Confidence Limits.

The graphic shows the percent of 8-hour time weighted average (TWA) exposure monitoring results that exceed the action level, grouped by work activity for the cumulative data through 2021. The detailed data in the table provide additional summary statistics for the composite 8-hour TWA results by work activity.

For the cumulative data, the highest percentage of action level exceedances by work history activity is among workers where the work activity is unknown or not reported.

Infographic Details

Guest

Upper confidence limit for F: 6.1
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.1
Lower confidence limit for F: <0.1

Service

Upper confidence limit for F: 1.5
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 1.3
Lower confidence limit for F: 1.2

In-house Professional

Upper confidence limit for F: 2.4
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 2.1
Lower confidence limit for F: 1.8

Craft

Upper confidence limit for F: 0.8
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 0.8
Lower confidence limit for F: 0.7

Field Professional

Upper confidence limit for F: 1.8
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 1.6
Lower confidence limit for F: 1.4

Not Reported

Upper confidence limit for F: 2.4
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 2.1
Lower confidence limit for F: 1.8

Administrative

Upper confidence limit for F: 1.5
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 1.0
Lower confidence limit for F: 0.7

Security & Fire

Upper confidence limit for F: 3.2
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 1.9
Lower confidence limit for F: 1.1

Line Operator

Upper confidence limit for F: 2.4
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 2.2
Lower confidence limit for F: 2.0

Management

Upper confidence limit for F: 1.6
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 1.3
Lower confidence limit for F: 1.1

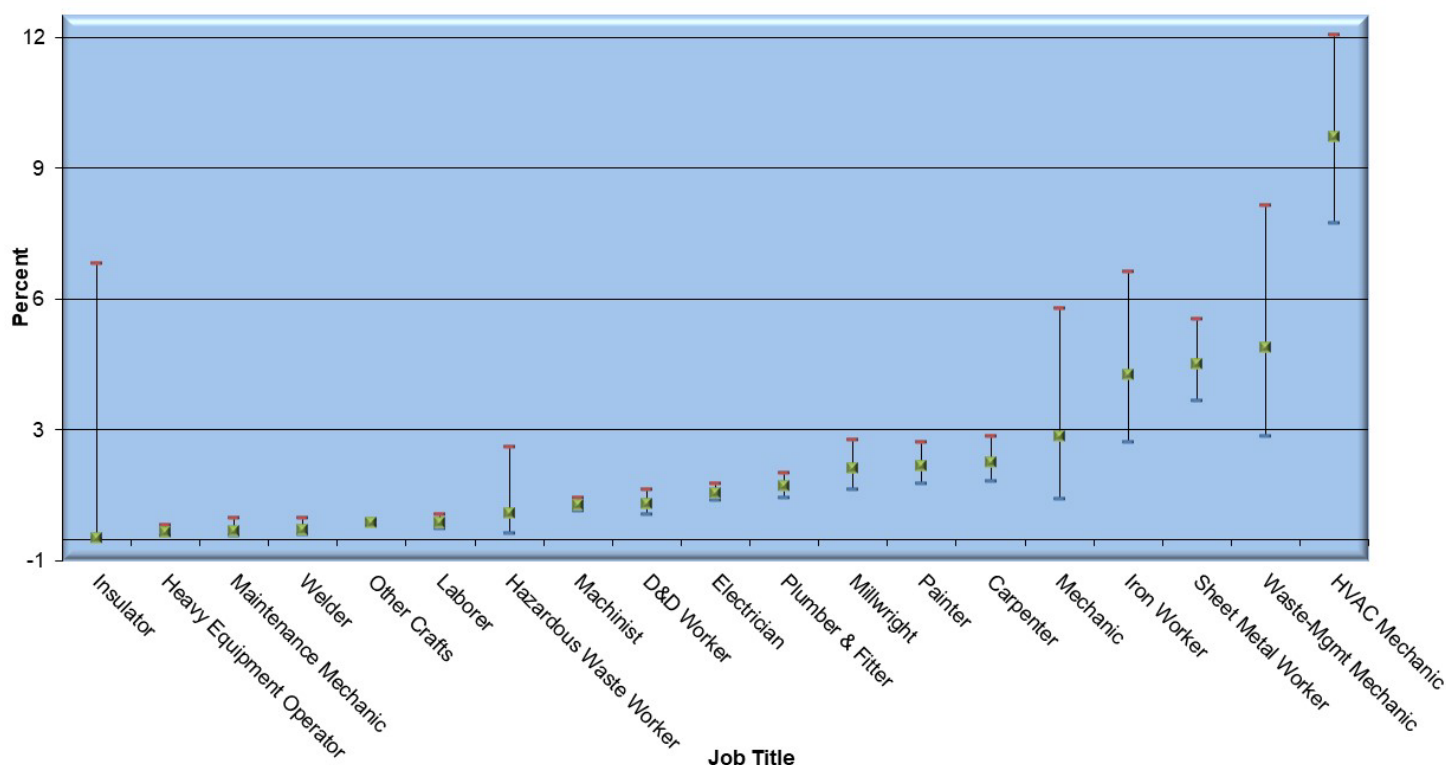
Technical Support

Upper confidence limit for F: 2.2
Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ (F): 2.0
Lower confidence limit for F: 1.8

Summary Statistics for 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m³ by Work History Activity (2002–2021) *												
Work History Activity	Admin	Craft	Field Prof	Guest	In-House Prof	Line Operator	Management	Security & Fire	Service	Tech Support	Not Reported	Total
No. reported monitoring results	1,398 (1.2%)	52,361 (46.1%)	6,255 (5.5%)	34 (0%)	4,586 (4%)	12,008 (10.6%)	5,396 (4.7%)	391 (0.3%)	9,830 (8.7%)	13,440 (11.8%)	7,941 (7%)	113,633 (100%)
No. detected values	56 (0.6%)	2,583 (27.2%)	586 (6.2%)	8 (0.1%)	511 (5.4%)	1,155 (12.2%)	514 (5.4%)	18 (0.2%)	634 (6.7%)	1,641 (17.3%)	1,786 (18.8%)	9,491 (100%)
% non-detects	96	95.1	90.6	76.5	88.9	90.4	90.5	95.4	93.6	87.8	77.5	91.6
No. individuals monitored	112 (1.4%)	2,663 (33.8%)	787 (10%)	7 (0.1%)	371 (4.7%)	1,356 (17.2%)	325 (4.1%)	94 (1.2%)	886 (11.2%)	1,420 (18%)	771 (9.8%)	7,885 (100%)
Observed 95th percentile of data (µg/m³)	0.000	0.008	0.030	0.019	0.048	0.051	0.025	0.004	0.014	0.052	0.086	0.022
95% UTL of 95th percentile (µg/m³)	0.050	0.050	0.056	NA	0.057	0.096	0.050	0.057	0.050	0.080	0.107	0.050
Largest value (µg/m³)	28.475	51.895	26.678	0.313	16.697	575.930	87.419	11.700	84.933	29.852	7.670	575.930
% > 0.2 µg/m³ (F)	1.0	0.8	1.6	0.7	2.1	2.2	1.3	1.9	1.3	2.0	2.2	1.4
Lower confidence limit for F	0.7	0.7	1.4	<0.1	1.8	2.0	1.1	1.1	1.2	1.8	2.0	1.4
Upper confidence limit for F	1.5	0.8	1.8	6.1	2.4	2.4	1.6	3.2	1.5	2.2	2.4	1.4

* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding 0.2 µg/m³ based on 95% Confidence Limits.

Percent of 8-hour time weighted average (TWA) Exceeding Action Level $0.2 \mu\text{g}/\text{m}^3$ by Job Title for Craft Workers (2002–2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ based on 95% Confidence Limits.

This graphic shows individuals with job titles in the craft work activity category. The detailed data through 2021 presented in the accompanying table include the summary statistics for cumulative 8-hour TWA monitoring results by craft job title. Deactivation & Decommissioning (D&D) worker, electrician, plumber & fitter, millwright, painter, carpenter, mechanic, iron worker, sheet metal worker, waste-management mechanic, and Heating, Ventilation, and Air Conditioning (HVAC) mechanic individually have percent exceedances that are higher than when all crafts are combined (0.8% to 9.2% as compared to 0.8%, as shown in the table below).

Among craft workers, HVAC mechanics, waste-management mechanics, and sheet metal workers show percentages exceeding the $0.2 \mu\text{g}/\text{m}^3$ action level that are higher than the percentages experienced by other craft workers. However, the percentage for HVAC mechanics reflects exposure monitoring results for only 32 individuals, and for sheet metal workers only 130 individuals.

Infographic Details

Insulator

Upper confidence limit for F: 6.3
 Percent exceeding 0.2 µg/m³ (F): <0.1
 Lower confidence limit for F: <0.1

Heavy Equipment Operator

Upper confidence limit for F: 0.3
 Percent exceeding 0.2 µg/m³ (F): 0.2
 Lower confidence limit for F: 0.1

Maintenance Mechanic

Upper confidence limit for F: 0.5
 Percent exceeding 0.2 µg/m³ (F): 0.2
 Lower confidence limit for F: 0.1

Welder

Upper confidence limit for F: 0.5
 Percent exceeding 0.2 µg/m³ (F): 0.2
 Lower confidence limit for F: 0.1

Other Crafts

Upper confidence limit for F: 0.4
 Percent exceeding 0.2 µg/m³ (F): 0.4
 Lower confidence limit for F: 0.3

Laborer

Upper confidence limit for F: 0.6
 Percent exceeding 0.2 µg/m³ (F): 0.4
 Lower confidence limit for F: 0.2

Hazardous Waste Worker

Upper confidence limit for F: 2.1
 Percent exceeding 0.2 µg/m³ (F): 0.6
 Lower confidence limit for F: 0.1

Machinist

Upper confidence limit for F: 0.9
 Percent exceeding 0.2 µg/m³ (F): 0.8
 Lower confidence limit for F: 0.6

D&D Worker

Upper confidence limit for F: 1.1
 Percent exceeding 0.2 µg/m³ (F): 0.8
 Lower confidence limit for F: 0.6

Electrician

Upper confidence limit for F: 1.3
 Percent exceeding 0.2 µg/m³ (F): 1.1
 Lower confidence limit for F: 0.9

Plumber & Fitter

Upper confidence limit for F: 1.5
 Percent exceeding 0.2 µg/m³ (F): 1.2
 Lower confidence limit for F: 0.9

Millwright

Upper confidence limit for F: 2.3
 Percent exceeding 0.2 µg/m³ (F): 1.6
 Lower confidence limit for F: 1.1

Painter

Upper confidence limit for F: 2.2
 Percent exceeding 0.2 µg/m³ (F): 1.7
 Lower confidence limit for F: 1.3

Carpenter

Upper confidence limit for F: 2.3
 Percent exceeding 0.2 µg/m³ (F): 1.8
 Lower confidence limit for F: 1.3

Mechanic

Upper confidence limit for F: 5.3
 Percent exceeding 0.2 µg/m³ (F): 2.3
 Lower confidence limit for F: 0.9

Iron Worker

Upper confidence limit for F: 6.1
 Percent exceeding 0.2 µg/m³ (F): 3.8
 Lower confidence limit for F: 2.2

Sheet Metal Worker

Upper confidence limit for F: 5.0
 Percent exceeding 0.2 µg/m³ (F): 4.0
 Lower confidence limit for F: 3.2

Waste-Management Mechanic

Upper confidence limit for F: 7.6
 Percent exceeding 0.2 µg/m³ (F): 4.4
 Lower confidence limit for F: 2.3

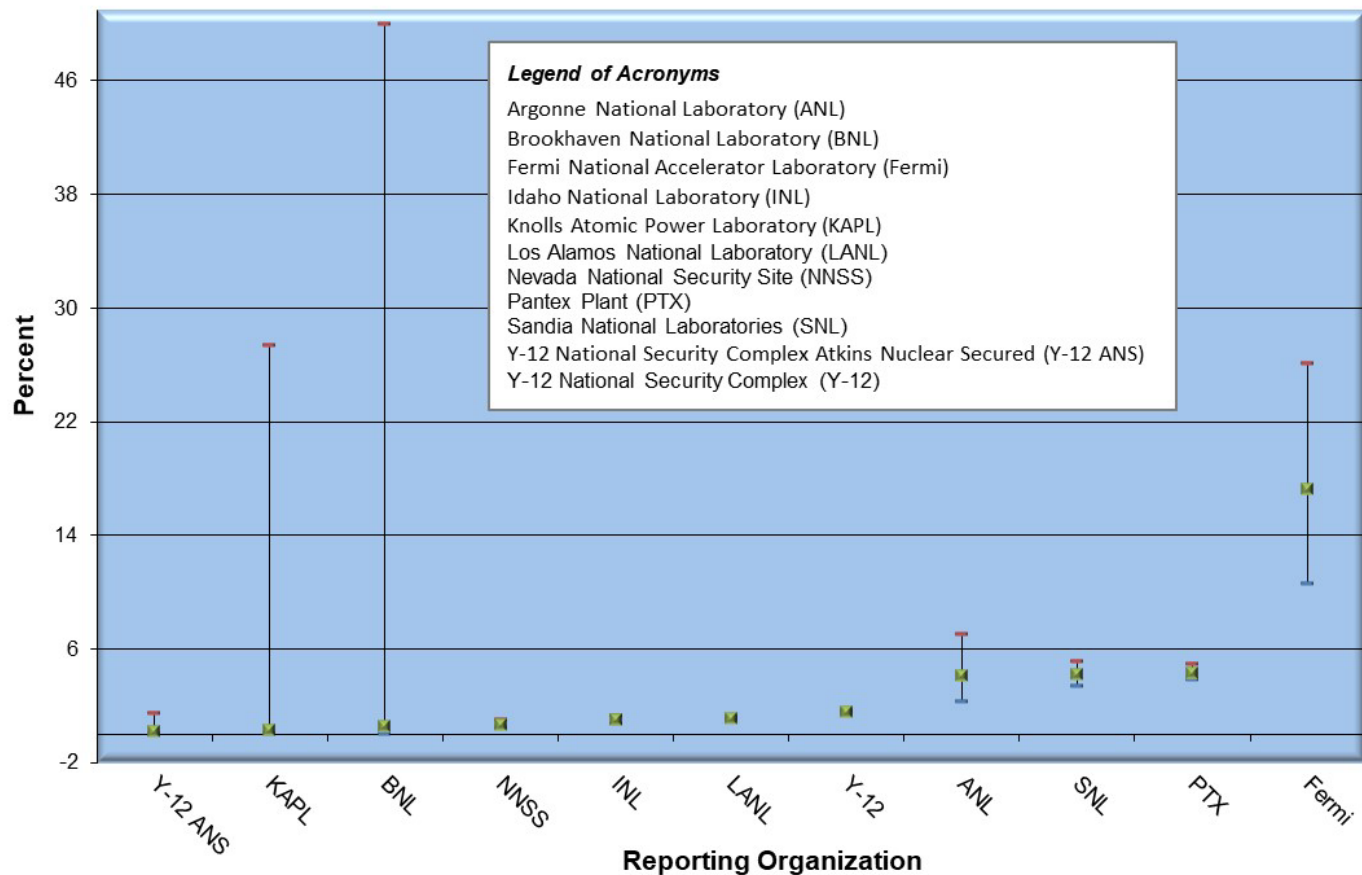
HVAC Mechanic

Upper confidence limit for F: 11.5
 Percent exceeding 0.2 µg/m³ (F): 9.2
 Lower confidence limit for F: 7.2

Summary Statistics for 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m³ by Job Title (2002–2021) *										
Craft Job Title	Number of reported monitoring results	Number of detected values	Percent non-detects	Number of individuals monitored	Observed 95th% of data (µg/m³)	95% UTL of 95th% (µg/m³)	Largest value (µg/m³)	Percent exceeding 0.2 µg/m³ (F)	Lower confidence limit for F	Upper confidence limit for F
Insulator	151 (0%)	3 (0%)	98	31 (1%)	<0.1	0.20	0.20	<0.1	<0.1	6.3
Heavy Equipment Operator	1443 (3%)	63 (2%)	95.6	156 (6%)	<0.1	0.02	10.44	0.2	0.1	0.3
Maintenance Mechanic	740 (1%)	17 (1%)	97.7	117 (4%)	<0.1	0.03	0.20	0.2	0.1	0.5
Welder	1,142 (2%)	32 (1%)	97.2	54 (2%)	<0.1	0.02	0.36	0.2	0.1	0.5
Other Crafts	24,734 (47%)	718 (28%)	97.1	457 (17%)	<0.1	0.02	37.30	0.4	0.3	0.4
Laborer	2,756 (5%)	75 (3%)	97.3	367 (14%)	<0.1	0.05	10.34	0.4	0.2	0.6
Hazardous Waste Worker	259 (0%)	6 (0%)	97.7	26 (1%)	<0.1	0.17	0.19	0.6	0.1	2.1
Machinist	6,751 (13%)	307 (12%)	95.5	127 (5%)	<0.1	0.05	51.89	0.8	0.6	0.9
Deactivation & Decommissioning (D&D) Worker	1,513 (3%)	151 (6%)	90	165 (6%)	0.03	0.04	2.47	0.8	0.6	1.1
Electrician	4,802 (9%)	363 (14%)	92.4	448 (17%)	0.02	0.05	14.42	1.1	0.9	1.3
Plumber & Fitter	2,839 (5%)	170 (7%)	94	286 (11%)	<0.1	0.05	5.73	1.2	0.9	1.5
Millwright	956 (2%)	53 (2%)	94.5	145 (5%)	<0.1	0.05	23.08	1.6	1.1	2.3
Painter	1,360 (3%)	185 (7%)	86.4	66 (2%)	0.05	0.07	7.42	1.7	1.3	2.2
Carpenter	1,261 (2%)	116 (4%)	90.8	144 (5%)	0.04	0.05	3.18	1.76	1.31	2.3
Mechanic	121 (0%)	13 (1%)	89.3	44 (2%)	0.02	0.09	0.14	2.3	0.9	5.3
Iron Worker	205 (0%)	29 (1%)	85.9	51 (2%)	0.17	0.41	1.85	3.8	2.2	6.1
Sheet Metal Worker	850 (2%)	125 (5%)	85.3	130 (5%)	0.21	0.33	8.87	4.0	3.2	5.0
Waste-Management Mechanic	134 (0%)	18 (1%)	86.6	14 (1%)	0.15	1.29	2.39	4.4	2.3	7.6
Heating, Ventilation, and Air Conditioning (HVAC) Mechanic	344 (1%)	139 (5%)	59.6	32 (1%)	0.41	0.88	6.40	9.2	7.2	11.5
All Combined	52,361 (100%)	2,583 (100%)	95.1	2,663 (100%)	<0.1	0.05	51.89	0.8	0.7	0.8

*Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding 0.2 µg/m³ based on 95% Confidence Limits.

Percent of 8-hour time weighted average (TWA) Exceeding Action Level $0.2 \mu\text{g}/\text{m}^3$ by Reporting Organization (2002–2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ based on 95% Confidence Limits.

This chart summarizes the cumulative 8-hour TWA exposure monitoring results through Calendar Year 2021 by reporting organization. The detailed data presented below include the summary statistics for the cumulative 8-hour TWA monitoring results for each reporting organization that reported workers with a percentage exceeding the action level. The percent of monitoring results exceeding the action level at Y-12, ANL, SNL, PTX, and Fermi (ranging from 1.6 to 17.2%) were higher than the overall percent exceedances when data across all organizations are combined (1.4%).

The graphic does not include results from AMES, ETP, HAN, KCNSC, LANL N3B, LBNL, LLNL CHES, ORNL, PADUCAH, PNNL, SLAC, and SRS because of the small number of total samples and/or low percent exceeding the action level. Collectively, these data indicate that the majority of reporting organizations have acceptable sampling programs. However, the data also show that some organizations with ongoing beryllium activities, but small numbers of exposure monitoring samples could revisit their sampling strategies and consider increasing the volume of sampling.

Infographic Details

Y-12 ANS

Upper confidence limit for F: 1.5
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 0.2
Lower confidence limit for F: < 0.1

KAPL

Upper confidence limit for F: 27.4
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 0.3
Lower confidence limit for F: < 0.1

BNL

Upper confidence limit for F: 50.0
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 0.5
Lower confidence limit for F: < 0.1

NNSS

Upper confidence limit for F: 1.0
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 0.7
Lower confidence limit for F: 0.4

INL

Upper confidence limit for F: 1.2
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 0.9
Lower confidence limit for F: 0.7

LANL

Upper confidence limit for F: 1.2
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 1.1
Lower confidence limit for F: 1.0

Y-12

Upper confidence limit for F: 1.6
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 1.6
Lower confidence limit for F: 1.5

ANL

Upper confidence limit for F: 7.0
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 4.1
Lower confidence limit for F: 2.3

SNL

Upper confidence limit for F: 5.0
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 4.1
Lower confidence limit for F: 3.4

PTX

Upper confidence limit for F: 4.9
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 4.3
Lower confidence limit for F: 3.8

Fermi

Upper confidence limit for F: 26.1
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): 17.2
Lower confidence limit for F: 10.6

Not Shown in Graph

AMES

Upper confidence limit for F: 91.1
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

DOE-ORO

Upper confidence limit for F: 95.0
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

ETTP

Upper confidence limit for F: 0.2
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

HAN

Upper confidence limit for F: 0.5
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

KCNSC

Upper confidence limit for F: 25.9
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

LANL N3B

Upper confidence limit for F: 77.6
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

LBNL

Upper confidence limit for F: 15.3
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

LLNL

Upper confidence limit for F: 18.1
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

LLNL CHES

Upper confidence limit for F: 63.2
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

ORNL

Upper confidence limit for F: 0.1
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

Paducah

Upper confidence limit for F: 6.7
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

PNNL

Upper confidence limit for F: 18.1
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

SLAC

Upper confidence limit for F: 6.9
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

SRS

Upper confidence limit for F: 52.7
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F): < 0.1
Lower confidence limit for F: < 0.1

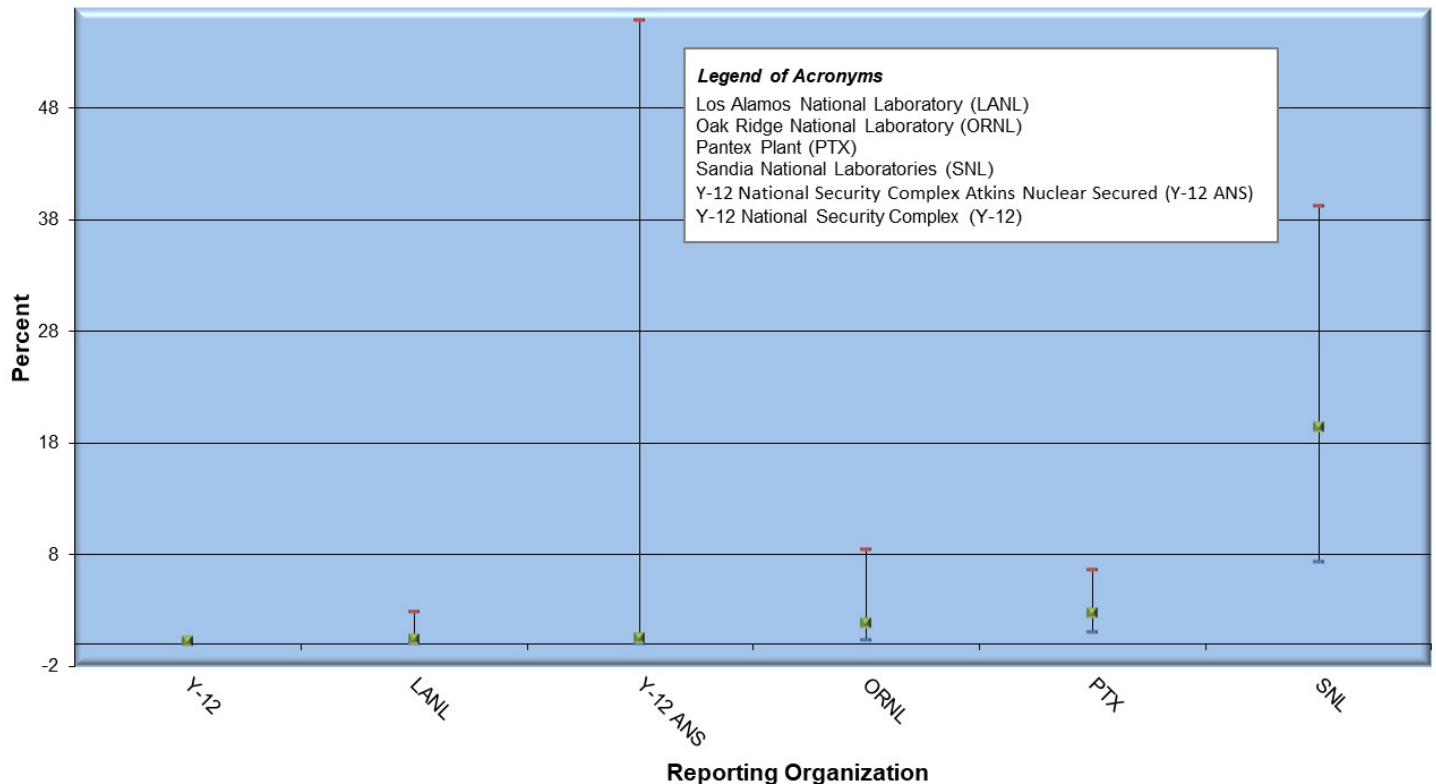
Summary Statistics for 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m³ by Reporting Organization (2002–2021) *

Reporting Organization	No. monitoring results	No. detected values	% non-detects	No. individ. monitored	Obs. 95 th percentile (µg/m ³)	95% UTL/ 95 th % (µg/m ³)	Largest value (µg/m ³)	% > 0.2 µg/m ³ (F)	Lower confidence limit for F	Upper confidence limit for F
AMES	57 (0.1%)	3 (0.0%)	94.7	12 (1.4%)	0.000	<0.1	0.028	<0.1	<0.1	91.1
ANL	155 (0.1%)	18 (0.2%)	88.4	19 (2.3%)	0.145	1.100	2.390	4.1	2.3	7.0
BNL	105 (0.1%)	2 (0.0%)	98.1	8 (0.9%)	0.002	0.100	0.100	0.5	<0.1	50.0
ETTP	1,284 (1.1%)	0 (0.0%)	100	168 (19.9%)	0.010	<0.1	0.069	<0.1	<0.1	0.2
Fermi	48 (0.0%)	22 (0.2%)	54.2	26 (3.1%)	1.296	<0.1	4.800	17.2	10.6	26.1
HAN	596 (0.5%)	0 (0.0%)	100	168 (19.9%)	0.017	<0.1	0.118	<0.1	<0.1	0.5
INL	33 (0%)	1 (0.0%)	97.0	202 (23.9%)	0.011	<0.1	0.022	<0.1	<0.1	8.7
KAPL	236 (0.2%)	2 (0.0%)	99.2	39 (4.6%)	0.006	0.200	0.200	0.3	<0.1	27.4
KCNSC	10 (0.0%)	0 (0.0%)	100	22 (2.6%)	0.013	<0.1	0.014	<0.1	<0.1	25.9
LANL	14,074 (12.4%)	2,698 (28.4%)	80.8	7 (0.8%)	0.040	0.054	26.678	1.1	1.0	1.2
LANL N3B	2 (0.0%)	0 (0.0%)	100	2 (0.2%)	0.014	<0.1	0.014	<0.1	<0.1	77.6
LBNL	18 (0.0%)	0 (0.0%)	100	8 (0.9%)	0.100	<0.1	0.100	<0.1	<0.1	15.3
LLNL	15 (0.0%)	0 (0.0%)	100	6 (0.7%)	0.064	<0.1	0.064	<0.1	<0.1	18.1
LLNL CHES	3 (0.0%)	0 (0.0%)	100	1 (0.1%)	0.040	<0.1	0.042	<0.1	<0.1	63.2
NNSS	1,129 (1.0%)	94 (1.0%)	91.7	297 (35.2%)	0.010	0.052	0.317	0.7	0.4	1.0
ORNL	1,420 (1.2%)	18 (0.2%)	98.7	6 (0.7%)	0.002	0.011	0.157	0.0	<0.1	0.1
PADUCAH	43 (0.0%)	0 (0.0%)	100	4 (0.5%)	0.011	<0.1	0.110	<0.1	<0.1	6.7
PNNL	15 (0.0%)	0 (0.0%)	100	4 (0.5%)	0.004	<0.1	0.004	<0.1	<0.1	18.1
PTX	2,661 (2.3%)	295 (3.1%)	88.9	41 (4.9%)	0.190	0.292	575.930	4.3	3.8	4.9
SLAC	42 (0.0%)	0 (0.0%)	100	26 (3.1%)	0.040	<0.1	0.150	<0.1	<0.1	6.9
SNL	987 (0.9%)	373 (3.9%)	62.2	6 (0.7%)	0.129	0.180	3.820	4.1	3.4	5.0
SRS	4 (0.0%)	0 (0.0%)	100	4 (0.5%)	0.004	<0.1	0.004	<0.1	<0.1	52.7
Y-12	62,886 (55.3%)	4,884 (51.5%)	92.2	283 (33.5%)	0.036	0.050	87.419	1.6	1.5	1.6
Y-12 ANS	412 (0.4%)	4 (0.0%)	99.0	18 (2.1%)	0.001	0.010	0.150	0.2	<0.1	1.5
All	113,633 (100.0%)	9,491 (100.0%)	91.6	844 (100.0%)	0.022	0.050	575.930	1.4	1.4	1.4

[Click here for List of Acronyms](#)

* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding 0.2 µg/m³ based on 95% Confidence Limits.

Exposure Monitoring Results Exceeding Action Level $0.2 \mu\text{g}/\text{m}^3$ by Reporting Organization (2021) *



* Percent exceeding $0.2 \mu\text{g}/\text{m}^3$ based on 95% Confidence Limits.

This graphic provides the percent of exposure monitoring results that exceeded the action level by reporting organization for Calendar Year 2021 (CY2021). Fewer organizations reported exposure monitoring in recent years, and those organizations submitting data have also reported fewer sampling results. This downward trend impacts the analysis and interpretation of results in the Beryllium-Associated Worker Registry (BAWR). The small sample size reduces accuracy and causes higher variability in the statistical models used. Certainly, the wide confidence intervals in the single year CY2021 analysis demonstrate the reduction of statistical power and confidence in the interpretation when compared to similar but larger samples of the population.

The table below gives additional summary statistics for organizations reporting exposure data to the BAWR during CY2021. Organizations that did not report data for CY2021 are not included in this table.

The data in the graphic and table show that Sandia National Laboratory had the greatest percentage (19.4%) of reported exposure monitoring results exceeding the action level in CY2021.

Infographic Details

<i>Y-12</i> Upper confidence limit for F: 0.3 Percent exceeding 0.2 µg/m³ (F): 0.2 Lower confidence limit for F: 0.1	<i>Y-12 ANS</i> Upper confidence limit for F: 55.9 Percent exceeding 0.2 µg/m³ (F): 0.6 Lower confidence limit for F: 0.0	<i>PTX</i> Upper confidence limit for F: 6.6 Percent exceeding 0.2 µg/m³ (F): 2.8 Lower confidence limit for F: 1.0
<i>LANL</i> Upper confidence limit for F: 2.9 Percent exceeding 0.2 µg/m³ (F): 0.4 Lower confidence limit for F: 0.0	<i>ORNL</i> Upper confidence limit for F: 8.5 Percent exceeding 0.2 µg/m³ (F): 1.9 Lower confidence limit for F: 0.3	<i>SNL</i> Upper confidence limit for F: 39.2 Percent exceeding 0.2 µg/m³ (F): 19.4 Lower confidence limit for F: 7.4

Summary Statistics for Exposure Monitoring Results Exceeding Action Level 0.2 µg/m³ by Reporting Organization (2021) *										
Reporting Organization	No. monitoring results	No. detected values	% non-detects	No. individ. monitored	Obs. 95 th percentile (µg/m³)	95% UTL /95 th % (µg/m³)	Largest value (µg/m³)	% > 0.2 µg/m³ (F)	Lower confidence limit for F	Upper confidence limit for F
ETTP	1,207 (36%)	0 (0%)	100	151 (21%)						
HAN	607 (18%)	0 (0%)	100	202 (29%)						
INL	1 (0%)	0 (0%)	100	1 (0%)						
KCNSC	3 (0%)	0 (0%)	100	2 (0%)						
LANL	152 (4%)	5 (7%)	96.6	47 (7%)	0.007	0.080	0.363	0.4	<0.1	2.9
LANL N3B	2 (0%)	0 (0%)	100	2 (0%)						
LLNL	17 (1%)	0 (0%)	100	6 (1%)						
ORNL	42 (1%)	8 (12%)	80.5	28 (4%)	0.075	<0.1	0.135	1.9	0.3	8.5
PADUCAH	43 (1%)	0 (0%)	100	6 (1%)						
PNNL	16 (0%)	0 (0%)	100	4 (1%)						
PTX	43 (1%)	9 (13%)	90	26 (4%)	0.030	1.498	6.609	2.8	1.0	6.8
SNL	14 (0%)	9 (13%)	35.7	6 (1%)	0.381	<0.1	0.500	19.4	7.4	39.2
SRS	4 (0%)	0 (0%)	100	4 (1%)						
Y-12	1,208 (36%)	35 (51%)	35.7	233 (33%)	0.001	0.009	1.555	0.2	0.1	0.3
Y-12 ANS	37 (1%)	2 (3%)	97.8	16 (2%)	0.008	0.107	0.107	0.6	<0.1	55.9
All	3,396 (100%)	69 (100%)	98.4	704 (100%)	<0.1	0.011	6.609	0.3	0.2	0.4

Click here for List of Acronyms

* Percent exceeding 0.2 µg/m³ based on 95% Confidence Limits.

Exposure Monitoring Results Exceeding Action Level 0.2 µg/m³ by Reporting Organization (2021)

This table provides the reporting organization, process description, 8-hour time weighted average (TWA), and the respirator assigned protection factor (APF) for the results observed above the action level through Calendar Year 2021 (CY2021).

Exceedances for CY2021 were greater than in CY2020 with twelve (12) samples exceeding the action level in CY2021, compared with 4 in CY2020, and 21 in CY2019. Since the total reported exposure sampling results continue to decrease over time, the proportion of exceedances is greater than in previous years. In all cases, work planning processes identified the potential for beryllium exposure and workers wore appropriate respiratory protection.

Reporting Organization	Process Description	Job Title	8-hr TWA µg/m ³	Respirator APF
PTX	Production Technician	Crafts	6.61	1,000
Y-12	-	-	1.56	1,000
Y-12	-	-	1.56	1,000
PTX	Material Handler	Other Crafts	1.5	1,000
Y-12	Other Crafts	-	1.31	1,000
SNL	Technician	-	0.5	50
SNL	Technician	-	0.33	25
PTX	Production Technician	Other Crafts	0.32	1,000
Y-12	Other Crafts	-	0.28	1,000
Y-12	Other Technicians	-	0.23	1
SNL	Technician	-	0.22	25
SNL	Technician	-	0.21	1,000

[Click here for List of Acronyms](#)

* Percent exceeding 0.2 µg/m³ based on 95% Confidence Limits.

Exposure Monitoring Results Exceeding Action Level 0.2 µg/m³ by Reporting Organization (2020)

This table provides the reporting organization, process description, 8-hour time weighted average (TWA), and the respirator assigned protection factor (APF) for the results observed above the action level through Calendar Year 2020 (CY2020).

Exceedances for CY2020 were less than in CY2019 with four (4) samples exceeding the action level in CY2020, compared with 21 in CY2019, and 31 in CY2018. Since the total reported exposure sampling results continue to decrease over time, the proportion of exceedances is greater than in previous years. In all cases work planning processes identified the potential for beryllium exposure and workers wore appropriate respiratory protection.

Reporting Organization	Process Description	Job Title	8-hr TWA µg/m ³	Respirator APF
Y-12	Production	Other Crafts	17.34	1,000
Y-12	Production	Crafts	0.5	1,000
Y-12	Production	Other Crafts	0.43	1,000
ETTP	Collection/Monitoring	-	0.39	50

[Click here for List of Acronyms](#)

* Percent exceeding 0.2 µg/m³ based on 95% Confidence Limits.

Exposure Monitoring Results Exceeding Action Level 0.2 µg/m³ by Reporting Organization (2019) *

This table provides the reporting organization, process description, 8-hour time weighted average (TWA), and the respirator assigned protection factor (APF) for the results observed above the action level through Calendar Year 2019 (CY2019).

Exceedances for CY2019 were less than in CY2018 with twenty-one (21) samples exceeding the action level in CY2019, compared with 31 in CY2018, and 36 in CY2017. Since the total reported exposure sampling results continue to decrease over time, the proportion of exceedances is greater than in previous years. In all cases work planning processes identified the potential for beryllium exposure and workers wore appropriate respiratory protection.

Reporting Organization	Process Description	Job Title	8-hr TWA µg/m ³	Respirator APF
Y-12	Support	Engineering Technicians	16.71	50
Y-12	Support	Other Engineers	11.06	50
Y-12	Support	Environmental Engineers	6.26	50
INL	RCRA/CERCLA Work	Deactivation & Decommissioning (D & D) Skilled Trade	2.47	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	1.03	1,000
INL	RCRA/CERCLA Work	Radiological Control Technician	0.92	1,000
INL	Fire Protection Equipment Test/Repair	Technician	0.82	1,000
Y-12	Support	Environmental Engineers	0.77	50
Y-12	Support	Engineering Technicians	0.65	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	0.62	1,000
INL	RCRA/CERCLA Work	Radiological Control Technician	0.54	1,000
INL	Fire Protection Equipment Test/Repair	Fire Protection Technician	0.53	1,000
Y-12	Production	Other Engineers	0.52	50
INL	RCRA/CERCLA Work	D & D Skilled Trade	0.51	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	0.49	10,000
INL	RCRA/CERCLA Work	Radiological Control Technician	0.47	10,000
Y-12	Support	Painters	0.44	1,000
Y-12	Production	Machinists	0.42	1,000
Y-12	Support	Engineering Technicians	0.39	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	0.37	1,000
INL	Fire Protection Equipment Test/Repair	Engineering/Laboratory Technician	0.35	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	0.32	1,000
Y-12	Support	Painters	0.30	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	0.27	1,000
Y-12	Production	Other Crafts	0.26	1,000
INL	RCRA/CERCLA Work	Radiological Control Technician	0.25	1,000
INL	RCRA/CERCLA Work	Radiological Control Technician	0.24	1,000
Y-12	Production	Other Crafts	0.24	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	0.23	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	0.23	1,000
Y-12	Support	Painters	0.22	1,000

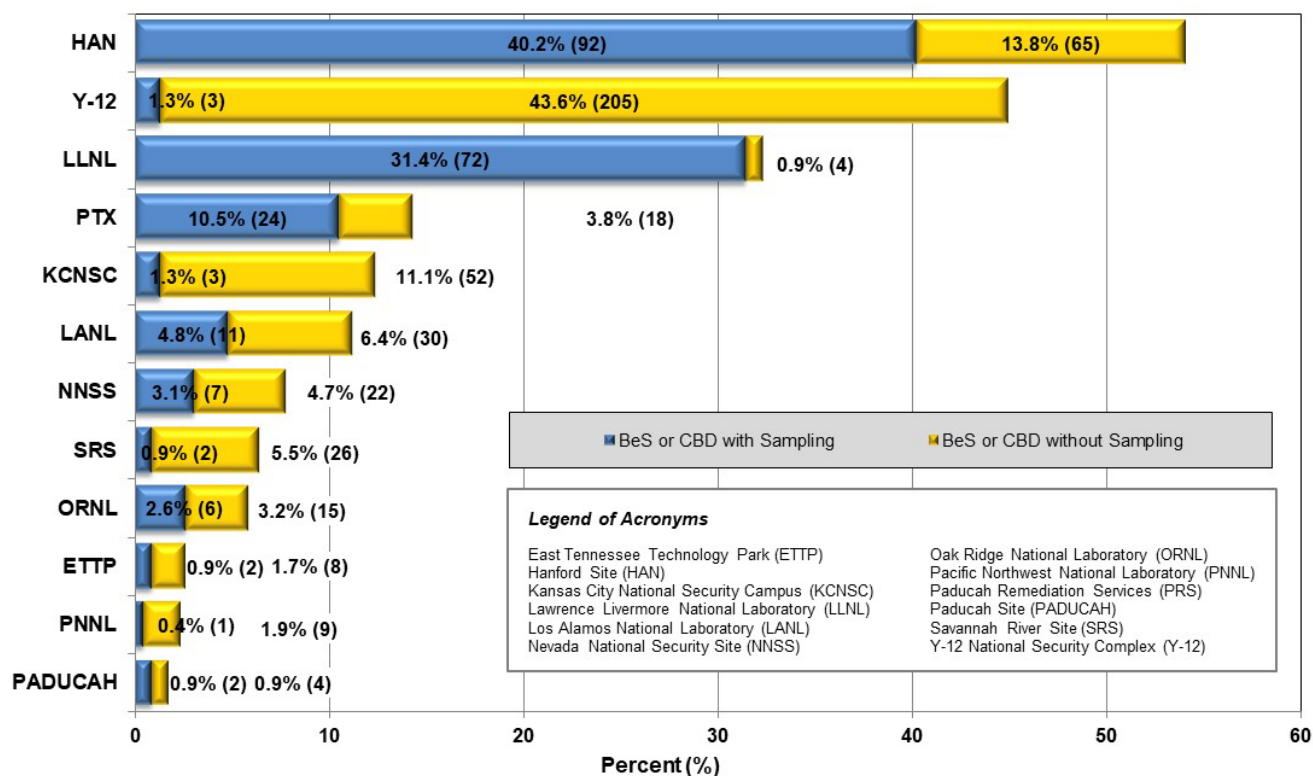
[Click here for List of Acronyms](#)

* Percent exceeding 0.2 µg/m³ based on 95% Confidence Limits.

Health and Monitoring Comparisons

Two different reporting organization groups collect the data associated with health monitoring and exposure monitoring. Occupational health and medical groups collect health monitoring data and industrial hygiene groups collect exposure monitoring data. In most cases, a data coordinator collates the data prior to submission to the Registry. In this section, the health screening data compared to the exposure monitoring data provides insight on the effectiveness of coordination between the 2 activities.

Comparison of the Number and Percent Proportion for Beryllium-Associated Workers Diagnosed with BeS or CBD with and without Exposure Sampling Results by Reporting Organizations (n=687) (2002-2021) *



* Some reporting organizations have provided data that predate the 2002 start date of the registry.

The data in the figure shows the collective number of Beryllium Sensitized (BeS) or Chronic Beryllium Disease (CBD) individuals through Calendar Year (2021) who have had exposure monitoring results submitted to the Registry. The figure also illustrates the collective number of individuals who have not had exposure data submitted to the Registry. More than two-thirds (470 out of 699, or 67%) of the workers currently identified as BeS or diagnosed with CBD have no exposure sampling data. The proportion reported in the CY2018, CY2019, and CY2020 annual summaries were 68%.

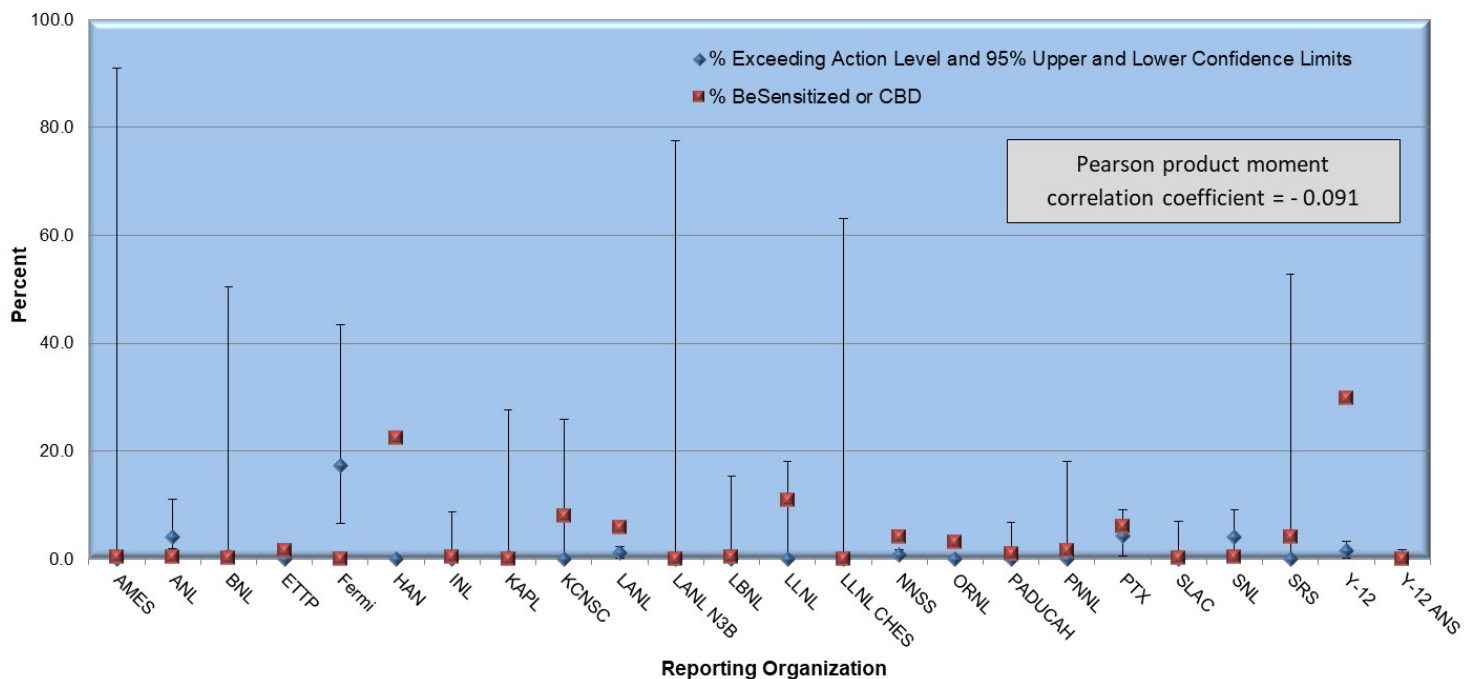
DOE and ORISE program staff evaluated these data by each mutually exclusive subcategory, BeS or CBD. Of the 544 workers who are BeS and have not progressed to CBD, only 229 (33%) had any exposure sampling measurements submitted to the Registry. Only 111 (55%) of these sensitization cases had any exposure records dated earlier than their reported date of sensitization.

Of the 229 sensitization cases with exposure sampling data, 90 cases only had exposure sampling data with monitoring dates later than their reported date of BeS. In other words, 39% of the BeS cases with exposure data had exposure monitoring initiated only after diagnosed as sensitized.

Of the 155 workers reported as diagnosed with CBD, 50 (32%) of the cases had at least one exposure sampling measurement submitted to the Registry. Only 31 (20%) of the total CBD cases had at least one reported exposure record in the Registry dated earlier than their reported date of CBD diagnosis.

In comparison, 31 (21%) CBD cases had at least one reported exposure record dated later than their date of CBD diagnosis. Industrial hygiene programs monitor workers diagnosed with CBD to ensure compliance with restricted duty. Nevertheless, 19 of the CBD cases only had exposure sampling data later than their reported date of CBD diagnosis. Therefore, only 29 of the CBD cases had exposure monitoring records prior to their CBD diagnosis. Most sites will not assign BeS or CBD workers to jobs where there is a risk of beryllium exposure, so no sampling is required.

Comparison of the Percent of Workers Diagnosed with BeS or CBD with Percent Exceeding Action Level 0.2 $\mu\text{g}/\text{m}^3$ by Reporting Organization (2002-2021) *



[Click here for List of Acronyms](#)

* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ based on 95% Confidence Limits.

The figure compares the cumulative percent of workers diagnosed with beryllium-sensitized (BeS) or chronic beryllium disease (CBD) to the percent of exposure samples exceeding the 0.2 $\mu\text{g}/\text{m}^3$ action level for each reporting agency. These data illustrate that no statistical correlation exists between the incidence of BeS/CBD and the percent of exceedances among the exposure sampling results submitted to the Registry (Pearson product moment correlation coefficient = -0.091). The lack of correlation could be due to sensitization and CBD cases associated with past work locations or conditions rather than the environment currently monitored.

However, it is also possible that the exposure monitoring programs are missing sources of exposure. Reporting organizations with low exposure monitoring results and high sensitization or CBD rates should investigate cases to determine if there is a possibility of ongoing exposures.

Supplementary

Acronym List

Acronym	Description
AMES	Ames Laboratory
AMWTP	Advanced Mixed Waste Treatment Project
ANL	Argonne National Laboratory
BAL	Bronchoalveolar Lavage
BAWR	Beryllium-Associated Worker Registry
Be	Beryllium
BeLPT	Beryllium Lymphocyte Proliferation Test
BeS	Beryllium Sensitization or Beryllium-Sensitized
BNL	Brookhaven National Laboratory
CBD	Chronic Beryllium Disease
CBDPP	Chronic Beryllium Disease Prevention Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CY	Calendar Year
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE-ORO	U.S. Department of Energy - Oak Ridge Office
DOL	U.S. Department of Labor
EEOICPA	Energy Employees Occupational Illness Compensation Program Act
EHSS	Office of the Associate Under Secretary for Environment, Health, Safety and Security
EHSS-10	Office of Health and Safety
ETTP	East Tennessee Technology Park
EX	Arithmetic Mean
F	Percent Exceeding 0.2 µg/m ³
Fermi	Fermi National Accelerator Laboratory
GSVCS	Golden SVCS, LLC
HAN	Hanford Site
INL	Idaho National Laboratory
KAPL	Knolls Atomic Power Laboratory
KCNSC	Kansas City National Security Campus
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LANL N3B	Newport News Nuclear BWXT Los Alamos
LBNL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
LLNL BU	Lawrence Livermore National Laboratory Boston University (subcontractor)
LLNL CHES	Lawrence Livermore National Laboratory Clean Harbors Environmental Services (subcontractor)
LLNL ENVC	Lawrence Livermore National Laboratory Envirocon, Inc. (subcontractor)
LLNL NW	Lawrence Livermore National Laboratory North Wind Services, LLC (subcontractor)
NA	Not Applicable

Acronym	Description
NETL	National Energy Technology Laboratory
NNSA	DOE National Nuclear Security Administration
NNSS	Nevada National Security Site
NSC	National Security Campus
NSPS	National Strategic Protective Services, LLC for ETPP and ORNL
NTS	Nevada Test Site
OIG	DOE Office of Inspector General
ORNL	Oak Ridge National Laboratory
ORISE	Oak Ridge Institute for Science and Education
OSHA	DOL Occupational Safety and Health Administration
PADUCAH	Paducah Site
PEL	Personal Exposure Limit
PII	Personally Identifiable Information
PNNL	Pacific Northwest National Laboratory
PRS	Paducah Remediation Services
PTX	Pantex Plant
RCRA	Resource Conservation and Recovery Act of 1976
Respirator APF	Respirator Assigned Protection Factor
RF	Rocky Flats Closure Project
SLAC	SLAC National Accelerator Laboratory
SNL	Sandia National Laboratories
SOMD	Site Occupational Medical Director
SRS	Savannah River Site
SWPA	Southwestern Power Administration
TWA	Time Weighted Average
µg/m³	Micrograms per Cubic Meter
UTL	Upper Tolerance Limit
WSHP	Worker Safety and Health Program
WSI	Wackenhut Security Services, Inc. for ETPP, ORNL, and Y-12
Y-12	Y-12 National Security Complex
Y-12 ANS	Y-12 National Security Complex Atkins Nuclear Secured (subcontractor)
Y-12 NRE	Y-12 National Security Complex Navarro Research and Engineering (subcontractor)
Y-12 URS	Y-12 National Security Complex URS Corporation (subcontractor)

Calculations

Beryllium Sensitization Algorithm (current until revisions to 10 CFR 850 are passed): A worker is considered sensitized if any one of the following clinical criteria and incidence rules for the case definition of beryllium sensitizations is met. Often, a worker's data will satisfy multiple criteria, and their date of sensitization is calculated as the earliest date any one of these is met.

- 2 positive or abnormal beryllium proliferation test (BELPT) results (based on 2 separate blood draws).
- 1 positive or abnormal plus 2 (or more) borderline BELPT results.
- A positive or abnormal bronchoalveolar lavage (BAL) result.
- CBD evaluation with a finding of sensitization but no chronic beryllium disease (CBD).

Exposure Monitoring Statistics: These calculations are based on the methods described in the *Statistical Methods and Software for the Analysis of Occupational Exposure Data with Non-Detectable Values* [<https://info.ornl.gov/sites/publications/Files/Pub57493.pdf>]. Due to the limitations in laboratory analytic methods approaching nano-scales much of the airborne exposure monitoring data are subject to left censoring with a measurement below the detectable limit. The methods applied estimate non-detectable levels using maximum likelihoods for randomly left censored, lognormal data with alternative non-parametric methods applied when the lognormal distribution is in doubt due to small sample sizes.

Pearson Product-Moment Correlation Coefficient: The *Pearson Product-Moment Correlation Coefficient* [<https://support.microsoft.com/en-us/office/pearson-function-0c3e30fc-e5af-49c4-808a-3ef66e034c18>] monitors the dose response represented by the Beryllium-Associated Worker Registry (BAWR) data, and is calculated by site with the percent exceeding the action level and the percent beryllium sensitized or diagnosed with CBD.

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