



## ***Beryllium-Associated Worker Registry Dashboard, (2020)***

Welcome to the new Beryllium-Associated Worker Registry (BAWR) Dashboard, developed by the *Oak Ridge Institute for Science and Education (ORISE)* [<https://orise.orau.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 DOE sites throughout the United States. The first Registry publication reported data for 12,267 workers through 2005. In 2020, the Registry has grown to more than 41,000 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 2020 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.

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](mailto:Linh.Duong@hq.doe.gov) or [BAWR@orau.org](mailto:BAWR@orau.org).

## 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 employees, contractors, and subcontractors. The Office of the Associate Under Secretary for 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.orau.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 employees are at risk for chronic beryllium disease (CBD). Sites that determine employees 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 beryllium lymphocyte proliferation tests (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 2020 Dashboard provides a summary of data collected by DOE-affiliated reporting organizations through the end of the 2020 calendar year.

During the 2020 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 BeLPT results were reported between 2001 and 2010, was 35. This rate dropped to an average of 10 from 2011-2020. 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 beryllium sensitization than are monitored for exposure to beryllium.
- While health monitoring for BeS appears vigorous, industrial hygiene programs submit fewer exposure sampling measurements to the BAWR each year. For example, between 2019 and 2020, the number of reported measurements dropped from 2,593 to 2,560 (see the "DOE-wide Trend in Reported Exposure Sampling for 2011 - 2020" 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 employees 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, 2020

The Beryllium-Associated Worker Registry (BAWR) 2020 Dashboard provides a summary of cumulative data collected by DOE-affiliated reporting organizations through the end of the 2020 calendar year. 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 2020 reporting period. There were no changes in reporting organizations for 2020.
- There were 5 changes in data coordinators in 2020. The Registry includes 41,922 workers among the active reporting sites.
- The majority of the workers in the Registry are males over 50 years of age (56% of employees). The number of workers increased by 2,284 (from 39,638 workers in 2019 to 41,922 workers in 2020).

## Health Monitoring

- Participants' medical surveillance programs screened a total of 7,279 employees for beryllium sensitization in 2020, which included 497 new workers with beryllium sensitization test results reported to the Registry.
- The Registry has a total 542 beryllium-sensitized (BeS) workers and 155 workers diagnosed with chronic beryllium disease (CBD). The Registry reported 10 new beryllium sensitizations and 0 CBD cases in 2020.
- 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 22% 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 2,560 air monitoring samples for 704 employees in 2020.
- Of the samples measured in 2020, approximately 91% had non-detectable results. Only 1.4% 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 Fermi reported the largest number of samples exceeding the action level with 17% of the reported exceedances.
- The highest 8-hour TWA level measured during 2020 was  $17.34 \mu\text{g}/\text{m}^3$  at Y-12 among machinists. This was lower than the highest reported measurement in 2019 which was  $23.08 \mu\text{g}/\text{m}^3$  at Y-12 among machinists.

## Health and Exposure Monitoring Comparisons

- Site medical programs screen a greater proportion of workers for beryllium sensitization 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; employees 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.
- 68% of workers identified as beryllium-sensitized 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, 37% of workers only have exposure monitoring results after identification as beryllium-sensitized.

## 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 *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 10 from 2011 to 2020.
  - 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 employees), 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 µg/m<sup>3</sup>. ORISE staff created and provided a de-identified file for OSHA with a limited number of fields to protect employees' 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 employee 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 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 Employee 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 or chronic beryllium disease. The clinical criteria and incidence rules for the case definition of beryllium sensitizations 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 beryllium sensitization.

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 is updated and published, revisions to the current algorithm for determining beryllium sensitization 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 employees with potential beryllium exposure due to current or past work locations or activities. The number of workers tested using the beryllium lymphocyte proliferation test (BeLPT), 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 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 employees' actual exposure levels and time weighted averages. Timely and complete reporting of 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 sensitizations 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 2,600 exposure records submitted to the Registry during the Calendar Year 2020 (CY2020), 2,349 had monitoring dates in 2020 and 251 records were for monitoring years prior to 2020. 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 beryllium sensitization 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 employees 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 employees 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 2020 calendar, 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. DOE Oak Ridge Operations (DOE-ORO) and Golden SVCS, LLC (GSVCS) 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.

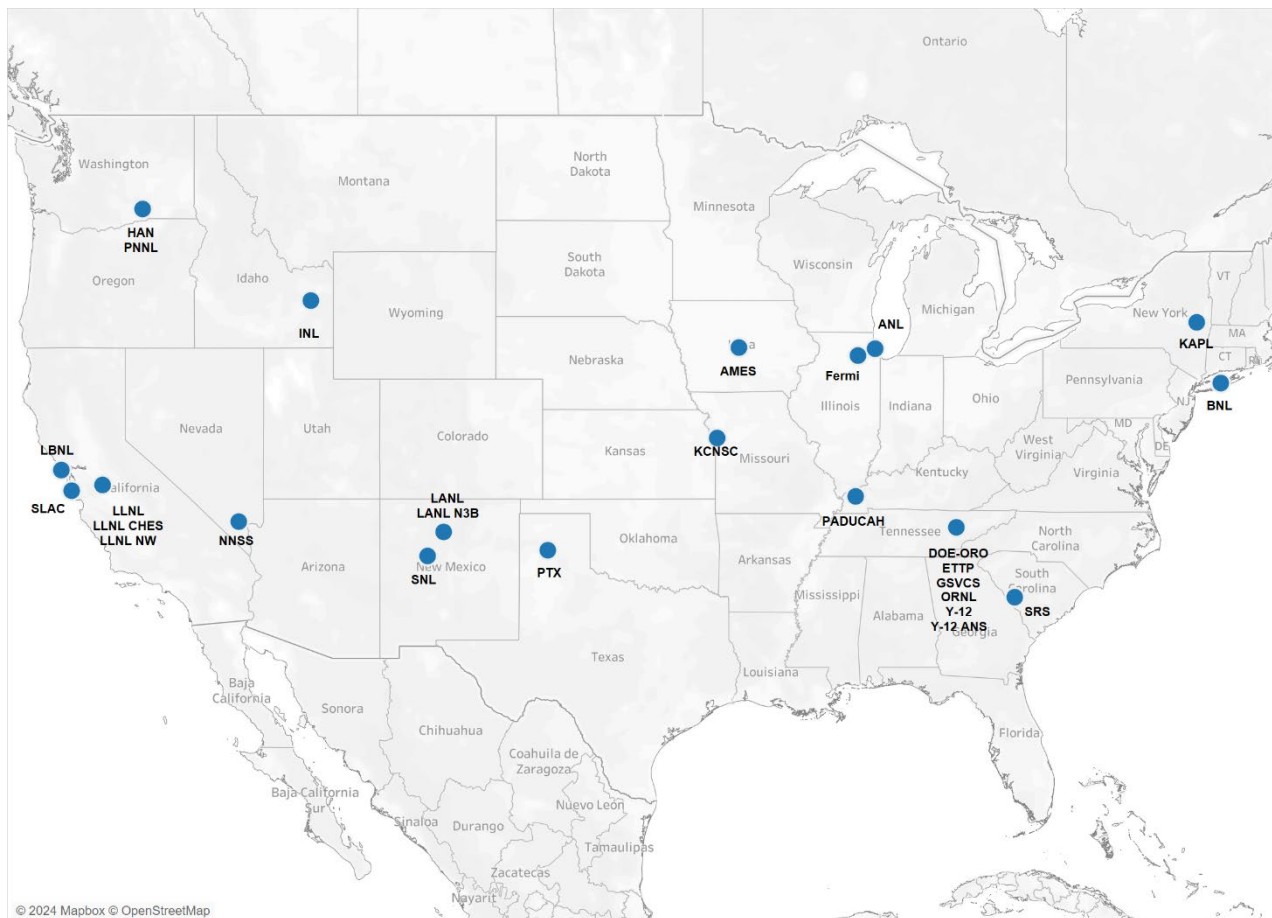
## Inactive BAWR Reporting Organizations

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 (2020)



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 Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
44	44	2	0	12

### Argonne National Laboratory (ANL)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
422	190	3	0	23

### Brookhaven National Laboratory (BNL)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
82	74	1	0	48

### Fermi National Accelerator Laboratory (Fermi)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
29	27	0	0	23

### Richland Area Reporting Locations

#### Hanford Site (HAN)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
17,133	10,271	121	34	2,146

#### Pacific Northwest National Laboratory (PNNL)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
428	395	10	0	54

#### Idaho National Laboratory (INL)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,450	497	3	0	384

*Knolls Atomic Power Laboratory (KAPL)*

Number of Employees:				
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 Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
5,243	4,375	33	8	907

## LANL N3B Project (LANL N3B)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
106	97	0	0	17

*Lawrence Berkeley National Laboratory (LBNL)*

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

*Livermore Area Reporting Locations*

## Lawrence Livermore National Laboratory (LLNL)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
2,717	1,905	72	4	326

## LLNL Clean Harbors Environmental Services (LLNL CHES)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
46	45	0	0	1

## LLNL North Wind (LLNL NW)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
19	19	1	0	0

*Kansas City National Security Campus (KCNSC)*

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,395	1,295	41	14	190

*Nevada National Security Site (NNS)*

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,382	1,229	23	6	297

*Oak Ridge Area Reporting Locations*

## DOE Oak Ridge Office (DOE-ORO)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
98	98	1	0	-

## East Tennessee Technology Park (ETTP)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,171	898	6	4	414

## Golden SVCS, LLC (GSVCS)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
7	6	0	0	-

## Oak Ridge National Laboratory (ORNL)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,065	1,031	21	0	294

## Y-12 National Security Complex (Y-12)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
3,726	3,052	146	62	1,271

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

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
45	45	0	0	29

## Paducah Site (PADUCAH)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
355	318	6	0	86

## Pantex Plant (PTX)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
2,173	2,089	27	15	580

## Sandia National Laboratories (SNL)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
666	660	1	1	151

## Savannah River Site (SRS)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
1,918	873	22	6	204

## SLAC National Accelerator Laboratory (SLAC)

Number of Employees:				
Roster	BeLPT Tested	Be Sensitized	CBD	Exposure Monitored
87	79	0	1	26

## Data Coordinator Changes by Reporting Organization (2013–2020)

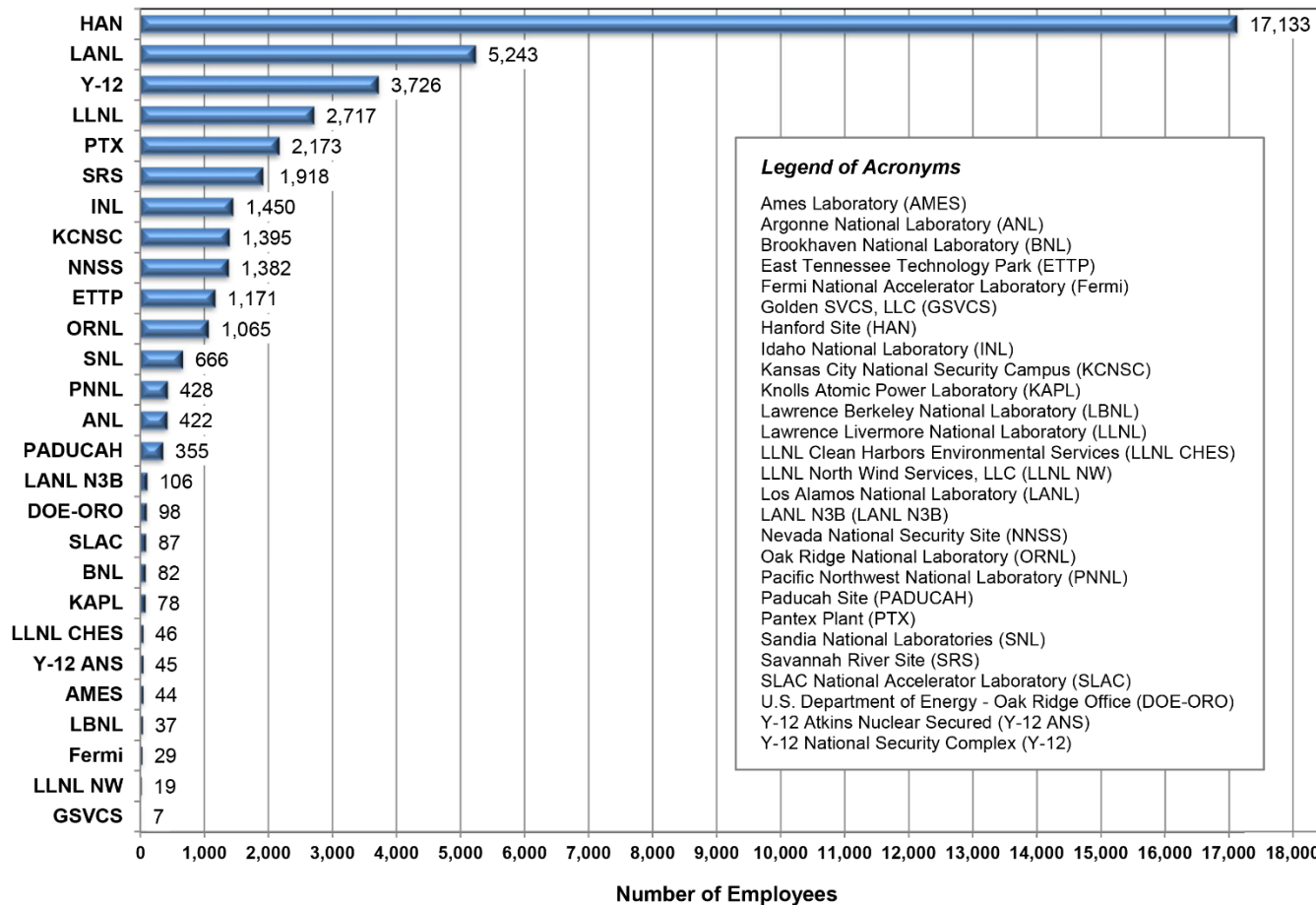
Each reporting organization designates a data coordinator who is responsible for coordinating activities at the site related to data collection, timely submittal of data, and responding to inquiries from the DOE Program Manager and ORISE Data Center as outlined in the DOE technical standard, DOE-STD-1187-2019. The following table shows that there were 5 data coordinator changes in 2020.

Year	Number (%) of Reporting Organizations	Total Data Coordinator Changes	Organizations with $\geq 2$ Data Coordinator Changes in Same Year
2013	5 (19 %)	6	1
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

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.



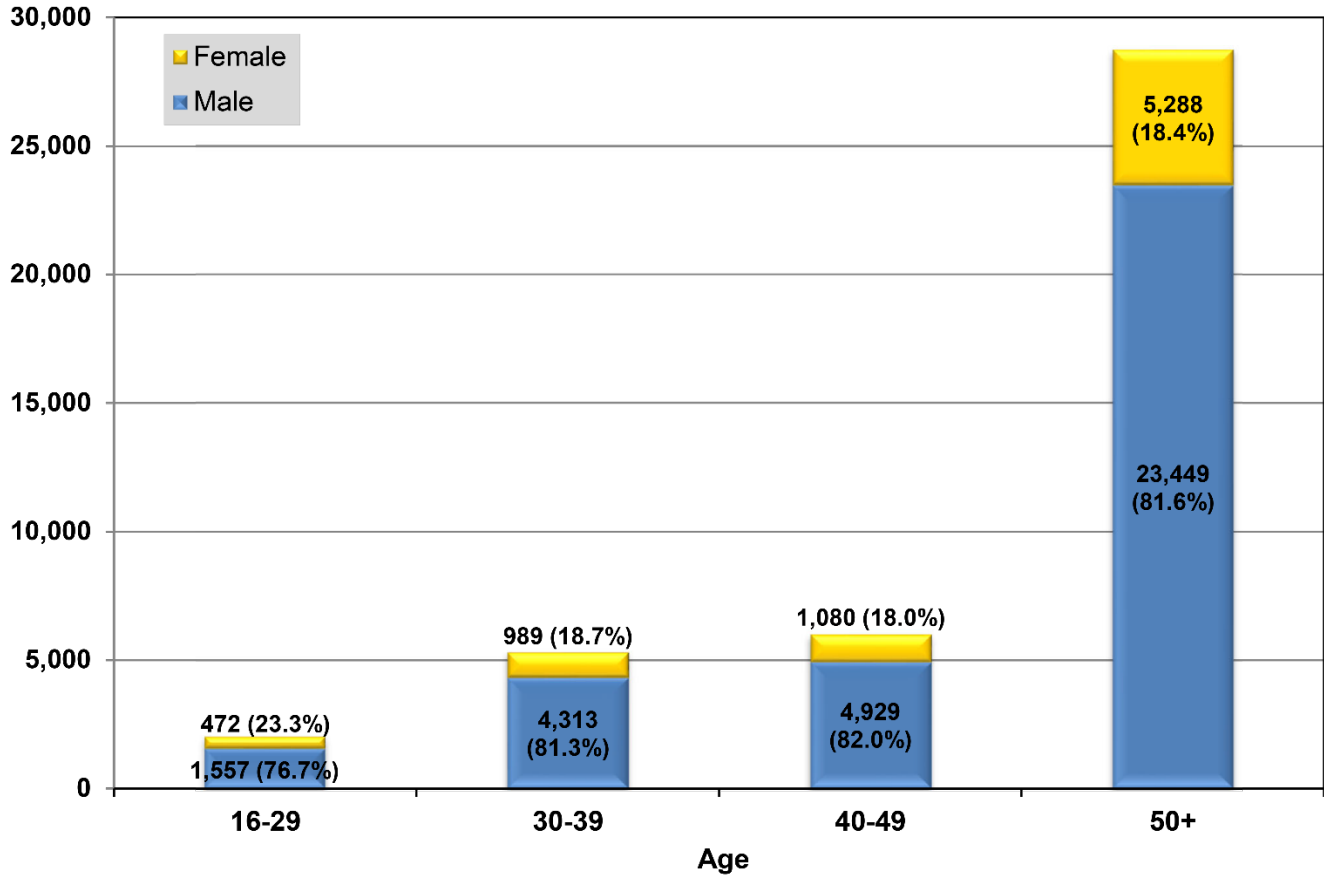
**Workers reported to the BAWR by Reporting Organization (2002–2020) \***



\* 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 BAWR by reporting organization. Through CY2020, there were 41,922 workers in the cumulative roster as compared to 39,638 workers in the cumulative roster through CY2019, for an increase of 2,284 workers. Hanford site has 17,133 employees in the roster, constituting the largest number (41%) in the cumulative roster.

### Gender and Age Distribution for Workers (2002–2020) \*



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

Workers are predominantly male (approximately 81%) and greater than 50 years old (56%). This chart excludes 10 workers for whom demographic data were not available.

## Health Monitoring Results

Sites' health clinics collect medical surveillance data on employees 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 (SOMD) determines the content and frequency of surveillance evaluations and tests based on policies, standards, and the employee's health and work history. The most vital information collected and reported on an annual basis are the number of employees monitored for beryllium sensitization using the beryllium lymphocyte proliferation test BeLPT, the number of new beryllium sensitization (BeS) cases identified, and the number of new cases of chronic beryllium disease (CBD).

Some employees in the roster may decline testing for sensitizations. As a result, no records will be available for individuals who refuse this diagnostic evaluation. Some employees 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 employee releases their evaluation report, and it becomes part of the organization's electronic medical records. Also, advanced medical testing results when employees 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 BAWR through Calendar Year 2020 (CY2020) was 29,688. When compared with the 27,204 workers screened through CY2019, this corresponds to an additional 2,484 employees tested for an increase of 9%.

There was a total of 542 sensitized workers included in the BAWR, and medical staff diagnosed 155 as having CBD through CY2020. 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=29,688) (2002–2020) \*

Reporting Organization	No. Employees with BeLPT Results	No. Sensitized Employees	No. Employees with CBD
HAN	10,271	121 (1.2%)	34 (0.3%)
LANL	4,375	33 (0.8%)	8 (0.2%)
Y-12	3,052	146 (4.8%)	62 (2.0%)
PTX	2,089	27 (1.3%)	15 (0.7%)
LLNL	1,905	72 (3.8%)	4 (0.2%)
KCNCS	1,295	41 (3.2%)	14 (1.1%)
NNSS	1,229	23 (1.9%)	6 (0.5%)
ORNL	1,031	21 (2.0%)	0 (0.0%)
ETTP	898	6 (0.7%)	4 (0.4%)
SRS	873	22 (2.5%)	6 (0.7%)
SNL	660	1 (0.2%)	1 (0.2%)
INL	497	3 (0.6%)	0 (0.0%)
PNNL	395	10 (2.5%)	0 (0.0%)
PADUCAH	318	6 (1.9%)	0 (0.0%)
ANL	190	3 (1.6%)	0 (0.0%)
DOE-ORO	98	1 (1.0%)	0 (0.0%)
LANL N3B	97	0 (0.0%)	0 (0.0%)
SLAC	79	0 (0.0%)	1 (1.3%)
BNL	74	1 (1.4%)	0 (0.0%)
Y-12 ANS	45	0 (0.0%)	0 (0.0%)
LLNL CHES	45	0 (0.0%)	0 (0.0%)
AMES	44	2 (4.5%)	0 (0.0%)
KAPL	39	0 (0.0%)	0 (0.0%)
LBNL	37	2 (5.4%)	0 (0.0%)
Fermi	27	0 (0.0%)	0 (0.0%)
LLNL NW	19	1 (5.3%)	0 (0.0%)
GSVCS	6	0 (0.0%)	0 (0.0%)
<b>Totals</b>	<b>29,688</b>	<b>542 (1.8%)</b>	<b>155 (0.5%)</b>

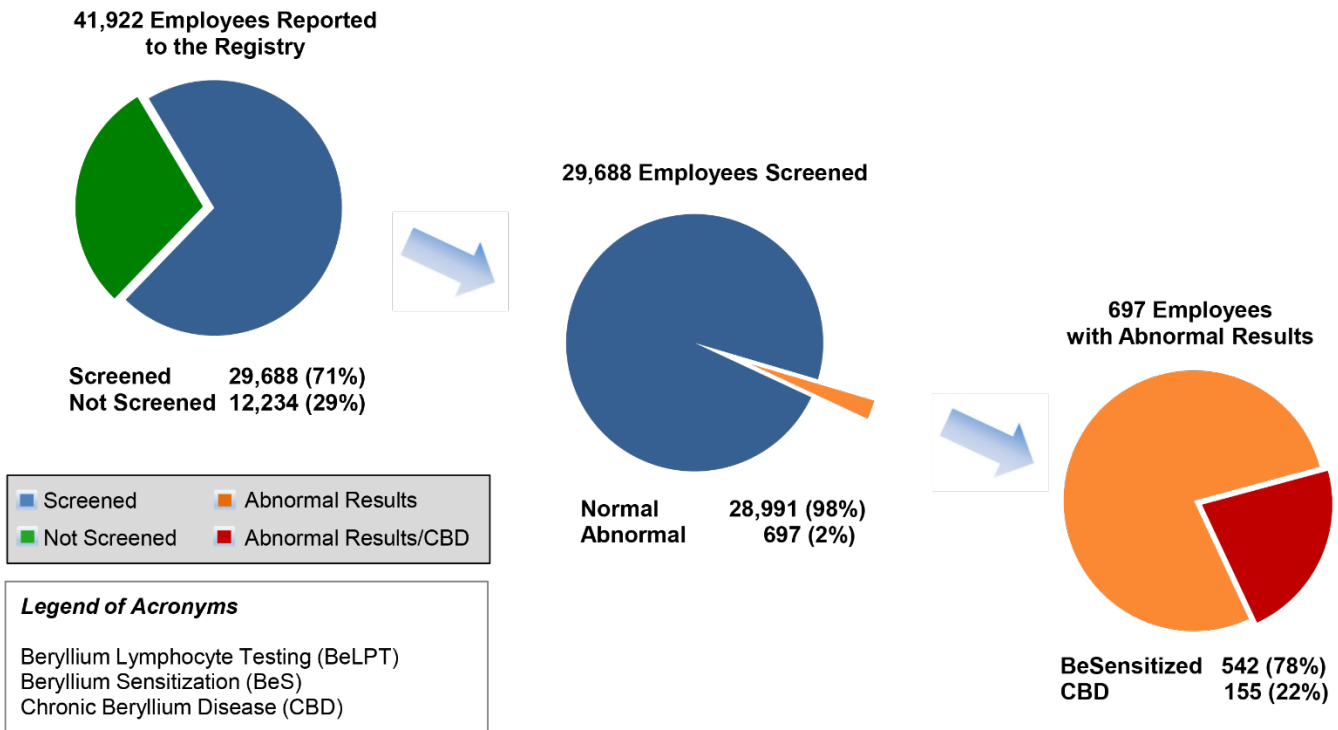
[Click here for List of Acronyms](#)

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

The total number of beryllium-sensitized (BeS) employees increased by 10 through Calendar Year 2020 (CY2020) (542 total BeS cases reported). The newly reported BeS cases were from 6 reporting organizations (1 at LANL, 1 at LLNL, 1 at NNSS, 3 at ORNL, 2 at PNNL, and 2 at SRS). Three (3) employees had reported dates of sensitization in 2020. The remaining seven (7) cases had dates of sensitization ranging from 2009 through 2018.

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

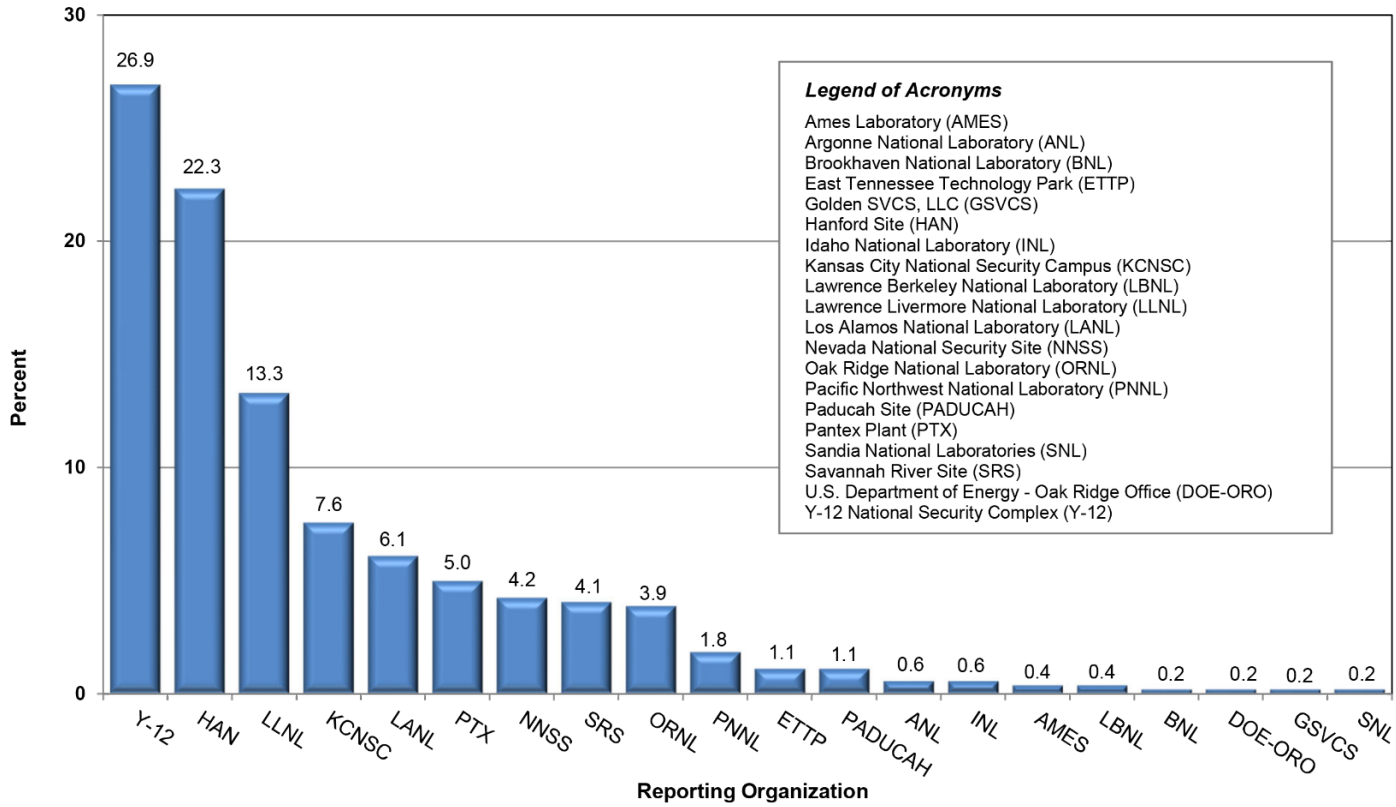
### Number and Percent Proportion of Workers Undergoing BeLPT Testing, and Yielding Abnormal BeS or CBD Results (n=41,922) (2002–2020) \*



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

This figure depicts the numbers and percentages across the DOE complex of employees screened using the BeLPT and among those employees 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.

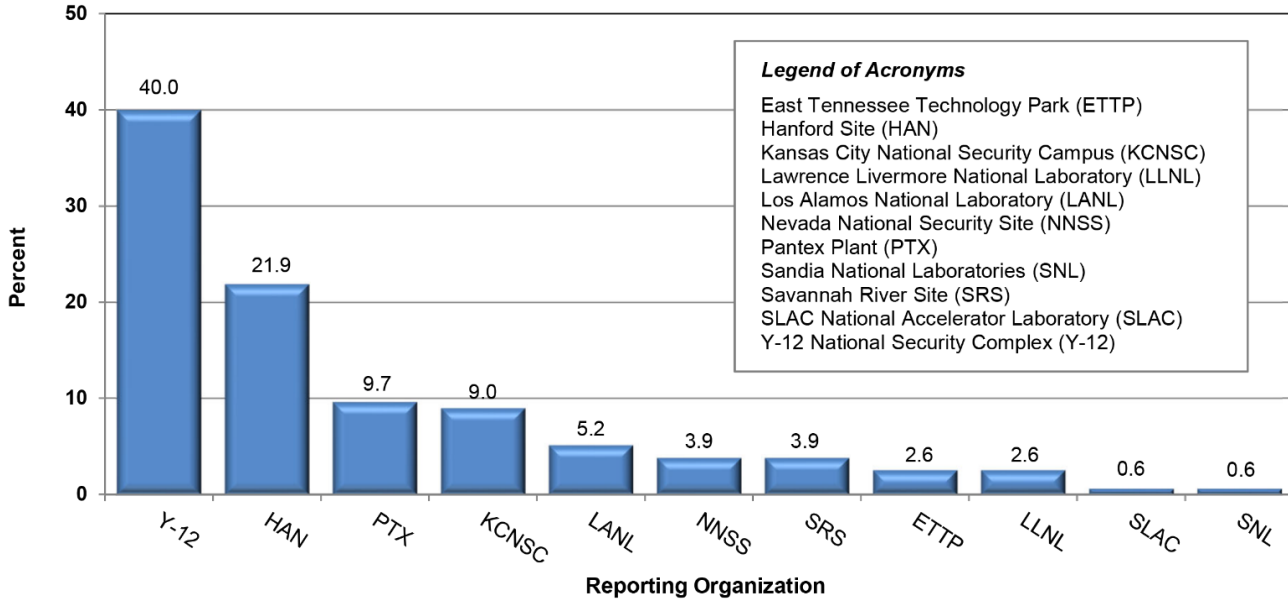
**Percent Proportion of Workers Diagnosed as BeS by Reporting Organization (n=542) (2002–2020) \***



\* 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.

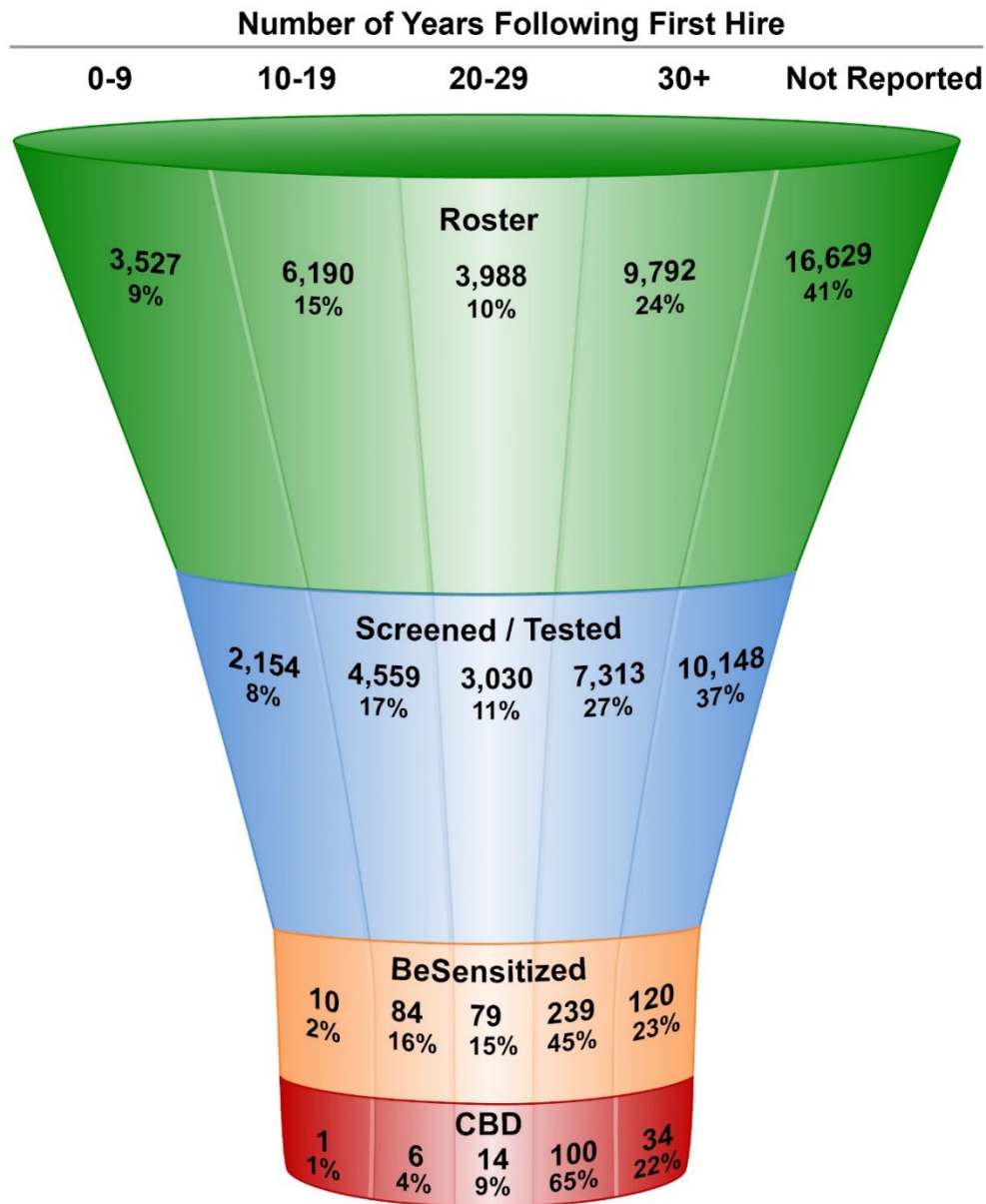
**Percent Proportion of Workers Diagnosed as CBD by Reporting Organization (n=155) (2002–2020) \***



\* 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 employees 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=41,922) \***



\* 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, including roster total, those screened, and those with beryllium sensitization or chronic beryllium disease.



## Number of Workers Undergoing BeLPT and Diagnosed with BeS or Diagnosed with CBD (n=41,922) (2002–2020) \*

This table provides the numbers of beryllium-associated workers with Beryllium Lymphocyte Proliferation Testing (BeLPT) test results submitted to the BAWR each year, and the year of first positive or abnormal BeLPT result for those who were beryllium-sensitized 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 an employee 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. Employees Tested	No. Sensitized Employees	No. Employees 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	7,279	10	0
Year Not Reported	0	28	51

\* The number of "Employees Tested" includes all testing with results of Normal, Negative, Borderline, Positive, Abnormal, and Unsatisfactory. Employees 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=29,688) (2002–2020) \*

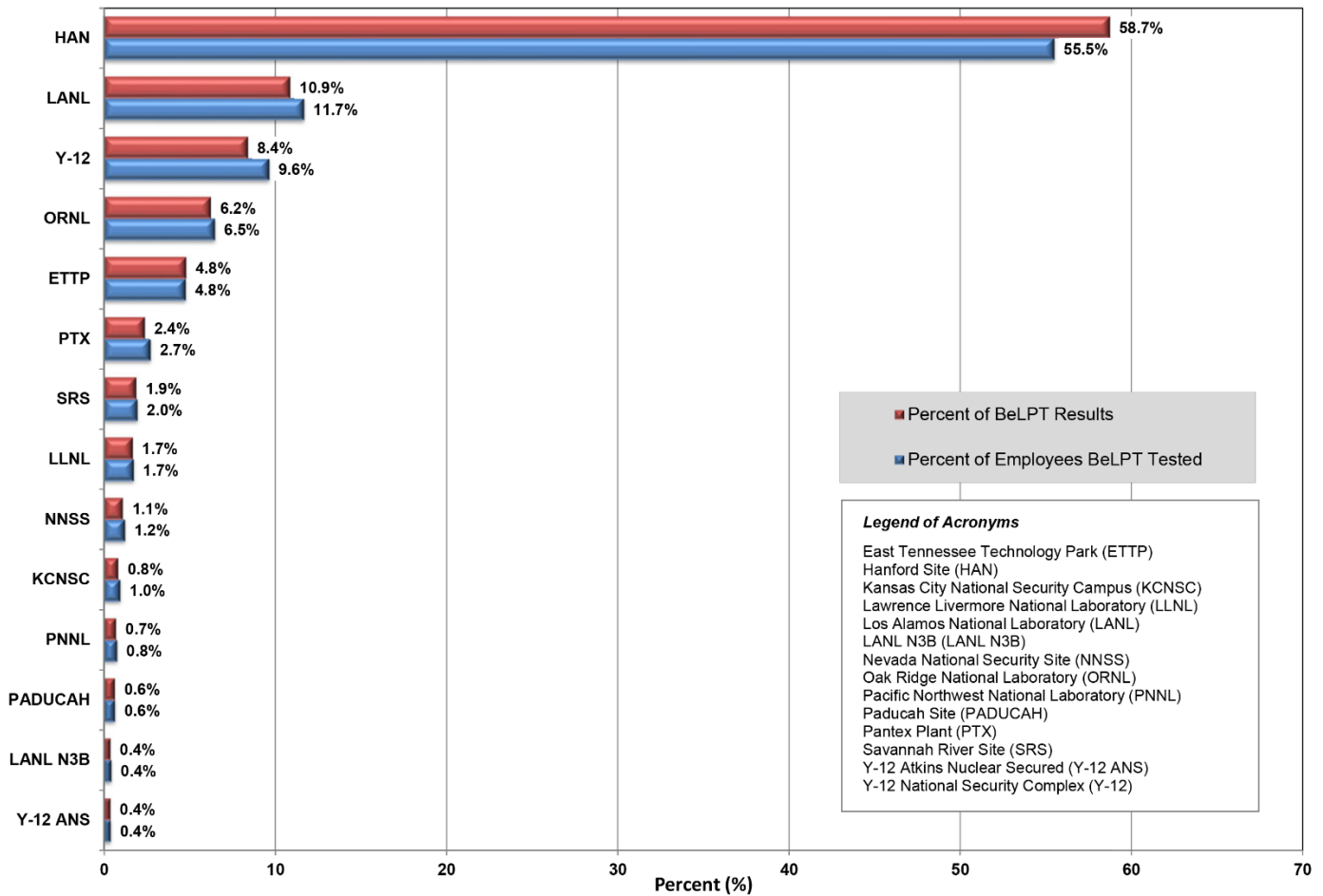
The yearly average for workers developing sensitization, whose first abnormal lymphocyte proliferation test results were between 2001 and 2010, was 35. This rate dropped to an average of 10 from 2011 to 2020. These results provide evidence that programs are serving to improve worker protection and reduce the risk of chronic beryllium disease (CBD).

This table lists beryllium-sensitized, or CBD diagnosed workers, through 2020 grouped by their work history activity, which is a high-level rollup of job function. Based on the data submitted through 2020 and as presented in the table, the majority of both reported beryllium sensitizations (37 %) and CBD cases (39%) occurred among the broad occupational groups of Crafts and Line Operators.

Work History Activity	Employees with BeLPT Results (n=29,688)	No. Sensitized Employees (n=542)	Beryllium Sensitization (%) (n=542)	No. Employees with CBD (n=155)	Chronic Beryllium Disease (%) (n=155)
Management	2,227	45 (2.0%)	8%	10 (0.4%)	6%
Admin. Support	1,152	33 (2.9%)	6%	11 (1.0%)	7%
In-House	2,066	43 (2.1%)	8%	14 (0.7%)	9%
Field	3,061	49 (1.6%)	9%	8 (0.3%)	5%
Technical	4,549	73 (1.6%)	13%	15 (0.3%)	10%
Service	1,793	32 (1.8%)	6%	12 (0.7%)	8%
Security and Fire	1,720	26 (1.5%)	5%	9 (0.5%)	6%
Crafts	5,754	106 (1.8%)	20%	37 (0.6%)	24%
Line Operator	3,839	90 (2.3%)	17%	23 (0.6%)	15%
Guests	131	1 (0.8%)	<1%	0 (0.0%)	0%
Unknown	1,381	14 (1.5%)	3%	11 (0.8%)	7%
Not Reported	2,015	30 (1.8%)	6%	5 (0.2%)	3%
<b>Totals</b>	<b>29,688</b>	<b>542 (1.8%)</b>	<b>-</b>	<b>155 (0.5%)</b>	<b>-</b>

\* 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 Employees with BeLPT Results by Reporting Organization (n=7,279) (2020)



This figure compares the percent of Beryllium Lymphocyte Proliferation Testing (BeLPT) tests conducted to the number of employees tested for each reporting organization in 2020. Employees 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 employees 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 employees 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 – Employees

The cumulative number of employees monitored through Calendar Year 2020 (CY2020) was 7,545 compared to 7,239 employees monitored through CY2019 as reported in the Beryllium-Associated Worker Registry 2019 Dashboard. This equates to an increase of 306 employees monitored for exposure to beryllium through CY2020.

Fifteen (15) reporting organizations provided exposure monitoring results with monitoring dates in 2020. 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=3,969) (2011–2020) \*

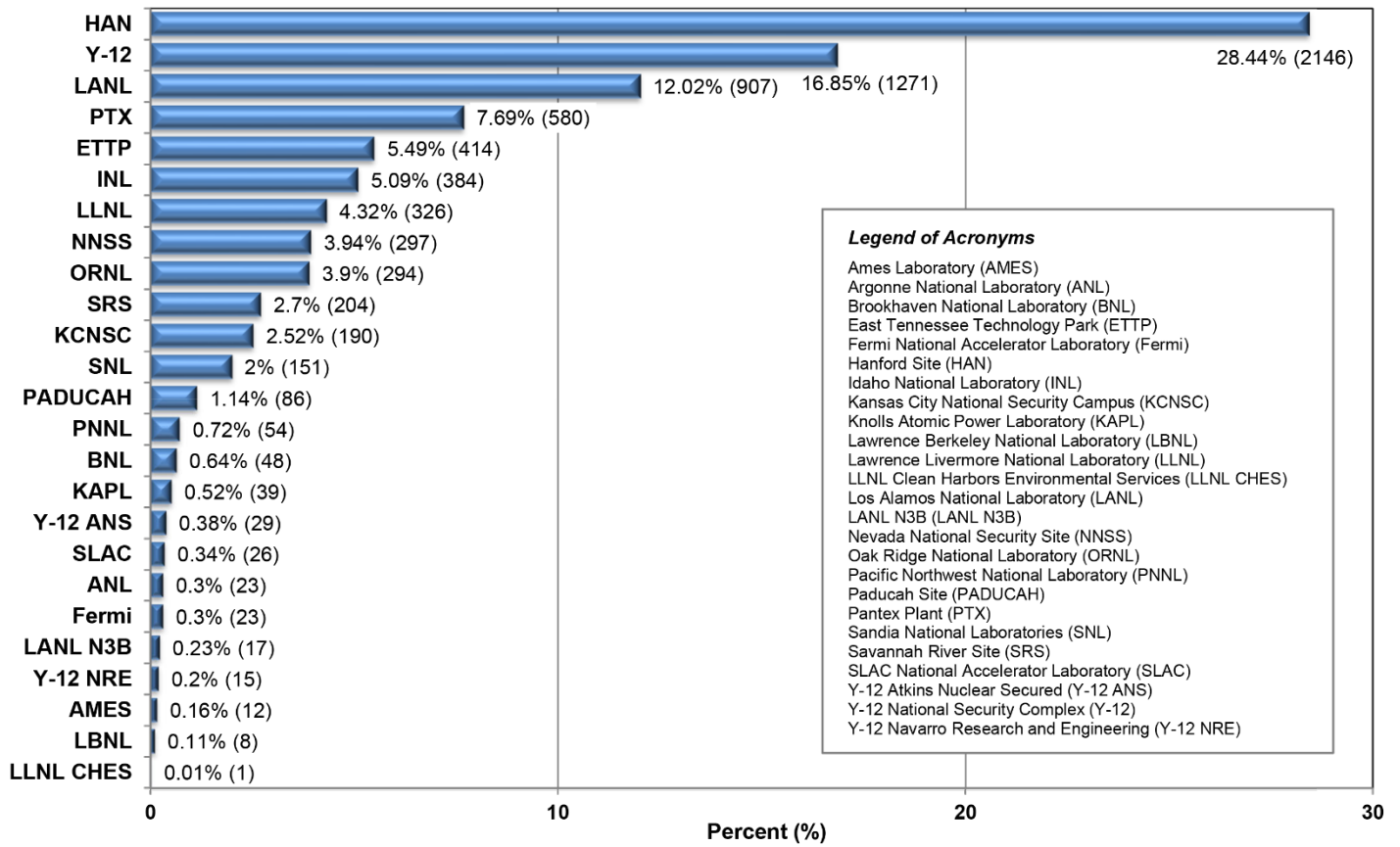
Reporting Organization	2011 n=1,102	2012 n=826	2013 n=787	2014 n=833	2015 n=712	2016 n=696	2017 n=731	2018 n=682	2019 n=730	2020 n=704
AMES				2 (0.2%)					5 (0.7%)	
ANL										
BNL	1 (0.1%)	18 (2.2%)		2 (0.2%)	3 (0.4%)	4 (0.6%)	4 (0.5%)	1 (0.1%)		
DOE-ORO										
ETTP	30 (2.7%)	3 (0.4%)	9 (1.1%)	2 (0.2%)		2 (0.3%)			8 (1.1%)	85 (12.1%)
Fermi				1 (0.1%)						
GSVCS										
HAN	395 (35.8%)	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%)
INL	39 (3.5%)	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%)
KAPL	4 (0.4%)	4 (0.5%)	3 (0.4%)	2 (0.2%)						2 (0.3%)
KCNSC	17 (1.5%)	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%)
LANL	46 (4.2%)	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%)
LANL N3B									10 (1.4%)	7 (1%)
LBNL	2 (0.2%)		1 (0.1%)	3 (0.4%)						
LLNL	63 (5.7%)	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%)
LLNL CHES	1 (0.1%)									
NNSS	19 (1.7%)	22 (2.7%)	14 (1.8%)	17 (2%)	5 (0.7%)	5 (0.7%)	1 (0.1%)	4 (0.6%)	15 (2.1%)	
ORNL	47 (4.3%)	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%)
PADUCAH	3 (0.3%)	5 (0.6%)	4 (0.5%)	5 (0.6%)			13 (1.8%)	15 (2.2%)	5 (0.7%)	12 (1.7%)
PNNL			1 (0.1%)	19 (2.3%)	7 (1%)	10 (1.4%)	8 (1.1%)	19 (2.8%)	9 (1.2%)	
PTX	42 (3.8%)	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%)
SLAC	2 (0.2%)									
SNL	19 (1.7%)	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%)
SRS	2 (0.2%)	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%)
Y-12	363 (32.9%)	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%)
Y-12 ANS					15 (2.1%)	10 (1.4%)	10 (1.4%)	13 (1.9%)	14 (1.9%)	19 (2.7%)
Y-12 NRE	5 (0.5%)	4 (0.5%)	5 (0.6%)	4 (0.5%)						
<b>Totals</b>	<b>1,102 (100%)</b>	<b>826 (100%)</b>	<b>787 (100%)</b>	<b>833 (100%)</b>	<b>712 (100%)</b>	<b>696 (100%)</b>	<b>731 (100%)</b>	<b>682 (100%)</b>	<b>730 (100%)</b>	<b>704 (100%)</b>

[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 employees by reporting organization at least once in each year for the past 10 years (i.e., between 2011 and 2020).

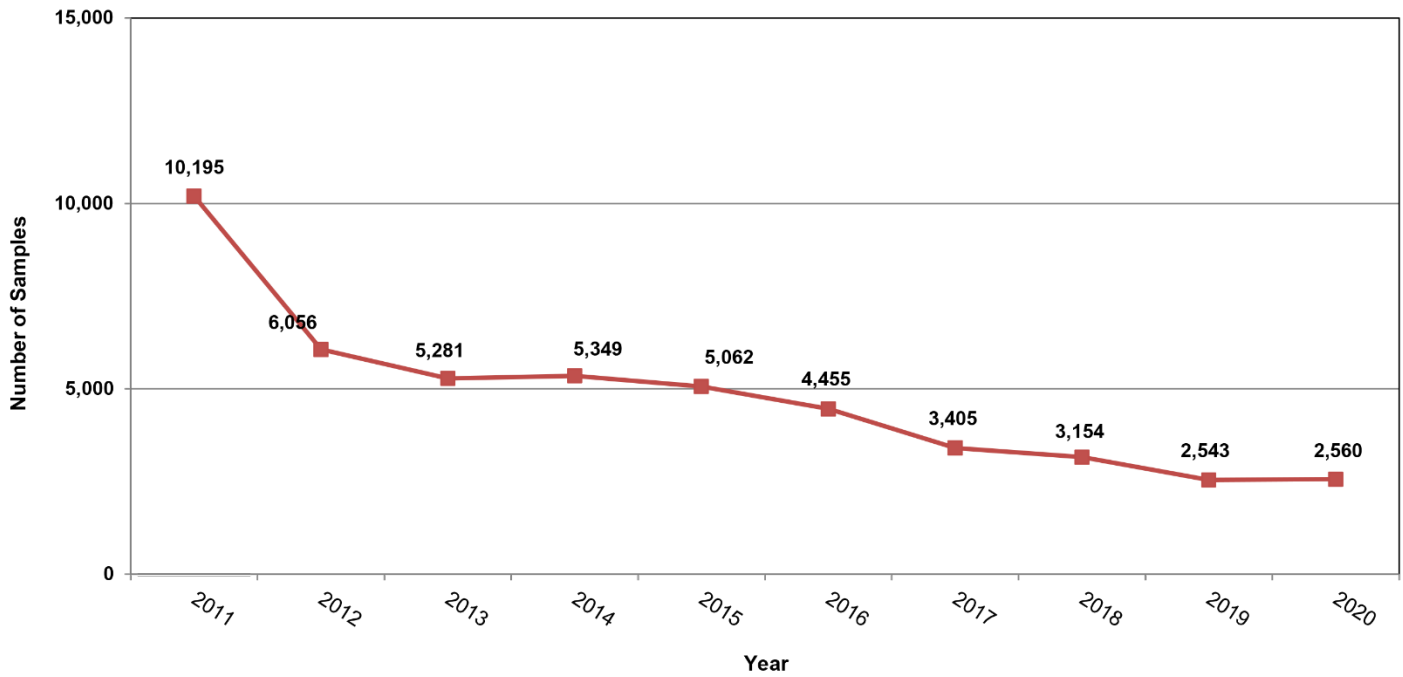
### Number and Percent Proportion of Workers Undergoing Beryllium Exposure Monitoring by Reporting Organization (n=7,545) (2020)



This figure displays the cumulative 7,545 beryllium-associated workers monitored for beryllium exposure through Calendar Year 2020 by reporting organization.

## Exposure Monitoring Trends - Samples

### Number and Percent Proportion of Exposure Sample Results by Year (N=48,060) (2011–2020) \*

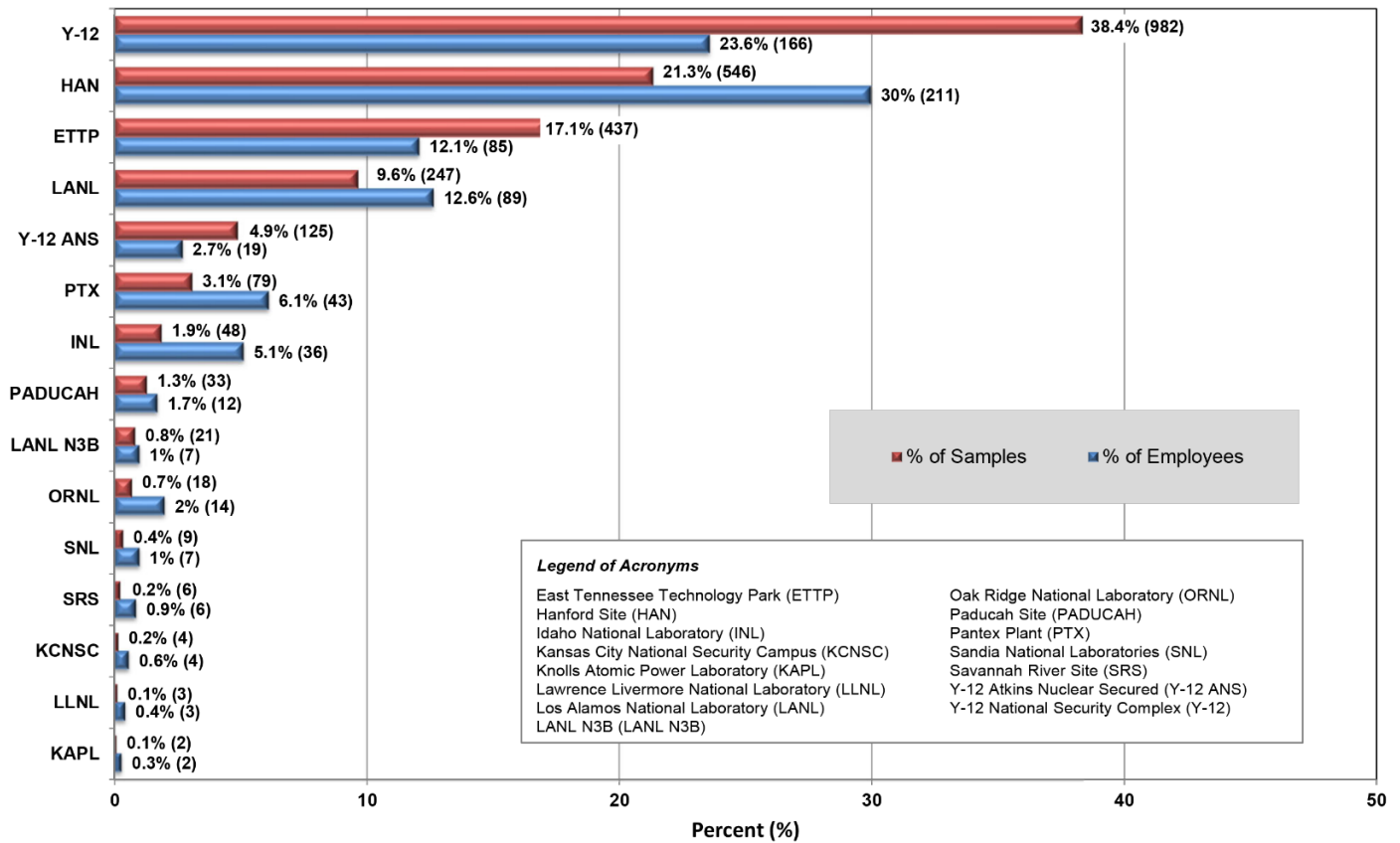


\* Some reporting organizations have provided data that predate the 2002 start date of the registry.

The numbers of exposure sampling results in the Registry 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 the Beryllium-Associated Worker Registry. The small sample size reduces accuracy and causes higher variability in the statistical models used for the BAWR analyses.

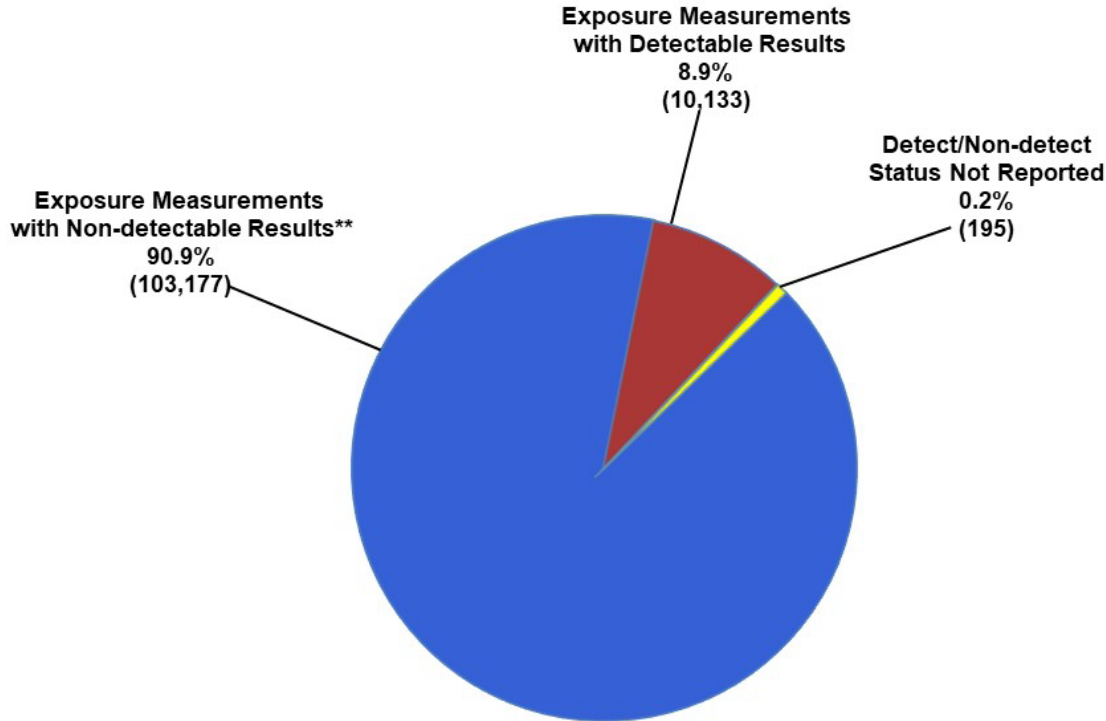
### Comparison of the Number and Percent Proportion of Exposure Samples to Workers with Exposure Sampling Results by Reporting Organizations (n=2,560) (2020)



This graphic illustrates the distribution of exposure samples and employees monitored across 27 reporting organizations during 2020. Similar to the beryllium screening results, most employees monitored for beryllium exposure have multiple exposure measurements throughout the year. The frequency of monitoring is dependent on the employee’s specific type of work and their employer’s monitoring schemes.

Reporting organizations submitted a total of 113,505 exposure measurements to the Registry through Calendar Year 2020 (CY2020). This equates to an additional 2,600 exposure sampling results collected and submitted to the 110,905 total through CY2020. The number of monitoring results for CY2020 alone was 2,560 as indicated above. Therefore, 40 of the sampling results submitted in CY2020 were sampling data for years prior to 2020.

### Number and Percent Proportion of Non-Detectable Results Exposure Measurements, Detectable Exposure Measurement Results and Exposure Measurement Status Not Reported (N=113,505) (2002–2020) \*



\* 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.

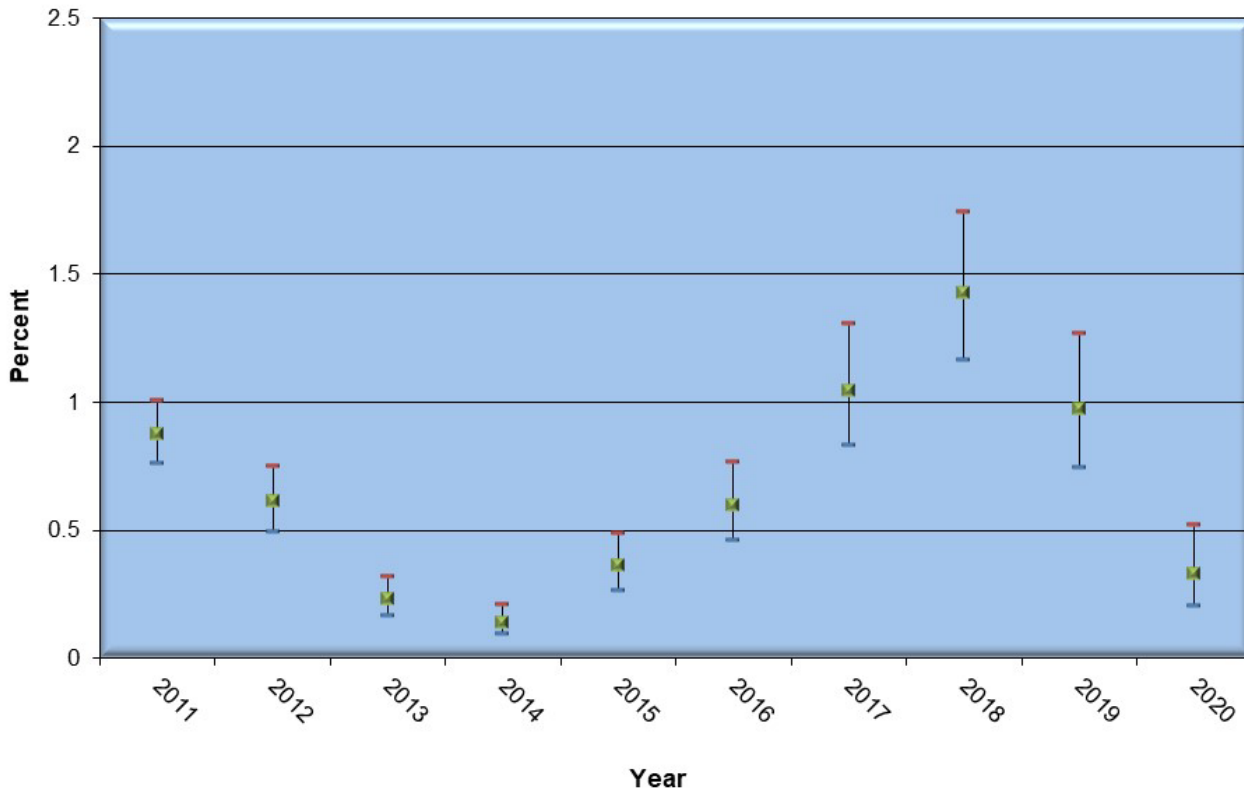
Of the 113,505 exposure monitoring records submitted to the Registry through Calendar Year CY2020, 90.9% have “non-detectable” results, indicating that the sample analysis results were less than the laboratory’s reporting limit. The reporting limit can vary from sample to sample because of differing 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, 110,905 cumulative exposure monitoring results were submitted through CY2019, for an increase through 2020 of 2,600 records (with monitoring dates in 2019 and earlier). This 2,600 increase in sampling results is lower than 3,048 increase in records submitted between 2018 and 2019 and even lower than the 3,104 increase between 2017 and 2018.



## Trends in Exposure Levels

### Percent of 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m<sup>3</sup> by Year (2011–2020) \*



\* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding 0.2 µg/m<sup>3</sup> 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 µg/m<sup>3</sup> in each of the 10 years from 2011 to 2020.

### Infographic Details

**2011**  
 Upper confidence limit for F: 1.0  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.9  
 Lower confidence limit for F: 0.8

**2012**  
 Upper confidence limit for F: 0.7  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.6  
 Lower confidence limit for F: 0.5

**2013**  
 Upper confidence limit for F: 0.3  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.2  
 Lower confidence limit for F: 0.2

**2014**  
 Upper confidence limit for F: 0.2  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.1  
 Lower confidence limit for F: 0.1

**2015**  
 Upper confidence limit for F: 0.5  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.4  
 Lower confidence limit for F: 0.3

**2016**  
 Upper confidence limit for F: 0.8  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.6  
 Lower confidence limit for F: 0.5

**2017**  
 Upper confidence limit for F: 1.3  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 1.0  
 Lower confidence limit for F: 0.8

**2018**  
 Upper confidence limit for F: 1.7  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 1.4  
 Lower confidence limit for F: 1.2

**2019**  
 Upper confidence limit for F: 1.3  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 1.0  
 Lower confidence limit for F: 0.7

**2020**  
 Upper confidence limit for F: 0.5  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.3  
 Lower confidence limit for F: 0.2

## Summary Statistics for 2011–2020 8-Hour Time Weighted Average Exposure Monitoring Results

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	10-year Summary
<b>Number of reported monitoring results</b>	10,195 (21.2%)	6,056 (12.6%)	5,281 (11%)	5,349 (11.1%)	5,062 (10.5%)	4,455 (9.3%)	3,405 (7.1%)	3,154 (6.6%)	2,543 (5.3%)	2,560 (5.2%)	48,060 (100%)
<b>Number of detected values</b>	527 (23.4%)	302 (13.4%)	216 (9.6%)	177 (7.8%)	170 (7.5%)	240 (10.6%)	175 (7.8%)	240 (10.6%)	157 (7%)	70 (3.1%)	2,256 (100%)
<b>Percent non-detects</b>	94.8	95.0	95.9	96.7	96.6	94.6	94.9	92.4	93.8	97.2	95.3
<b>Number of individuals monitored</b>	1,101 (27.7%)	826 (20.8%)	787 (19.8%)	827 (20.8%)	711 (17.9%)	693 (17.5%)	730 (18.4%)	682 (17.2%)	730 (18.4%)	704 (17.7%)	3,969 (100%)
<b>Arithmetic mean (EX) (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.096	0.032	0.004	0.002	0.008	0.016	0.842	0.360	0.182	0.022	0.038
<b>Lower confidence limit of EX (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.047	0.015	0.003	0.002	0.004	0.008	0.128	0.099	0.040	0.003	0.028
<b>Upper confidence limit of EX (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.197	0.069	0.006	0.003	0.017	0.032	5.521	1.310	0.830	0.150	0.052
<b>Observed 95th percentile of data (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.009	0.007	0.005	0.004	0.004	0.005	0.006	0.020	0.011	0.001	0.006
<b>95% upper tolerance limit of the 95th percentile (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.021	0.017	0.015	0.017	0.017	0.020	0.020	0.030	0.026	0.011	0.018
<b>Largest value (<math>\mu\text{g}/\text{m}^3</math>)</b>	18.023	4.013	0.804	0.876	1.847	8.865	87.419	16.712	23.084	17.340	87.419
<b>Percent exceeding 0.2 <math>\mu\text{g}/\text{m}^3</math> (F)</b>	0.9	0.6	0.2	0.1	0.3	0.6	1.0	1.4	1.0	0.3	0.6
<b>Lower confidence limit for F</b>	0.8	0.5	0.2	0.1	0.2	0.5	0.8	1.2	0.7	0.2	0.6
<b>Upper confidence limit for F</b>	1.0	0.8	0.3	0.2	0.4	0.8	1.3	1.7	1.3	0.5	0.7

\* Many individuals were monitored in more than 1 year. The total number of individuals measured at least once in the 10-year period from 2011 through 2020 is 3,969.

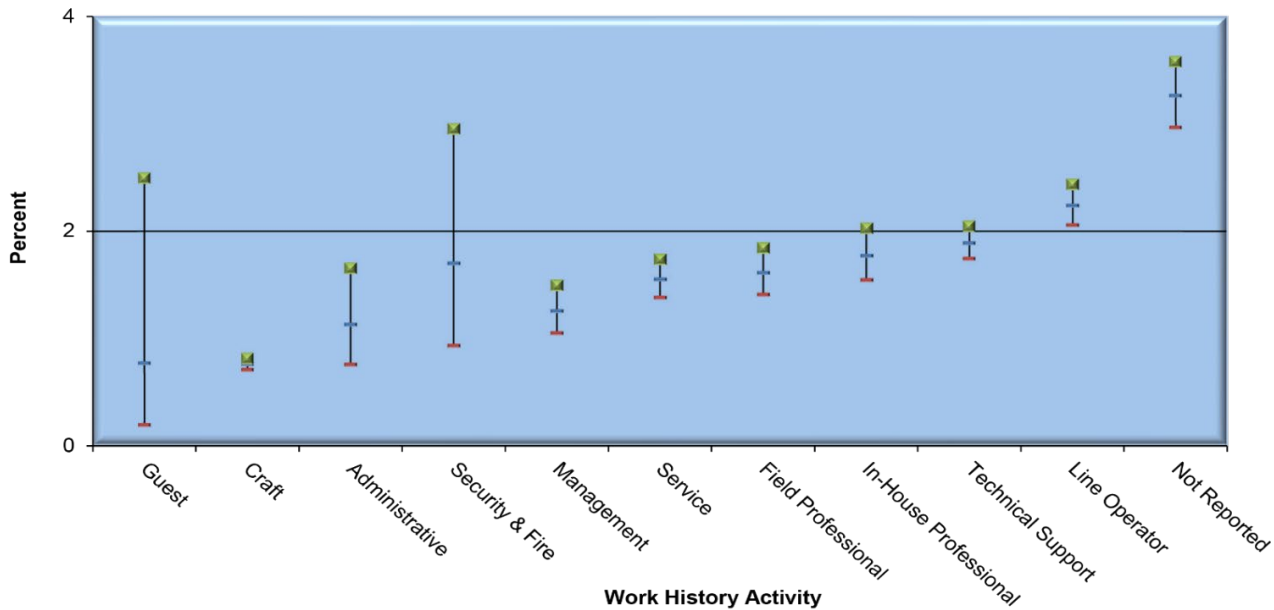
The detailed data presented in the table above provide additional summary statistics for the DOE-wide 8-hour TWA results for each of the past 10 years. The very high percentage of non-detected results from workplaces compliant with the 0.2  $\mu\text{g}/\text{m}^3$  action level points to the need to 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 BAWR indicate that the CBD 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 2020

### Percent of 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m<sup>3</sup> by Work History Activity (2002–2020) \*



\* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding 0.2 µg/m<sup>3</sup> based on 95% Confidence Limits.

The graphic shows the percent of 8-hour TWA exposure monitoring results that exceed the action level, grouped by work activity for the cumulative data through 2020. 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:** 1.8  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 1.6  
**Lower confidence limit for F:** 1.4

*Craft*

**Upper confidence limit for F:** 0.8  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 0.7  
**Lower confidence limit for F:** 0.8

*Administrative*

**Upper confidence limit for F:** 1.7  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 1.1  
**Lower confidence limit for F:** 0.8

*Security & Fire*

**Upper confidence limit for F:** 2.4  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 2.1  
**Lower confidence limit for F:** 2.2

*Management*

**Upper confidence limit for F:** 2.0  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 1.8  
**Lower confidence limit for F:** 1.5

*Service*

**Upper confidence limit for F:** 1.7  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 1.4  
**Lower confidence limit for F:** 1.6

*Field Professional*

**Upper confidence limit for F:** 3.0  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 0.9  
**Lower confidence limit for F:** 1.7

*In-house Professional*

**Upper confidence limit for F:** 2.5  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 0.2  
**Lower confidence limit for F:** 0.8

*Technical Support*

**Upper confidence limit for F:** 2.0  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 1.7  
**Lower confidence limit for F:** 1.9

*Line Operator*

**Upper confidence limit for F:** 2.0  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 1.8  
**Lower confidence limit for F:** 1.5

*Not Reported*

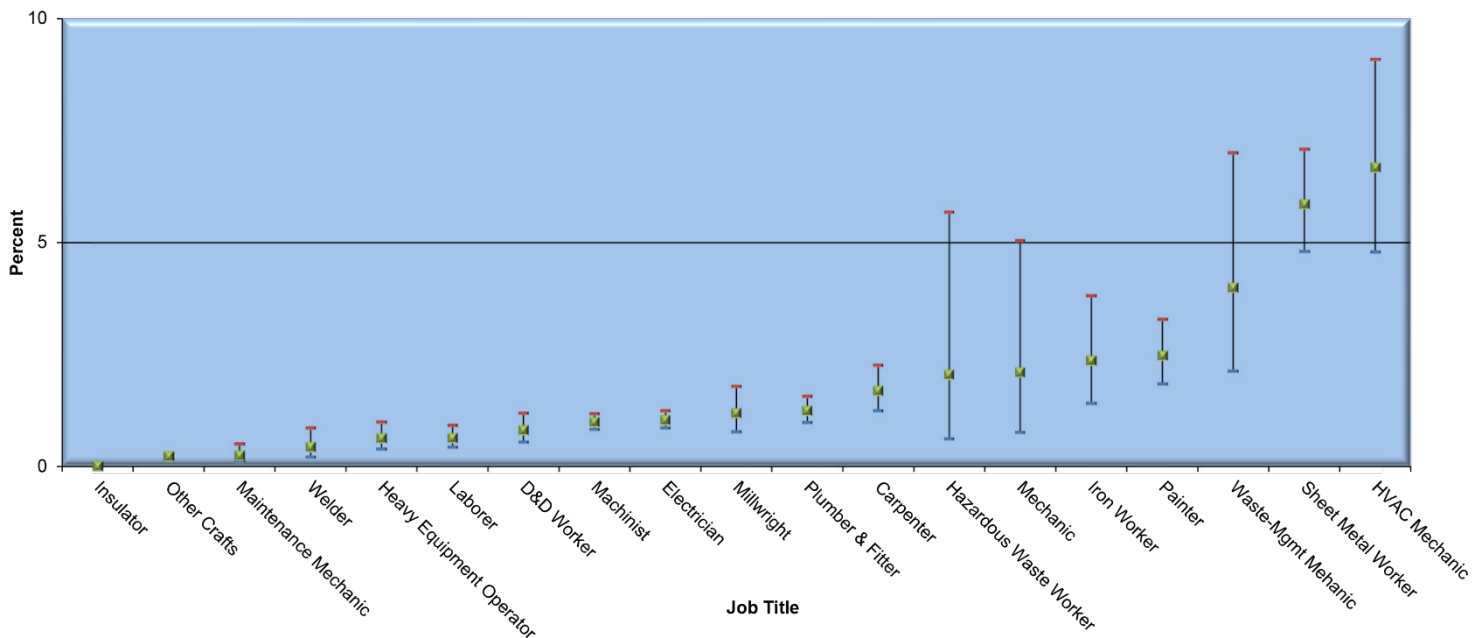
**Upper confidence limit for F:** 3.6  
**Percent exceeding 0.2 µg/m<sup>3</sup> (F):** 3.3  
**Lower confidence limit for F:** 3.0

Summary Statistics for 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m<sup>3</sup> by Work History Activity (2002–2020) \*

Work History Activity	Admin	Craft	Field Prof	Guest	In-House Prof	Line Operator	Management	Security & Fire	Service	Tech Support	Not Reported	Total
<b>No. reported monitoring results</b>	1,070 (1%)	50,445 (46%)	393 (0%)	6,138 (6%)	97 (0%)	5,483 (5%)	4,487 (4%)	11,487 (11%)	9,030 (8%)	14,618 (13%)	5,863 (5%)	109,111 (100%)
<b>No. detected values</b>	80 (1%)	2,301 (24%)	14 (0%)	551 (6%)	28 (0%)	610 (6%)	432 (5%)	1,171 (12%)	626 (7%)	1,898 (20%)	1,706 (18%)	9,417 (100%)
<b>% non-detects</b>	92.5	95.4	96.4	91.0	71.1	88.9	90.4	89.8	93.1	87.0	70.9	91.4
<b>No. individuals monitored</b>	83 (1%)	2,302 (31%)	71 (1%)	676 (9%)	8 (0%)	321 (4%)	301 (4%)	1,194 (16%)	660 (9%)	1,223 (16%)	619 (8%)	7,458 (100%)
<b>Observed 95th percentile of data (ug/m3)</b>	0.020	0.007	0.001	0.027	0.027	0.046	0.022	0.058	0.017	0.050	0.117	0.024
<b>95% UTL of 95th percentile (ug/m3)</b>	0.050	0.050	0.050	0.069	0.291	0.054	0.050	0.098	0.050	0.078	0.150	0.051
<b>Largest value (ug/m3)</b>	21.771	87.419	11.700	26.678	0.313	12.611	11.762	134.000	84.933	29.852	7.670	134.000
<b>% &gt; 0.2 ug/m3 (F)</b>	1.1	0.8	1.7	1.6	0.8	1.8	1.3	2.2	1.6	1.9	3.3	1.4
<b>Lower confidence limit for F</b>	0.8	0.7	0.9	1.4	0.2	1.5	1.1	2.1	1.4	1.7	3.0	1.4
<b>Upper confidence limit for F</b>	1.7	0.8	3.0	1.8	2.5	2.0	1.5	2.4	1.7	2.0	3.6	1.5

\* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding 0.2 µg/m<sup>3</sup> based on 95% Confidence Limits.

**Percent of 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m<sup>3</sup> by Job Title for Craft Workers (2002–2020) \***



\* Some reporting organizations have provided data that predate the 2002 start date of the registry. Percent exceeding 0.2 µg/m<sup>3</sup> based on 95% Confidence Limits.

This graphic shows individuals with job titles in the craft work activity category. The detailed data through 2020 presented in the accompanying table include the summary statistics for cumulative 8-hour TWA monitoring results by craft job title. Machinist, electrician, millwright, plumber and fitter, carpenter, hazardous waste worker, mechanic, iron worker, painter, waste-management mechanic, sheet metal worker, and HVAC mechanic individually have percent exceedances that are higher than when all crafts are combined (1.0% to 6.7% as compared to 0.8%, as shown in the table below).

Among craft workers, HVAC mechanics and sheet metal workers show percentages exceeding the 0.2 µg/m<sup>3</sup> 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 98 individuals, and for sheet metal workers only 158 individuals.

## Infographic Details

### *Insulator*

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

### *Other Crafts*

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

### *Maintenance Mechanic*

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

### *Welder*

Upper confidence limit for F: 0.9  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 0.4  
 Lower confidence limit for F: 0.2

### *Heavy Equipment Operator*

Upper confidence limit for F: 1.0  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 0.6  
 Lower confidence limit for F: 0.4

### *Laborer*

Upper confidence limit for F: 0.9  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 0.6  
 Lower confidence limit for F: 0.4

### *D&D Worker*

Upper confidence limit for F: 1.2  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 0.8  
 Lower confidence limit for F: 0.5

### *Machinist*

Upper confidence limit for F: 1.2  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 1.0  
 Lower confidence limit for F: 0.8

### *Electrician*

Upper confidence limit for F: 1.2  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 1.0  
 Lower confidence limit for F: 0.9

### *Millwright*

Upper confidence limit for F: 1.8  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 1.2  
 Lower confidence limit for F: 0.8

### *Plumber & Fitter*

Upper confidence limit for F: 1.6  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 1.2  
 Lower confidence limit for F: 1.0

### *Carpenter*

Upper confidence limit for F: 2.3  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 1.7  
 Lower confidence limit for F: 1.2

### *Hazardous Waste Worker*

Upper confidence limit for F: 5.7  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 2.0  
 Lower confidence limit for F: 0.6

### *Mechanic*

Upper confidence limit for F: 5.0  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 2.1  
 Lower confidence limit for F: 0.8

### *Iron Worker*

Upper confidence limit for F: 3.8  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 2.4  
 Lower confidence limit for F: 1.4

### *Painter*

Upper confidence limit for F: 3.3  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 2.5  
 Lower confidence limit for F: 1.8

### *Waste-Mgmt Mechanic*

Upper confidence limit for F: 7.0  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 4.0  
 Lower confidence limit for F: 2.1

### *Sheet Metal Worker*

Upper confidence limit for F: 7.1  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 5.9  
 Lower confidence limit for F: 4.8

### *HVAC Mechanic*

Upper confidence limit for F: 9.1  
 Percent exceeding  $0.2 \mu\text{g}/\text{m}^3$  (F): 6.7  
 Lower confidence limit for F: 4.8

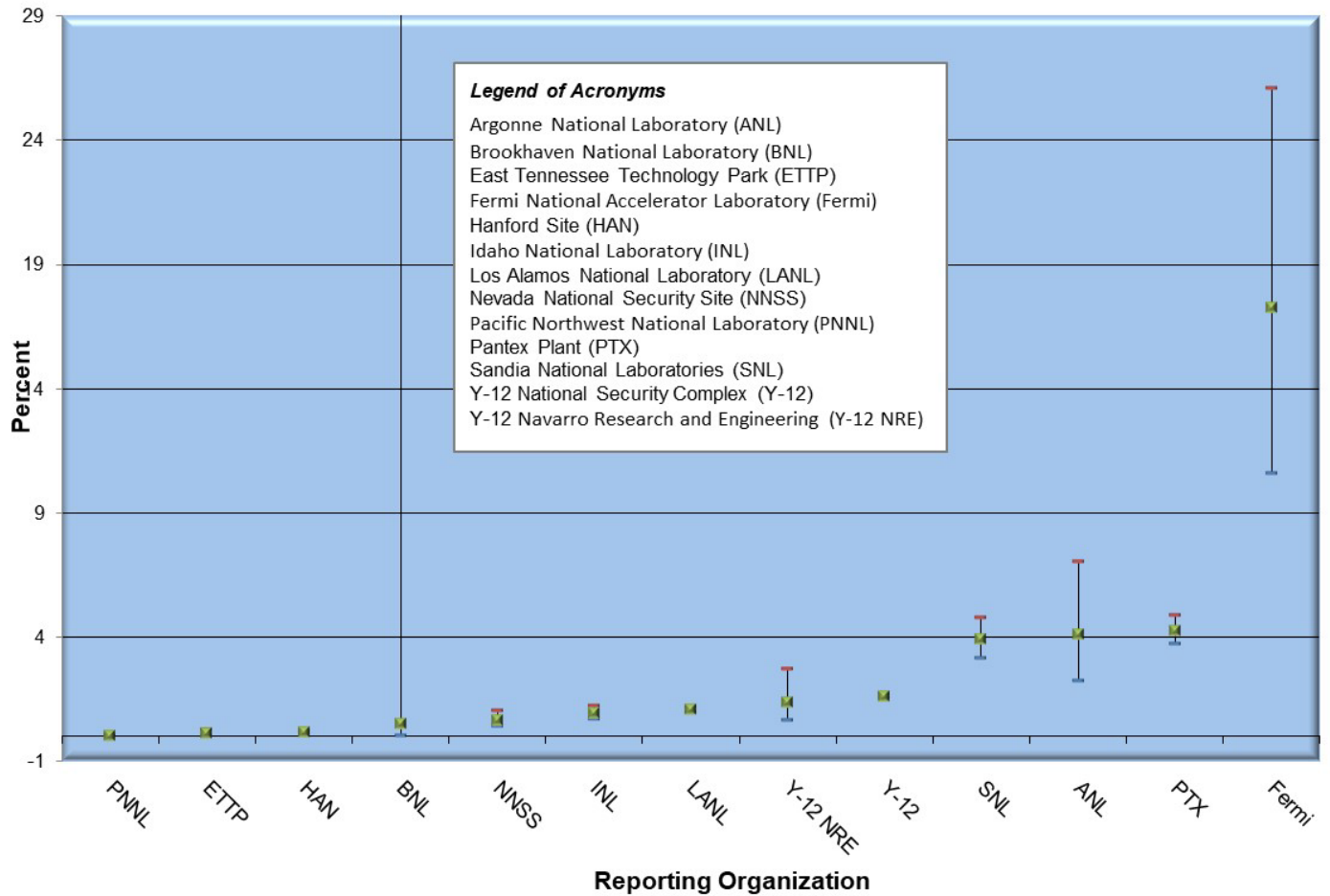
Summary Statistics for 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m<sup>3</sup> by Job Title (2002–2020) \*

Craft Job Title	Number of reported monitoring results	Number of detected values	Percent non-detects	Number of individuals monitored	Observed 95th% of data (ug/m3)	95% UTL of 95th% (µg/m3)	Largest value (ug/m3)	Percent exceeding 0.2 ug/m3 (F)	Lower confidence limit for F	Upper confidence limit for F
Insulator	684 (1%)	15 (1%)	97.8	32 (1%)	0.002	0.030	0.200	< 0.1	< 0.1	< 0.1
Other Crafts	24,979 (50%)	451 (20%)	98.2	260 (11%)	0.003	0.017	37.300	0.2	0.2	0.3
Maintenance Mechanic	1,002 (2%)	30 (1%)	97.0	111 (5%)	0.001	0.052	0.200	0.2	0.1	0.5
Welder	1,216 (2%)	61 (3%)	95.0	115 (5%)	0.004	0.021	16.697	0.6	0.4	1.0
Heavy Equipment Operator	1,829 (4%)	81 (4%)	95.6	274 (12%)	0.007	0.052	10.340	0.6	0.4	0.9
Laborer	1,296 (3%)	123 (5%)	90.5	155 (7%)	0.029	0.039	2.475	0.8	0.5	1.2
D&D Worker	809 (2%)	35 (2%)	95.7	39 (2%)	0.007	0.021	0.356	0.4	0.2	0.9
Machinist	6,328 (13%)	291 (13%)	95.4	118 (5%)	0.010	0.050	87.419	1.0	0.8	1.2
Electrician	4,717 (9%)	369 (16%)	92.2	404 (18%)	0.020	0.050	14.419	1.0	0.9	1.2
Millwright	936 (2%)	46 (2%)	95.1	155 (7%)	0.008	0.050	20.176	1.2	0.8	1.8
Plumber & Fitter	2,762 (5%)	184 (8%)	93.3	238 (10%)	0.015	0.050	5.735	1.2	1.0	1.6
Carpenter	97 (0%)	9 (0%)	90.7	20 (1%)	0.070	0.167	0.176	2.0	0.6	5.7
Hazardous Waste Worker	336 (1%)	36 (2%)	89.3	46 (2%)	0.064	0.190	1.847	2.4	1.4	3.8
Mechanic	869 (2%)	173 (8%)	80.1	51 (2%)	0.079	0.119	7.423	2.5	1.8	3.3
Iron Worker	1,250 (2%)	113 (5%)	91.0	118 (5%)	0.037	0.053	3.176	1.7	1.2	2.3
Painter	121 (0%)	11 (0%)	90.9	42 (2%)	0.017	0.091	0.137	2.1	0.8	5.0
Waste-Mgmt Mechanic	147 (0%)	17 (1%)	88.4	15 (1%)	0.093	1.290	2.390	4.0	2.1	7.0
Sheet Metal Worker	809 (2%)	158 (7%)	80.5	80 (3%)	0.355	0.538	8.865	5.9	4.8	7.1
HVAC Mechanic	258 (1%)	98 (4%)	62.0	29 (1%)	0.281	0.494	5.836	6.7	4.8	9.1
All Combined	50,445 (100%)	2,301 (100%)	95.4	2,302 (100%)	0.007	0.050	87.419	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/m<sup>3</sup> based on 95% Confidence Limits.



**Percent of 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m3 by Reporting Organization (2002–2020) \***



\* 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.

This chart summarizes the cumulative 8-hour TWA exposure monitoring results through 2020 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 employees with a percentage exceeding the action level. The percent of monitoring results exceeding the action level at Fermi Y-12, SNL, ANL, and PTX (ranging from 1.5 to 10.6%) were higher than the overall percent exceedances when data across all organizations are combined (1.5%).

The graphic does not include results from AMES, KAPL, KCNSC, LANL N3B, LBNL, LLNL, LLNL CHES, ORNL, Paducah, SLAC, SRS, and Y-12 ANS 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***PNNL*

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

*ETTP*

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

*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 NRE*

Upper confidence limit for F: 2.7  
 Percent exceeding 0.2  $\mu\text{g}/\text{m}^3$  (F): 1.4  
 Lower confidence limit for F: 0.6

*Y-12*

Upper confidence limit for F: 1.7  
 Percent exceeding 0.2  $\mu\text{g}/\text{m}^3$  (F): 1.6  
 Lower confidence limit for F: 1.6

*SNL*

Upper confidence limit for F: 4.8  
 Percent exceeding 0.2  $\mu\text{g}/\text{m}^3$  (F): 3.9  
 Lower confidence limit for F: 3.2

*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

*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: 4.3

*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: 17.2

*Not Shown in Graph**AMES*

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

*KAPL*

Upper confidence limit for F: 776  
 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: 52.7  
 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: 13.3  
 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: 63.2  
 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: 15.3  
 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: 8.7  
 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: 39.3  
 Percent exceeding 0.2  $\mu\text{g}/\text{m}^3$  (F): <0.1  
 Lower confidence limit for F: <0.1

*Y-12 ANS*

Upper confidence limit for F: 2.4  
 Percent exceeding 0.2  $\mu\text{g}/\text{m}^3$  (F): <0.1  
 Lower confidence limit for F: <0.1

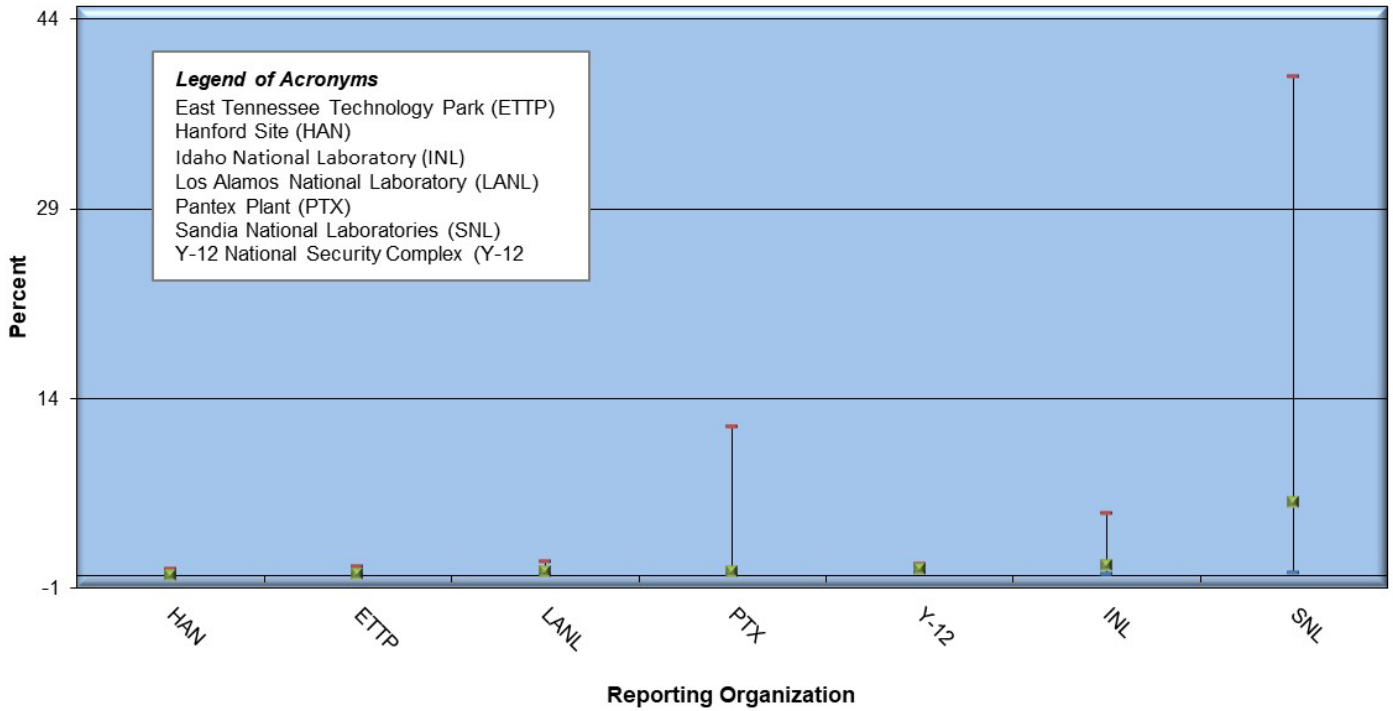
Summary Statistics for 8-hour time weighted average (TWA) Exceeding Action Level 0.2 µg/m<sup>3</sup> by Reporting Organization (2002–2020) \*

Reporting Organization	No. monitoring results	No. detected values	% non-detects	No. individ. monitored	Obs. 95th percentile (ug/m <sup>3</sup> )	95% UTL /95th % (ug/m <sup>3</sup> )	Largest value (ug/m <sup>3</sup> )	% > 0.2 ug/m <sup>3</sup> (F)	Lower confidence limit for F	Upper confidence limit for F
AMES	57 (0.1%)	3 (0%)	94.7	12 (0.2%)	< 0.001	NA	0.028	0	0	91.1
ANL	155 (0.1%)	18 (0.2%)	88.4	23 (0.3%)	0.145	1.100	2.390	4.1	2.3	7.0
BNL	105 (0.1%)	2 (0%)	98.1	48 (0.6%)	0.002	0.100	0.100	0.5	< 0.1	50.0
ETTP	1,349 (1.2%)	40 (0.4%)	97	414 (5.5%)	0.007	0.080	2.264	0.1	< 0.1	0.3
Fermi	48 (0%)	22 (0.2%)	54.2	23 (0.3%)	1.296	NA	4.800	17.2	10.6	26.1
HAN	14,066 (12.9%)	443 (4.7%)	96.9	2,146 (28.4%)	0.008	0.019	12.513	0.2	0.2	0.2
INL	2146 (2%)	231 (2.5%)	89.2	384 (5.1%)	0.033	0.088	2.475	0.4	0.3	0.5
KAPL	2 (0%)	0 (0%)	100	39 (0.5%)	0.007	0.200	0.200	0.3	< 0.1	27.5
KCNCS	4 (0%)	0 (0%)	100	190 (2.5%)	0.001	0.145	0.196	0.1	< 0.1	0.2
LANL	13,796 (12.6%)	2,685 (28.5%)	80.5	907 (12%)	0.042	0.055	26.678	1.1	1.0	1.2
LANL N3B	21 (0%)	0 (0%)	100	17 (0.2%)	0.005	NA	0.015	0	0	12.2
LBNL	18 (0%)	0 (0%)	100	8 (0.1%)	0.100	NA	0.100	0	0	15.3
LLNL	3 (0%)	0 (0%)	100	326 (4.3%)	0.021	0.033	5.133	0.1	0.1	0.2
LLNL CHES	3 (0%)	0 (0%)	100	1 (0%)	0.040	NA	0.042	0	0	63.2
NNSS	1,129 (1%)	94 (1%)	91.7	297 (3.9%)	0.014	0.052	0.317	0.7	0.5	1.1
ORNL	18 (0%)	1 (0%)	94.4	294 (3.9%)	0.002	0.011	0.157	< 0.1	< 0.1	< 0.1
PADUCAH	33 (0%)	0 (0%)	100	86 (1.1%)	< 0.001	0.009	0.019	0.1	< 0.1	0.8
PNNL	213 (0.2%)	10 (0.1%)	95.3	54 (0.7%)	0.002	0.005	0.028	< 0.1	< 0.1	< 0.1
PTX	2,556 (2.3%)	283 (3%)	88.9	580 (7.7%)	0.200	0.300	134.000	4.4	3.9	5.0
SLAC	42 (0%)	0 (0%)	100	26 (0.3%)	0.040	NA	0.150	0	0	6.9
SNL	973 (0.9%)	364 (3.9%)	62.6	151 (2%)	0.112	0.160	3.820	3.8	3.1	4.7
SRS	6 (0%)	0 (0%)	100.0	204 (2.7%)	0.019	0.070	0.320	1.1	0.5	2.1
Y-12	60,734 (55.7%)	4,849 (51.5%)	92	1,271 (16.8%)	0.039	0.050	87.419	1.6	1.6	1.7
Y-12 ANS	125 (0.1%)	0 (0%)	100.0	29 (0.4%)	0.010	0.010	0.150	< 0.1	< 0.1	< 0.1
Y-12 NRE	291 (0.3%)	15 (0.2%)	94.8	15 (0.2%)	0.009	0.039	1.111	1.4	0.6	2.7
All	109,111 (100%)	9,417 (100%)	91.4	7545 (100%)	0.026	0.052	134.000	1.3	1.3	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/m<sup>3</sup> based on 95% Confidence Limits.

**Exposure Monitoring Results Exceeding Action Level 0.2 µg/m<sup>3</sup> by Reporting Organization (2020) \***



\* Percent exceeding 0.2 µg/m<sup>3</sup> 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 2020 (CY2020). 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 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 2020 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 2020. Organizations that did not report data for calendar year 2020 are not included in this table.

The data in the graphic and table show that Fermi National Laboratory had the greatest percentage (10.5%) of reported exposure monitoring results exceeding the action level in CY2020.

## Infographic Details

### ETTP

Upper confidence limit for F: 0.7  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): < 0.1  
 Lower confidence limit for F: 0.09

### INL

Upper confidence limit for F: 4.9  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.8  
 Lower confidence limit for F: 0.1

### Y-12

Upper confidence limit for F: 0.9  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.2  
 Lower confidence limit for F: 0.5

### PTX

Upper confidence limit for F: 11.8  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.3  
 Lower confidence limit for F: < 0.1

### HAN

Upper confidence limit for F: 0.5  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): < 0.1  
 Lower confidence limit for F: 0

### LANL

Upper confidence limit for F: 1.1  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 0.0  
 Lower confidence limit for F: 0.3

### SNL

Upper confidence limit for F: 39.4  
 Percent exceeding 0.2 µg/m<sup>3</sup> (F): 5.7  
 Lower confidence limit for F: 0.2

## Summary Statistics for Exposure Monitoring Results Exceeding Action Level 0.2 µg/m<sup>3</sup> by Reporting Organization (2020)

Reporting Organization	No. monitoring results	No. detected values	% non-detects	No. individ. monitored	Obs. 95th percentile (ug/m <sup>3</sup> )	95% UTL /95th % (ug/m <sup>3</sup> )	Largest value (ug/m <sup>3</sup> )	% > 0.2 ug/m <sup>3</sup> (F)	Lower confidence limit for F	Upper confidence limit for F
ETTP	437 (17.1%)	8 (11.4%)	98.2	85 (12.1%)	0.007	0.010	0.387	0.09	<0.1	0.7
HAN	546 (21.3%)	5 (7.1%)	99.1	211 (30%)	0.020	0.015	0.027	0.0	<0.1	0.5
INL	48 (1.9%)	11 (15.7%)	77.1	36 (5.1%)	0.050	NA	0.101	0.8	0.1	4.9
KAPL	2 (0.1%)	0 (0%)	100	2 (0.3%)						
KCNSC	4 (0.2%)	0 (0%)	100	4 (0.6%)						
LANL	247 (9.6%)	16 (22.9%)	93.5	89 (12.6%)	0.008	0.026	0.146	0.3	0.0	1.1
LANL N3B	21 (0.8%)	0 (0%)	100	7 (1%)						
LLNL	3 (0.1%)	0 (0%)	100	3 (0.4%)						
ORNL	18 (0.7%)	0 (0%)	100	14 (2%)						
PADUCAH	33 (1.3%)	0 (0%)	100	12 (1.7%)						
PTX	79 (3.1%)	3 (4.3%)	96	43 (6.1%)	0.001	0.043	0.043	0.3	<0.1	11.8
SNL	9 (0.4%)	4 (5.7%)	55.6	7 (1%)	0.143	NA	0.170	5.7	0.2	39.4
SRS	6 (0.2%)	0 (0%)	100	6 (0.9%)						
Y-12	982 (38.4%)	22 (31.4%)	97.7	166 (23.6%)	0.008	0.010	17.340	0.5	0.2	0.9
Y-12 ANS	125 (4.9%)	0 (0%)	100	19 (2.7%)						
All	2,560 (100%)	70 (100%)	97.2	704 (100%)	0.001	0.011	17.340	0.3	0.2	0.5

[Click here for List of Acronyms](#)

\* Percent exceeding 0.2 µg/m<sup>3</sup> based on 95% Confidence Limits.

## Exposure Monitoring Results Exceeding Action Level 0.2 µg/m<sup>3</sup> by Reporting Organization (2020)

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

Exceedances for 2020 were less than in 2019 with four (4) samples exceeding the action level in 2020, compared with 21 in 2019, and 31 in 2018. 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 ug/m3	Respirator APF
Y-12	PRODUCTION	Other Crafts	17.34	1000
Y-12	PRODUCTION	Crafts	0.5	1000
Y-12	PRODUCTION	Other Crafts	0.43	1000
ETTP	Collection/Monitoring		0.39	50

*[Click here for List of Acronyms](#)*

\* Percent exceeding 0.2 µg/m<sup>3</sup> based on 95% Confidence Limits.

**Exposure Monitoring Results Exceeding Action Level 0.2 µg/m<sup>3</sup> by Reporting Organization (2019) \***

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

Exceedances for 2019 were less than in 2018 with twenty-one (21) samples exceeding the action level in 2019, compared with 31 in 2018, and 36 in 2017. 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 ug/m <sup>3</sup>	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	D & D Skilled Trade	2.47	1,000
INL	RCRA/CERCLA Work	D & D Skilled Trade	1.03	1,000
INL	RCRA/CERCLA Work	Rad Con Tech	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	Rad Con Tech	0.54	1,000
INL	Fire Protection Equipment Test/Repair	Fire Protection Tech	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	Rad Con Tech	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 Prot. Equipment Test/Repair	Eng./Lab Tech	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	Rad Con Tech	0.25	1,000
INL	RCRA/CERCLA Work	Rad Con Tech	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/m<sup>3</sup> based on 95% Confidence Limits.

## Exposure Monitoring Results Exceeding Action Level 0.2 µg/m<sup>3</sup> by Reporting Organization (2018) \*

This table provides the reporting organization, process description, 8-hour TWA, and the respirator assigned protection factor (APF) for the results observed above the action level through 2018.

Exceedances for 2019 were less than in 2017, but greater than in any other years since 2012. Thirty-one (31) samples exceeded the action level in 2018, compared with 36 in 2017, and 26 in 2016. Since the total reported exposure sampling results continue to decrease over time, the proportion of exceedances is greater than in previous years. Exceedances in 2018 were associated with RCRA and fire equipment maintenance at INL and support, and production activities at Y-12. In all but a few 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 ug/m <sup>3</sup>	Respirator APF
Y-12	SUPPORT	Machinists	87.42	50
Y-12	SUPPORT	Other Crafts	37.30	50
Y-12	SUPPORT	Machinists	15.12	50
Y-12	SUPPORT	Electricians	14.42	50
Y-12	SUPPORT	Machinists	6.67	50
Y-12	SUPPORT	First Line Supervisors	6.00	50
Y-12	SUPPORT	Machinists	4.70	50
Y-12	SUPPORT	Machinists	4.52	1,000
Y-12	PRODUCTION	Machinists	4.37	1,000
Y-12	SUPPORT	Other Crafts	3.17	1,000
Y-12	SUPPORT	Machinists	2.93	1,000
Y-12	SUPPORT	Machinists	2.69	1,000
HAN		Nuclear Waste Process Operators	1.99	10,000
Y-12	PRODUCTION	Other Crafts	1.69	50
Y-12	PRODUCTION	Other Crafts	1.69	1,000
Y-12	SUPPORT	Machinists	1.38	50
Y-12	SUPPORT	Machinists	1.19	50
Y-12	SUPPORT	Electricians	1.17	1,000
SNL	OPERATIONAL SUPPORT	Technician	1.10	50
Y-12	SUPPORT	Machinists	1.06	1,000
Y-12	PRODUCTION	Other Crafts	0.98	1,000
Y-12	PRODUCTION	Other Crafts	0.98	50
Y-12	SUPPORT	Janitors and Cleaners	0.91	1,000
Y-12	SUPPORT	Other Crafts	0.74	1,000
Y-12	SUPPORT	Machinists	0.67	50
Y-12	SUPPORT	Machinists	0.67	1,000
Y-12	SUPPORT	Engineering Technicians	0.45	1,000
Y-12	SUPPORT	Engineering Technicians	0.45	50
Y-12	SUPPORT	Other Technicians	0.40	50
SNL	OPERATIONAL SUPPORT	Technician	0.35	50
Y-12	PRODUCTION	Machinists	0.33	1,000
Y-12	SUPPORT	Machinists	0.31	50
SNL	OPERATIONAL SUPPORT	Technician	0.29	50
Y-12	SUPPORT	Other Crafts	0.24	50
Y-12	SUPPORT	Other Crafts	0.22	1,000
Y-12	PRODUCTION	Other Crafts	0.21	1

[Click here for List of Acronyms](#)

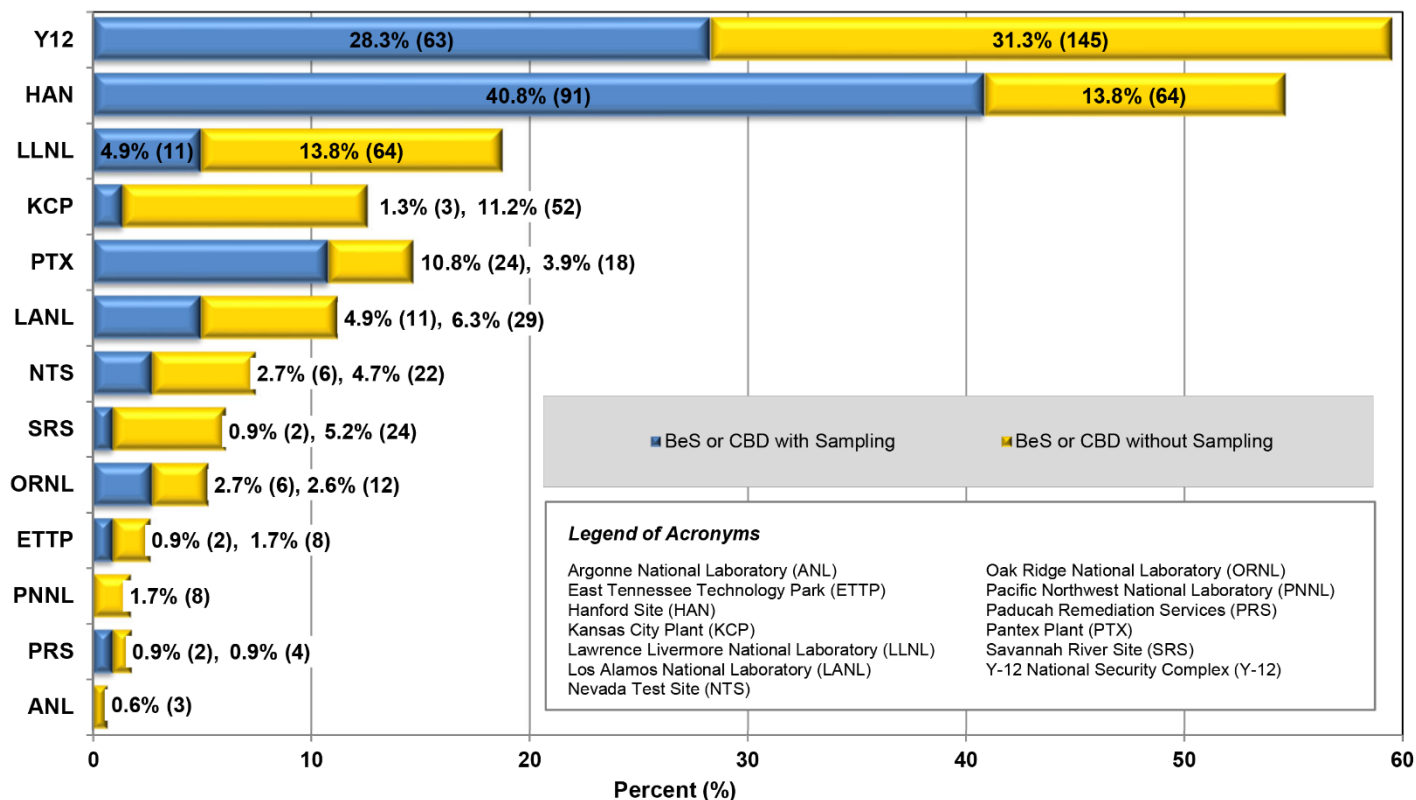
\* Percent exceeding 0.2 µg/m<sup>3</sup> based on 95% Confidence Limits.



### 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) (2002–2020) \*



\* 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 BeS or CBD individuals through 2020 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 (464 out of 687, or 68%) of the workers currently identified as BeS or diagnosed with CBD have no exposure sampling data. The proportion reported in the 2017, 2018, and 2019 annual summaries were also 68%. The proportion reported in each of the summaries for 2016 through 2013 was 67%.

DOE and ORISE program staff evaluated these data by each mutually exclusive subcategory, BeS or CBD. Of the 542 employees who are sensitized (BeS) and have not progressed to CBD, only 223 (32%) had any exposure sampling measurements submitted to the Registry. Only 111 (21%) of these sensitization cases had any exposure records dated earlier than their reported date of sensitization.

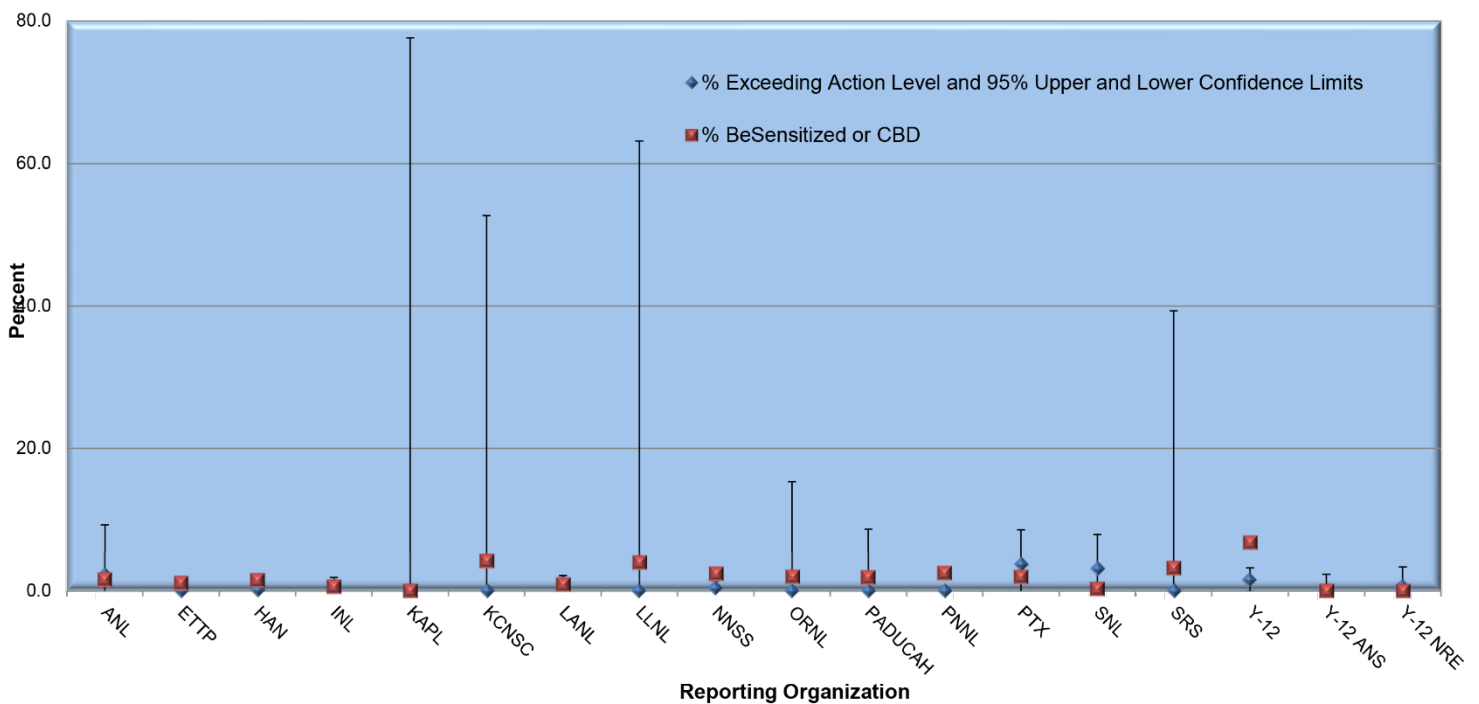
Of the 223 sensitization cases with exposure sampling data, 63 cases only had exposure sampling data with monitoring dates later than their reported date of beryllium sensitization. In other words, 28% of the BeS cases with exposure data had exposure monitoring initiated only after diagnosed as sensitized.

Eighty-eight (88) of the 542 sensitization cases had at least one reported exposure record dated later than their reported date of beryllium sensitization; but this includes the 25 cases that had exposure data both before and after their date of sensitization.

Of the 155 employees 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 µg/m<sup>3</sup> by Reporting Organization (2002–2020). \***



[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/m<sup>3</sup> based on 95% Confidence Limits.

The figure compares the cumulative percent of workers sensitized or CBD to the percent of exposure samples exceeding the 0.2 µg/m<sup>3</sup> 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 = -0.049). 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
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 <sup>3</sup>
Fermi	Fermi National Accelerator Laboratory
GSVCS	Golden SVCS, LLC
HAN	Hanford Site
INL	Idaho National Laboratory
KAPL	Knolls Atomic Power Laboratory
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
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
NETL	National Energy Technology Laboratory
NNSA	DOE National Nuclear Security Administration
NNSS	Nevada National Security Site

<b>Acronym</b>	<b>Description</b>
<b>NSC</b>	National Security Campus
<b>NSPS</b>	National Strategic Protective Services, LLC for ETPP and ORNL
<b>NTS</b>	Nevada Test Site
<b>OIG</b>	DOE Office of Inspector General
<b>ORNL</b>	Oak Ridge National Laboratory
<b>ORISE</b>	Oak Ridge Institute for Science and Education
<b>OSHA</b>	DOL Occupational Safety and Health Administration
<b>PADUCAH</b>	Paducah Site
<b>PEL</b>	Personal Exposure Limit
<b>PII</b>	Personally Identifiable Information
<b>PNNL</b>	Pacific Northwest National Laboratory
<b>PRS</b>	Paducah Remediation Services
<b>PTX</b>	Pantex Plant
<b>Respirator APF</b>	Respirator Assigned Protection Factor
<b>RF</b>	Rocky Flats Closure Project
<b>SLAC</b>	SLAC National Accelerator Laboratory
<b>SNL</b>	Sandia National Laboratories
<b>SOMD</b>	Site Occupational Medical Director
<b>SRS</b>	Savannah River Site
<b>SWPA</b>	Southwestern Power Administration
<b>TWA</b>	Time Weighted Average
<b>µg/m<sup>3</sup></b>	Micrograms per Cubic Meter
<b>UTL</b>	Upper Tolerance Limit
<b>WSHP</b>	Worker Safety and Health Program
<b>WSI</b>	Wackenhut Security Services, Inc. for ETPP, ORNL, and Y-12
<b>Y-12</b>	Y-12 National Security Complex
<b>Y-12 ANS</b>	Y-12 National Security Complex Atkins Nuclear Secured (subcontractor)
<b>Y-12 NRE</b>	Y-12 National Security Complex Navarro Research and Engineering (subcontractor)
<b>Y-12 URS</b>	Y-12 National Security Complex URS Corporation (subcontractor)

## Calculations

**Beryllium Sensitization Algorithm (current until revisions to 10 CFR 850 are passed):** An employee is considered sensitized if any one of the following clinical criteria and incidence rules for the case definition of beryllium sensitizations is met. Often, an employee'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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