

# ryllium-Associated

# Worker Registry

# 2017



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## ***Beryllium-Associated Worker Registry Summary***

### **Data Cumulative Through 2017**

The U.S. Department of Energy (DOE) has the responsibility to protect the health and safety of DOE employees, contractors, and subcontractors. The Office of Environment, Health, Safety and Security (AU) provides the corporate-level leadership and strategic vision necessary to establish clear expectations for health, safety, environment, and security programs. In support of this mission, the AU Office of Health and Safety (AU-10) 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 programs (CBDPP), the purpose of which are 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](#)) 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.

This summary includes data cumulative through calendar year 2017 submitted or corrected by the end of April 2018, somewhat delayed by late site data submissions.

#### **Reporting Organizations:**

The 2017 report covers 26 active reporting organizations. Since the 2016 report, 1 organization became inactive and the name of 1 organization changed:

- With the Fluor contract award at Idaho National Laboratory (INL), the Advanced Mixed Waste Treatment Project (AMWTP) became an inactive reporting organization, and reporting at INL expanded to include all former AMWTP workers offered employment under the new contract.
- With the Four Rivers Partnership contract award at Paducah, the name of the reporting organization changed from Fluor Paducah Deactivation Project (FPDP) to Paducah Site (PADUCAH), and reporting expanded to include beryllium-associated workers at Mid-America Conversion Services and Swift and Staley (providing support to the Paducah Gaseous Diffusion Plant) in addition to those at the Paducah Deactivation Project.

Health data were collected through the operation of current worker medical surveillance programs for all 26 active reporting organizations. Industrial hygiene programs submitted exposure sampling data for 24 of the 26 active reporting organizations. Neither DOE-Oak Ridge Operations (DOE-ORO) nor National Strategic Protective Services, LLC (NSPS) submits exposure sampling data. With the addition of Advanced Mixed Waste Treatment Project (AMWTP), the number of inactive sites increased to 7.



**Caveats:**

A few caveats should guide the interpretation of the results of analyses presented in this report.

- The BAWR does not receive health outcome information about workers other than the development of beryllium sensitization (BeS) or chronic beryllium disease (CBD). To be considered beryllium sensitized, an individual must have 2 abnormal blood tests, or 1 abnormal and 2 borderline blood tests, or 1 abnormal bronchoalveolar lavage BeLPT, or a clinical evaluation with a diagnosis of beryllium sensitization.
- Cause of death is not available to the program, which precludes analyses focused on estimation of mortality risk from particular causes.
- Frequently, the Registry cannot be certain about date of first hire because some organizations characterize 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.
- The Registry collects no personally identified information on any workers. Each reporting organization is free to choose its own encryption algorithm to assign a unique identifier for a given worker. While this approach greatly increases 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.
- Although the vast majority of workers represented in the figures and tables of this report are unique, there undoubtedly are some workers counted more than once. This issue can arise when a worker moves from one reporting organization to another, e.g., from site to site, where he or she may be assigned a new identifier based on a different encryption algorithm. Although the number of affected workers is believed small, without personally identified information about 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.

**Observations:**

- The 2017 report includes 1,290 more workers than the 2016 report.
- Beryllium screening was reported for 1,008 more workers than in calendar year 2016.
- An additional 220 employees were monitored for exposure through CY2017 (6,661 versus 6,441 in CY2016).
- The Registry received 3,584 additional exposure sampling results through CY2017 (a total of 104,753 samples versus 101,169 samples in CY2016). Only 4 of these records were reported for years prior to 2017.

- Of the 24,950 workers screened through CY2017 using the Beryllium lymphocyte proliferation test (BeLPT), 498 were beryllium sensitized (BeS, 2.0 percent) and 147 were diagnosed as having CBD (0.6 percent). In this report, the numbers of employees who are sensitized and the numbers of employees with CBD are mutually exclusive, i.e., the BeS category excludes individuals diagnosed with CBD.
- Thirty-four (34) additional beryllium sensitizations were reported in 2017, of which 16 were actually from 2017; 18 others were from previous years.<sup>1</sup> By comparison, 7 total BeS cases were reported for 2016, 11 for 2015, and 14 for 2014.
- No new cases of chronic beryllium disease were reported during calendar year 2017. The most recent case, a current employee at Nevada National Security Site working in the Crafts and Laborer job categories, was reported during calendar year 2016 and was the first reported since 2011. Only 2 exposure sampling records were available for this individual, both from 2007 and both reflecting extremely low time weighted average exposures. This case brought the Registry's total to 147 CBD cases.
- Limited or missing exposure information continues to restrict the interpretation of analyses addressing exposure levels prior to the diagnosis of BeS or CBD. Among the 498 individuals diagnosed with beryllium sensitization, only 161 (32 percent) have any exposure sampling data reported. Of these 161 BeS cases, 61 only have exposure sampling data dated *later* than their reported date of beryllium sensitization. Only 100 (20 percent) of the 498 BeS cases have at least one exposure sample reported *prior* to sensitization.
- As noted with the BeS cases, the large number of CBD cases with no exposure sampling data or having only exposure sampling data *later* than their date of diagnosis limits analysis of the relationship between CBD and the timing and magnitude of beryllium exposure. Of the 147 employees reported as diagnosed with CBD, 48 have at least one exposure sampling measurement. However, only 29 (20 percent) of the 147 employees have at least one reported exposure record dated *earlier* than their reported date of CBD diagnosis.
- Thirty-four (34) samples exceeded the action level of 0.2 µg/m<sup>3</sup> in 2017 compared with 26 in 2016, 24 in 2015, 15 in 2014, 7 in 2013, and 40 in 2012. (Totals may differ from previous reports due to late submitted and corrected data.) In 2015 through 2017, exceedances were largely associated with support activities at Sandia National Laboratory (SNL) and Y-12 National Security Complex (Y-12). In most cases, the potential for these exceedances was identified by work planning processes and appropriate respiratory protection was in use.
- Through 2017, the highest percentage of both reported beryllium sensitizations (36.1 percent) and CBD cases (40.1 percent) occurred among the broad occupational groups of Crafts and Line Operators (page 15). Among Craft workers, HVAC mechanics continue to show percentages exceeding the 0.2 µg/m<sup>3</sup> action level that are much higher than the percentages experienced by other Craft workers, but the percentage reflects exposure monitoring results for only 28 individuals (pages 26 and 27).

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<sup>1</sup> The increase in cases reported for previous years is due to late submitted and corrected data.

- Through 2017, the highest percentage of action level exceedances by work history activity (a high level rollup of job functions) is among workers where the work activity is unknown or not reported.
- Data coordinator turnover remained below the level observed in 2014.

Reporting Organizations with Data Coordinator Changes in Calendar Years 2013-2017			
Year	Number (and Percentage) of Reporting Organizations	Total Data Coordinator Changes	Reporting Organizations with 2 or More 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

The BAWR program remains a key component of AU evaluation and analysis to inform management and stakeholders of the continued vigilance and success of the DOE sites in protecting worker health. The occurrence of a new CBD diagnosis in 2016, the first new case since 2011, emphasizes the value of continued adherence to safety and monitoring programs. The number of new beryllium sensitizations occurring in 2017, 16 compared with 7 in 2016, provides evidence of a significant change in the frequency of BeS diagnoses between the two years. While exceedances above the action level occurred in 2017 at a slightly higher frequency than in 2016 and 2015, exceedances in these years still remain below the frequency recorded before 2013. As in past years, a major limitation in interpreting the occurrence of sensitizations and CBD in relation to exposure levels and time since exposure is a lack of pre-diagnosis exposure monitoring data for the majority of both sensitized workers and those diagnosed with CBD.

As the new program lead for the BAWR, comments and feedback on the program and the annual report are very welcome and appreciated

Best regards,

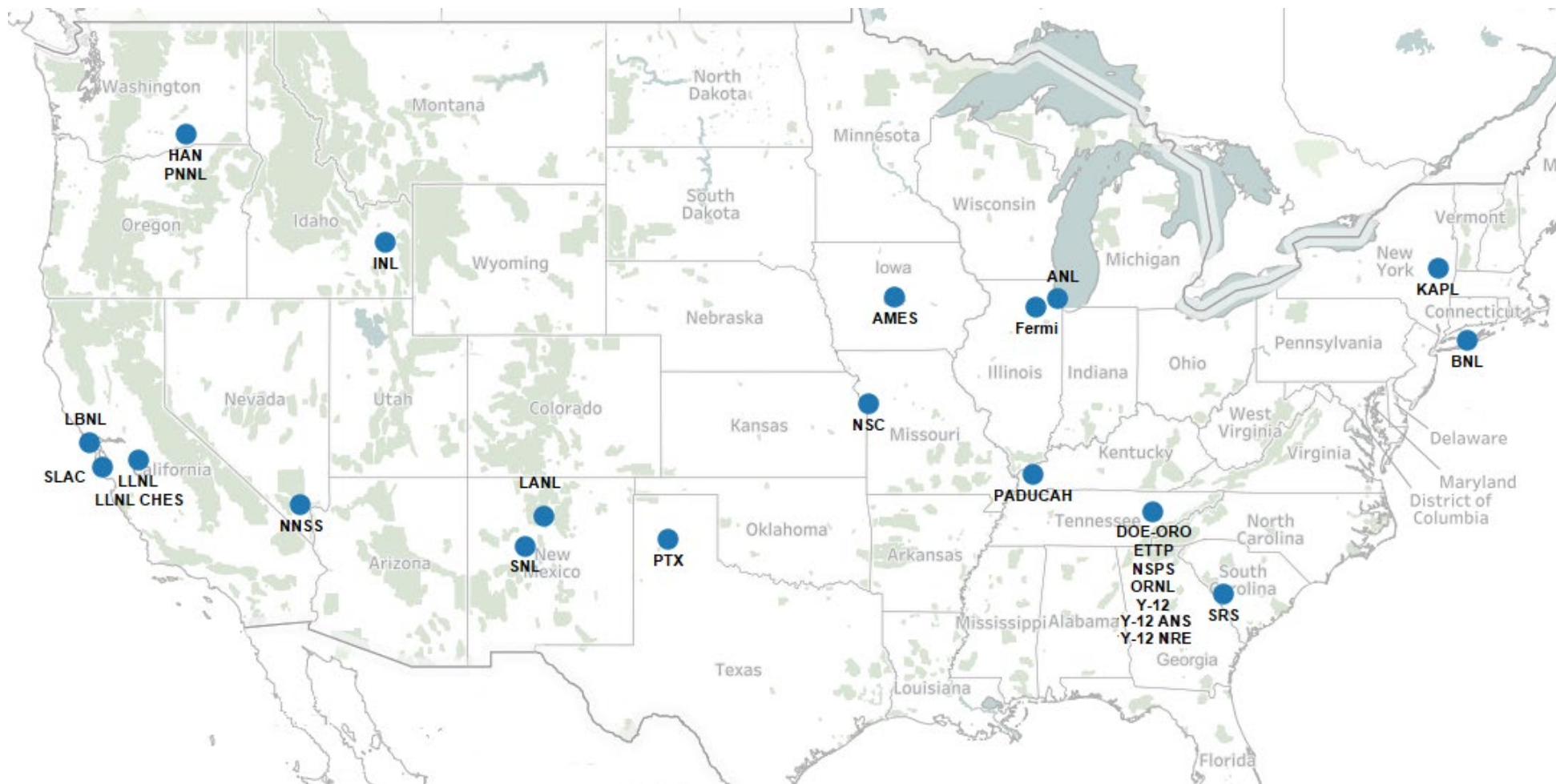
Daniela Stricklin, Ph.D., MPH  
Program Manager, BAWR

**Finalized on behalf of:**

*Cliff Strader*

Cliff Strader, Ph.D.  
Program Manager, BAWR (retired November 30, 2018)

## ***Location of 26 Reporting Organizations Currently Submitting Data to BAWR***



This map of the continental United States shows the locations of the reporting organizations.



## ***26 Reporting Organizations Currently Submitting Data to BAWR***

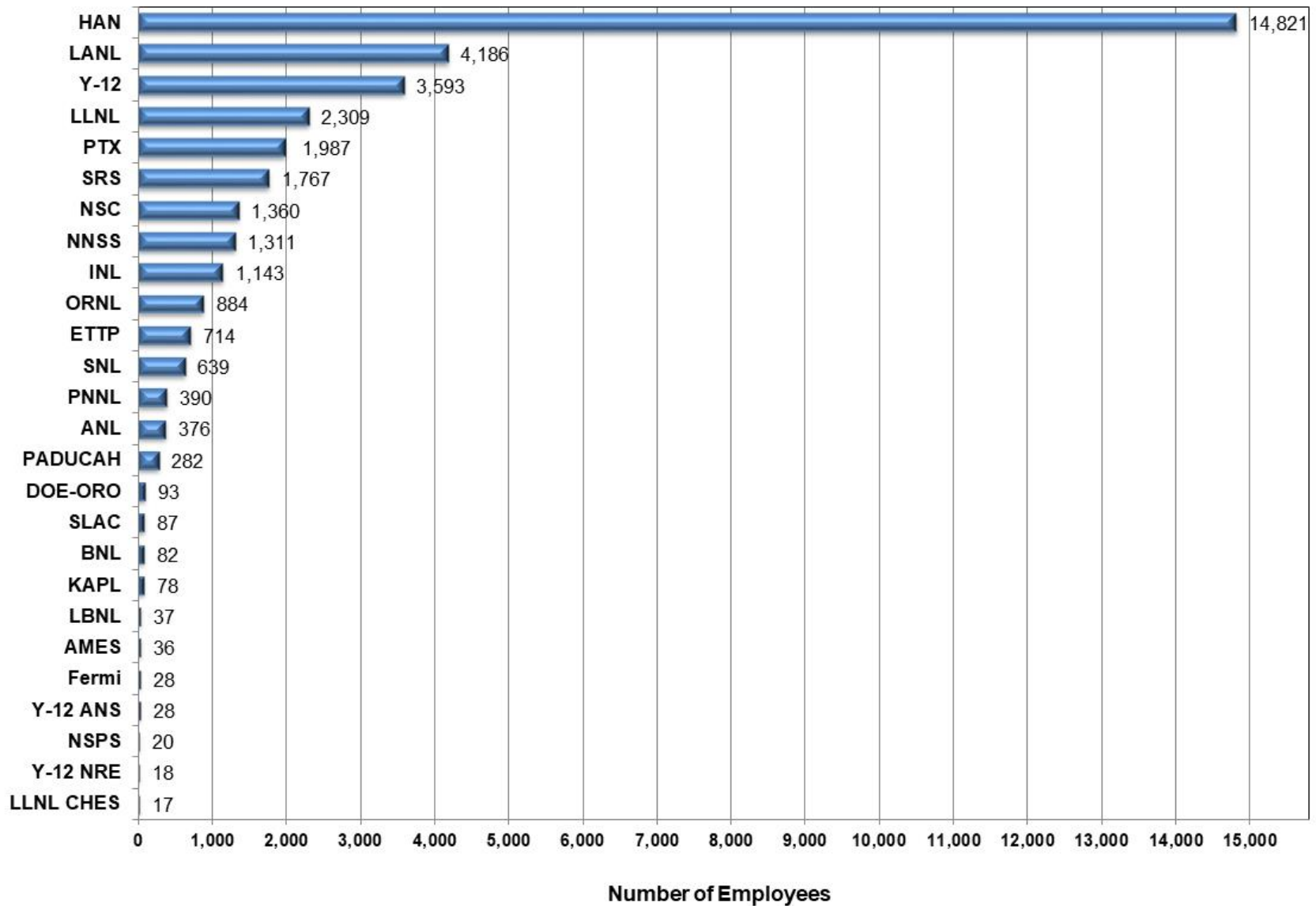
Ames Laboratory (AMES)	National Security Campus (NSC)
Argonne National Laboratory (ANL)	National Strategic Protective Services, LLC for ETP and ORNL (NSPS)
Brookhaven National Laboratory (BNL)	Nevada National Security Site (NNSS)
DOE Oak Ridge Office (DOE-ORO)	Oak Ridge National Laboratory (ORNL)
East Tennessee Technology Park (ETTP)	Pacific Northwest National Laboratory (PNNL)
Fermi National Accelerator Laboratory (Fermi)	Paducah Site (PADUCAH)
Hanford Site (HAN)	Pantex Plant (PTX)
Idaho National Laboratory (INL)	Sandia National Laboratories (SNL)
Knolls Atomic Power Laboratory (KAPL)	Savannah River Site (SRS)
Lawrence Berkeley National Laboratory (LBNL)	SLAC National Accelerator Laboratory (SLAC)
Lawrence Livermore National Laboratory (LLNL)	Y-12 Atkins Nuclear Secured (Y-12 ANS)
LLNL Clean Harbors Environmental Services (LLNL CHES)	Y-12 National Security Complex (Y-12)
Los Alamos National Laboratory (LANL)	Y-12 Navarro Research and Engineering (Y-12 NRE)

## ***7 Inactive BAWR Reporting Organizations***

Advanced Mixed Waste Treatment Project (AMWTP)	Southwestern Power Administration (SWPA)
LLNL Boston University (LLNL BU)	Wackenhut Security Services Inc. for ETP, ORNL, and Y-12 (WSI)
LLNL Envirocon, Inc. (LLNL ENVC)	Y-12 URS Corporation (Y-12 URS)
Rocky Flats Closure Project (RF)	

These tables show the organizations that are submitting or have previously submitted data to the Registry.

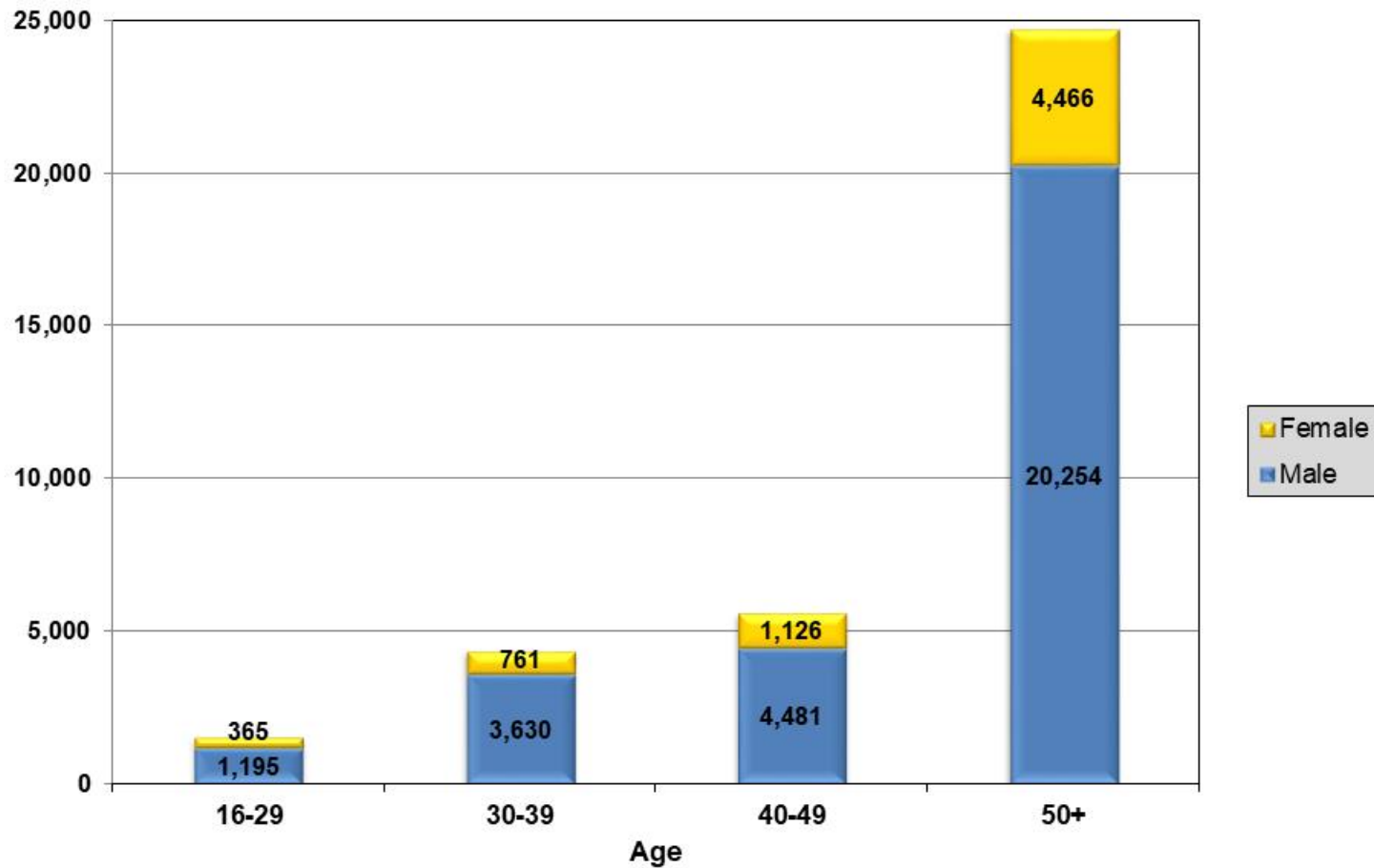
**Total 36,286 Employees by BAWR Reporting Organization Through 2017\***



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

The figure above shows the cumulative numbers of beryllium-associated workers reported to the Registry by reporting organization.

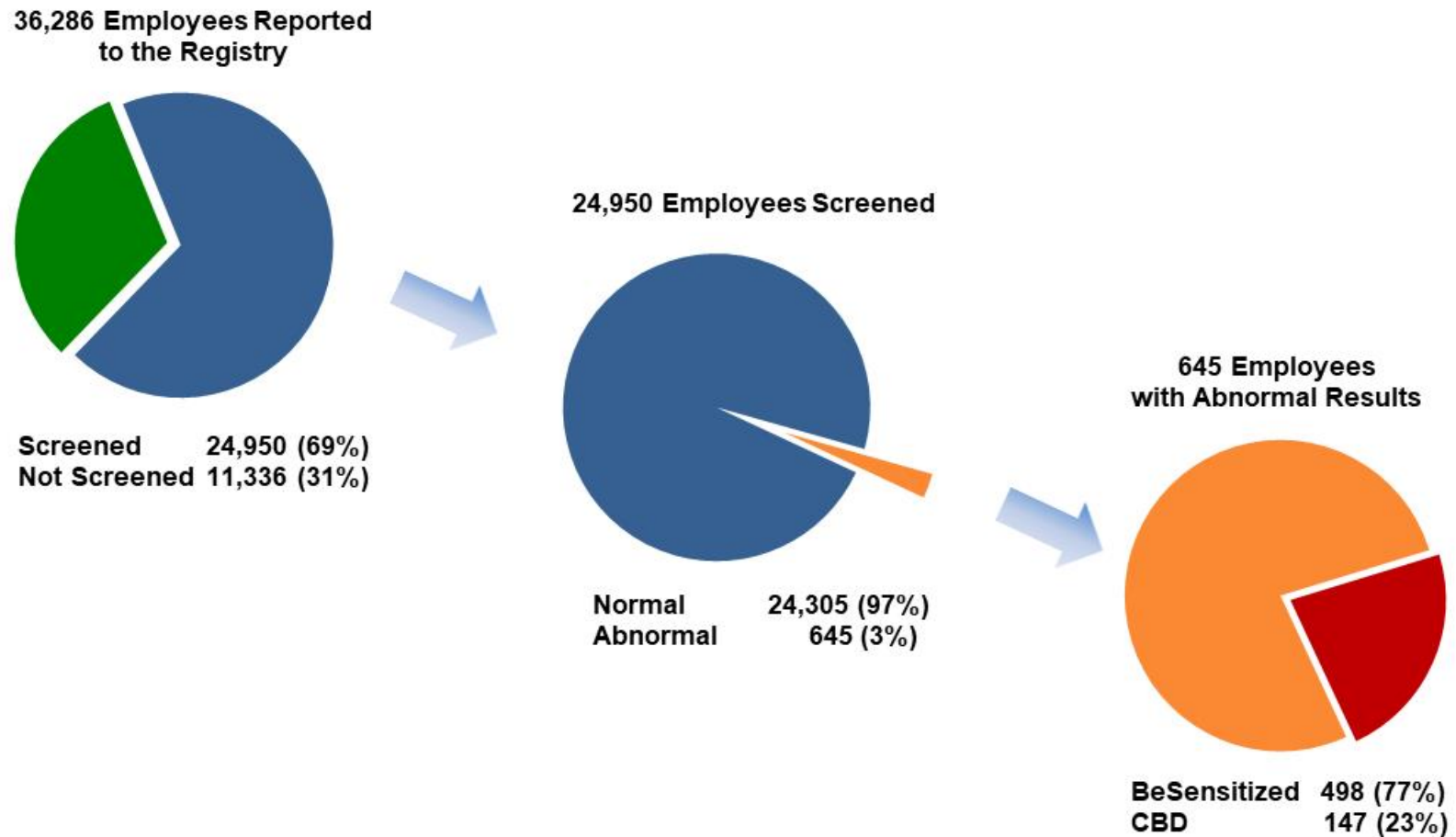
***Gender and Age Distribution of Employees Reported to BAWR Through 2017\****



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

These stacked bars depict the gender and age distribution of beryllium-associated workers reported to the Registry through 2017, showing they are predominantly male and long-term workers. Eight (8) workers, for whom demographic data were not available, are excluded from this chart.

***Screening Status and Progression from BeLPT Testing to “Sensitized” to CBD Through 2017\****



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

From 2016 to 2017, the 26 organizations currently reporting to the Registry identified 34 additional sensitized employees and no additional employees with CBD.

***Number of Employees BeLPT Tested, “Sensitized,” or CBD by Reporting Organization Through 2017\****

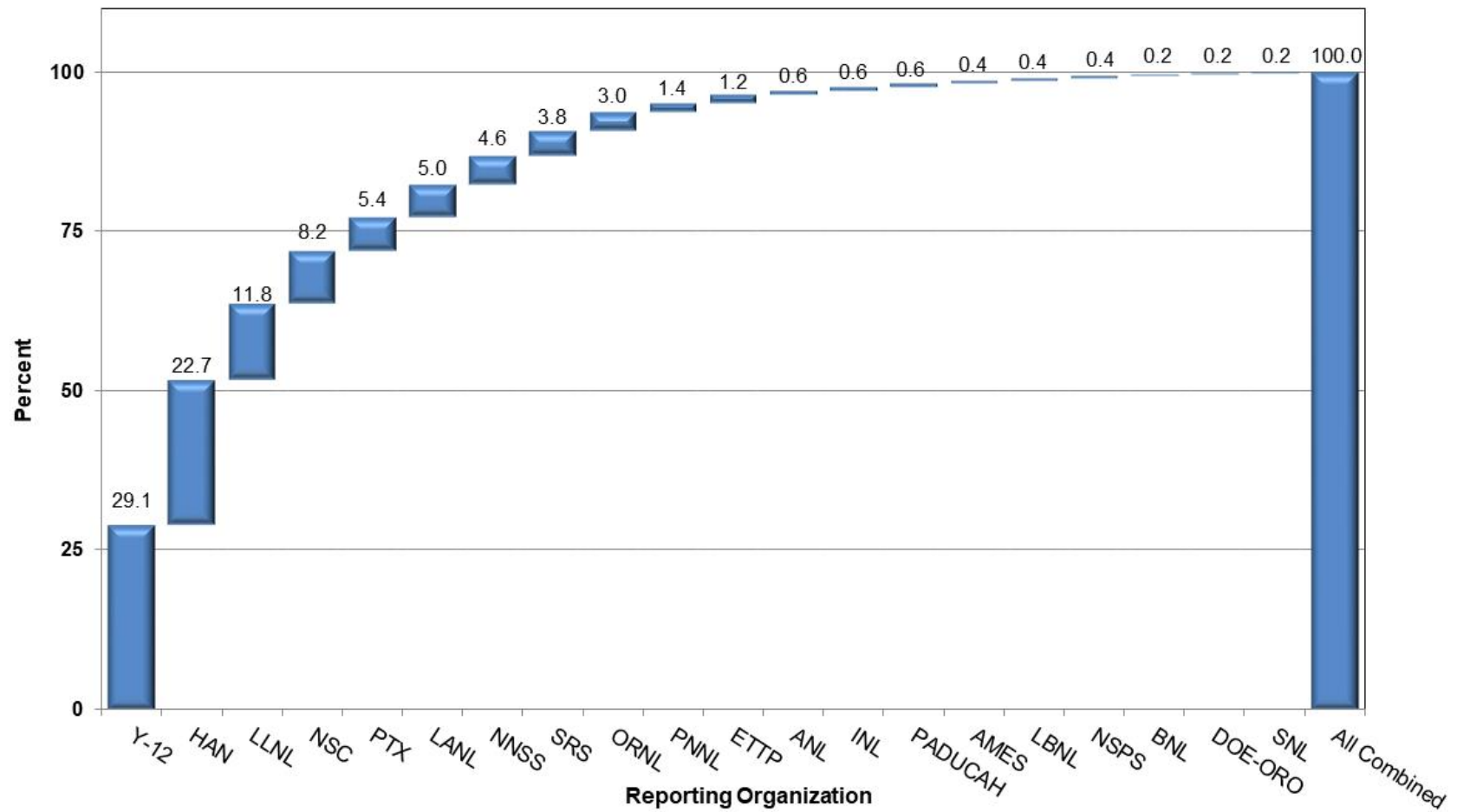
Reporting Organization	Number of:		
	Employees with BeLPT Results	“Sensitized” Employees	Employees with CBD
HAN	9,137	113 (1.2 %)	34 (0.4 %)
Y-12	2,919	145 (5.0 %)	62 (2.1 %)
LANL	2,854	25 (0.9 %)	3 (0.1 %)
PTX	1,892	27 (1.4 %)	15 (0.8 %)
LLNL	1,577	59 (3.7 %)	3 (0.2 %)
NSC	1,261	41 (3.3 %)	14 (1.1 %)
NNSS	1,169	23 (2.0 %)	5 (0.4 %)
ORNL	804	15 (1.9 %)	0
SRS	788	19 (2.4 %)	6 (0.8 %)
SNL	636	1 (0.2 %)	0
INL	421	3 (0.7 %)	0
ETTP	405	6 (1.5 %)	4 (1.0 %)
PNNL	360	7 (1.9 %)	0
ANL	169	3 (1.8 %)	0
PADUCAH	167	3 (1.8 %)	0
DOE-ORO	93	1 (1.1 %)	0
BNL	51	1 (2.0 %)	0
SLAC	49	0	1 (2.0 %)
KAPL	39	0	0
AMES	36	2 (5.6 %)	0
Y-12 ANS	27	0	0
LBNL	26	2 (7.7 %)	0
Fermi	20	0	0
NSPS	19	2 (10.5 %)	0
Y-12 NRE	18	0	0
LLNL CHES	13	0	0
<b>Totals</b>	<b>24,950</b>	<b>498 (2.0 %)</b>	<b>147 (0.6 %)</b>

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

This table shows the cumulative numbers of beryllium-associated workers reported to the Registry who have been screened using BeLPT testing, have BeLPT results indicating they are “sensitized,” or have been diagnosed with CBD.



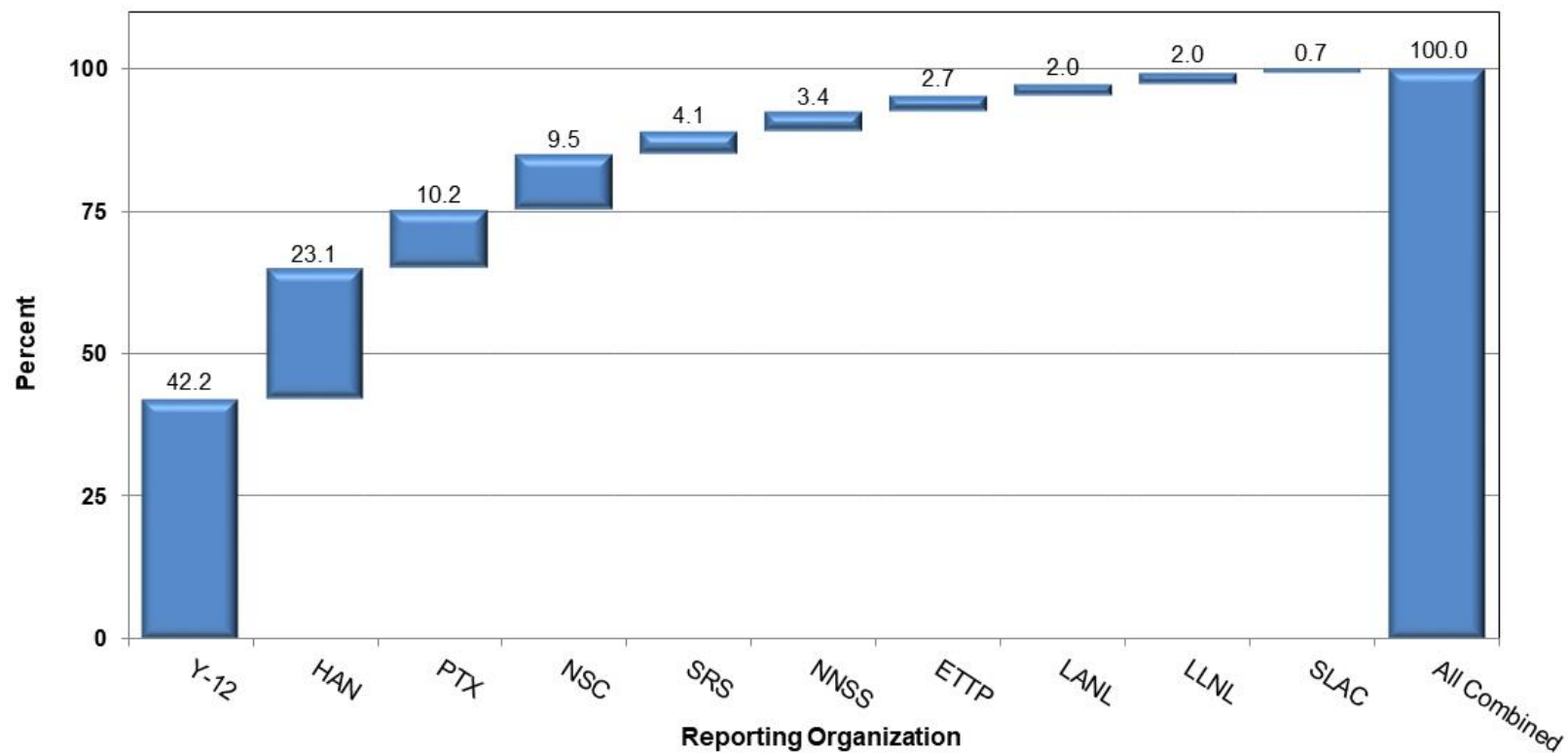
**Percentage Distribution by Reporting Organization of 498 BeSensitized Employees Through 2017\***



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

The chart above depicts the percentage distribution of beryllium sensitized employees by reporting organization.

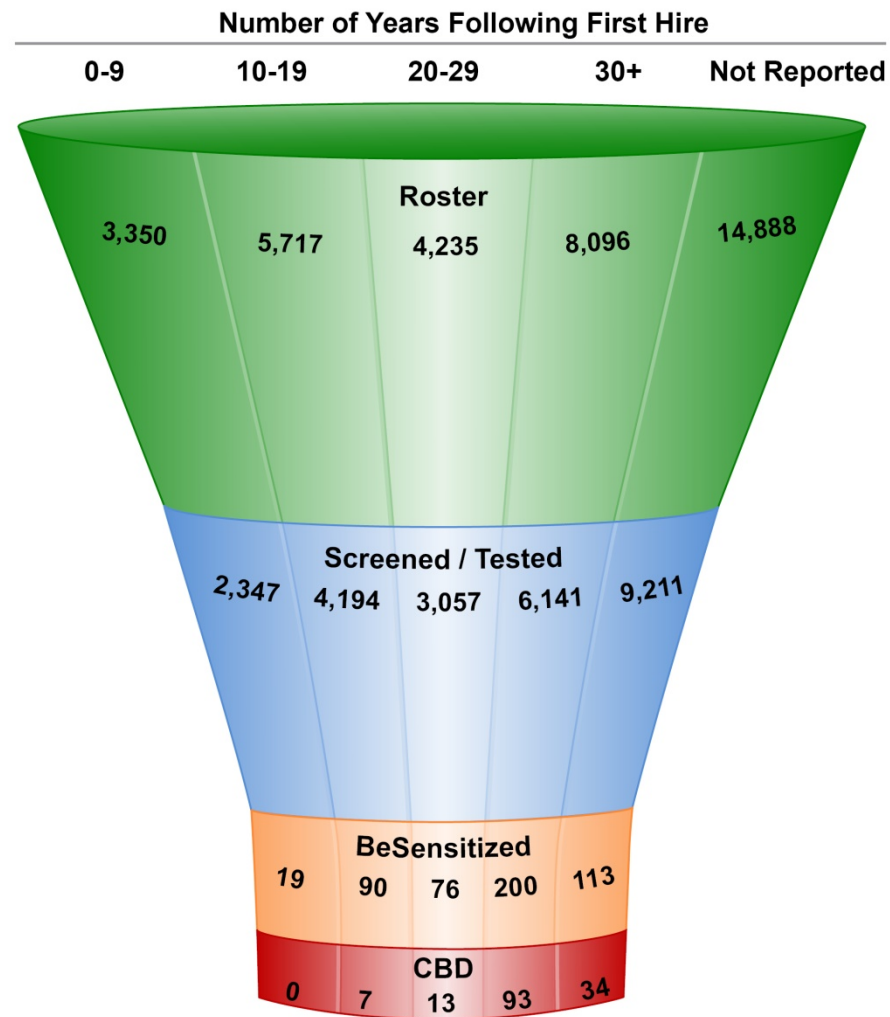
**Percentage Distribution by Reporting Organization of 147 Employees Diagnosed with CBD Through 2017\***



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

This chart illustrates the percentage distribution of employees diagnosed with CBD by reporting organization.

***Number of Years Following Year of First Hire for Employees Who Are “Sensitized” or CBD***



The above chart categorizes beryllium-associated workers by years following first hire, including roster total and those who have been diagnosed as either beryllium sensitized or having CBD.

***Year of First Positive or Abnormal BeLPT Result for Beryllium-Associated Workers Who Have Been Tested***

Year of BeLPT Result	Number of:		
	Employees Tested	"Sensitized" Employees	Employees with CBD
<2000	708	35	10
2000	1,629	29	17
2001	3,236	43	17
2002	3,967	43	15
2003	3,967	13	5
2004	3,814	14	3
2005	5,115	28	6
2006	4,860	45	9
2007	4,578	46	5
2008	5,073	29	7
2009	6,218	50	2
2010	6,892	34	1
2011	7,926	21	0
2012	6,172	5	0
2013	5,577	8	0
2014	6,010	11	0
2015	6,052	13	0
2016	6,058	2	0
2017	6,624	8	0
<b>Year Not Reported</b>	0	21	50

The table above lists the numbers of beryllium-associated workers BeLPT tested each year, and the year of first positive or abnormal BeLPT result for those beryllium sensitized or diagnosed as having CBD.

***Work History Activity and BeLPT Status for 24,950 Beryllium-Associated Workers Screened Through 2017\****

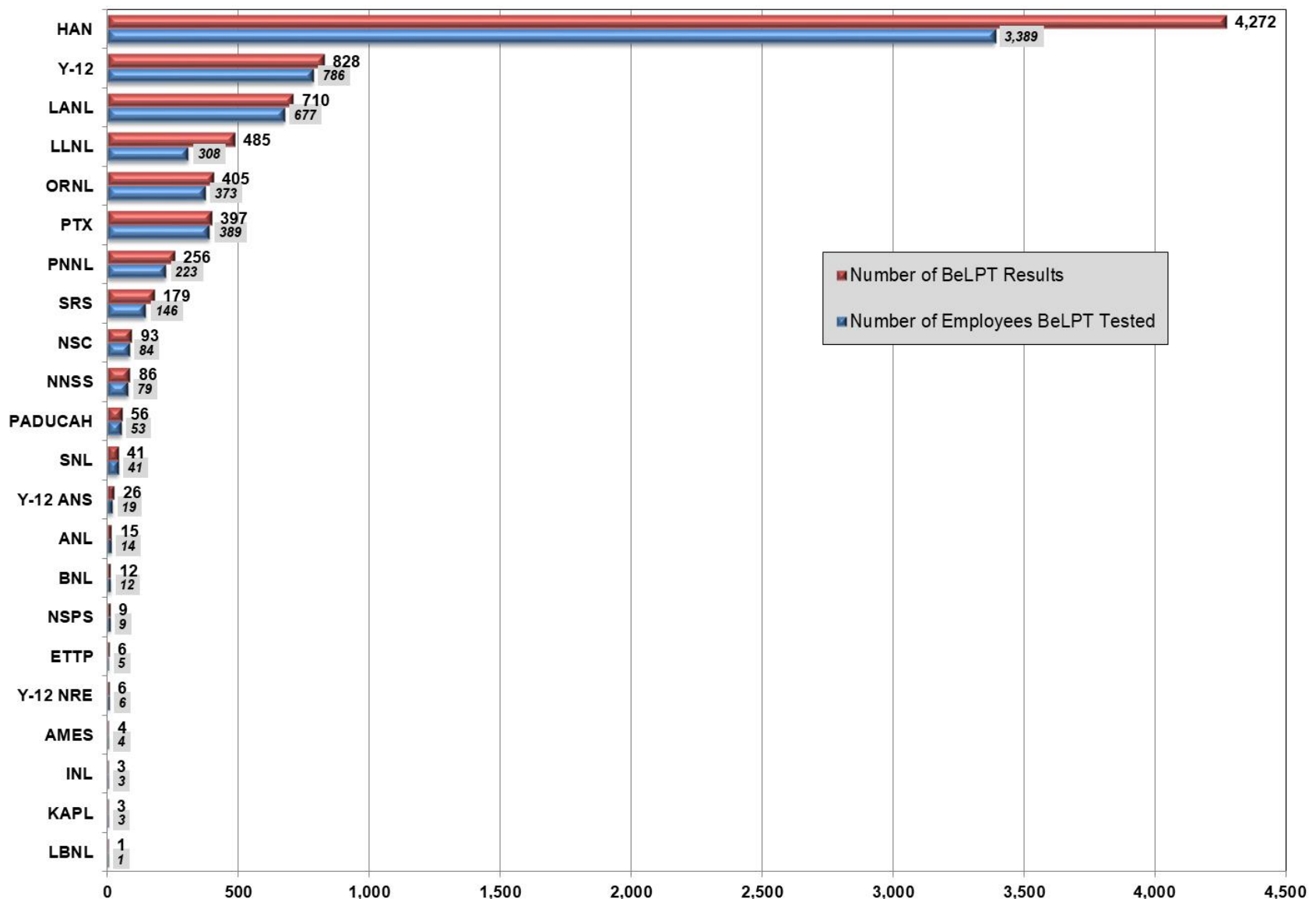
Work History Activity	Number of:		
	Employees with BeLPT Results	"Sensitized" Employees	Employees with CBD
Management	1,707	42	10
Administrative Support	1,043	32	10
In-House Professionals	1,650	38	14
Field Professionals	2,143	44	7
Technical Support	3,231	65	13
Service	1,434	29	12
Security and Fire	1,495	27	7
Crafts	4,270	101	36
Line Operators	2,772	79	23
Guests	68	0	0
Unknown	713	13	11
Not Reported	4,424	28	4
<b>Totals</b>	<b>24,950</b>	<b>498</b>	<b>147</b>

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

The above table lists beryllium sensitized or CBD diagnosed beryllium-associated workers through 2017 grouped by their work history activity, which is a high level rollup of job function.

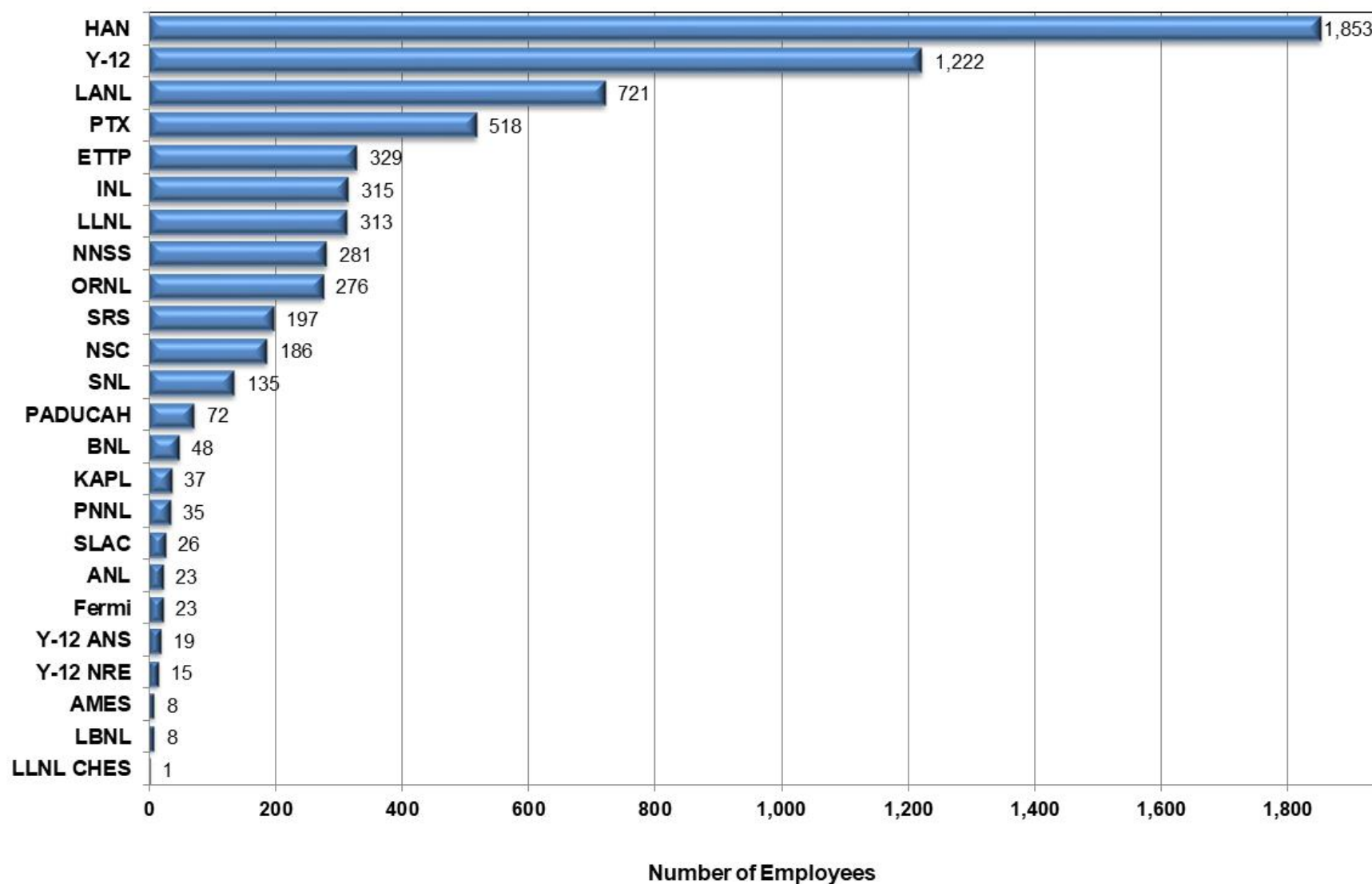


***Distribution of 7,893 BeLPT Results for 6,624 Employees by Reporting Organization for Calendar Year 2017***



This chart compares the number of BeLPT tests conducted to the number of employees tested for reporting organizations. Employees with Abnormal or Borderline BeLPT results will probably be tested multiple times in a year.

***Distribution by Reporting Organization of 6,661 Beryllium-Associated Workers Exposure Monitored Through 2017\****



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

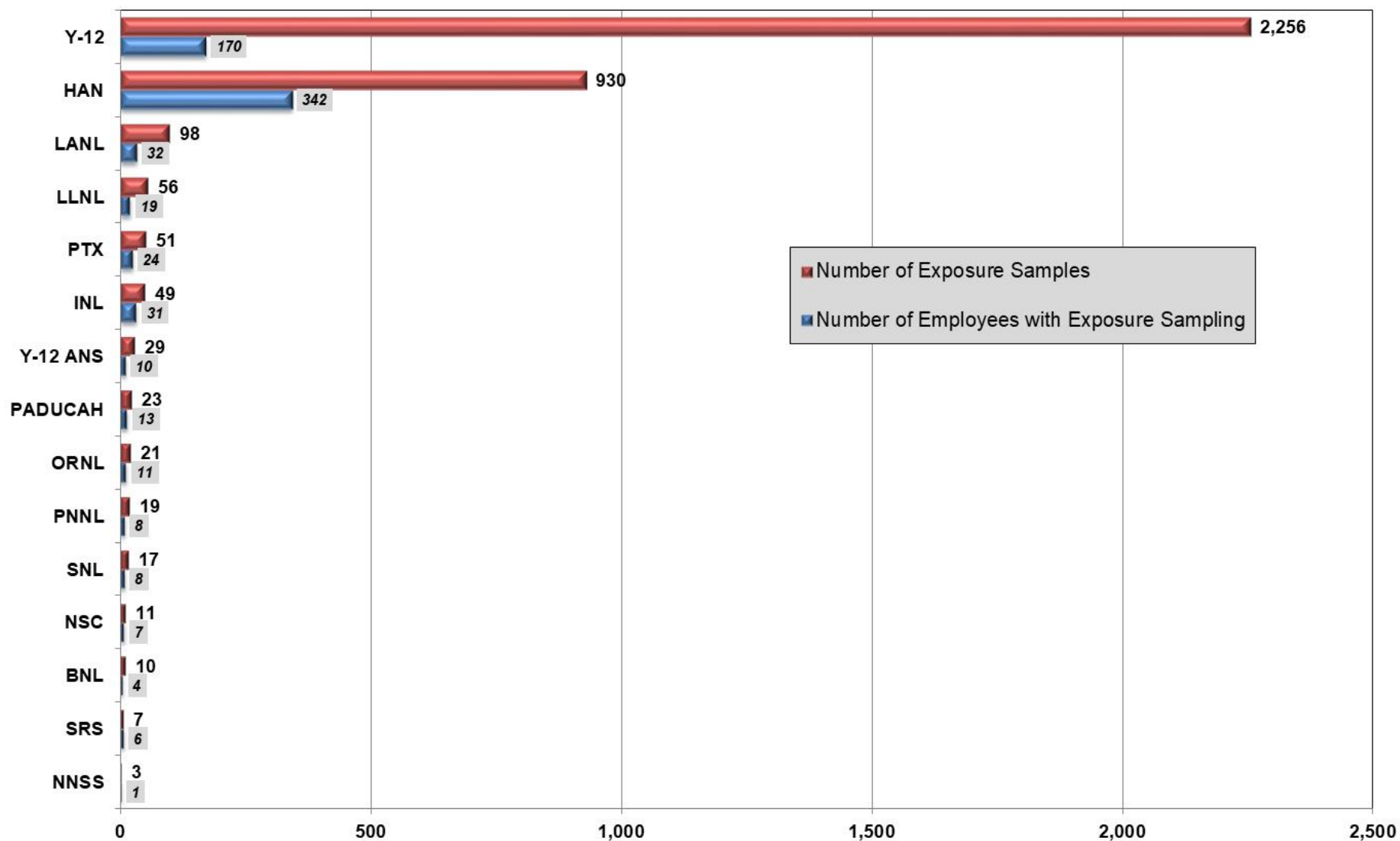
This chart shows the distribution of beryllium-associated workers by reporting organization who have been monitored for beryllium exposure.

***Annual Number of Employees Exposure Monitored by Reporting Organization for 2008 – 2017***

Reporting Organization	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
AMES		6	1	2			2			
ANL	1									
BNL	8	3	7	1	18		2	3	2	4
DOE-ORO										
ETTP		19	42	30	3	9	2		2	
Fermi							1			
HAN	163	135	313	395	249	287	325	290	265	342
INL	49	57	44	39	5	42	45	55	45	31
KAPL	5	5	5	4	4	3	2			
LANL	59	73	55	46	44	34	80	31	59	32
LBNL	1			2		1	3			
LLNL	76	100	78	63	59	34	25	32	21	19
LLNL CHES				1						
NNSS	43	18	18	19	22	14	17	5	5	1
NSC	18	15	18	17	43	27	18	9	9	7
NSPS										
ORNL	46	48	44	47	46	61	24	20	15	11
PADUCAH		9	47	3	5	4	5			13
PNNL						1	19	7	10	8
PTX	38	35	30	42	51	23	21	20	52	24
SLAC	2			2						
SNL		5	16	19	17	3	5	16	10	8
SRS	34	28	19	2	10	1	5	2	3	6
Y-12	216	307	435	362	244	237	220	204	175	170
Y-12 ANS								15	10	10
Y-12 NRE	4	10	8	5	4	5	4			

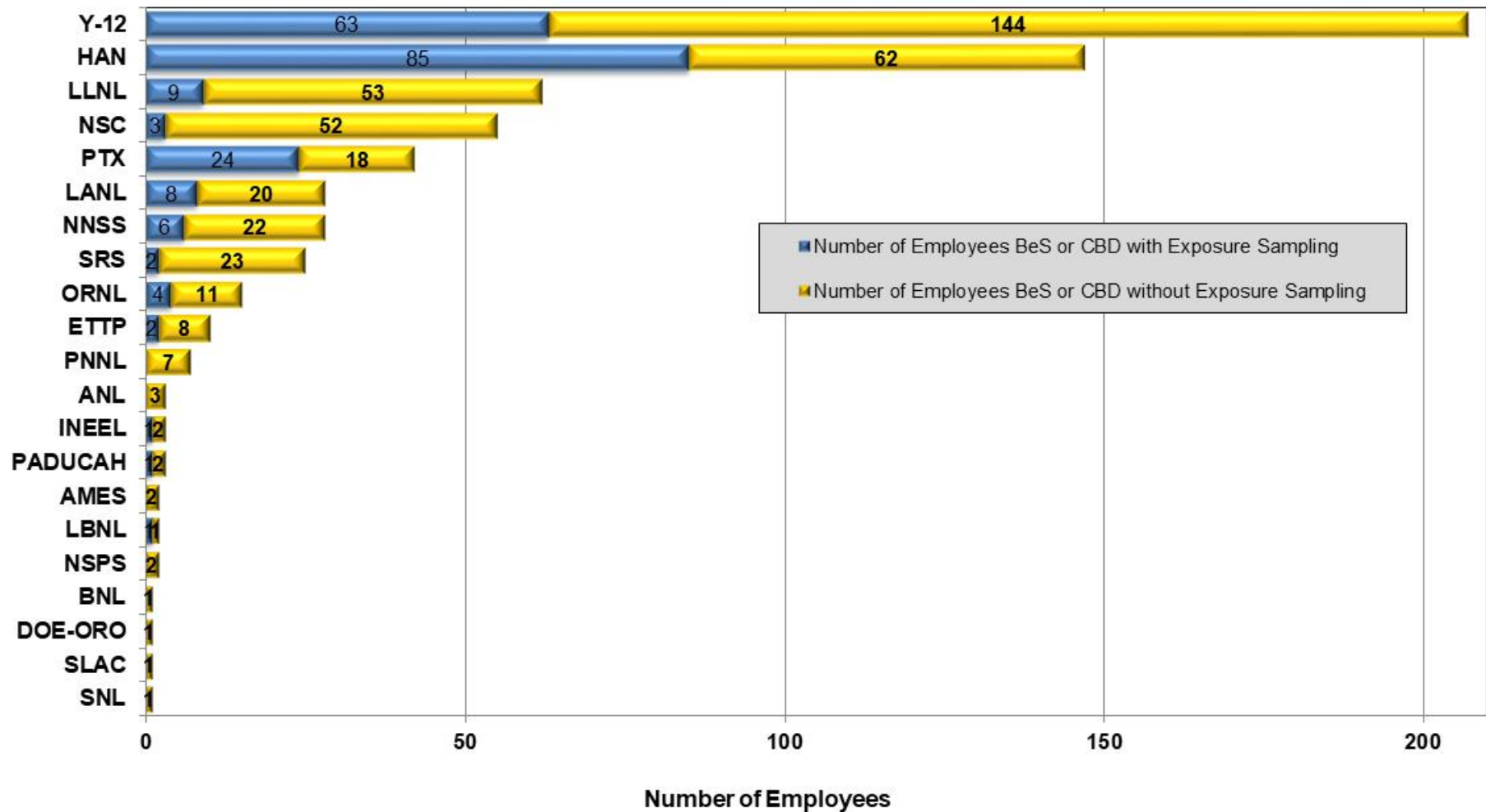
The table above shows the numbers of individuals by reporting organization whose exposures were monitored by an industrial hygienist at least once in each year in the past 10 years. Fifteen (15) reporting organizations provided exposure monitoring results with monitoring dates in 2017. Organization-specific totals for a given year may change from totals in previous annual reports due to late reporting and/or corrections.

***Distribution of 3,580 Exposure Samples for 686 Employees by Reporting Organization for Calendar Year 2017***



The chart above illustrates the distribution of exposure samples and employees monitored across 15 reporting organizations during 2017.

***Distribution of Employees BeSensitized or CBD by  
Reporting Organization and Exposure Sampling Status Through 2017\****

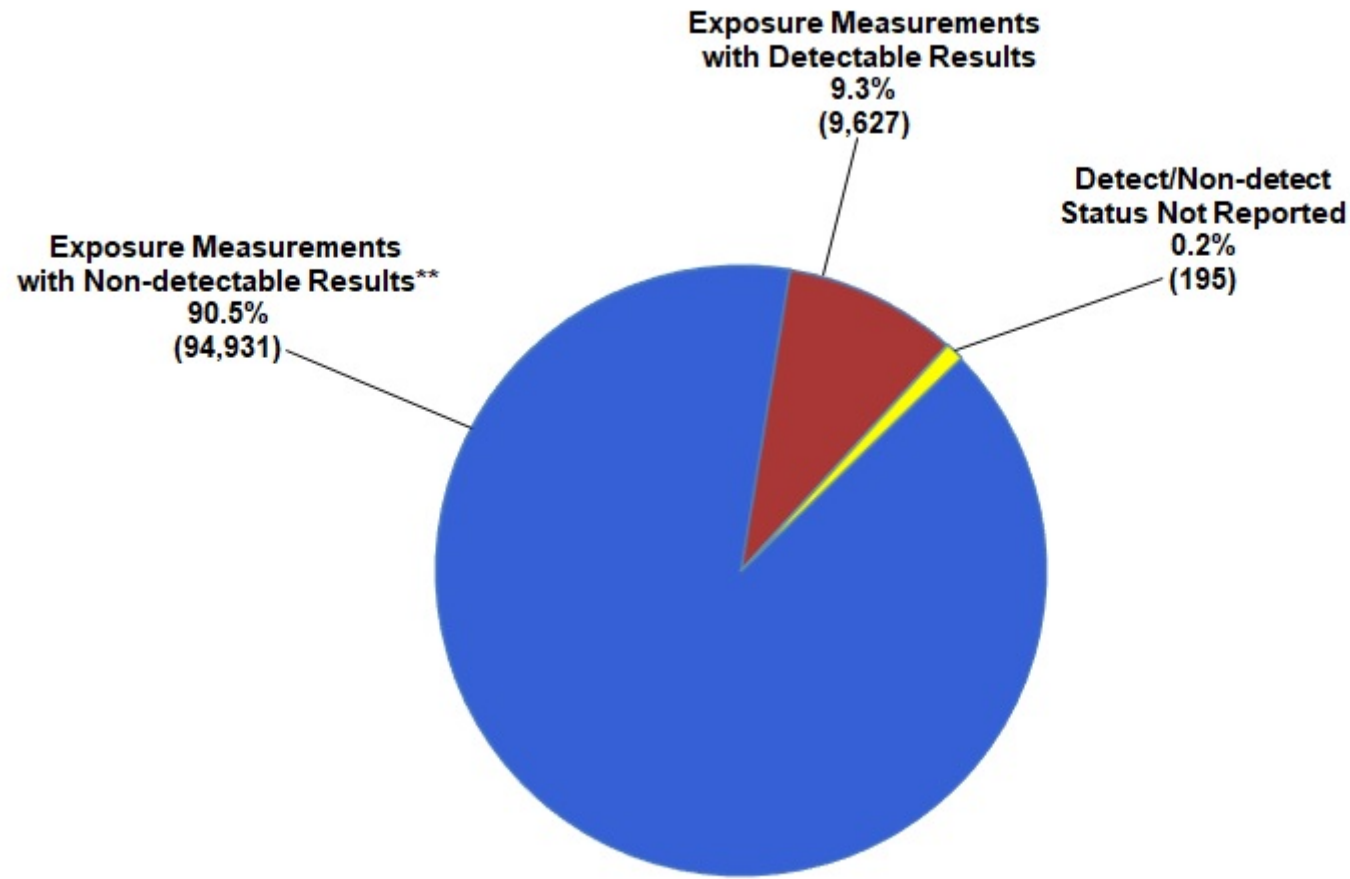


\*Some reporting organizations have provided data that predate the 2002 start date of the Registry.

Reporting from the Registry shows that no exposure sampling data have been reported for 436 (68 percent) of the 645 employees who are BeSensitized or diagnosed with CBD.



***Distribution of 104,753 Reported Exposure Levels Through 2017\****



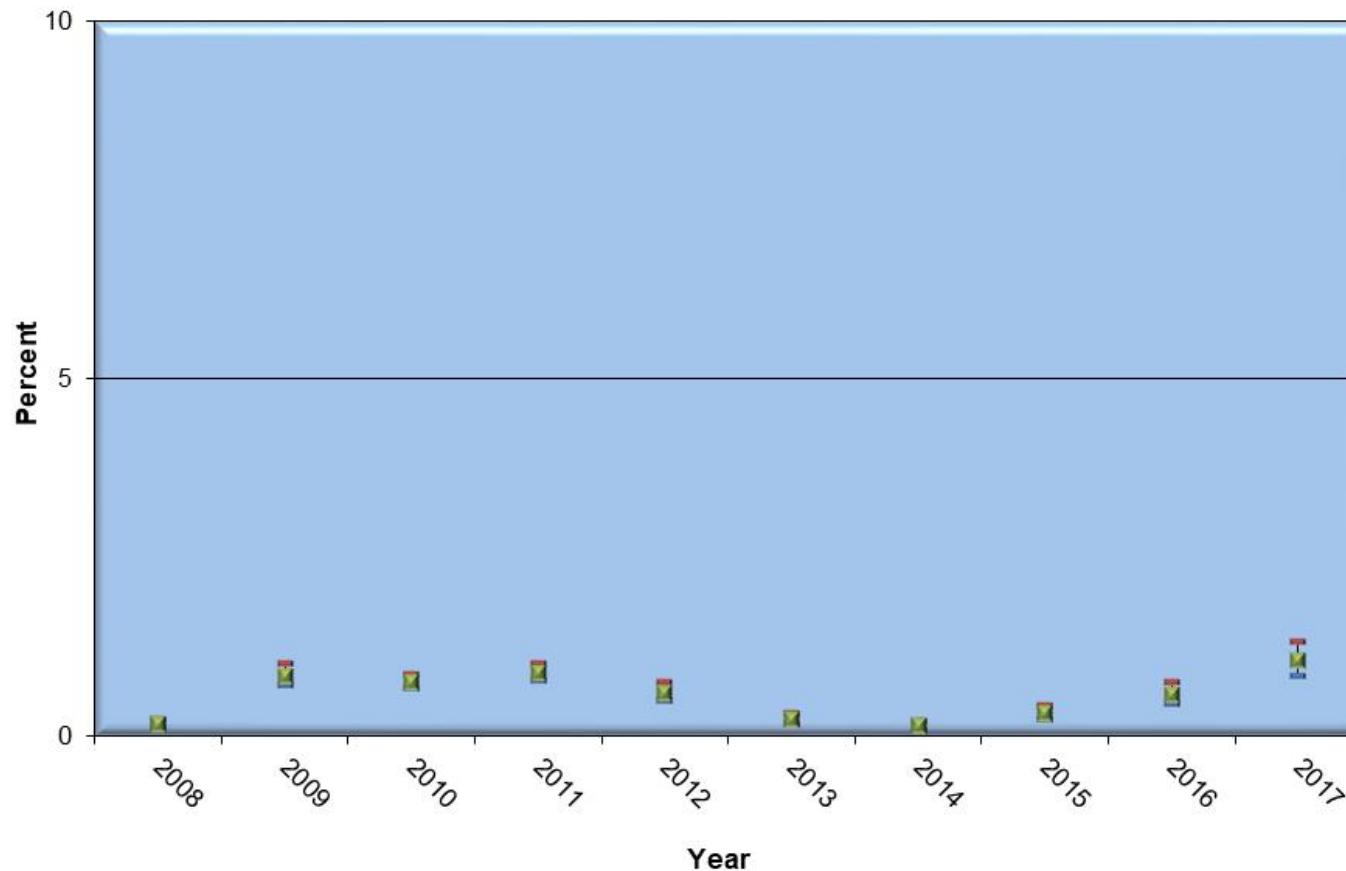
\*Some reporting organizations have provided data that predate the 2002 start date of the Registry.

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

Of the 104,753 exposure monitoring records submitted to the Registry, 90.5 percent 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  $\mu\text{g}/\text{m}^3$ .

## DOE-wide Exposure Trend for 2008 – 2017

Percent Exceeding  $0.2 \mu\text{g}/\text{m}^3$  Based on 95 Percent Confidence Limits



This figure is a DOE-wide rollup of 8-hour time weighted average personal exposure monitoring results. Detailed data are presented on the following page. Totals for an individual year may vary from previous reports due to late reporting and/or corrections. These data indicate that the CBD prevention programs being 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.

The metrics are distribution-free product limit estimates of percent exceeding, which are used to accommodate the high percentage of non-detect results in these data sets. Non-detected values greater than  $0.2 \mu\text{g}/\text{m}^3$  were excluded from this analysis. For details see "Statistical Methods and Software for the Analysis of Occupational Exposure Data with Non-Detectable Values," Frome EL and Wambach PF, ORNL/TM-2005/52, <http://www.csm.ornl.gov/esh/aoed/ORNLTm2005-52.pdf>.

### Summary Statistics for 2008 – 2017 8-Hour Time Weighted Average Exposure Monitoring Results

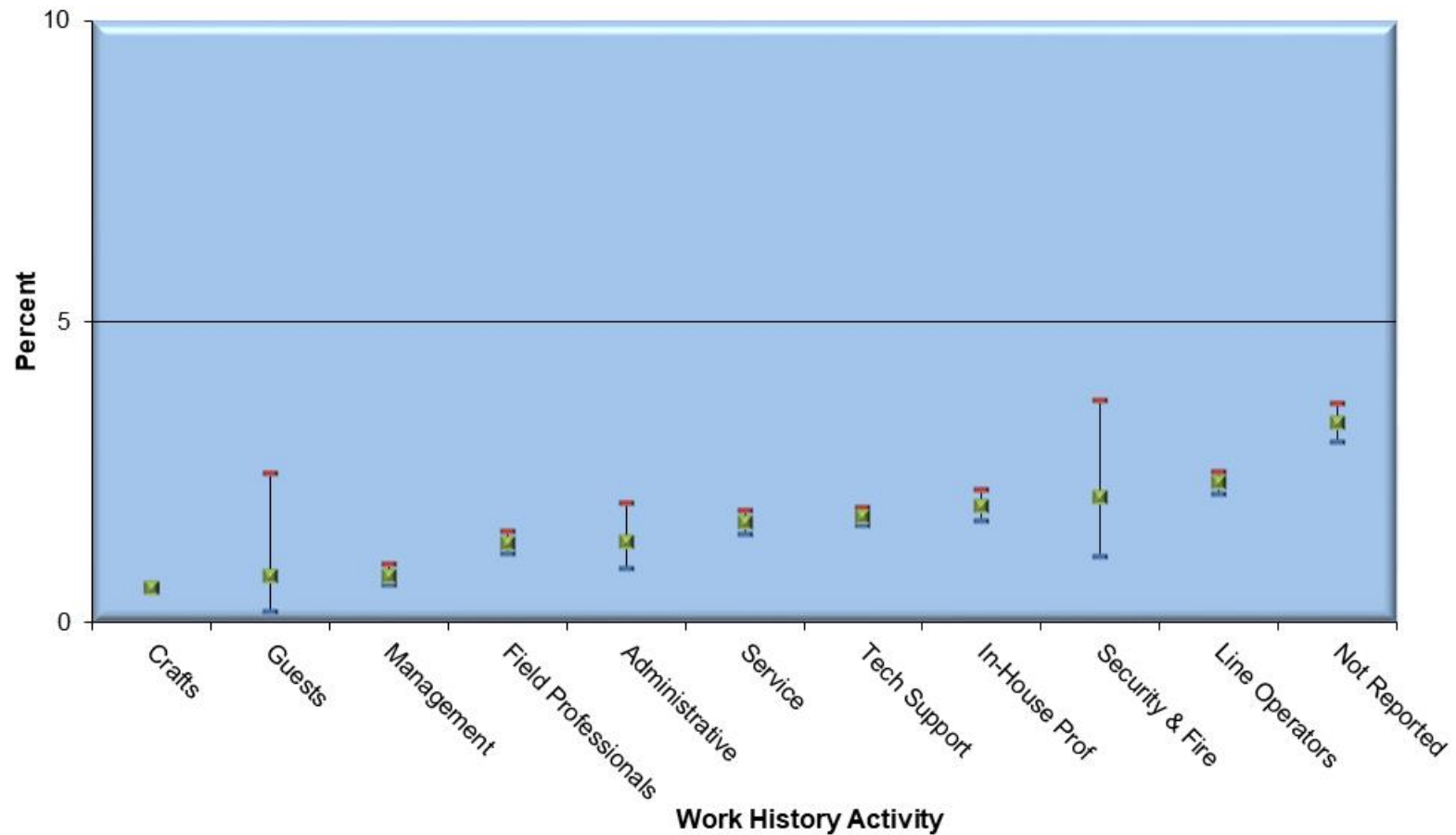
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	All Years
Number of reported monitoring results	5,188	6,667	13,384	10,190	6,049	5,272	5,335	5,050	4,436	3,271	64,842
Number of detected values	453	273	624	530	303	216	175	168	238	164	3,144
Percent non-detects	91.3	95.9	95.3	94.8	95.0	95.9	96.7	96.7	94.6	95.0	95.2
Number of individuals monitored	759	872	1,178	1,101	824	786	819	708	680	686	4,150*
Arithmetic mean (EX) ( $\mu\text{g}/\text{m}^3$ )	0.004	0.163	0.052	0.099	0.032	0.004	0.002	0.008	0.016	1.263	0.025
Lower confidence limit of EX ( $\mu\text{g}/\text{m}^3$ )	0.004	0.049	0.029	0.048	0.015	0.003	0.002	0.004	0.008	0.159	0.020
Upper confidence limit of EX ( $\mu\text{g}/\text{m}^3$ )	0.005	0.541	0.092	0.201	0.068	0.006	0.003	0.017	0.031	10.008	0.031
Observed 95th percentile of data ( $\mu\text{g}/\text{m}^3$ )	0.016	0.005	0.009	0.009	0.007	0.005	0.004	0.004	0.005	0.006	0.007
95% upper tolerance limit of the 95th percentile ( $\mu\text{g}/\text{m}^3$ )	0.033	0.022	0.020	0.021	0.017	0.015	0.017	0.017	0.020	0.020	0.020
Largest value ( $\mu\text{g}/\text{m}^3$ )	1.774	11.762	79.330	18.023	4.013	0.804	0.876	1.847	8.865	87.419	87.419
Percent exceeding 0.2 $\mu\text{g}/\text{m}^3$ (F)	0.2	0.9	0.8	0.9	0.6	0.2	0.1	0.3	0.6	1.1	0.6
Lower confidence limit for F	0.1	0.7	0.7	0.8	0.5	0.2	0.1	0.2	0.5	0.8	0.6
Upper confidence limit for F	0.2	1.0	0.9	1.0	0.8	0.3	0.2	0.4	0.8	1.3	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 2008 through 2017 is 4,150.

This table provides additional summary statistics for the DOE-wide rollup of 8-hour time weighted average personal exposure monitoring results. Arithmetic mean, 95th percentile, and percent exceeding metrics are Kaplan-Meier product limit estimates. The very high percent 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.

***Exposure by Work History Activity Through 2017\* (Ranked by Percent Exceeding)***

**Percent Exceeding 0.2  $\mu\text{g}/\text{m}^3$  Based on 95 Percent Confidence Limits**



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

Shown above are exposure data grouped by work activity. The data are through calendar year 2017 and detailed data are presented on the following page. The work activities are the high level rollup of job functions used in the table "Work History Activity and BeLPT Status for 24,950 Beryllium-Associated Workers Screened Through 2017." Direct comparison with prior years' reports may be problematic due to late reporting and/or corrections.

### Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Work History Activity Through 2017

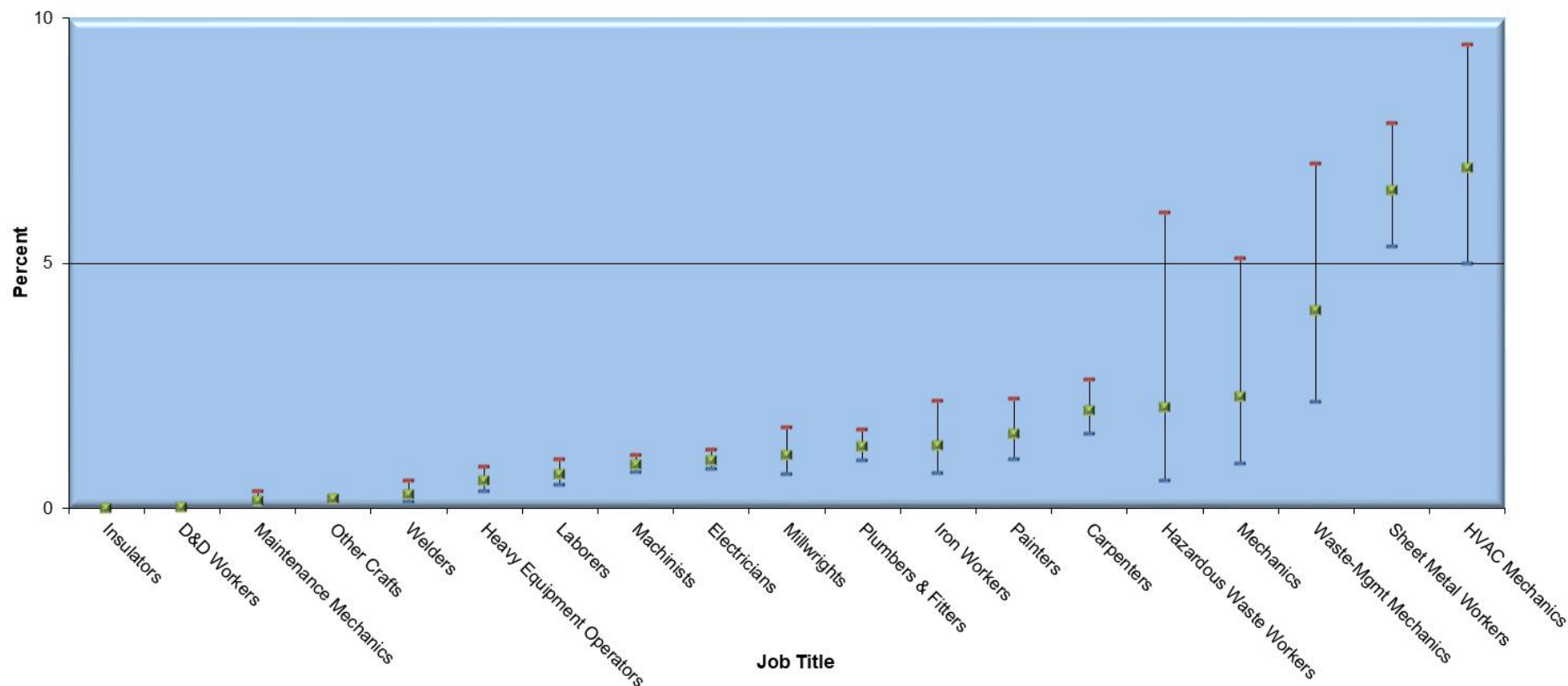
Work History Activity	Admin	Crafts	Field Prof	Guests	In-House Prof	Line Operators	Management	Security & Fire	Service	Tech Support	Not Reported	All Combined
Number of reported monitoring results	888	46,986	5,876	97	4,461	11,004	4,171	302	7,871	13,856	5,081	100,593
Number of detected values	82	2,723	621	28	687	1,986	470	12	684	2,161	1,704	11,158
Percent non-detects	90.8	94.2	89.4	71.1	84.6	82.0	88.7	96.0	91.3	84.4	66.5	88.9
Number of individuals monitored	79	2,067	603	8	300	1,102	283	64	575	1,121	371	2,067
Observed 95th percentile of data (ug/m <sup>3</sup> )	0.027	0.008	0.021	0.027	0.058	0.062	0.019	0.002	0.021	0.056	0.130	0.027
95% upper tolerance limit of the 95th percentile (ug/m <sup>3</sup> )	0.052	0.050	0.060	0.291	0.068	0.100	0.050	0.356	0.050	0.080	0.170	0.053
Largest value (ug/m <sup>3</sup> )	21.771	87.419	26.678	0.313	12.611	575.930	11.762	11.700	84.933	29.852	7.670	575.930
Percent exceeding 0.2 ug/m <sup>3</sup> (F)	1.4	0.6	1.3	0.8	1.9	2.3	0.8	2.1	1.7	1.8	3.3	1.3
Lower confidence limit for F	0.9	0.5	1.1	0.2	1.7	2.1	0.6	1.1	1.5	1.6	3.0	1.3
Upper confidence limit for F	2.0	0.6	1.5	2.5	2.2	2.5	1.0	3.7	1.9	1.9	3.7	1.4

This table provides additional summary statistics for 8-hour time weighted average exposure monitoring results grouped by work activity.



## Exposure by Job Title for Craft Workers Through 2017\* (Ranked by Percent Exceeding)

Percent Exceeding  $0.2 \mu\text{g}/\text{m}^3$  Based on 95 Percent Confidence Limits



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

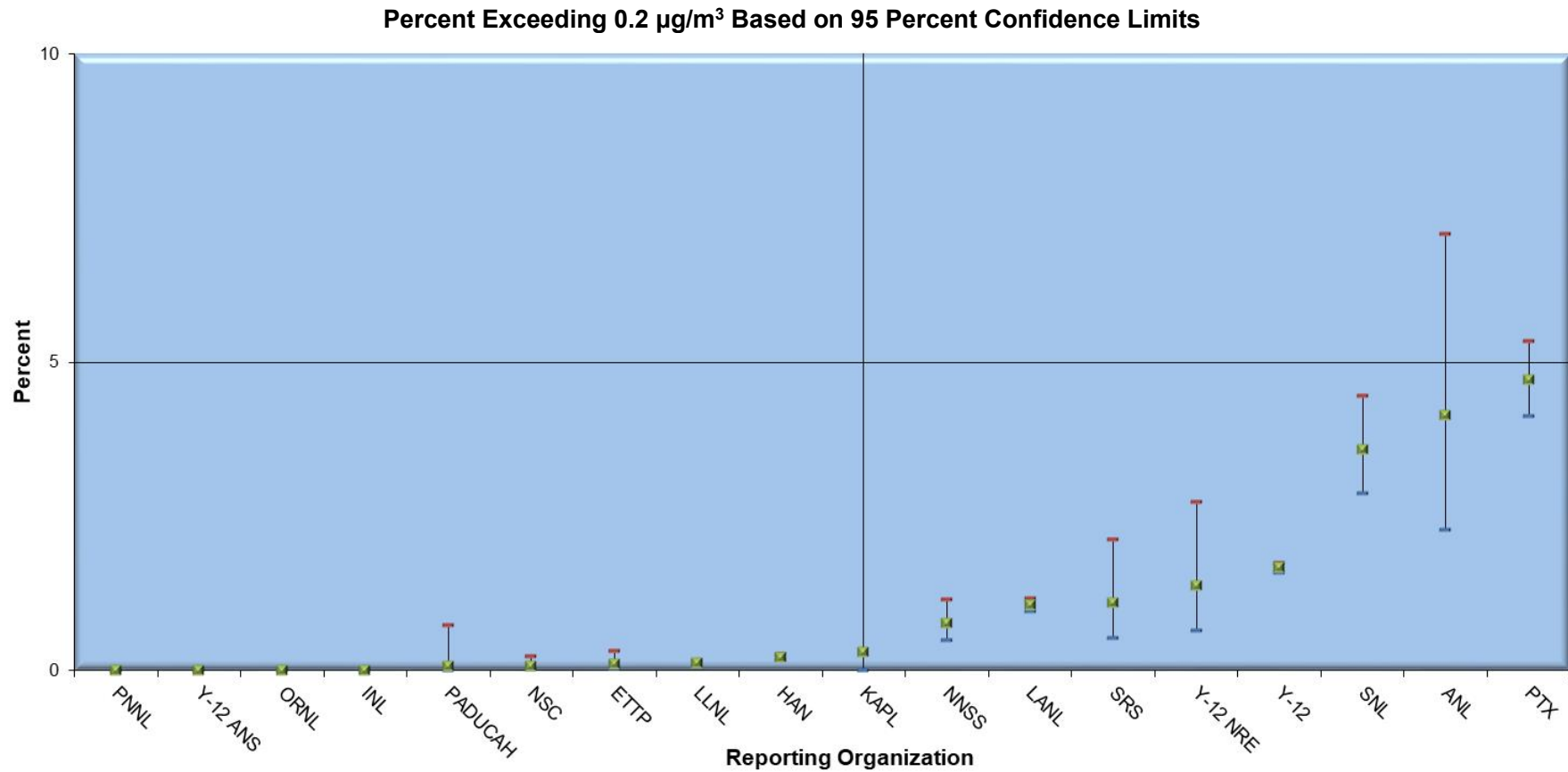
This figure displays differences in exposure level for individuals with job titles that were grouped together in the Craft work activity category. Detailed data are presented on the following page. Laborers, Machinists, Electricians, Millwrights, Plumbers & Fitters, Iron Workers, Painters, Carpenters, Hazardous Waste Workers, Mechanics, Waste-Management Mechanics, Sheet Metal Workers, and HVAC Mechanics have exceedance rates higher than all Crafts combined ( $0.6 \mu\text{g}/\text{m}^3$ , as shown in the table on page 27). Direct comparison with prior years' reports may be problematic due to late reporting and/or corrections.

**Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results for Craft Job Titles Through 2017  
(Ranked by Percent Exceeding)**

Craft Job Title	Number of reported monitoring results	Number of detected values	Percent non-detects	Number of individuals monitored	Observed 95th percentile of data (ug/m <sup>3</sup> )	95% upper tolerance limit of the 95th percentile (ug/m <sup>3</sup> )	Largest value (ug/m <sup>3</sup> )	Percent exceeding 0.2 ug/m <sup>3</sup> (F)	Lower confidence limit for F	Upper confidence limit for F
Insulators	664	208	68.7	29	0.010	0.030	0.200	< 0.1	< 0.1	< 0.1
D&D Workers	1,101	156	85.8	133	0.016	0.037	0.234	< 0.1	< 0.1	< 0.1
Maintenance Mechanics	940	31	96.7	99	0.002	0.052	0.200	0.1	0.1	0.3
Other Crafts	23,173	447	98.1	254	0.005	0.017	37.300	0.2	0.2	0.2
Welders	1,093	36	96.7	37	0.007	0.021	0.356	0.3	0.1	0.6
Heavy Equipment Operators	1,271	109	91.4	107	0.006	0.020	16.697	0.6	0.4	0.8
Laborers	1,714	82	95.2	253	0.009	0.053	10.340	0.7	0.5	1.0
Machinists	5,961	285	95.2	111	0.012	0.050	87.419	0.9	0.7	1.1
Electricians	4,406	441	90.0	359	0.022	0.050	14.419	1.0	0.8	1.2
Millwrights	904	61	93.3	145	0.009	0.050	20.176	1.1	0.7	1.6
Plumbers & Fitters	2,247	204	90.9	199	0.018	0.050	5.735	1.3	1.0	1.6
Iron Workers	292	93	68.2	34	0.129	0.262	1.847	1.3	0.7	2.2
Painters	675	112	83.4	46	0.058	0.100	7.423	1.5	1.0	2.2
Carpenters	1,235	144	88.3	107	0.044	0.066	3.176	2.0	1.5	2.6
Hazardous Waste Workers	84	9	89.3	14	0.072	0.176	0.176	2.1	0.6	6.0
Mechanics	106	20	81.1	38	0.017	0.070	0.091	2.3	0.9	5.1
Waste-Mgmt Mechanics	147	18	87.8	15	0.093	1.290	2.390	4.0	2.2	7.0
Sheet Metal Workers	723	171	76.3	59	0.438	0.662	8.865	6.5	5.3	7.8
HVAC Mechanics	250	96	61.6	28	0.283	0.494	5.836	7.0	5.0	9.5
All Combined	46,986	2,723	94.2	2,067	0.008	0.050	87.419	0.6	0.5	0.6

This table provides summary statistics for 8-hour time weighted average monitoring results by craft job title.

**Percent of Exposure Monitoring Results Exceeding the Action Level by Reporting Organization Through 2017\*  
(Ranked by Percent Exceeding)**



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

This figure summarizes 8-hour time weighted average exposure monitoring results by reporting organization. Detailed data are presented on the following page. Exceedance rates at Fermi (not included in this figure), Y-12 NRE, Y-12, SNL, ANL, and PTX were higher than those for all organizations combined.

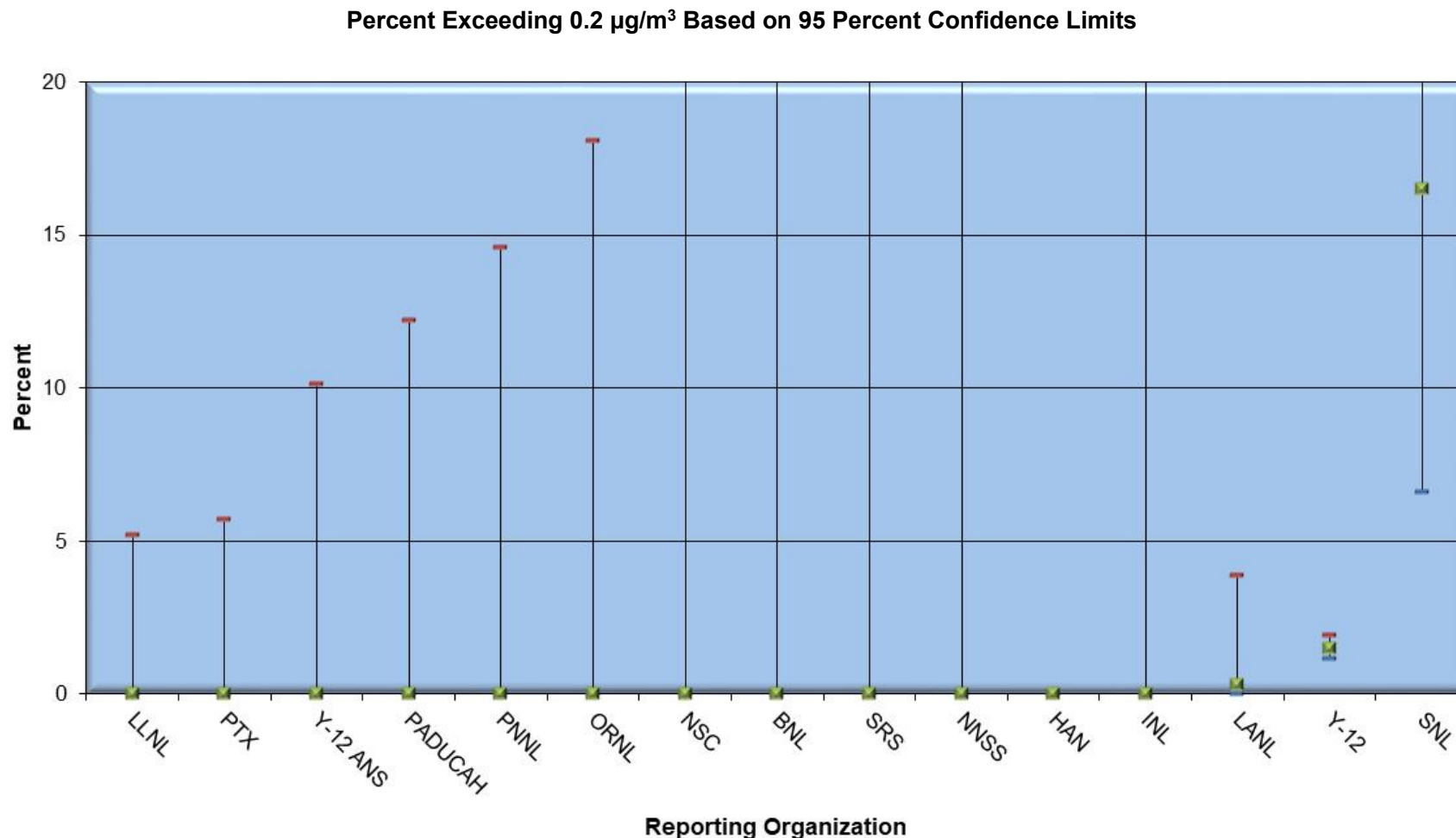
Results from AMES, BNL, Fermi, LBNL, LLNL CHES, and SLAC were not included in this figure because of the small number of total samples and/or low percent exceeding the action level. Direct comparison with prior years' reports may be problematic due to late reporting and/or corrections.

## Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Reporting Organization Through 2017

Reporting Organization	Number of reported monitoring results	Number of detected values	Percent non-detects	Number of individuals monitored	Observed 95th percentile of data (ug/m <sup>3</sup> )	95% upper tolerance limit of the 95th percentile (ug/m <sup>3</sup> )	Largest value (ug/m <sup>3</sup> )	Percent exceeding 0.2 ug/m <sup>3</sup> (F)	Lower confidence limit for F	Upper confidence limit for F
AMES	49	0	100	8	0.026	NA	0.028	0	0	5.9
ANL	155	19	87.7	8	0.145	1.100	2.390	4.1	2.3	7.1
BNL	102	0	100	48	0.057	NA	0.100	0	0	2.9
ETTP	905	32	96.5	8	0.007	0.080	2.264	0.1	< 0.1	0.3
Fermi	48	22	54.2	1	1.296	NA	4.800	17.2	10.6	26.1
HAN	11,930	1,615	86.5	26	0.008	0.019	12.513	0.2	0.2	0.3
INL	1,805	260	85.6	315	0.017	0.056	0.843	< 0.1	< 0.1	< 0.1
KAPL	234	2	99.1	37	0.007	0.200	0.200	0.3	< 0.1	27.5
LANL	12,968	2,602	79.9	721	0.045	0.057	26.678	1.1	1.0	1.2
LBNL	18	0	100	8	0.100	NA	0.100	0	0	15.3
LLNL	6,713	1,177	82.5	313	0.021	0.033	5.133	0.1	0.1	0.2
LLNL CHES	3	0	100	1	NA	NA	0.042	0	0	63.2
NNSS	1,104	88	92	281	0.014	0.052	0.317	0.8	0.5	1.2
NSC	1,662	18	98.9	184	0.001	0.145	0.196	< 0.1	< 0.1	0.2
ORNL	1,336	8	99.4	276	0.002	0.011	0.157	< 0.1	< 0.1	< 0.1
PADUCAH	589	4	99.3	72	0.000	0.011	0.019	0.1	< 0.1	0.7
PNNL	126	10	92.1	35	0.003	0.005	0.006	< 0.1	< 0.1	< 0.1
PTX	2,343	282	88.0	503	0.231	0.365	134.000	4.7	4.1	5.3
SLAC	42	0	100.0	26	0.040	NA	0.150	0	0	6.9
SNL	946	353	62.7	135	0.106	0.160	2.800	3.6	2.9	4.4
SRS	357	22	93.8	196	0.023	0.072	0.320	1.1	0.5	2.1
Y-12	56,793	4,608	91.9	1,222	0.041	0.050	87.419	1.7	1.6	1.7
Y-12 ANS	73	20	72.6	19	0.010	0.150	0.150	< 0.1	< 0.1	< 0.1
Y-12 NRE	291	15	94.8	15	0.009	0.039	1.111	1.4	0.6	2.7
All Combined	100,592	11,157	88.9	6,573	0.027	0.053	134.000	1.3	1.3	1.4

This table provides additional summary statistics for organizations reporting exposure data. While the majority have acceptable sampling programs, these data show some organizations could revisit their sampling strategies and consider increasing the number of samples taken.

**Percent of Exposure Monitoring Results Exceeding the Action Level by Reporting Organization for Calendar Year 2017  
(Ranked by Percent Exceeding)**



While Sandia National Laboratories had the greatest percentage of reported exposure monitoring results exceeding the action level in 2017, Y-12 had the greatest number (as shown on page 31). Detailed data are presented on the following page. The upper confidence limit is above 5 percent at organizations that reported 62 or fewer sampling results in 2017 or reported similar time weighted average values for detects and non-detects.

Historically, this graphic excluded results for reporting organizations with small numbers of total samples. However, fewer organizations have reported monitoring in recent years, and those organizations are reporting less sampling (pages 18, 23, and 31) as well. Since all but 3 organizations reported 62 or fewer results for calendar year 2017, data for all 15 organizations are included above.

**Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Reporting Organization  
for Calendar Year 2017**

Reporting Organization	Number of reported monitoring results	Number of detected values	Percent non-detects	Number of individuals monitored	Observed 95th percentile of data (ug/m <sup>3</sup> )	95% upper tolerance limit of the 95th percentile (ug/m <sup>3</sup> )	Largest value (ug/m <sup>3</sup> )	Percent exceeding 0.2 ug/m <sup>3</sup> (F)	Lower confidence limit for F	Upper confidence limit for F
BNL	10	0	100	4	NA	NA	0.013	0	0	26
HAN	924	18	98.1	342	< 0.001	0.020	0.060	< 0.1	< 0.1	< 0.1
INL	49	2	95.9	31	0.003	NA	0.014	< 0.1	0	100
LANL	94	5	94.7	32	0.009	0.093	0.119	0.3	< 0.1	3.9
LLNL	56	0	100	19	0.016	NA	0.069	0	0	5.2
NNSS	3	3	0	1	NA	NA	0.001	0	0	63.2
NSC	11	0	100	7	NA	NA	0.026	0	0	23.8
ORNL	15	0	100	11	NA	NA	0.010	0	0	18.1
PADUCAH	23	0	100	13	< 0.001	NA	< 0.001	0	0	12.2
PNNL	19	0	100	8	0.006	NA	0.006	0	0	14.6
PTX	51	0	100	24	0.016	NA	0.020	0	0	5.7
SNL	17	13	23.5	8	0.463	NA	1.100	16.5	6.6	32.9
SRS	7	0	100	6	NA	NA	0.007	0	0	34.8
Y-12	1,964	123	93.7	170	0.016	0.020	87.419	1.5	1.2	1.9
Y-12 ANS	28	0	100	10	0.008	NA	0.009	0	0	10.1
<b>All Combined</b>	<b>3,271</b>	<b>164</b>	<b>95</b>	<b>686</b>	<b>0.006</b>	<b>0.020</b>	<b>87.419</b>	<b>1.1</b>	<b>0.8</b>	<b>1.3</b>

The table above gives additional summary statistics for organizations reporting exposure data to the BAWR during 2017. Organizations that did not report data for calendar year 2017 are not included in this table.



## Exposure Monitoring Results Above the 0.2 µg/m<sup>3</sup> Action Level for Calendar Years 2017, 2016, and 2015

Calendar Year 2017:

Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, µg/m <sup>3</sup>	Respirator Assigned Protection Factor
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	Machinists	4.70	50
Y-12	SUPPORT	Machinists	4.52	1000
Y-12	PRODUCTION	Machinists	4.37	1000
Y-12	SUPPORT	Other Crafts	3.17	1000
Y-12	SUPPORT	Machinists	2.93	1000
Y-12	SUPPORT	Machinists	2.69	1000
HAN		Nuclear Waste Process Operators	1.99	10000
Y-12	PRODUCTION	Other Crafts	1.69	50
Y-12	PRODUCTION	Other Crafts	1.69	1000
Y-12	SUPPORT	Machinists	1.38	50
Y-12	SUPPORT	Machinists	1.19	50
Y-12	SUPPORT	Electricians	1.17	1000
SNL	OPERATIONAL SUPPORT	Technician	1.10	50
Y-12	SUPPORT	Machinists	1.06	1000
Y-12	PRODUCTION	Other Crafts	0.98	50
Y-12	PRODUCTION	Other Crafts	0.98	1000
Y-12	SUPPORT	Janitors and Cleaners	0.91	1000
Y-12	SUPPORT	Other Crafts	0.74	1000
Y-12	SUPPORT	Machinists	0.67	1000
Y-12	SUPPORT	Engineering Technicians	0.45	50
Y-12	SUPPORT	Engineering Technicians	0.45	1000
Y-12	SUPPORT	Electricians	0.40	50
SNL	OPERATIONAL SUPPORT	Technician	0.35	50
Y-12	PRODUCTION	Machinists	0.33	1000
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	1000
Y-12	PRODUCTION	Other Crafts	0.21	1

Calendar Year 2016:

Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, µg/m <sup>3</sup>	Respirator Assigned Protection Factor
LANL	SHEET METAL WORKER	SHEET METAL WORKER	8.87	100
LANL	SHEET METAL WORKER	SHEET METAL WORKER	8.33	100
LANL	SHEET METAL WORKER	SHEET METAL WORKER	2.03	100
LLNL	chamber cleanup	Sr. Technologist C/MS	0.72	1000
Y-12	SUPPORT	Engineering Technicians	0.70	100
LANL	SHEET METAL WORKER	SHEET METAL WORKER	0.65	100
Y-12	SUPPORT	Machinists	0.50	50
SNL	OPERATIONAL SUPPORT	Technician	0.49	50
SNL	OPERATIONAL SUPPORT	Technician	0.49	1000
HAN	WELDING	INDUSTRIAL HYGIENE TECH	0.46	1000
HAN	WELDING	INSTRUMENT SPECIALIST	0.46	1000
SNL	OPERATIONAL SUPPORT	Technician	0.45	50
Y-12	PRODUCTION	Other Crafts	0.41	50
PTX	BERYLLIUM WORK	PRODUCTION TECHNICIAN	0.33	1
SNL	OPERATIONAL SUPPORT	Technician	0.32	50
SNL	OPERATIONAL SUPPORT	Technician	0.32	50
PTX	BERYLLIUM WORK	PRODUCTION TECHNICIAN	0.31	1
SNL	OPERATIONAL SUPPORT	Technician	0.27	50
Y-12	PRODUCTION	Engineering Technicians	0.26	50
Y-12	SUPPORT	Engineering Technicians	0.26	100
SNL	OPERATIONAL SUPPORT	Technician	0.24	50
LANL	ENGINEERED SYSTEMS TECH	ENGINEERED SYSTEMS T	0.23	1000
SNL	OPERATIONAL SUPPORT	Technician	0.23	50
Y-12	PRODUCTION	Janitors and Cleaners	0.23	50
SNL	OPERATIONAL SUPPORT	Technician	0.22	50
Y-12	SUPPORT	Engineering Technicians	0.22	50

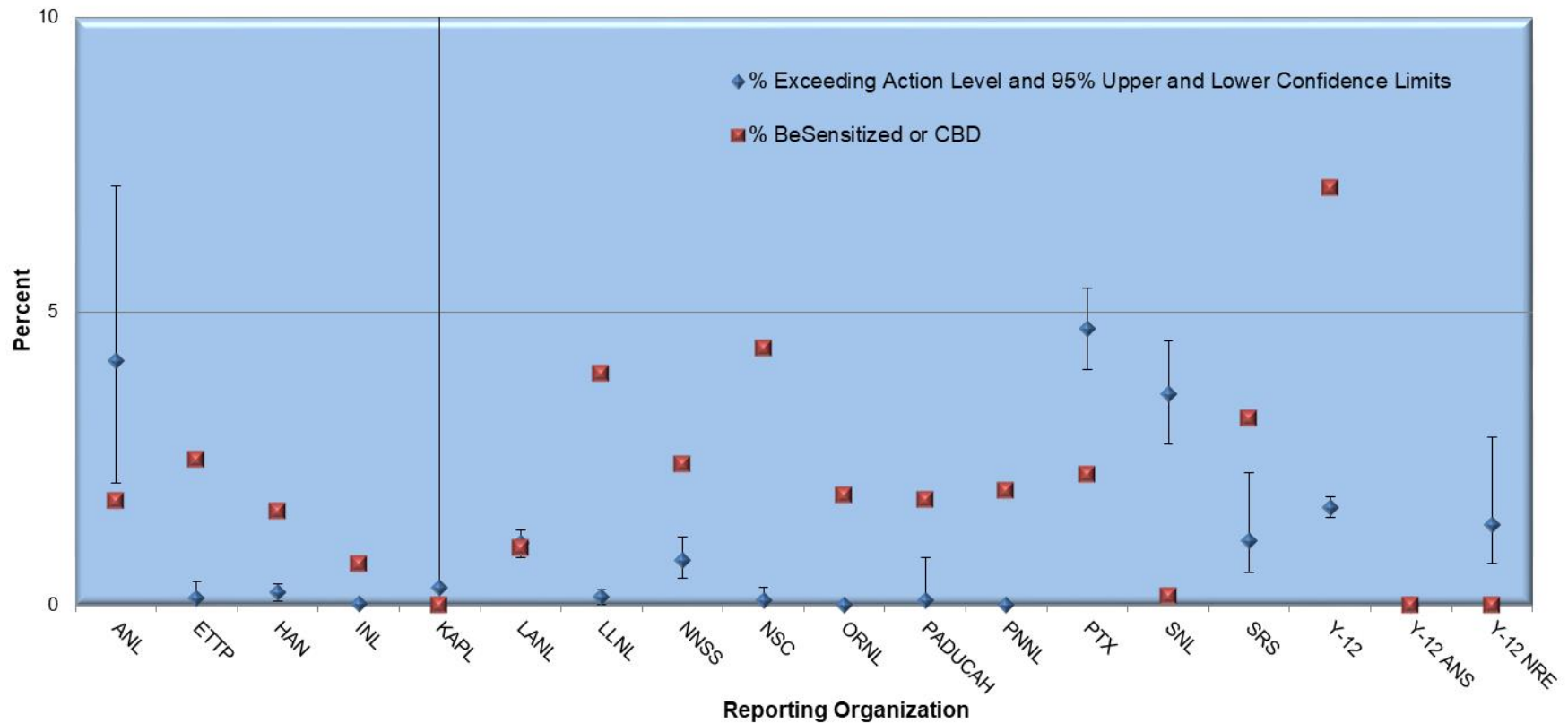
Calendar Year 2015:

Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, µg/m <sup>3</sup>	Respirator Assigned Protection Factor
LANL	IRONWORKER	IRONWORKER	1.85	1000
HAN		INDUSTRIAL HYGIENE TECH	1.57	1
HAN		Electricians	1.56	1
INL	Waste Processing	Operator	0.84	1000
Y-12	SUPPORT	Other Laborers and General Services	0.80	100
Y-12	SUPPORT	Handlers, Helpers, and Laborers (Gei	0.71	100
Y-12	PRODUCTION	Other Crafts	0.67	50
Y-12	SUPPORT	Other Laborers and General Services	0.53	100
SNL	OPERATIONAL SUPPORT	Technician	0.41	10
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	0.38	25
SNL	OPERATIONAL SUPPORT	Technician	0.32	10
SNL	OPERATIONAL SUPPORT	Technician	0.32	100
Y-12	SUPPORT	Other Laborers and General Services	0.32	100
LLNL	clean out valve	Scientific Technician	0.30	1000
Y-12	SUPPORT	Handlers, Helpers, and Laborers (Gei	0.29	100
SNL	OPERATIONAL SUPPORT	Technician	0.25	10
SNL	OPERATIONAL SUPPORT	Technician	0.25	100
SNL	OPERATIONAL SUPPORT	Technician	0.24	10
SNL	OPERATIONAL SUPPORT	Technician	0.24	100
SNL	OPERATIONAL SUPPORT	Technician	0.24	100
SNL	OPERATIONAL SUPPORT	Technician	0.23	100
Y-12	SUPPORT	Handlers, Helpers, and Laborers (Gei	0.22	100
SNL	OPERATIONAL SUPPORT	Technician	0.21	100
SNL	OPERATIONAL SUPPORT	Technician	0.21	100

Exceedances for 2017 were greater than in 2016 or 2015. Thirty-four (34) samples exceeded the action level in 2017 compared with 26 in 2016 and 24 in 2015. Nevertheless, the total number of reported exposure sampling results continued to decrease (page 23). Exceedances were primarily associated with support activities at SNL and Y-12. In all but a few cases, work planning processes identified the potential for beryllium exposure and workers were wearing respiratory protection.



### Cumulative Rates of Beryllium Sensitization or CBD versus Exposure Levels Through 2017\*



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

Medical monitoring results for beryllium sensitization or CBD and beryllium exposure monitoring results have no correlation (Pearson product moment correlation coefficient = -0.022). A likely explanation for this is that the sensitization or CBD being detected are due to past working conditions rather than those currently being monitored. However, it is also possible that monitoring programs are missing significant sources of exposure that are ongoing. Reporting organizations with low exposure monitoring results and high sensitization or CBD rates can investigate cases to determine if the possibility of ongoing exposure can be ruled out.