

# Beryllium-Associated Worker Registry

## 2014



Office of Environment, Health, Safety and Security

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

### **Data Cumulative Through 2014**

#### Background

The U.S. Department of Energy (DOE) Beryllium-Associated Worker Registry (BAWR) is a collection of health and exposure information for individuals potentially at risk for chronic beryllium disease (CBD) due to their work at DOE facilities. 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 to determine whether employees are at risk for CBD. Subpart C, Section 850.39, requires that responsible employers transmit all records generated as required by this rule to the DOE Assistant Secretary for Environment, Health, Safety and Security (AU, initially Environment, Safety and Health) while protecting their workers' confidentiality. To facilitate management of these data, a BAWR Data Center has been established at the Oak Ridge Institute for Science and Education, operated by Oak Ridge Associated Universities (ORAU), to receive and process the data and provide descriptive summaries that are included in the annual reports. The Registry includes, but is not limited to, an encrypted unique identifier, date of birth, gender, site, job history, medical screening test results, exposure measurements, and results of referrals for specialized medical evaluations.

Beryllium is a silver-gray metallic element found in approximately 30 minerals. It is a lightweight but strong, hard metal that has many industrial applications. Its primary commercial use is for hardening other metals, especially copper. Copper-beryllium alloys have many applications in electronics and other industries where strength and the ability to be fabricated into complex shapes and conduct electricity are desirable. The light weight and ability to dissipate heat of beryllium oxide ceramics have led to applications in the electronic, nuclear, and aerospace industries. Beryllium's transparency to x-rays and its ability to scatter and generate, but not absorb, neutrons when bombarded by protons have led to its use in nuclear weapons, experimental reactors, and accelerators.

DOE-AU takes the approach that summarization and periodic reporting of the results of ongoing data collection are within the Regulation's requirements to "...inventory and assess beryllium exposure hazards to determine whether employees are at risk for CBD." Annual reports organize the data into basic information with descriptive analyses in order to address 3 goals: (1) to perform basic data quality evaluation as part of continuous quality improvement, (2) to identify unusual patterns in a given year or over time that may warrant further evaluation, and (3) to provide feedback to site industrial hygienists, occupational medicine staff, management, and others with an interest in this aspect of worker safety and health.

A "beryllium-associated worker" is defined to include any current worker who is exposed through beryllium work or who had a past exposure or potential exposure to beryllium at a DOE facility. The workers include both long-term employees who worked with beryllium years ago and workers exposed recently. Current workers who identify themselves or are identified by supervisors as beryllium-associated workers are offered screening for CBD. These workers are predominantly older males (page 8).

The current annual report summarizes data cumulative through calendar year 2014 from reporting organizations (e.g., sites, subcontractors) that have determined that employees are at risk due to ongoing or past work. These reporting organizations have implemented CBD prevention programs that include the reporting of health and exposure data every 6 months to the DOE BAWR (see [DOE-STD-1187-2007](#) for the operating protocol). Health data were collected through the operation of current worker medical surveillance programs for all 27 reporting organizations submitting data (page 6). Exposure sampling data were submitted by the industrial hygiene programs for 24 reporting organizations that have continuing beryllium operations or cleanup efforts due to a legacy of past beryllium use.

The beryllium lymphocyte proliferation test (BeLPT) is a blood test that examines how lymphocytes (white blood cells in the immune system that fight disease) react to beryllium. A BeLPT is considered abnormal if a person’s lymphocytes are shown to proliferate more rapidly when exposed to beryllium. An abnormal BeLPT may indicate that an individual is more likely than others with similar exposure to develop CBD in the future or may be an early sign of CBD. Individuals who have abnormal results are offered confirmatory testing that involves splitting blood samples, which are then tested in 2 laboratories. To be considered beryllium sensitized (BeSensitized), 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. In this report, the numbers of “Employees Who Are Sensitized” and “Employees with CBD” are mutually exclusive; the “Employees Who Are Sensitized” category excludes individuals diagnosed with CBD.

The 2014 Report

A worrisome trend noted in the participating organizations’ operation and support of the BAWR is the continued level of turnover in Data Coordinator positions. The table below shows frequent changes at a high percentage of the Registry’s reporting organizations.

Reporting Organizations with Data Coordinator Changes in Calendar Years 2013 and 2014			
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

Data coordinators are the primary contacts between reporting organizations and the Data Center. They collect and transmit data to the Center, and they also act as points of contact for resolving questions and noting significant changes that could affect data availability or interpretation. Accordingly, they are expected to understand the reporting requirements of the program and stay in contact with their essential site contacts and the Data Center to make sure that data collection and transmission are timely, complete, and accurate. Ensuring this understanding of the reporting requirements is part of the training and support role of the Data Center, but frequent changes in data coordinators make the process problematic. Without sufficient orientation of new data coordinators by those leaving the role, the depth of experience and understanding gained by outgoing coordinators is lost. Those who oversee this task need to ensure that incoming data coordinators are provided with sufficient orientation to afford their successors an understanding of how the duties are carried out in their own reporting organization, and to notify the Data Center when a change in personnel is anticipated.

Tangent to sites’ operation and support of the BAWR is a lack of adherence by the reporting organizations to guidance provided through complex-wide webinars and the program’s technical standard (DOE-STD-1187-2007). Communications between the BAWR Data Center and the sites reveal some misunderstandings of what data should be reported to the BAWR. For example, 1 reporting organization was including only workers in their submission who had received a BeLPT. The technical standard is quite clear that all workers who are exposed or potentially exposed, plus self-identified exposed workers, should be included in the roster data

submitted to the BAWR. Additionally, some reporting organizations have indicated that they are not submitting all of the beryllium monitoring (exposure) data they are collecting. Again, the technical standard is very clear that all beryllium air sample monitoring data should be submitted to the BAWR. Another complex-wide webinar is planned for Spring 2016, during which these issues will be addressed.

Exposure sampling data were submitted by the industrial hygiene programs from 24 reporting organizations that have continuing beryllium operations or cleanup efforts due to a legacy of beryllium use from the past. Exposure data do not include DOE Oak Ridge Operations (DOE-ORO), National Strategic Protective Services (NSPS), and Y-12 URS Corporation (Y-12 URS). As a courtesy, DOE-ORO reports on Federal employees who are occasionally at the contractors' sites; thus, no exposure monitoring data exist for these workers. NSPS did not conduct exposure monitoring. Y-12 URS employees were monitored by Y-12 National Security Complex (Y-12), but the data were not reported. An additional 5,444 exposure sampling results were added in 2014 and 344 additional workers monitored for exposure. To date, 5,851 workers have been monitored for exposure, and the Registry contains 90,770 exposure monitoring measurements for these workers (pages 17-21).

A focal point in examining the monitoring/exposure data are the sampling values that exceed the  $0.2 \mu\text{g}/\text{m}^3$  action level. We noted 17 exceedances above the  $0.2 \mu\text{g}/\text{m}^3$  action level in 2014, a notable increase over the 7 exceedances reported during 2013 but fewer than the number reported in earlier years (page 32). In both 2012 and 2013, the observed exceedances were strongly associated with waste operations at Pantex Plant (PTX), but in 2014 the reported exceedances were primarily linked to support and production work at Y-12. In most cases, the potential for these exceedances was identified by work planning processes and appropriate respiratory protection was in use. The highest percentage of action level exceedances through 2014 occurred among workers whose work history activity (a high level rollup of job functions) was unknown or not reported (4.6 percent), followed by security and fire workers (2.6 percent) and line operators (2.5 percent) (pages 24-25).

Continued deactivation and decommissioning activities are revealing additional unknown beryllium use at some sites, thus leading management to require BeLPTs on workers engaged in these activities. This scenario has been observed for the past several years, which leads to the fact seen in the 2014 report of additional sensitizations. Although CBD will take varying lengths of time to manifest due to the physiological differences in workers, a beryllium sensitization can be detected fairly quickly through the BeLPT. Twelve additional beryllium sensitizations and no new CBD diagnoses were identified in 2014. By comparison, 8 new sensitizations were reported during 2013. At least partial data were submitted by 27 organizations for 2014. To date, a total of 419 workers have been identified as BeSensitized and 146 diagnosed with CBD (pages 9-10). Two-thirds of the workers currently identified as BeSensitized or diagnosed with CBD have no exposure sampling data reported to the Registry (page 20), presenting a major difficulty in accurately characterizing the progression from exposure to sensitization and on to disease. The potential discovery of new cases of beryllium sensitization and CBD has not yet been eliminated.

The percentages of both reported beryllium sensitizations (33.4 percent) and CBD cases (39.7 percent) occurring among the occupational groups of Craft and Line Operators were almost unchanged through 2014 (page 15). HVAC mechanics continued to show percentages of monitoring results exceeding the  $0.2 \mu\text{g}/\text{m}^3$  action level, much higher than the percentages experienced by other craft workers, but in 2014 the percentage reflected exposure monitoring results for only 26 individuals (page 27).

A persistent concern is that two-thirds of the workers identified to date as sensitized or diagnosed with CBD have no exposure sampling data. In addition, 31 percent of the workers reported in rosters have null or

unusable work history data. Of the 22,362 workers who have been screened/tested, 21 percent have null or unusable work history information, and 16.5 percent of this tested group do not have a usable “activity” group to assist in stratifying these workers for analysis.

In general, the overview presented in this report suggests areas of continued success and provides information of potential use in identifying areas in which further attention may contribute to the prevention of CBD. However, no summary report can offer individual organizations a satisfactory level of analysis or adequately focus on their particular concerns. For this reason, we are working to address growing interest in more focused data analyses for our reporting organizations and clients throughout the complex. Our hope is to provide more targeted analyses of participating organizations’ own and composite data sets to offer more information of potential use in planning, identifying risk groups, examining time trends, etc. to the extent that resources permit.

As always, I welcome your comments,

*Cliff Strader*

Manager, Beryllium-Associated Worker Registry

**Location of 27 Reporting Organizations Currently Submitting Data to BAWR**



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

**27 Reporting Organizations Currently Submitting Data to BAWR**

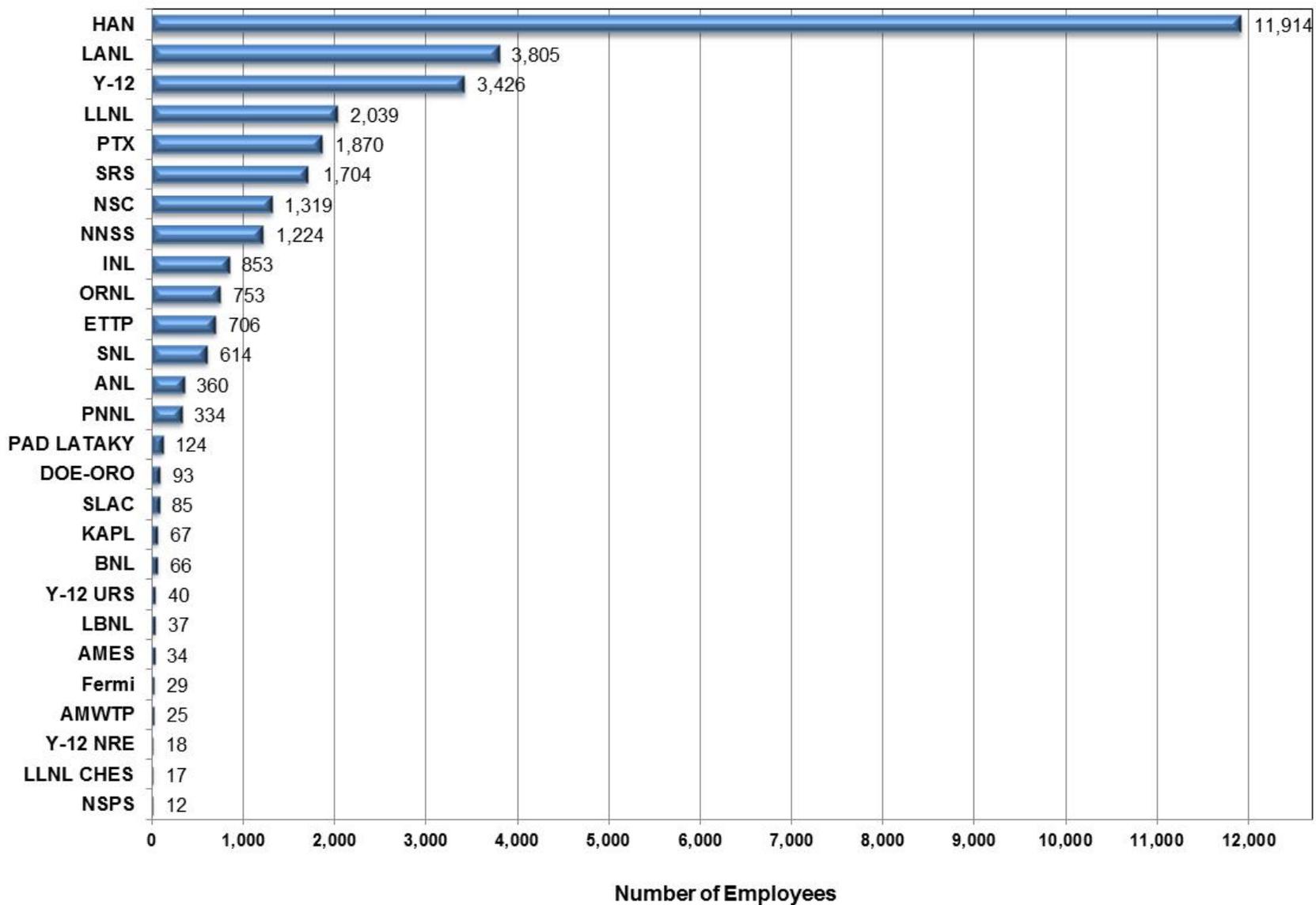
Advanced Mixed Waste Treatment Project (AMWTP)	Los Alamos National Laboratory (LANL)
Ames Laboratory (AMES)	National Security Campus (NSC)
Argonne National Laboratory (ANL)	National Strategic Protective Services, LLC for ETTP and ORNL (NSPS)
Brookhaven National Laboratory (BNL)	Nevada National Security 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)	Pantex Plant (PTX)
Hanford Site (HAN)	Sandia National Laboratories (SNL)
Idaho National Laboratory (INL)	Savannah River Site (SRS)
Knolls Atomic Power Laboratory (KAPL)	Stanford Linear Accelerator Center (SLAC)
LATA Environmental Services of Kentucky, LLC (PAD LATAKY)	Y-12 National Security Complex (Y-12)
Lawrence Berkeley National Laboratory (LBNL)	Y-12 Navarro Research and Engineering (Y-12 NRE)
Lawrence Livermore National Laboratory (LLNL)	Y-12 URS Corporation (Y-12 URS)
LLNL Clean Harbors Environmental Services (LLNL CHES)	

**5 Inactive BAWR Reporting Organizations**

LLNL Boston University (LLNL BU)	Southwestern Power Administration (SWPA)
LLNL Envirocon, Inc. (LLNL ENVC)	Wackenhut Security Services Inc. for ETTP, ORNL, and Y-12 (WSI)
Rocky Flats Closure Project (RF)	

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

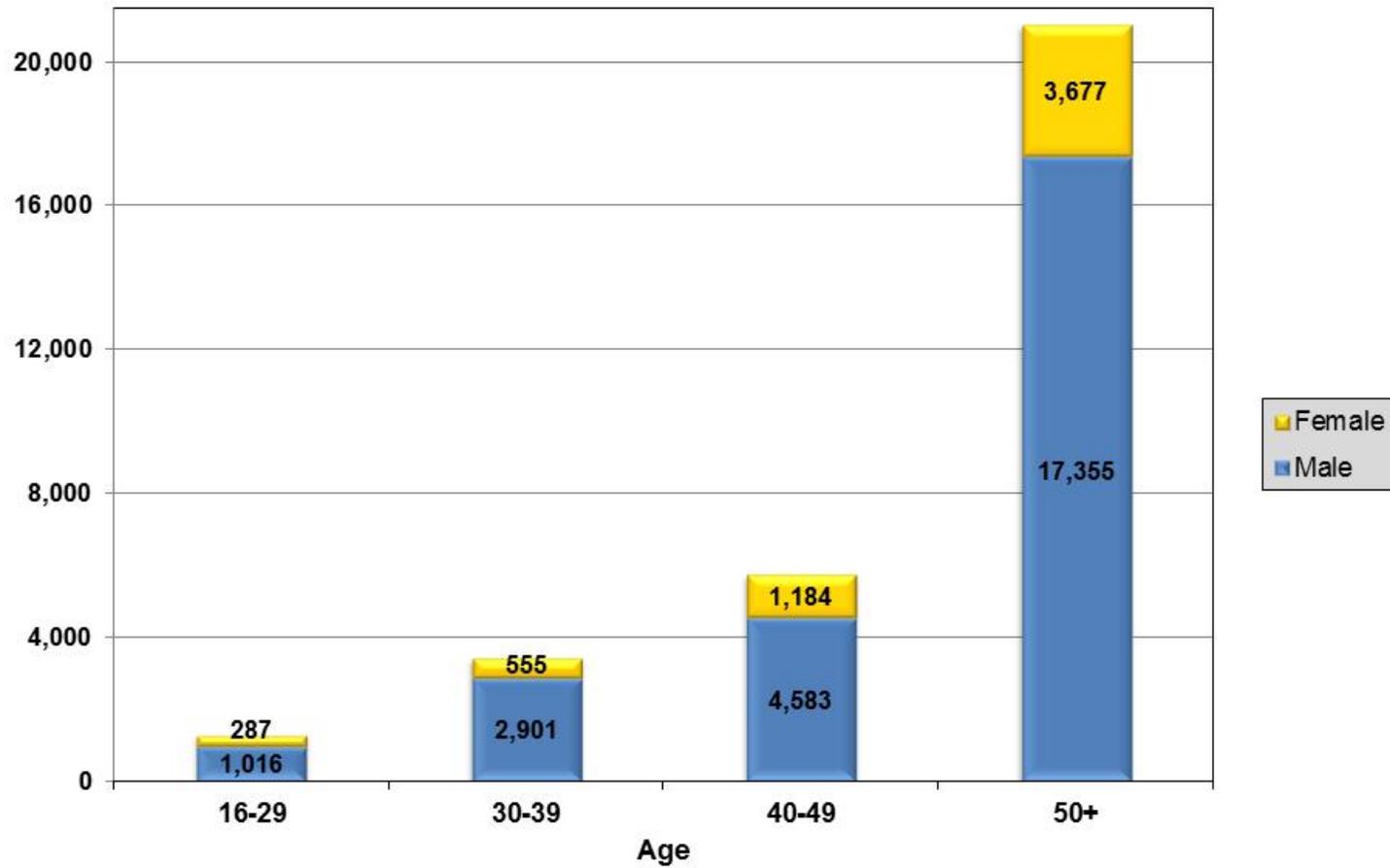
**Total 31,568 Employees by BAWR Reporting Organization Through 2014\***



\*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 2014\***



\*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 2014, showing they are predominantly male and long-term workers.

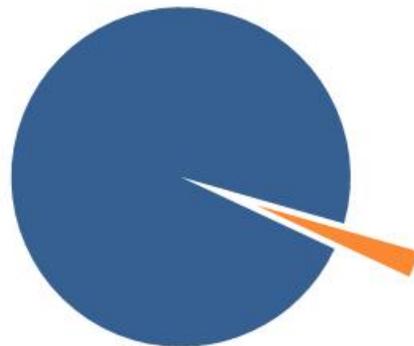
**Progression from BeLPT Testing to “Sensitized” to CBD Through 2014\***

**31,568 Employees Reported to the Registry**



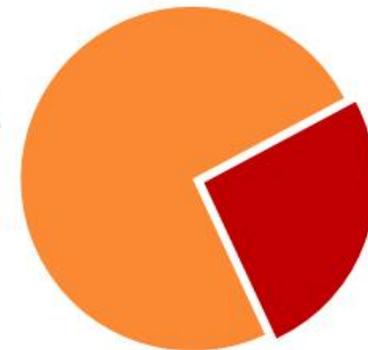
Screened 22,362 (71%)  
Not Screened 9,206 (29%)

**22,362 Employees Screened**



Normal 21,797 (97%)  
Abnormal 565 (3%)

**565 Employees with Abnormal Results**



BeSensitized 419 (74%)  
CBD 146 (26%)

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

From 2013 to 2014, the 27 organizations currently reporting to the Registry identified 12 additional sensitized employees and no additional employees with CBD.

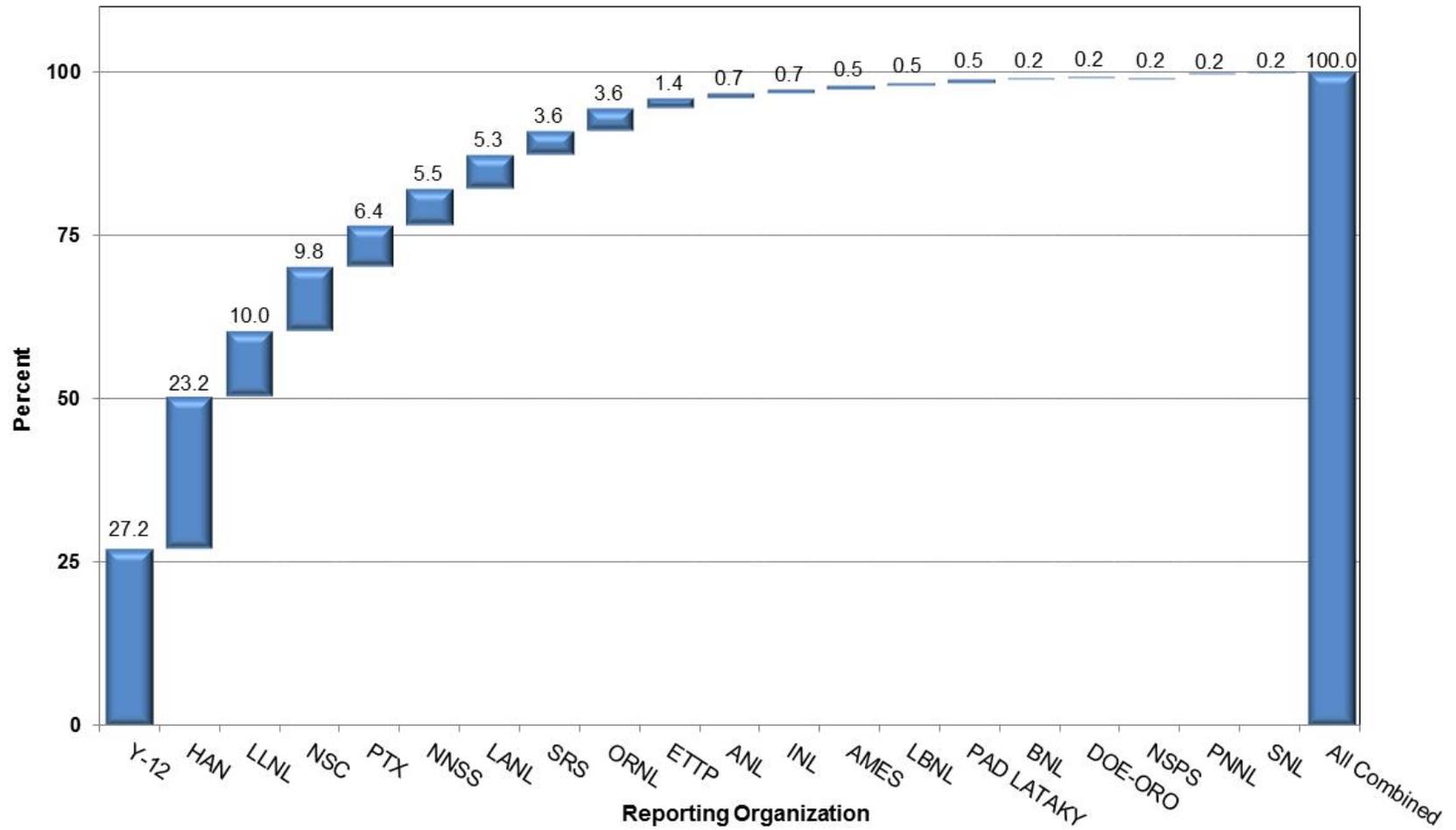
**Number of Employees BeLPT Tested, "Sensitized," or CBD by Reporting Organization Through 2014\***

Reporting Organization	Employees with BeLPT Results	Employees Who Are "Sensitized"	Employees with CBD
HAN	7,861	97 (1.2 %)	34 (0.4 %)
Y-12	2,744	114 (4.2 %)	62 (2.3 %)
LANL	2,599	22 (0.8 %)	3 (0.1 %)
PTX	1,784	27 (1.5 %)	15 (0.8 %)
LLNL	1,370	42 (3.1 %)	3 (0.2 %)
NSC	1,220	41 (3.4 %)	14 (1.1 %)
NNSS	1,080	23 (2.1 %)	4 (0.4 %)
SRS	722	15 (2.1 %)	6 (0.8 %)
ORNL	670	15 (2.2 %)	0
SNL	610	1 (0.2 %)	0
ETTP	401	6 (1.5 %)	4 (1.0 %)
INL	374	3 (0.8 %)	0
PNNL	267	1 (0.4 %)	0
ANL	155	3 (1.9 %)	0
PAD LATAKY	112	2 (1.8 %)	0
DOE-ORO	93	1 (1.1 %)	0
SLAC	49	0	1 (2.0 %)
Y-12 URS	39	0	0
BNL	38	1 (2.6 %)	0
AMES	34	2 (5.9 %)	0
KAPL	29	0	0
LBNL	26	2 (7.7 %)	0
AMWTP	22	0	0
Fermi	20	0	0
Y-12 NRE	18	0	0
LLNL CHES	13	0	0
NSPS	12	1 (8.3 %)	0
<b>Total</b>	<b>22,362</b>	<b>419 (1.9 %)</b>	<b>146 (0.7 %)</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.

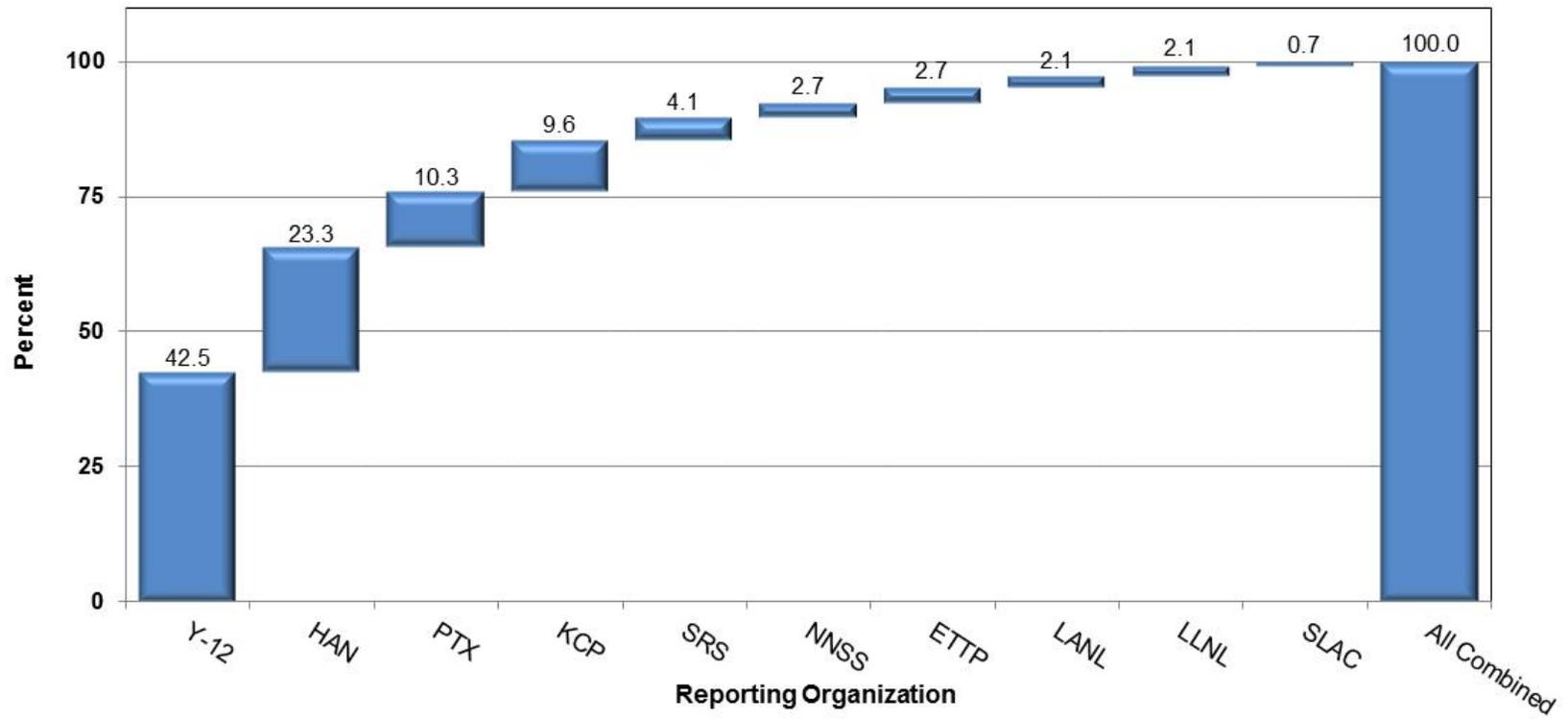
**Percentage Distribution by Reporting Organization of 419 BeSensitized Employees Through 2014\***



\*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.

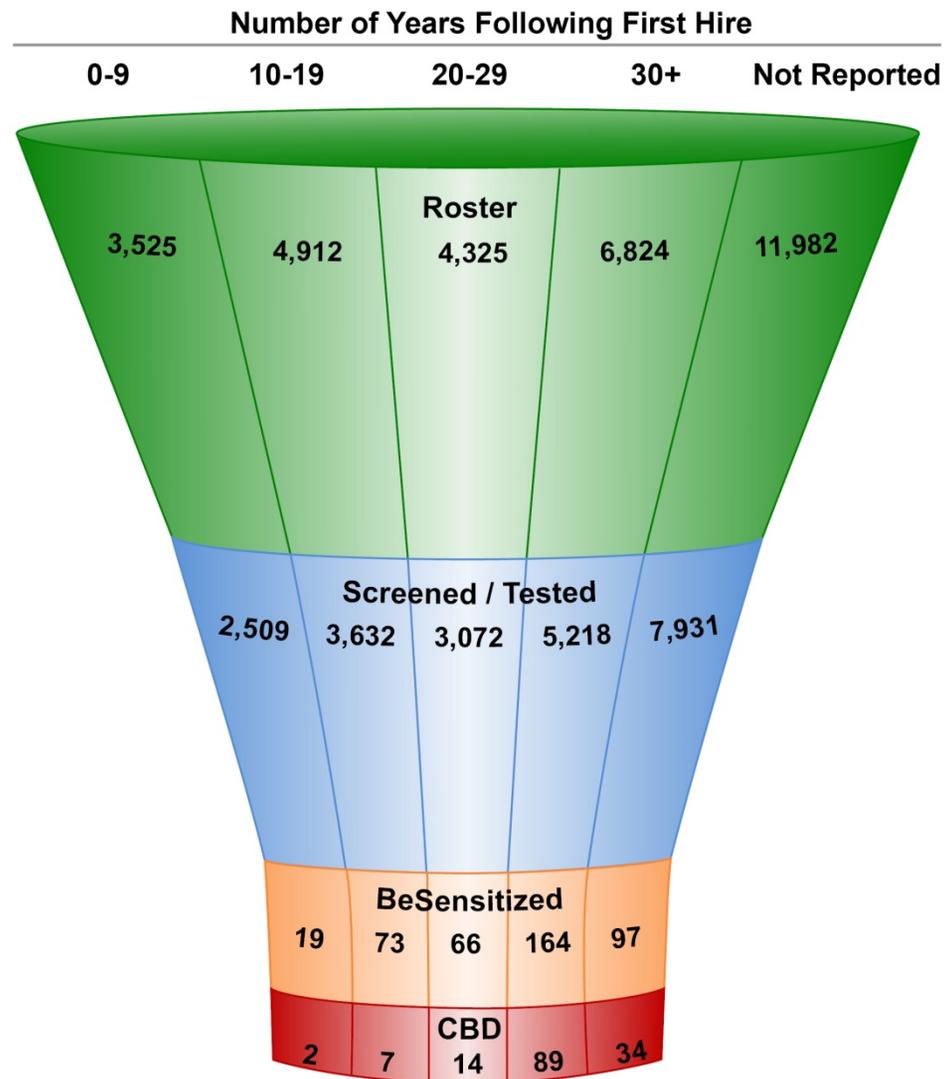
**Percentage Distribution by Reporting Organization of 146 Employees Diagnosed with CBD Through 2014\***



\*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 Employees Who Are “Sensitized” or CBD***

<b>Year of BeLPT Result</b>	<b>Employees Tested</b>	<b>Employees Who Are “Sensitized”</b>	<b>Employees with CBD</b>
<2000	708	35	10
2000	1,630	29	17
2001	3,236	43	17
2002	3,967	42	15
2003	3,967	13	5
2004	3,814	13	3
2005	5,115	26	6
2006	4,870	43	9
2007	4,583	41	5
2008	5,089	24	7
2009	6,178	36	2
2010	6,913	28	1
2011	7,945	16	0
2012	6,188	4	0
2013	5,594	5	0
2014	5,914	8	0
<b>Not Reported</b>	0	13	49

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

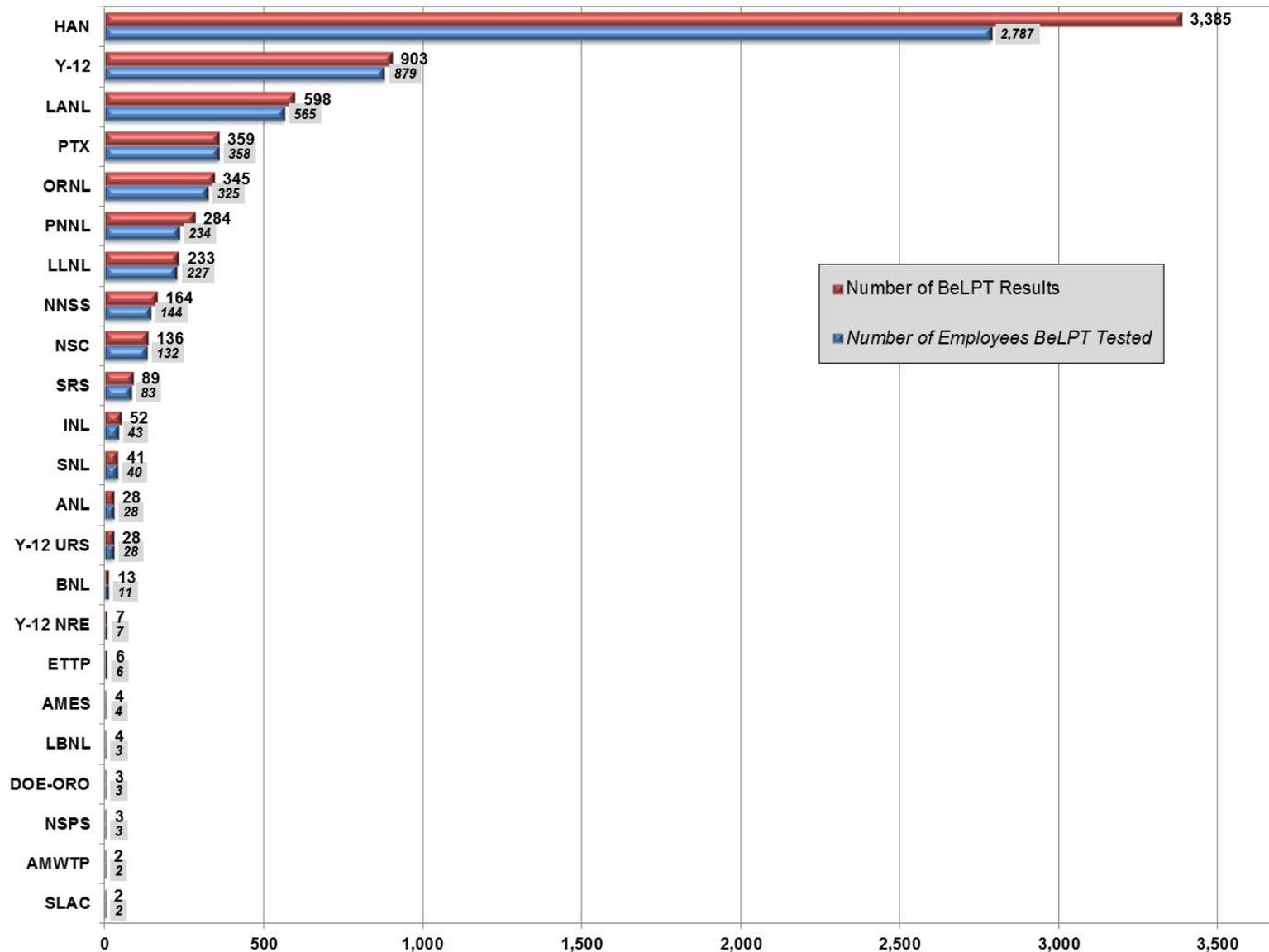
**Work History Activity for Employees Who Are “Sensitized” or CBD Through 2014\***

Work History Activity	Employees with BeLPT Results	Employees Who Are “Sensitized”	Employees with CBD
Management	1,497	32	10
Administrative Support	990	31	10
In-House Professionals	1,416	30	14
Field Professionals	1,961	43	7
Technical Support	2,885	55	13
Service	1,327	29	12
Security and Fire	1,423	18	7
Crafts	3,736	75	35
Line Operators	2,471	65	23
Guests	56	0	0
Unknown	723	12	11
Not Reported	2,968	17	4
<b>Totals</b>	<b>22,362</b>	<b>419</b>	<b>146</b>

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

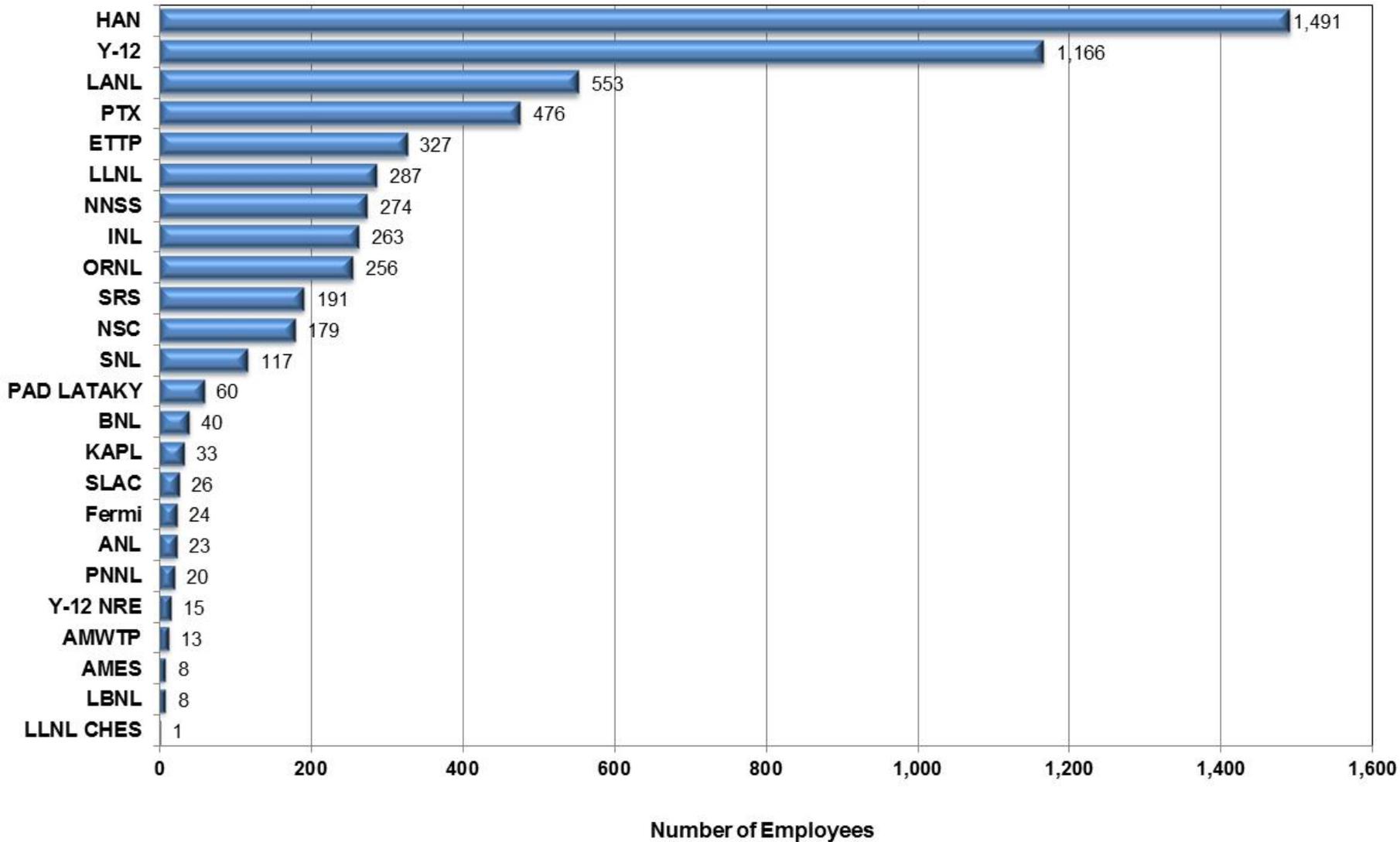
The above table lists beryllium sensitized or CBD diagnosed beryllium-associated workers through 2014 grouped by their work history activity, which is a high level rollup of job function.

**Distribution of 6,689 BeLPT Results for 5,914 Employees by Reporting Organization for Calendar Year 2014**



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 of 5,851 Employees Exposure Monitored by Reporting Organization Through 2014\****



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

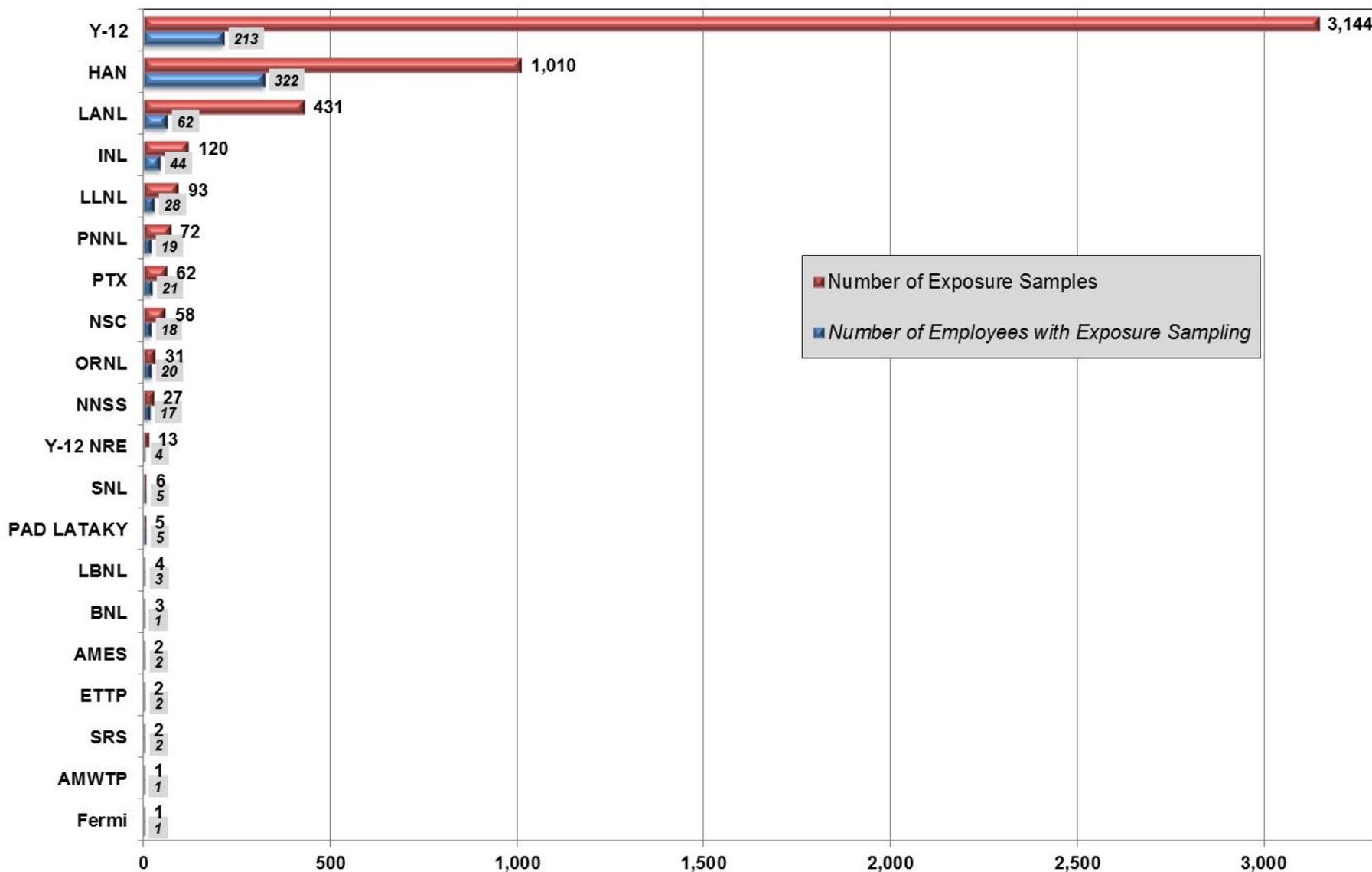
This chart shows the distribution of beryllium-associated workers by reporting organization who have been monitored for beryllium exposure.

**Number of Employees Exposure Monitored by Reporting Organization for 2005 – 2014**

Reporting Organization	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
AMES					6	1	2			2
AMWTP	10	5	4	4	4	2	2	2	1	1
ANL		8	3	1						
BNL	2	1	7	8	3	7	1	19		1
DOE-ORO										
ETTP	79	64	38		19	42	30	3	9	2
Fermi	2	1								1
HAN	70	149	103	163	135	313	395	249	287	322
INL	53	76	81	49	57	44	39	5	42	44
KAPL	1		5	5	5	5	4			
LANL	158	139	95	52	65	46	40	38	30	62
LBNL	1			1			2		1	3
LLNL	51	36	74	76	100	78	63	59	34	28
LLNL CHES							1			
NNSS	26	26	14	43	18	18	19	22	14	17
NSC	13	24	24	18	15	18	17	43	27	18
NSPS										
ORNL	38	59	53	46	48	44	47	46	58	20
PAD LATAKY					9	47	3	5	4	5
PNNL									1	19
PTX	26	38	50	38	35	30	42	51	23	21
SLAC	9	1	2	2			2			
SNL	21	17	7		5	16	19	17	3	5
SRS	35	6	18	34	28	19	2	10	1	2
Y-12	101	160	225	215	305	431	360	241	234	213
Y-12 NRE			3	4	10	8	5	4	5	4
Y-12 URS										

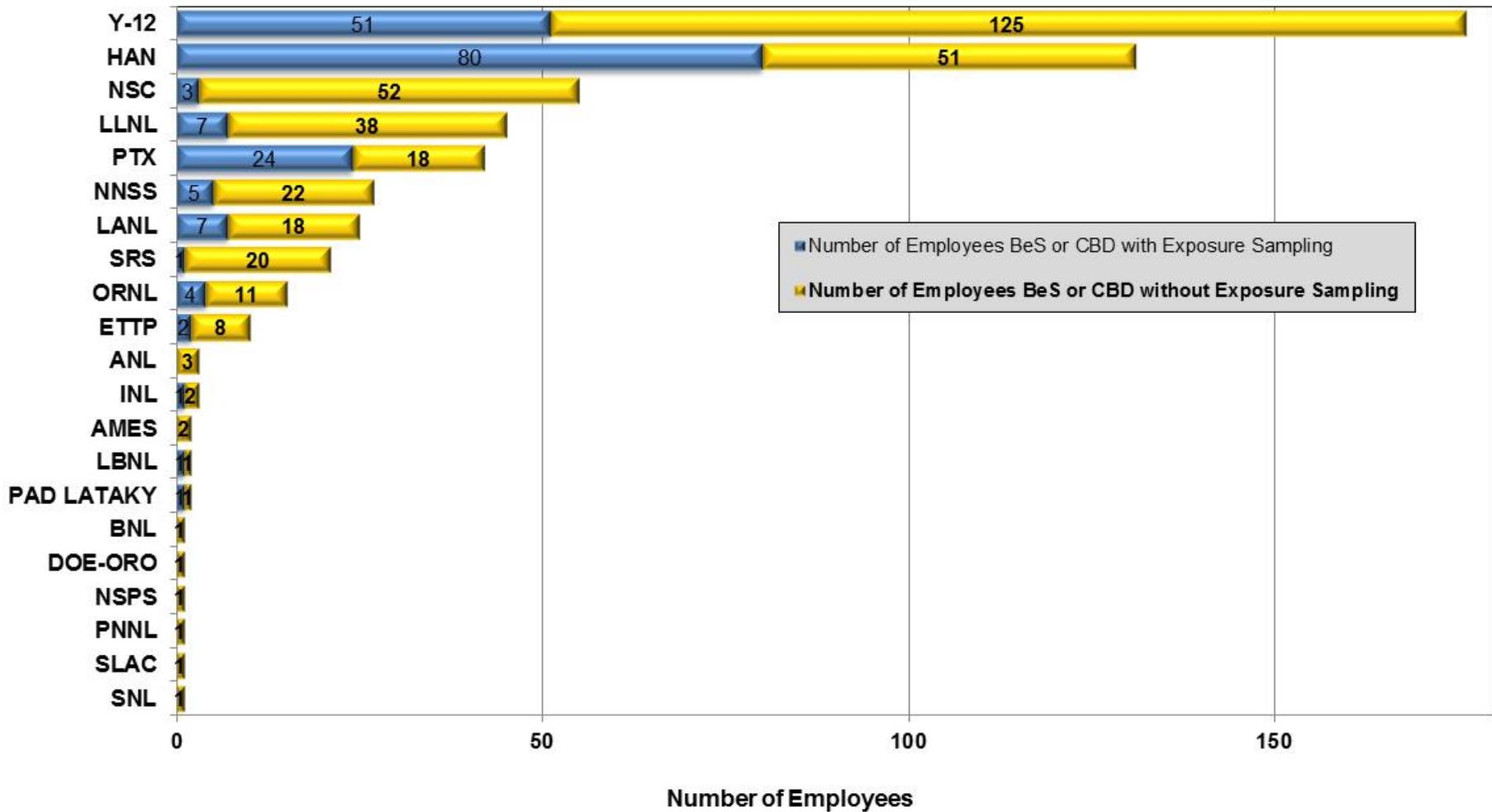
The figure above shows the numbers of individuals by reporting organization whose exposures were monitored by an industrial hygienist at least once in each year in the past 10 years. Twenty reporting organizations provided exposure monitoring results with monitoring dates in 2014. Organization-specific totals for a given year may change from totals in previous annual reports due to late reporting and/or corrections.

**Distribution of 5,087 Exposure Samples for 790 Employees by Reporting Organization for Calendar Year 2014**



The chart above illustrates the distribution of exposure samples and employees monitored across 20 reporting organizations during 2014.

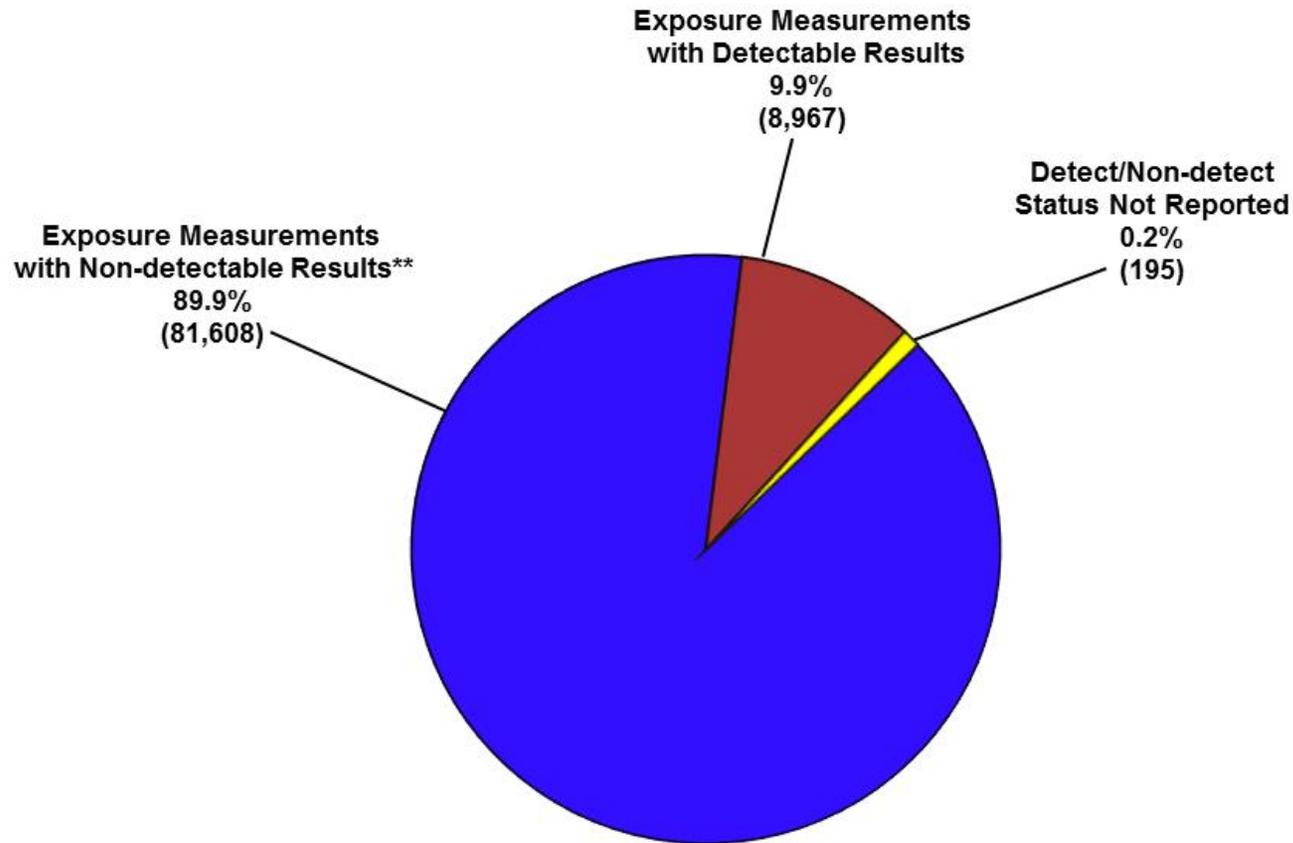
***Distribution of Employees BeSensitized or CBD by Reporting Organization and Exposure Sampling Status Through 2014\****



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

Reporting from the Registry shows that for the 565 employees (representing 21 organizations) who are BeSensitized or diagnosed with CBD, 378 employees (or 67 percent) have no exposure sampling data.

***Distribution of 90,770 Reported Exposure Levels Through 2014\****



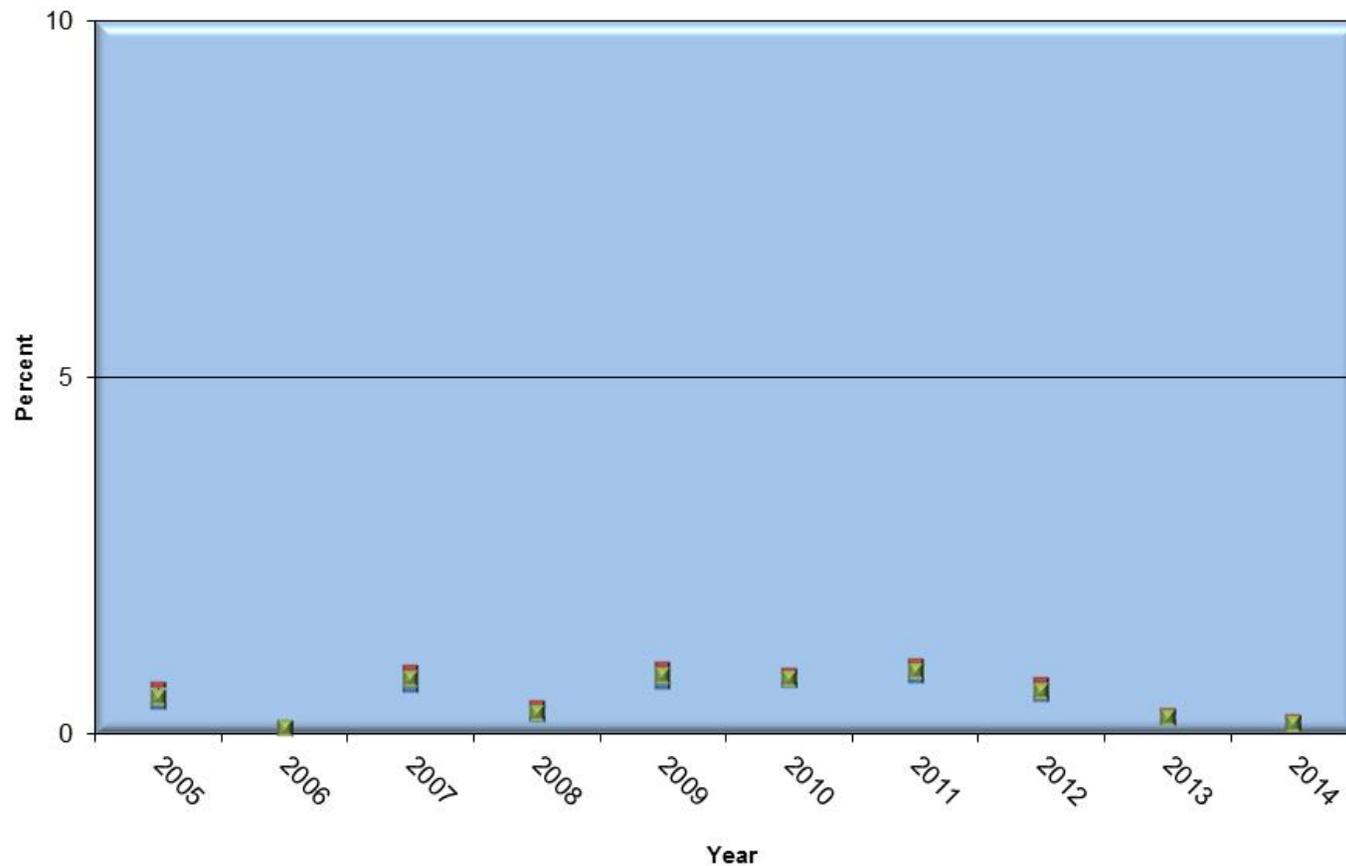
\*Some reporting organizations have provided data that predate the 2002 start date of the Registry.

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

Of the 90,770 exposure monitoring records submitted to the Registry, nearly 90 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 2005 – 2014

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 2005 – 2014 8-Hour Time Weighted Average Exposure Monitoring Results

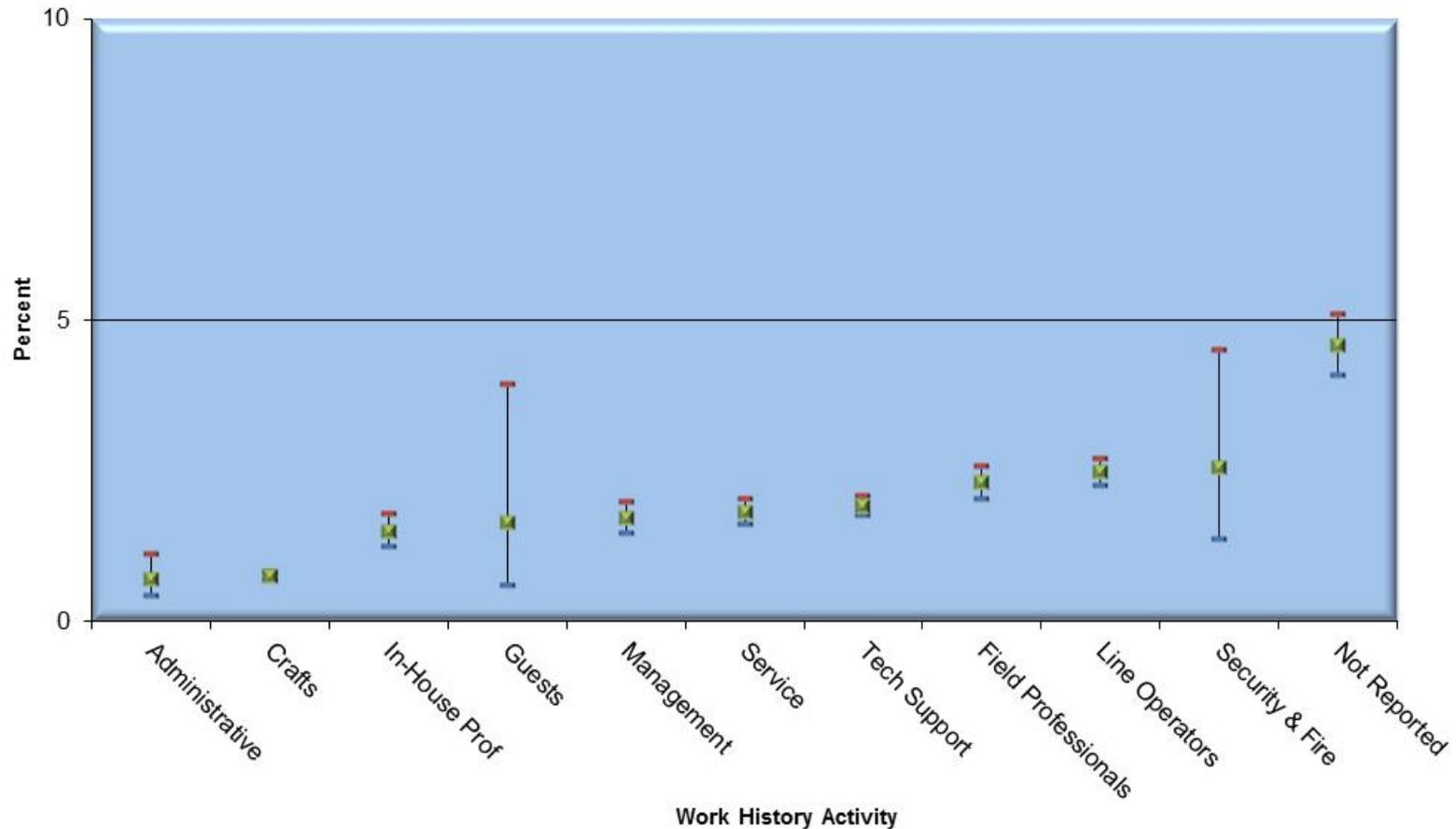
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	All Years
<b>Number of reported monitoring results</b>	3,795	6,261	5,907	5,155	6,619	13,741	10,181	6,016	5,253	5,061	67,989
<b>Number of detected values</b>	146	235	344	152	241	648	524	301	217	155	2,963
<b>Percent non-detects</b>	96.2	96.2	94.2	97.1	96.4	95.3	94.9	95.0	95.9	96.9	95.6
<b>Number of individuals monitored</b>	693	810	806	759	866	1,169	1,095	814	774	786	4,409*
<b>Arithmetic mean (EX) (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.009	0.002	0.021	0.006	0.296	0.054	0.099	0.033	0.004	0.003	0.022
<b>Lower confidence limit of EX (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.006	0.002	0.012	0.003	0.068	0.030	0.048	0.015	0.003	0.002	0.018
<b>Upper confidence limit of EX (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.016	0.002	0.035	0.013	1.284	0.094	0.203	0.070	0.006	0.004	0.028
<b>Observed 95th percentile of data (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.010	0.007	0.012	< 0.001	0.001	0.009	0.009	0.007	0.005	0.003	0.007
<b>95% upper tolerance limit of the 95th percentile (<math>\mu\text{g}/\text{m}^3</math>)</b>	0.011	0.006	0.012	0.004	0.005	0.008	0.008	0.006	0.004	0.003	0.006
<b>Largest value (<math>\mu\text{g}/\text{m}^3</math>)</b>	5.133	0.721	12.513	1.774	11.762	79.330	18.023	5.320	18.000	3.586	79.330
<b>Percent exceeding 0.2 <math>\mu\text{g}/\text{m}^3</math> (F)</b>	0.5	0.1	0.8	0.3	0.8	0.8	0.9	0.6	0.2	0.2	0.6
<b>Lower confidence limit for F</b>	0.4	0.1	0.6	0.2	0.7	0.7	0.8	0.5	0.2	0.1	0.5
<b>Upper confidence limit for F</b>	0.7	0.1	0.9	0.4	1.0	0.9	1.0	0.8	0.3	0.2	0.6

\*Many individuals were monitored in more than 1 year. The total number of individuals measured at least once in the 10-year period from 2005 through 2014 is 4,409.

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 2014\* (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 2014 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 for Employees Who Are "Sensitized" or CBD Through 2014." Direct comparison with prior years' reports may be problematic due to late reporting and/or corrections.

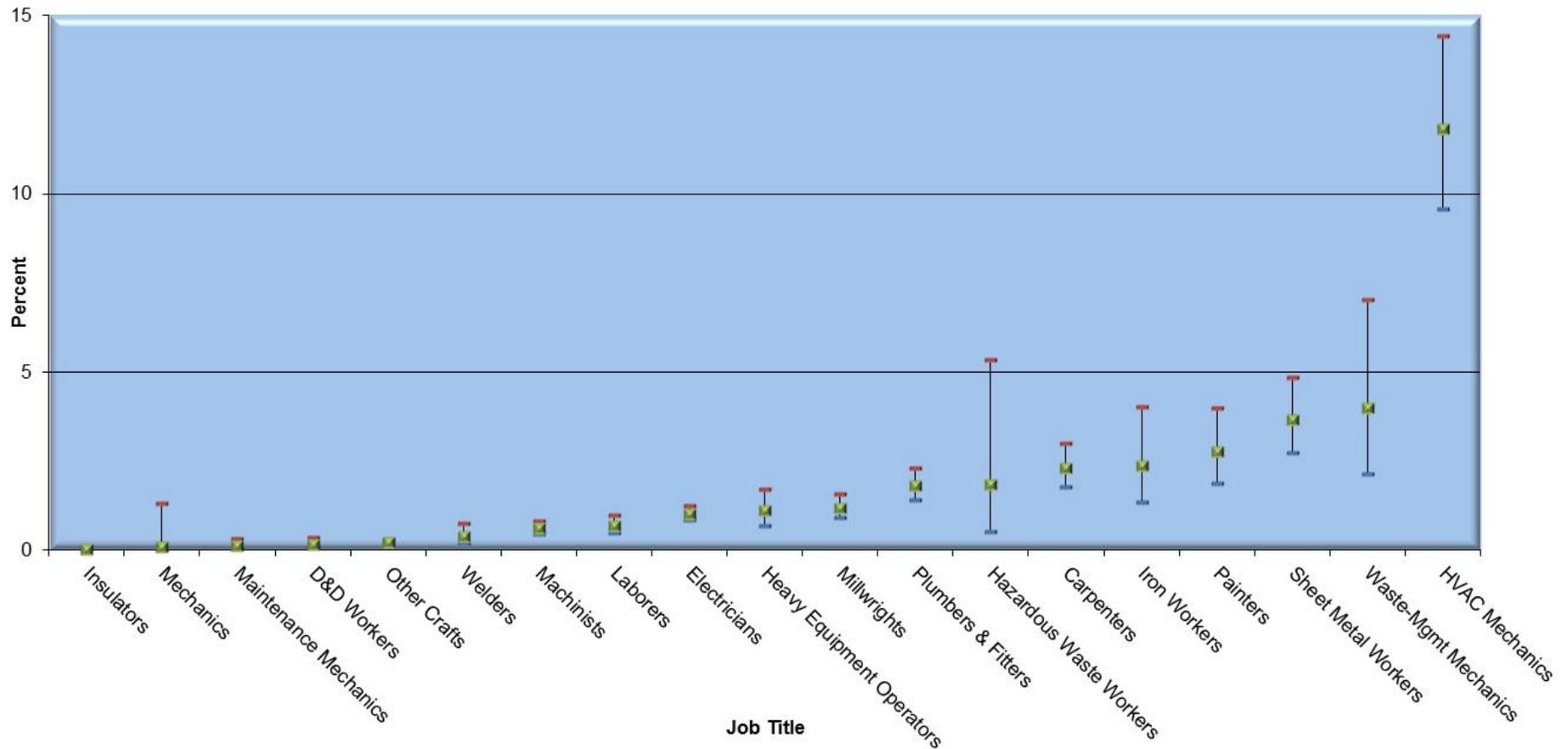
**Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Work History Activity Through 2014**

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	1,111	38,965	5,960	106	3,563	9,655	4,412	249	7,677	13,365	3,065	88,128
Number of detected values	69	1,793	772	33	316	1,016	718	12	624	1,811	1,222	8,386
Percent non-detects	93.8	95.4	87.0	68.9	91.1	89.5	83.7	95.2	91.9	86.4	60.1	90.5
Number of individuals monitored	81	1,858	531	7	272	957	249	56	522	1,024	254	5,811
Observed 95th percentile of data (ug/m <sup>3</sup> )	0.012	0.008	0.058	0.172	0.030	0.071	0.050	0.002	0.025	0.055	0.159	0.031
95% upper tolerance limit of the 95th percentile (ug/m <sup>3</sup> )	0.013	0.008	0.059	0.087	0.027	0.050	0.060	0.008	0.027	0.055	0.184	0.032
Largest value (ug/m <sup>3</sup> )	2.600	51.895	26.678	0.420	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)	0.7	0.8	2.3	1.6	1.5	2.5	1.7	2.6	1.8	1.9	4.6	1.6
Lower confidence limit for F	0.4	0.7	2.0	0.6	1.2	2.3	1.5	1.4	1.6	1.8	4.1	1.5
Upper confidence limit for F	1.1	0.8	2.6	3.9	1.8	2.7	2.0	4.5	2.0	2.1	5.1	1.7

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 2014\* (Ranked by Percent Exceeding)**

**Percent Exceeding 0.2 µg/m<sup>3</sup> Based on 95 Percent Confidence Limits**



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

The figure above provides an indication of 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. Electricians, Heavy Equipment Operators, Millwrights, Plumbers & Fitters, Hazardous Waste Workers, Carpenters, Iron Workers, Painters, Sheet Metal Workers, Waste-Management Mechanics, and HVAC Mechanics have exceedance rates significantly higher than all Crafts combined (0.8 µg/m<sup>3</sup>, as shown in the table on page 27). Direct comparison with prior years' reports may be problematic due to late reporting and/or corrections.

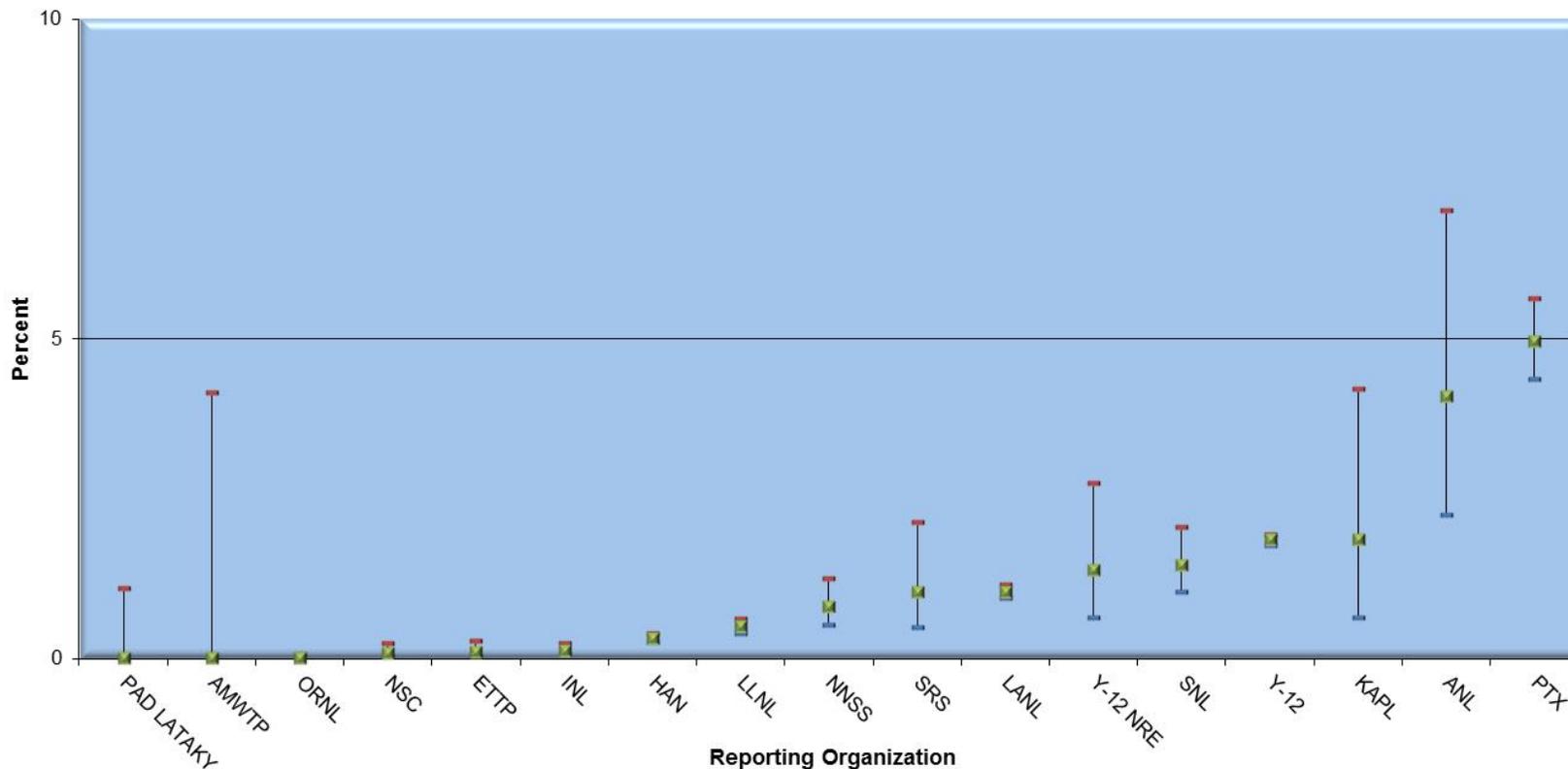
**Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results for Craft Job Titles Through 2014  
(Ranked by Percent Exceeding)**

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	657	14	97.9	26	0.001	0.003	0.700	< 0.1	< 0.1	0.1
Mechanics	89	9	89.9	30	0.017	0.019	0.091	0.1	< 0.1	1.3
Maintenance Mechanics	894	25	97.2	89	0.002	0.002	6.213	0.1	< 0.1	0.3
D&D Workers	996	54	94.6	117	0.015	0.014	0.301	0.2	0.1	0.3
Other Crafts	17,960	298	98.3	224	0.004	0.001	6.314	0.2	0.2	0.3
Welders	901	36	96.0	31	0.008	0.006	0.700	0.4	0.2	0.7
Machinists	3,935	129	96.7	88	< 0.001	0.006	51.895	0.6	0.4	0.8
Laborers	1,812	73	96.0	260	0.007	0.005	10.340	0.7	0.5	1.0
Electricians	4,080	314	92.3	306	0.020	0.018	1.999	1.0	0.8	1.2
Heavy Equipment Operators	739	54	92.7	95	0.006	0.011	16.697	1.1	0.7	1.7
Millwrights	1,967	130	93.4	155	0.015	0.016	20.176	1.2	0.9	1.6
Plumbers & Fitters	1,834	157	91.4	154	0.032	0.031	5.735	1.8	1.4	2.3
Hazardous Waste Workers	102	9	91.2	15	0.075	0.078	0.347	1.8	0.5	5.3
Carpenters	1,149	135	88.3	104	0.050	0.053	3.176	2.3	1.8	3.0
Iron Workers	278	27	90.3	34	0.063	0.044	1.006	2.4	1.3	4.0
Painters	486	70	85.6	44	0.079	0.075	7.423	2.8	1.9	4.0
Sheet Metal Workers	607	80	86.8	45	0.234	0.107	4.872	3.6	2.7	4.8
Waste-Mgmt Mechanics	147	17	88.4	15	0.093	0.124	2.390	4.0	2.1	7.0
HVAC Mechanics	332	162	51.2	26	0.553	0.679	6.404	11.8	9.6	14.4
All Combined	38,965	1,793	95.4	1,858	0.008	0.008	51.895	0.8	0.7	0.8

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 2014\*  
(Ranked by Percent Exceeding)**

**Percent Exceeding 0.2 µg/m<sup>3</sup> Based on 95 Percent Confidence Limits**



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

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, KAPL, ANL, and PTX were significantly higher than those for all organizations combined.

Results from AMES, BNL, Fermi, LBNL, LLNL CHES, PNNL, 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.

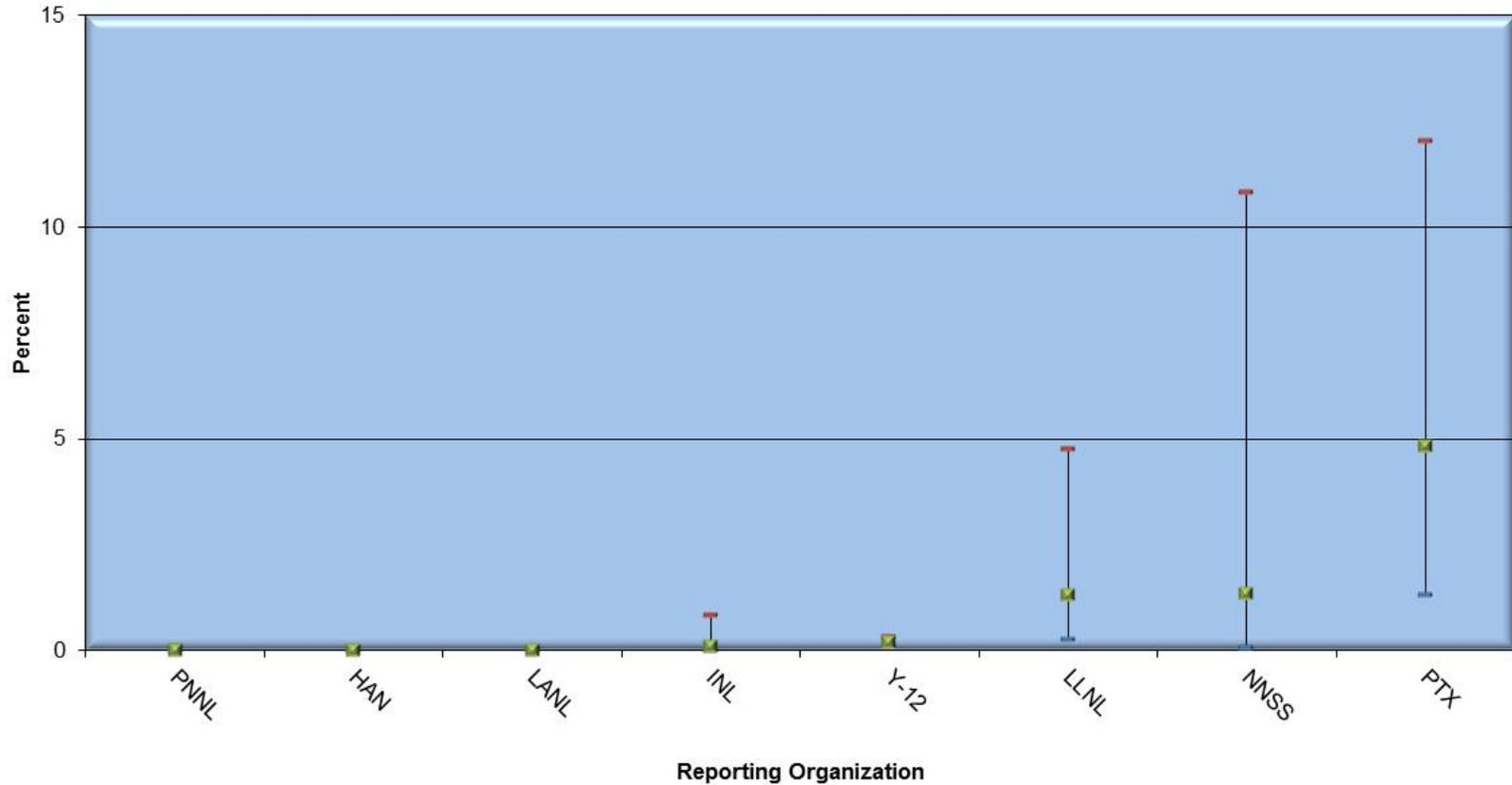
## Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Reporting Organization Through 2014

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	0	0.028	0	0	6.0
AMWTP	68	4	94.1	13	0.004	0.004	0.036	< 0.1	0	4.2
ANL	156	18	88.5	23	0.136	0.129	2.390	4.1	2.2	7.0
BNL	104	0	100	40	0.056	NA	0.900	0	0	2.8
ETTP	1,072	31	97.1	327	0.007	0.007	2.264	0.1	< 0.1	0.3
Fermi	53	25	52.8	17	0.931	0.927	4.800	18.8	12.1	27.3
HAN	8,866	387	95.6	1,459	0.004	0.002	12.513	0.3	0.3	0.4
INL	1,616	100	93.8	263	0.017	0.017	2.770	0.1	0.1	0.2
KAPL	215	2	99.1	33	0.007	< 0.001	0.700	1.9	0.6	4.2
LANL	12,200	2,533	79.2	553	0.046	0.059	26.678	1.0	0.9	1.2
LBNL	18	0	100	8	NA	NA	0.100	0	0	15.3
LLNL	6,882	325	95.3	287	0.013	0.013	15.947	0.5	0.4	0.6
LLNL CHES	3	0	100	1	NA	NA	0.042	0	0	63.2
NNSS	1,090	66	93.9	274	0.009	0.006	6.213	0.8	0.5	1.2
NSC	1,687	18	98.9	179	0.002	0.005	18.000	0.1	<0.1	0.2
ORNL	1,226	8	99.3	256	0.002	0.001	0.667	< 0.1	< 0.1	< 0.1
PAD LATAKY	566	4	99.3	60	0.004	0.002	0.019	< 0.1	0	1.1
PNNL	73	8	89.0	20	0.003	0.003	0.004	< 0.1	0	0.1
PTX	2,259	272	88.0	475	0.271	0.195	575.930	5.0	4.4	5.6
SLAC	45	0	100	26	0.198	NA	0.210	0	0	6.4
SNL	796	244	69.3	117	0.049	0.053	5.320	1.5	1.0	2.0
SRS	344	16	95.3	191	0.013	0.010	0.320	1.0	0.5	2.1
Y-12	48,449	4,310	91.1	1,166	0.050	0.034	79.330	1.8	1.8	1.9
Y-12 NRE	291	15	94.8	15	0.009	0.006	1.111	1.4	0.6	2.7
All Combined	88,128	8,386	90.5	5,811	0.031	0.032	575.930	1.6	1.5	1.7

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 2014  
(Ranked by Percent Exceeding)**

**Percent Exceeding 0.2 µg/m<sup>3</sup> Based on 95 Percent Confidence Limits**



While Pantex Plant had the greatest percentage of reported exposure monitoring results exceeding the action level in 2014, Y-12 had the greatest number (as shown on pages 31 and 32). 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 2014.

Results from AMES, AMWTP, BNL, ETTP, Fermi, LBNL, NSC, ORNL, PAD LATAKY, SNL, SRS, and Y-12 NRE were not included in this figure because of the small number of total samples.

**Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Reporting Organization  
for Calendar Year 2014**

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	2	0	100	2	NA	NA	0.020	0	0	77.6
AMWTP	1	0	100	1	NA	NA	0.003	0	0	95.0
BNL	2	0	100	1	NA	NA	0.020	0	0	77.6
ETTP	2	0	100	2	NA	NA	0.010	0	0	77.6
Fermi	1	0	100	1	NA	NA	0.009	0	0	95.0
HAN	992	26	97.4	318	0.002	0.002	3.586	< 0.1	< 0.1	0.1
INL	120	18	85.0	44	0.029	0.025	0.100	0.1	< 0.1	0.8
LANL	431	20	95.4	62	0.004	0.007	0.060	< 0.1	< 0.1	0.1
LBNL	4	0	100	3	NA	NA	0.004	0	0	52.7
LLNL	87	9	89.7	28	0.026	0.032	0.275	1.3	0.3	4.8
NNSS	27	6	77.8	17	0.036	0.044	0.317	1.4	0.1	10.8
NSC	58	1	98.3	18	5.034	NA	0.040	0	0	5.0
ORNL	30	2	93.3	20	0.004	0.004	0.007	0	0	9.5
PAD LATAKY	5	0	100	5	NA	NA	0.011	0	0	45.1
PNNL	72	8	88.9	19	0.003	0.003	0.004	< 0.1	0	0.1
PTX	62	2	96.8	21	< 0.001	0.001	0.672	4.8	1.3	12.0
SNL	6	0	100	5	NA	NA	0.010	0	0	39.3
SRS	2	0	100	2	NA	NA	0.003	0	0	77.6
Y-12	3,144	62	98.0	213	0.002	0.002	0.876	0.2	0.1	0.3
Y-12 NRE	13	1	92.3	4	NA	NA	0.010	0	0	20.6
<b>All Combined</b>	<b>5,061</b>	<b>155</b>	<b>96.9</b>	<b>786</b>	<b>0.003</b>	<b>0.003</b>	<b>3.586</b>	<b>0.2</b>	<b>0.1</b>	<b>0.2</b>

The table above gives additional summary statistics for organizations reporting exposure data to the BAWR during 2014. Organizations that did not report data for calendar year 2014 are not included in this table.

## Exposure Monitoring Results Above the 0.2 µg/m<sup>3</sup> Action Level for Calendar Years 2014, 2013, and 2012

### Calendar Year 2014:

Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, µg/m <sup>3</sup>	Respirator Assigned Protection Factor
HAN	Not identified	Vehicle and Mobile Equipment Mechanics	3.59	1000
Y-12	SUPPORT	Other Crafts	0.88	50
PTX	BERYLLIUM WORK	AREA MECHANIC	0.67	25
Y-12	SUPPORT	Plumbers and Pipefitters	0.65	100
Y-12	PRODUCTION	Other Crafts	0.62	1
Y-12	SUPPORT	Other Crafts	0.54	50
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	0.45	25
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.45	25
Y-12	PRODUCTION	Other Crafts	0.42	50
NNSS	Exposure Assessment	Miner	0.32	10
LLNL	Decontamination	Sr. Technologist C/MS	0.28	1000
Y-12	SUPPORT	Other Crafts	0.27	50
Y-12	SUPPORT	Millwrights	0.27	100
Y-12	SUPPORT	Plumbers and Pipefitters	0.26	100
LLNL	Decontamination	Sr. Technologist Mechanical	0.20	1000
Y-12	SUPPORT	Other Crafts	0.20	50
Y-12	SUPPORT	Other Crafts	0.20	100

### Calendar Year 2013:

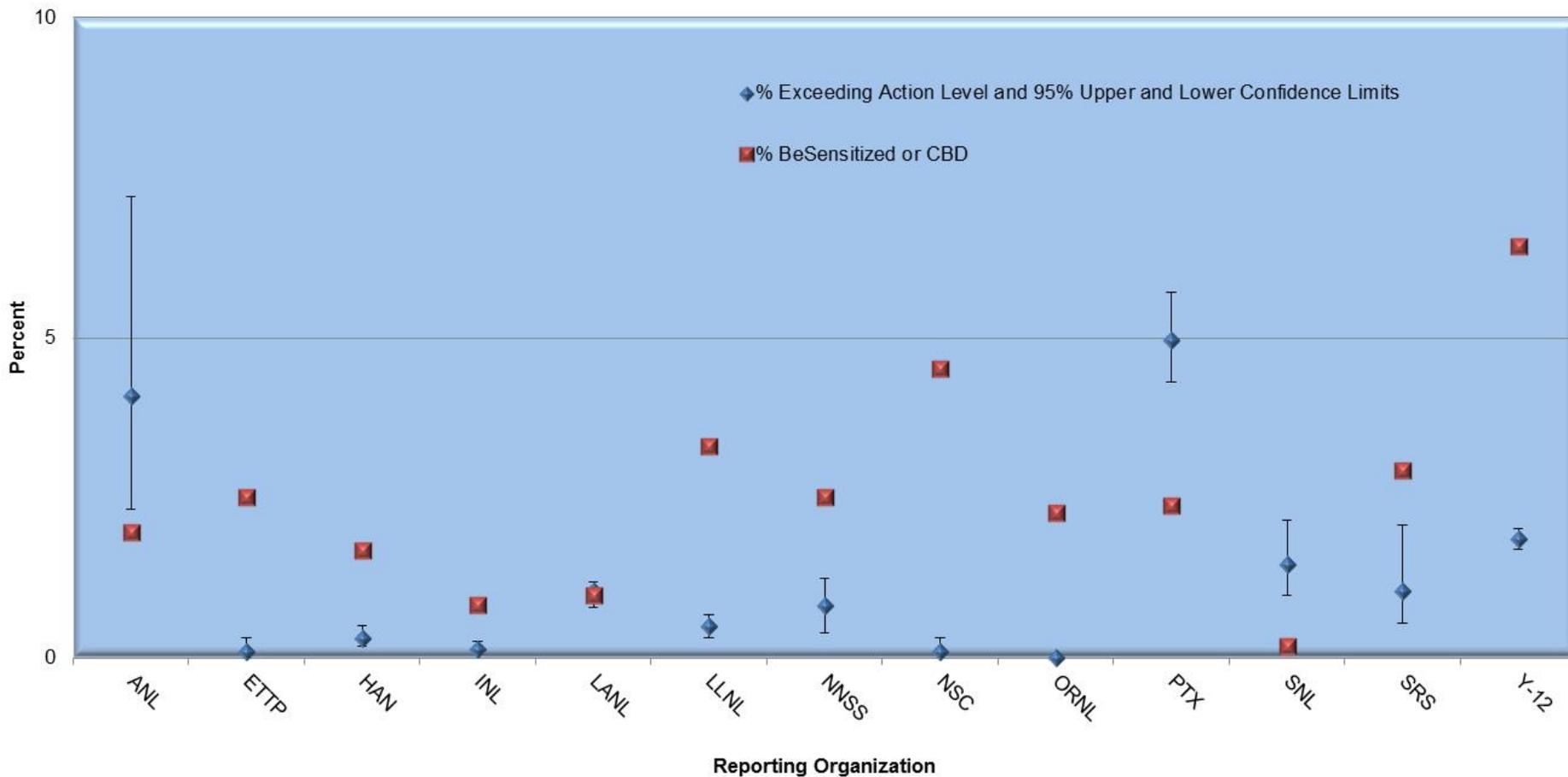
Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, µg/m <sup>3</sup>	Respirator Assigned Protection Factor
NSC	Decontamination	Laborer	18.00	50
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.80	25
LANL	RESEARCH TEC 5		0.30	100
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.30	25
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	0.29	25
Y-12	PRODUCTION	Machinists	0.26	50
Y-12	PRODUCTION	Engineering Technicians	0.22	50

### Calendar Year 2012:

Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, µg/m <sup>3</sup>	Respirator Assigned Protection Factor
SNL	DECONTAMINATION	Technician	5.32	25
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	4.01	100
PTX	BERYLLIUM WORK	ENG TECH. II (WASTE OPER)	3.21	100
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	2.47	100
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	2.25	100
LLNL	Not identified	Technologist - C/MS	2.08	1000
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	1.55	100
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	1.35	100
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	0.84	100
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.81	1
LLNL	Not identified	Technologist - C/MS	0.75	1000
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	0.75	100
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.73	100
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	0.73	100
LANL	INSPECT DRUM CONTENTS	STAFF MEMBER	0.58	100
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.49	100
LANL	R&D ENGINEER 4	TEAM LEADER	0.46	1000
LLNL	Not identified	Scientific Technician	0.43	1000
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.42	100
LANL	WET MACHINING	MACH/FAB TEC-S	0.41	1
LLNL	Not identified	Sr. Technologist C/MS	0.40	1000
LANL	ENGINEERED SYSTEMS T	EXPLOSIVES TEC 4	0.37	1000
LANL	INSPECT DRUM CONTENTS	STAFF MEMBER	0.37	10
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATIONS	0.36	100
PTX	BERYLLIUM WORK	ENG TECH (WASTE OPERATIONS)	0.34	100
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.33	100
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.33	100
LLNL	Not identified	Sr. Technologist C/MS	0.30	1000
LLNL	Not identified	Sr. Technologist C/MS	0.29	1000
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	0.27	100
LLNL	Not identified	Sr. Hydro Tech - S-300	0.27	1000
LANL	ENGINEERED SYSTEMS T	EXPLOSIVES TEC 4	0.26	1000
LLNL	Not identified	Sr. Technologist C/MS	0.24	1000
LLNL	Not identified	Sr. Technologist C/MS	0.23	1000
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.23	100
Y-12	PRODUCTION	Other Crafts	0.22	100
LANL	INSPECT DRUM CONTENTS	MTRLS SCI TEC	0.21	100
SNL	WASTE TREATMENT PROCES	Technician	0.21	100
LLNL	Not identified	Sr. Technologist C/MS	0.20	1000
PTX	BERYLLIUM WORK	ENG TECH (WASTE OPER) II	0.20	1

Exceedances for 2014 were greater than in 2013 but still fewer than in previous years. In 2014 17 samples exceeded the action level compared with only 7 in 2013 and 40 in 2012. Nevertheless, the total number of reported exposure sampling results continued to decrease (from 6,016 in 2012 to 5,253 in 2013 to 5,061 in 2014). In both 2013 and 2012 exceedances were primarily associated with waste operations work at Pantex Plant. In 2014 exceedances were primarily for support and production work at Y-12. In most 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 2014\*



\*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 = 0.06). 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.