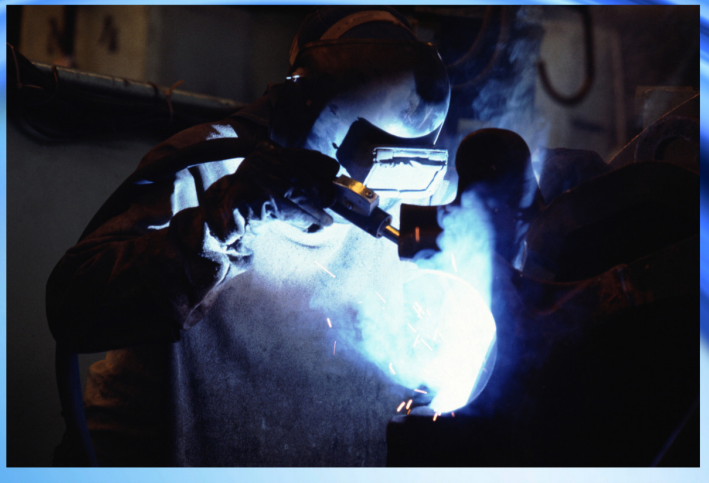
9.02 1 2

Be 4 2-2

Beryllium-Associated Worker Registry 2016



DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

EHSS

Office of Environment, Health, Safety and Security

Table of Contents

Beryllium-Associated Worker Registry Summary 1
Location of 27 Reporting Organizations Currently Submitting Data to BAWR 5
27 Reporting Organizations Currently Submitting Data to BAWR 6
6 Inactive BAWR Reporting Organizations 6
Total 34,996 Employees by BAWR Reporting Organization Through 2016 7
Gender and Age Distribution of Employees Reported to BAWR Through 2016 8
Screening Status and Progression from BeLPT Testing to "Sensitized" to CBD Through 2016 9
Number of Employees BeLPT Tested, "Sensitized," or CBD by Reporting Organization Through 2016 10
Percentage Distribution by Reporting Organization of 464 BeSensitized Employees Through 2016 11
Percentage Distribution by Reporting Organization of 147 Employees Diagnosed with CBD Through 2016 12
Number of Years Following Year of First Hire for Employees Who Are "Sensitized" or CBD 13
Year of First Positive or Abnormal BeLPT Result for Beryllium-Associated Workers Who Have Been Tested 14
Work History Activity and BeLPT Status for 23,942 Beryllium-Associated Workers Screened Through 2016 15
Distribution of 6,877 BeLPT Results for 6,052 Employees by Reporting Organization for Calendar Year 2016 16
Distribution by Reporting Organization of 6,441 Beryllium-Associated Workers Exposure Monitored Through 2016 17
Annual Number of Employees Exposure Monitored by Reporting Organization for 2007 – 2016 18
Distribution of 4,362 Exposure Samples for 684 Employees by Reporting Organization for Calendar Year 2016 19
Distribution of Employees BeSensitized or CBD by Reporting Organization and Exposure Sampling Status Through 2016 20
Distribution of 101,169 Reported Exposure Levels Through 2016 21
DOE-wide Exposure Trend for 2007 – 2016 22
Summary Statistics for 2007 – 2016 8-Hour Time Weighted Average Exposure Monitoring Results 23
Exposure by Work History Activity Through 2016 (Ranked by Percent Exceeding) 24
Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Work History Activity Through 2016 25
Exposure by Job Title for Craft Workers Through 2016 (Ranked by Percent Exceeding) 26
Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results for Craft Job Titles Through 2016 (Ranked by Percent Exceeding) 27
Percent of Exposure Monitoring Results Exceeding the Action Level by Reporting Organization Through 2016 (Ranked by Percent Exceeding) 28

Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Reporting Organization Through 2016 29

Percent of Exposure Monitoring Results Exceeding the Action Level by Reporting Organization for Calendar Year 2016 (Ranked by Percent Exceeding) 30

Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Reporting Organization for Calendar Year 2016 31

Exposure Monitoring Results Above the 0.2 µg/m^3 Action Level for Calendar Years 2016, 2015, 2014, and 2013 32

Cumulative Rates of Beryllium Sensitization or CBD versus Exposure Levels Through 2016 33

Beryllium-Associated Worker Registry Summary
Data Cumulative Through 2016

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 2016 submitted or corrected by the end of May 2017, somewhat delayed by late site data submissions.

Reporting Organizations:

The 2016 report covers 27 active reporting organizations, unchanged from the 2015 report. However, the names of 3 organizations changed:

- The subcontractor doing Liquid Waste Management System (LWMS) work at Y-12 National Security Complex (Y-12) merged with another company, and the name of the entity doing work in the U.S. changed from Y-12 EnergySolutions (Y-12 ES) to **Y-12 Atkins Nuclear Secured (Y-12 ANS)**.

- With the Fluor contract award at Paducah, LATA Environmental Services of Kentucky, LLC (PAD LATAKY) became **Fluor Paducah Deactivation Project (FPDP)**.

- Stanford Linear Accelerator Center (SLAC) informed us that their name had changed to **SLAC National Accelerator Laboratory (SLAC)**.

Health data were collected through the operation of current worker medical surveillance programs for all 27 active reporting organizations. Industrial hygiene programs submitted exposure sampling data for 25 of the 27 active reporting organizations. Neither DOE-Oak Ridge Operations (DOE-ORO) nor National Strategic Protective Services, LLC (NSPS) submits exposure sampling data. Six (6) sites remain inactive.

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 site of protecting the workers' privacy.

Observations:

- The 2016 report includes 1,647 more workers than the 2015 report.

- Beryllium screening was reported for 679 more workers than in calendar year 2015.

- An additional 355 employees were monitored for exposure through CY2016 (6,441 versus 6,086 in CY2015).

- The Registry received 4,933 additional exposure sampling results through CY2016. Five hundred seventy-one (571) of these records were reported for years prior to 2016, 4,362 monitoring records were added during CY2016.

- One new case of chronic beryllium disease was reported during calendar year 2016, the first reported since 2011. A current employee at Nevada National Security Site, the individual's work was in the Crafts and Laborer job categories. 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.

- Beryllium lymphocyte proliferation test (BeLPT) screening results were available for 679 more workers than in the 2015 report. Of the 23,942 workers tested through CY2016, 464 were beryllium sensitized (BeS, 1.9 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.

- Nine (9) additional beryllium sensitizations were reported in 2016, of which 6 were actually from 2016; 3 others were from previous years. By comparison, 8 new BeS cases were reported for 2015 (7 in the previous report plus 1 late reported case). Corrected data from Y-12 led to the withdrawal of 2 sensitizations reported in previous years.

- 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 464 individuals diagnosed with beryllium sensitization, only 156 (34 percent) have any exposure sampling data reported. Of these 156 BeS cases, 61 only have exposure sampling data dated *later* than their reported date of beryllium sensitization. Only 95 (20 percent) of the 464 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.

- Twenty-three (23) samples exceeded the action level of 0.2 $\mu g/m^3$ in 2016 compared with 24 in 2015, 15 in 2014, 7 in 2013, and 40 in 2012. In 2015, exceedances were largely associated with operational support work at Sandia National Laboratory (SNL). The majority of samples exceeding the action level in 2016 were associated with support activities at SNL and Y-12. In most cases, the potential for these exceedances was identified by work planning processes and appropriate respiratory protection was in use.

- Through 2016, the highest percentage of both reported beryllium sensitizations (36.0 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 $\mu g/m^3$ 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).

- Through 2016, 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 2013-2016			
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

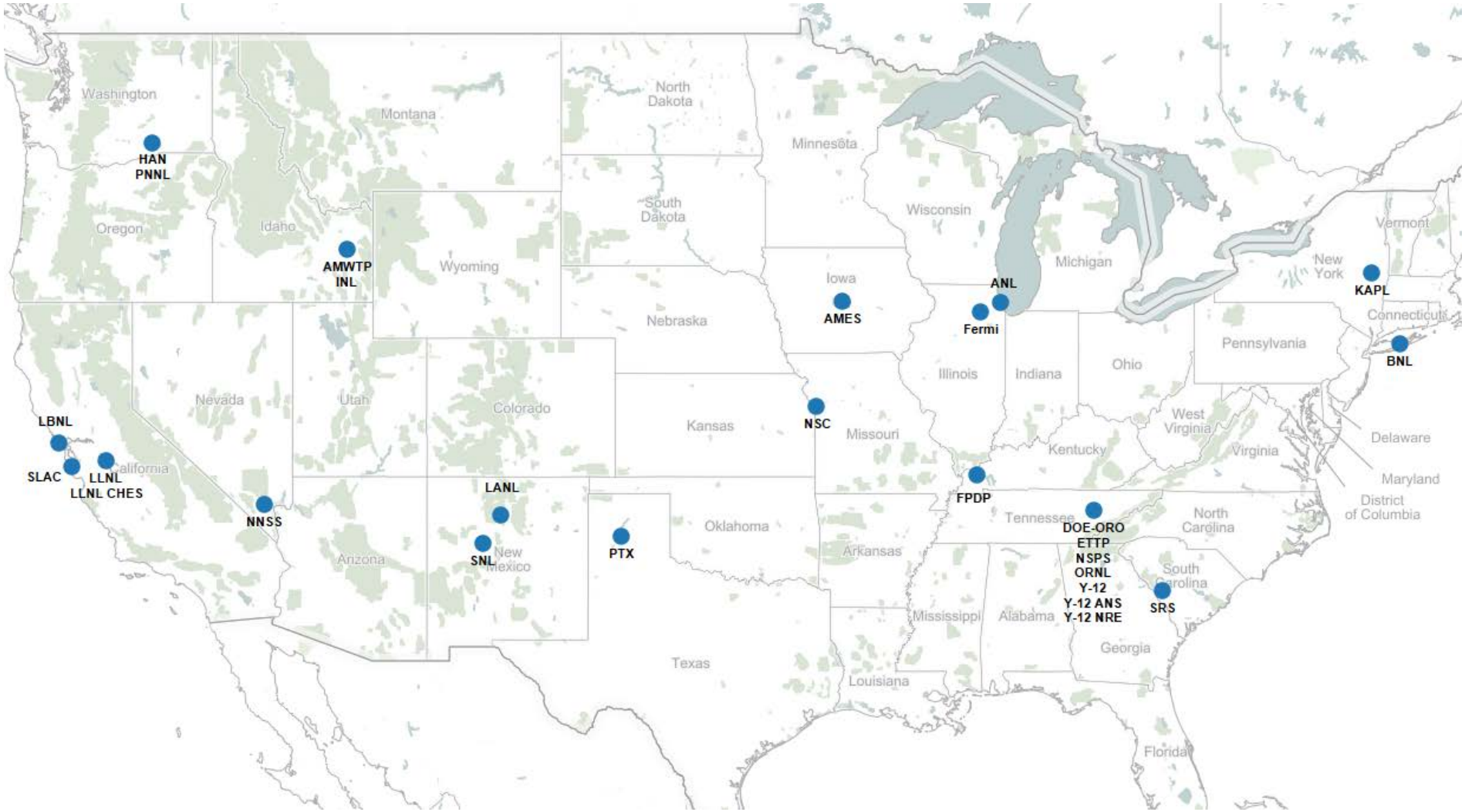
The BAWR program remains a key component of AU evaluation and analysis to inform management and stakeholders of the continued vigilance and success of the DOE sites in protecting worker health. The occurrence of a new CBD diagnosis in 2016, the first new case since 2011, emphasizes the value of continued adherence to safety and monitoring programs. The number of new beryllium sensitizations occurring in 2016, 6 compared with 8 in 2015, provides little evidence of a significant change in the frequency of BeS diagnoses between the two years. While exceedances above the action level occurred in 2016 with almost the same frequency as in 2015, exceedances in both years remained well 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 always, reader comments are welcome,

Cliff Strader

Cliff Strader, PhD
Program Manager, BAWR

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

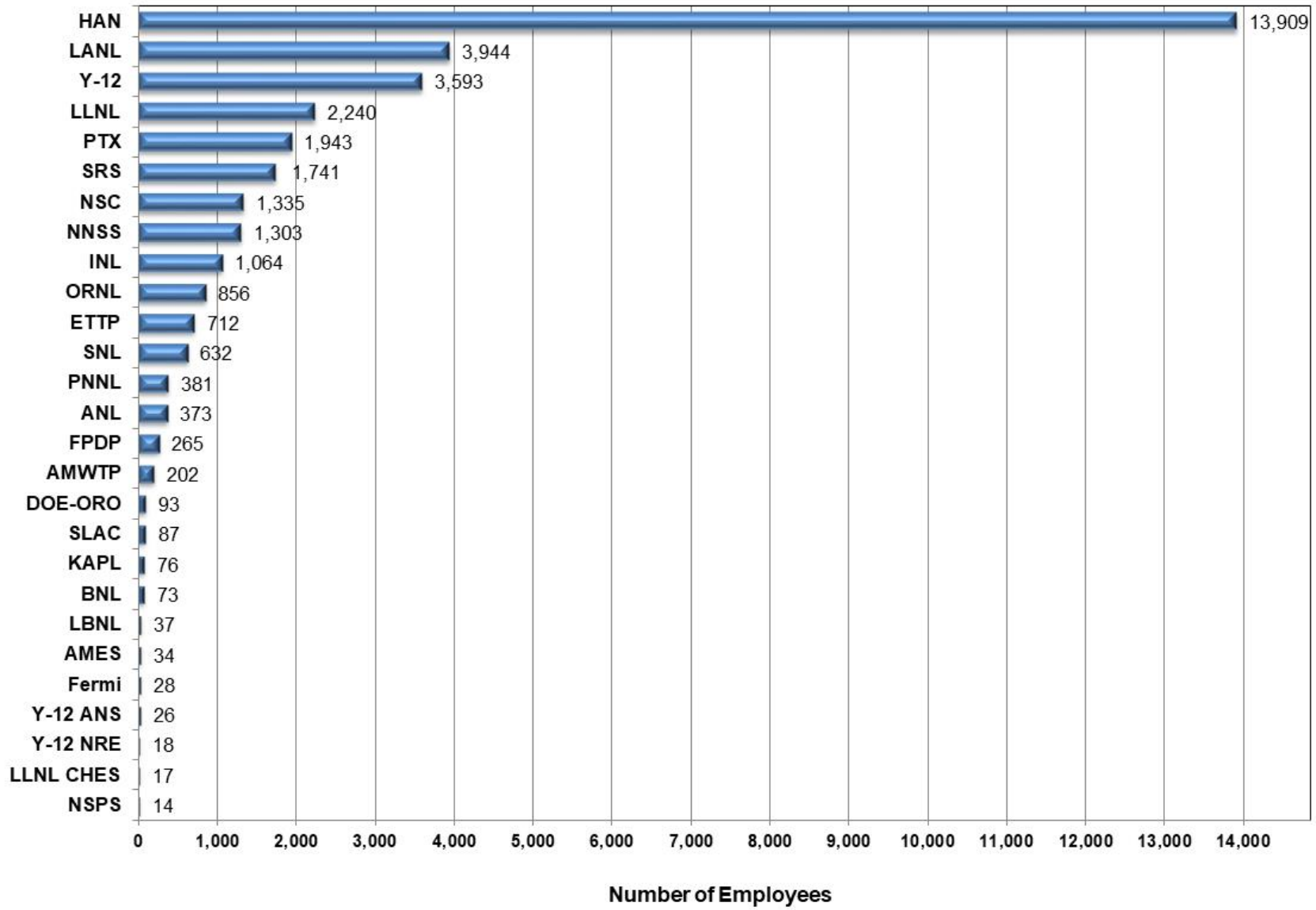
Advanced Mixed Waste Treatment Project (AMWTP)	Los Alamos National Laboratory (LANL)
Ames Laboratory (AMES)	National Security Campus (NSC)
Argonne National Laboratory (ANL)	National Strategic Protective Services, LLC for ETTP and ORNL (NSPS)
Brookhaven National Laboratory (BNL)	Nevada National Security 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)
Fluor Paducah Deactivation Project (FPDP)	Sandia National Laboratories (SNL)
Hanford Site (HAN)	Savannah River Site (SRS)
Idaho National Laboratory (INL)	SLAC National Accelerator Laboratory (SLAC)
Knolls Atomic Power Laboratory (KAPL)	Y-12 Atkins Nuclear Secured (Y-12 ANS)
Lawrence Berkeley National Laboratory (LBNL)	Y-12 National Security Complex (Y-12)
Lawrence Livermore National Laboratory (LLNL)	Y-12 Navarro Research and Engineering (Y-12 NRE)
LLNL Clean Harbors Environmental Services (LLNL CHES)	

6 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)	Y-12 URS Corporation (Y-12 URS)

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

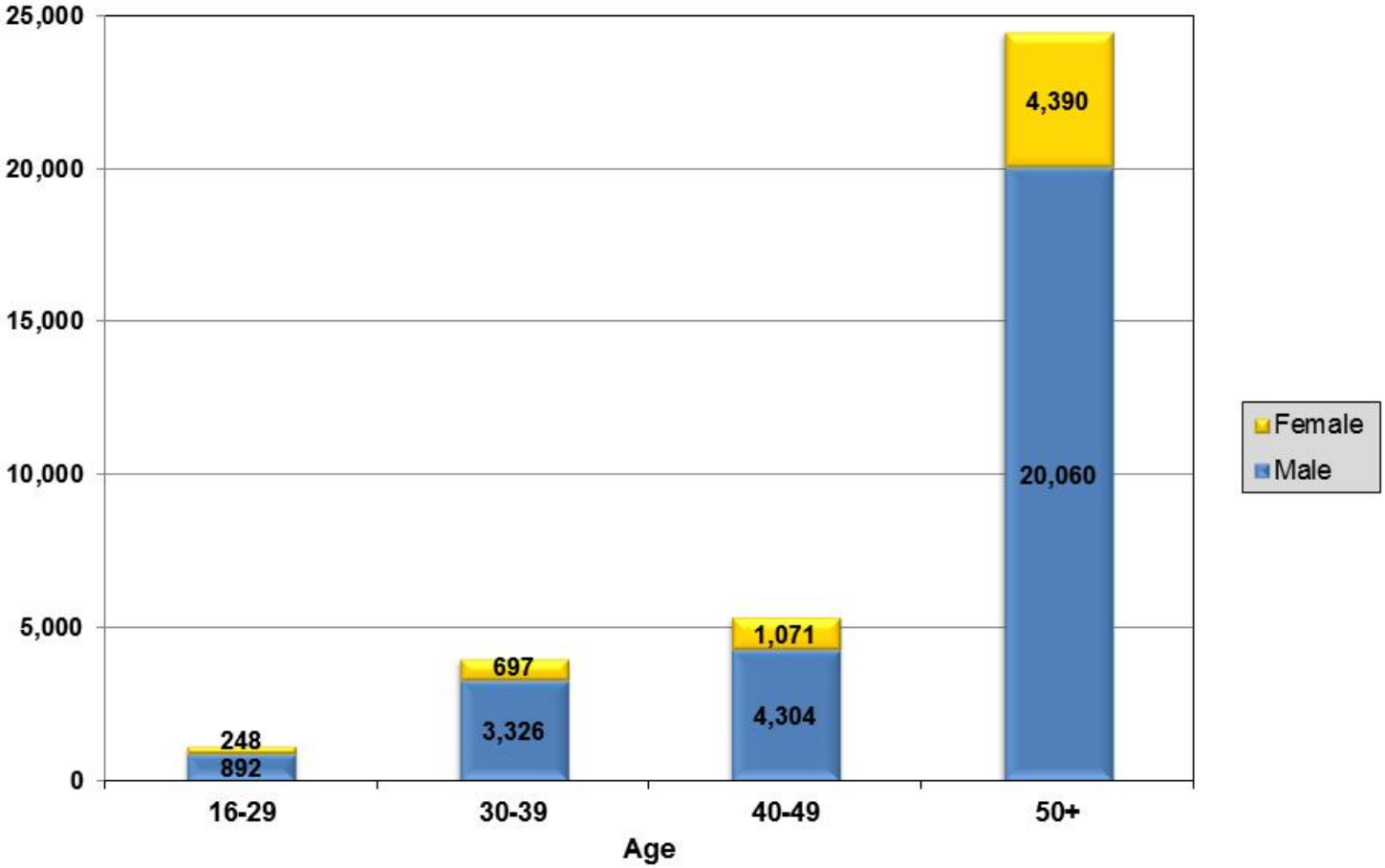
Total 34,996 Employees by BAWR Reporting Organization Through 2016*



*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.

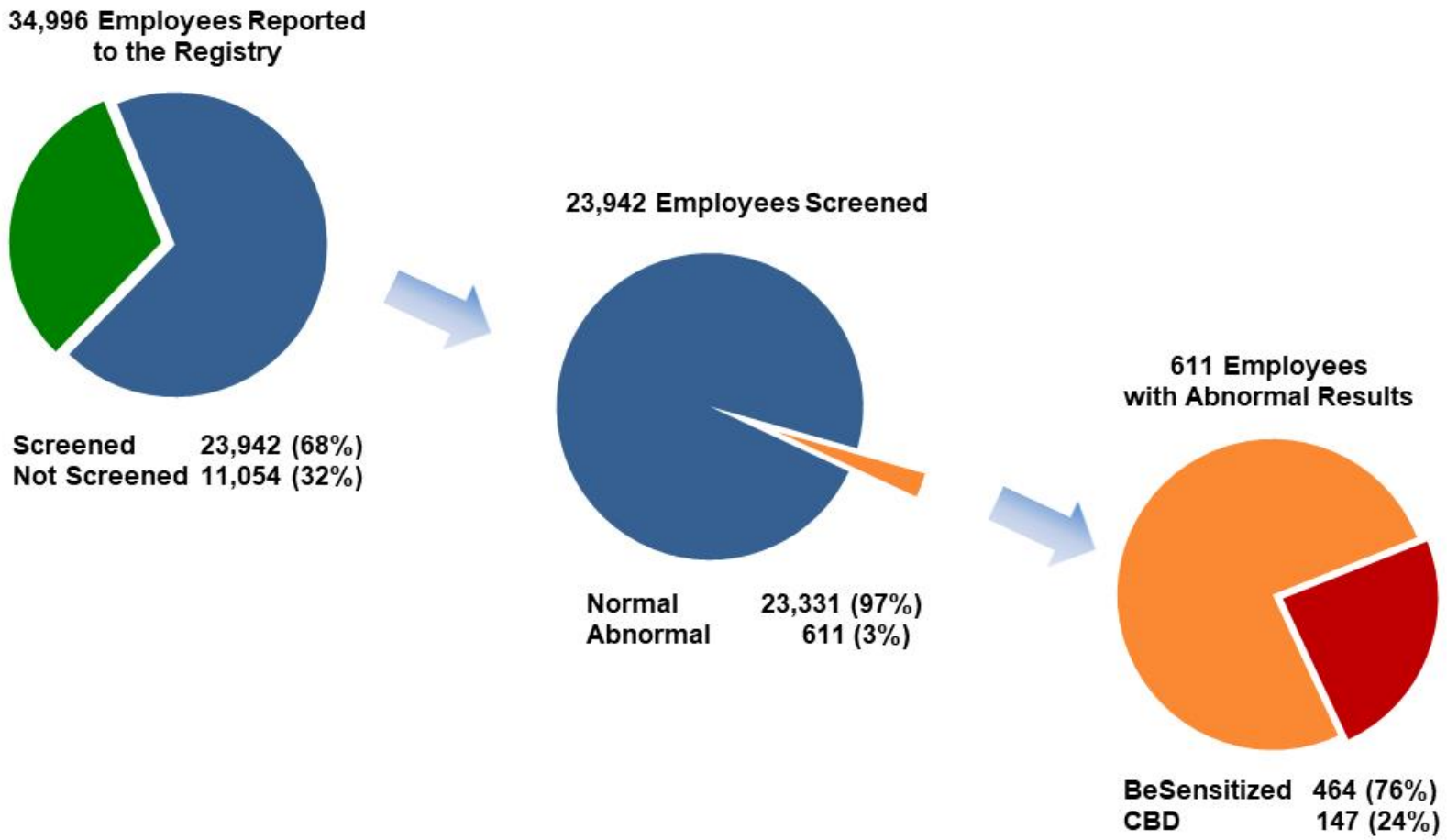
Gender and Age Distribution of Employees Reported to BAWR Through 2016*



*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 2016, 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 2016*



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

From 2015 to 2016, the 27 organizations currently reporting to the Registry identified 7 additional sensitized employees and 1 additional employee with CBD.

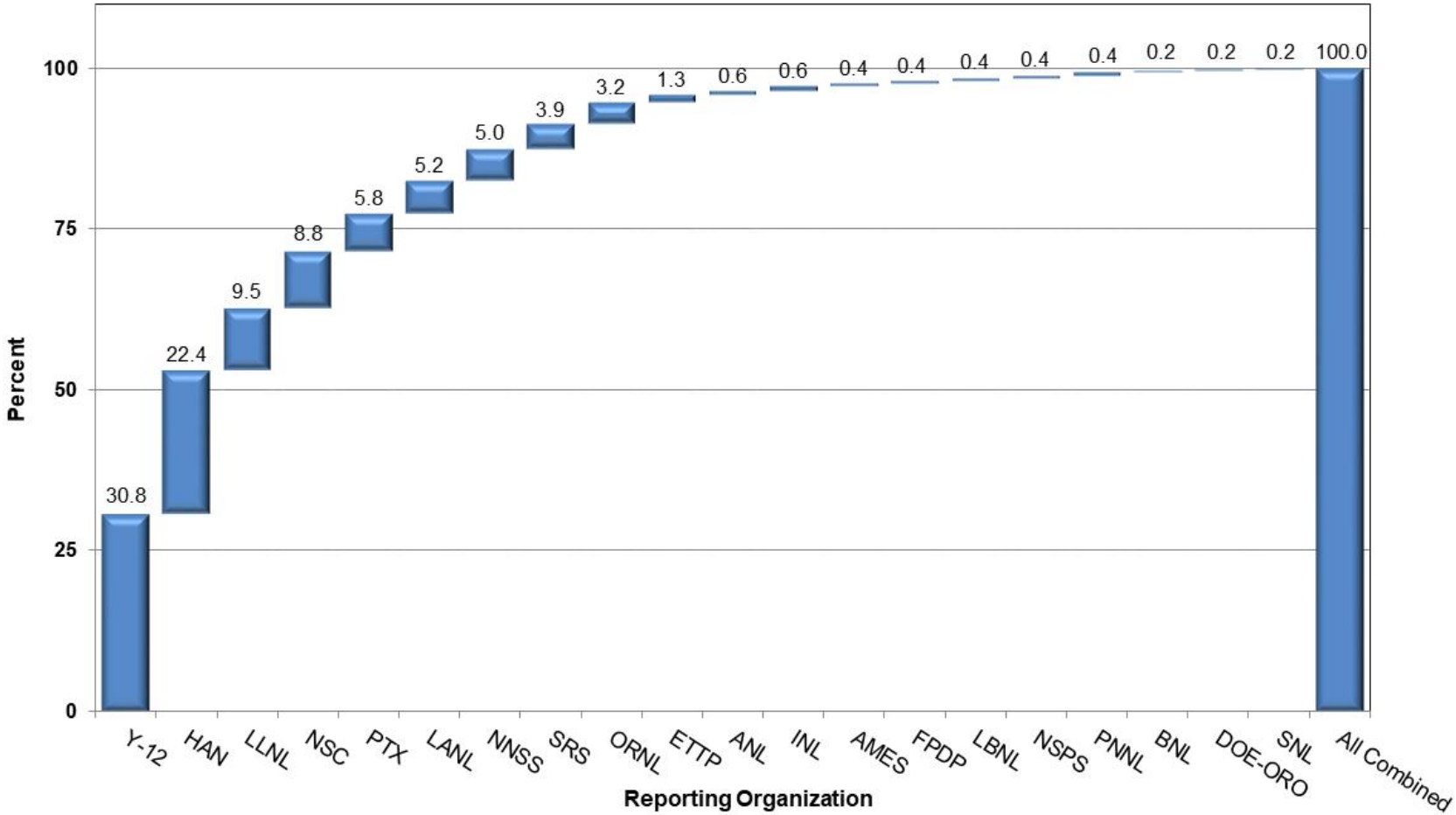
Number of Employees BeLPT Tested, "Sensitized," or CBD by Reporting Organization Through 2016*

Reporting Organization	Number of:		
	Employees with BeLPT Results	"Sensitized" Employees	Employees with CBD
HAN	8,550	104 (1.2 %)	34 (0.4 %)
Y-12	2,910	143 (4.9 %)	62 (2.1 %)
LANL	2,731	24 (0.9 %)	3 (0.1 %)
PTX	1,850	27 (1.5 %)	15 (0.8 %)
LLNL	1,506	44 (2.9 %)	3 (0.2 %)
NSC	1,236	41 (3.3 %)	14 (1.1 %)
NNSS	1,162	23 (2.0 %)	5 (0.4 %)
ORNL	769	15 (2.0 %)	0
SRS	763	18 (2.4 %)	6 (0.8 %)
SNL	628	1 (0.2 %)	0
INL	421	3 (0.7 %)	0
ETTP	404	6 (1.5 %)	4 (1.0 %)
PNNL	346	2 (0.6 %)	0
ANL	161	3 (1.9 %)	0
FPDP	112	2 (1.8 %)	0
DOE-ORO	93	1 (1.1 %)	0
SLAC	49	0	1 (2.0 %)
BNL	42	1 (2.4 %)	0
KAPL	38	0	0
AMES	34	2 (5.9 %)	0
LBNL	26	2 (7.7 %)	0
Y-12 ANS	24	0	0
AMWTP	22	0	0
Fermi	20	0	0
Y-12 NRE	18	0	0
NSPS	14	2 (14.3 %)	0
LLNL CHES	13	0	0
Total	**23,942**	**464 (1.9 %)**	**147 (0.6 %)**

*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.

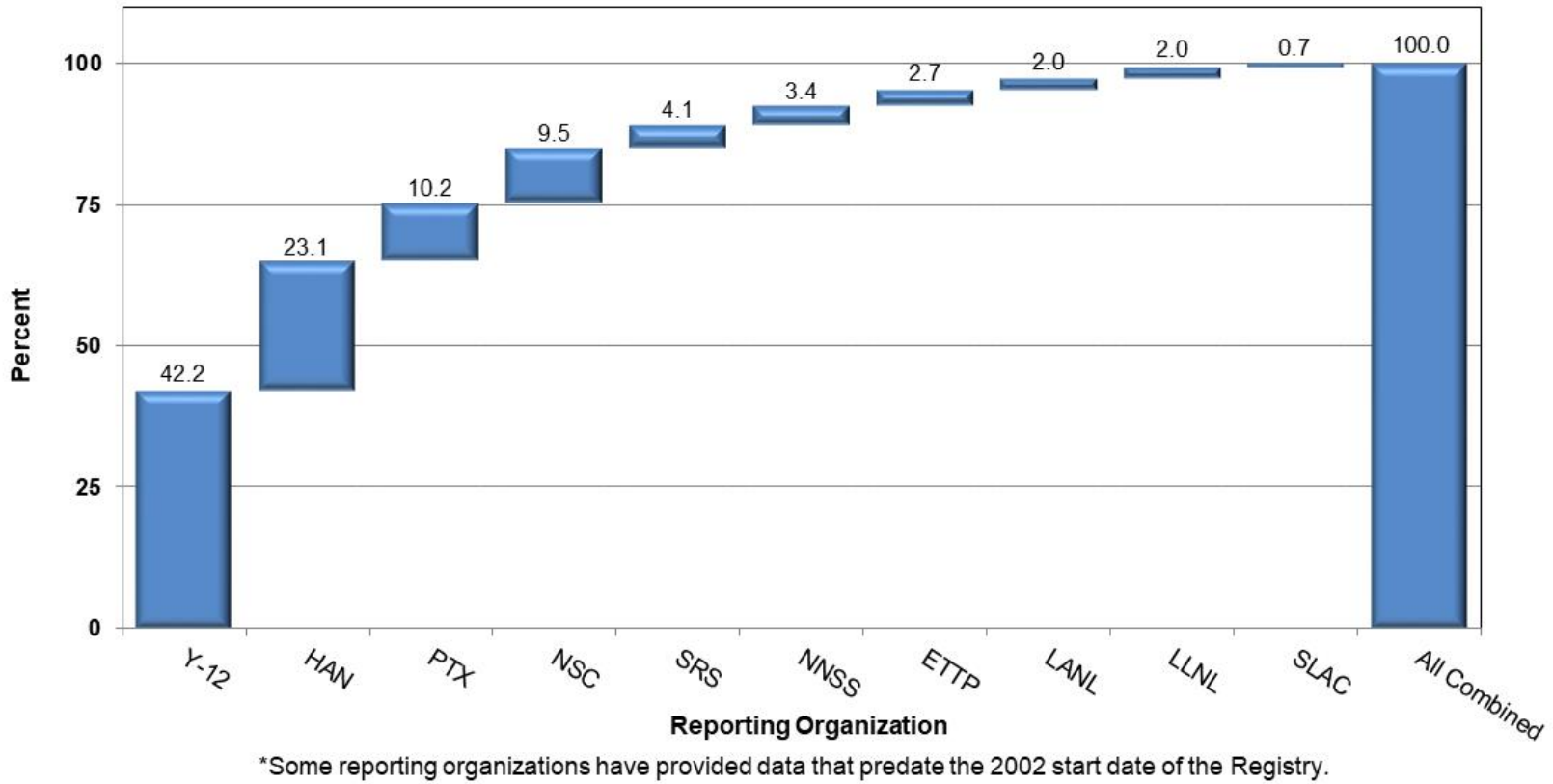
Percentage Distribution by Reporting Organization of 464 BeSensitized Employees Through 2016*



*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.

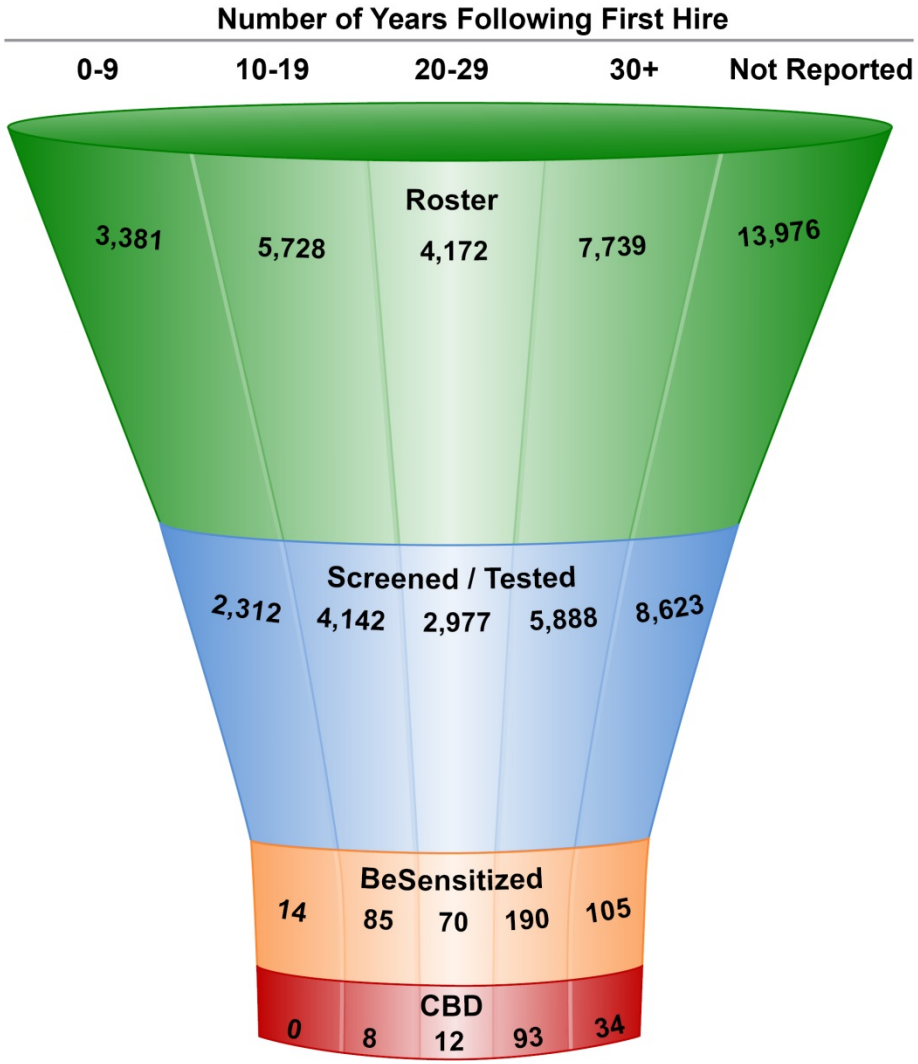
Percentage Distribution by Reporting Organization of 147 Employees Diagnosed with CBD Through 2016*



*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	1,630	29	17
2001	3,236	43	17
2002	3,967	43	15
2003	3,967	13	5
2004	3,814	13	3
2005	5,115	27	6
2006	4,870	44	9
2007	4,583	45	5
2008	5,077	28	7
2009	6,226	45	2
2010	6,894	30	1
2011	7,930	21	0
2012	6,175	5	0
2013	5,570	8	0
2014	5,996	8	0
2015	6,044	10	0
2016	6,052	2	0
Year Not Reported	0	15	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.

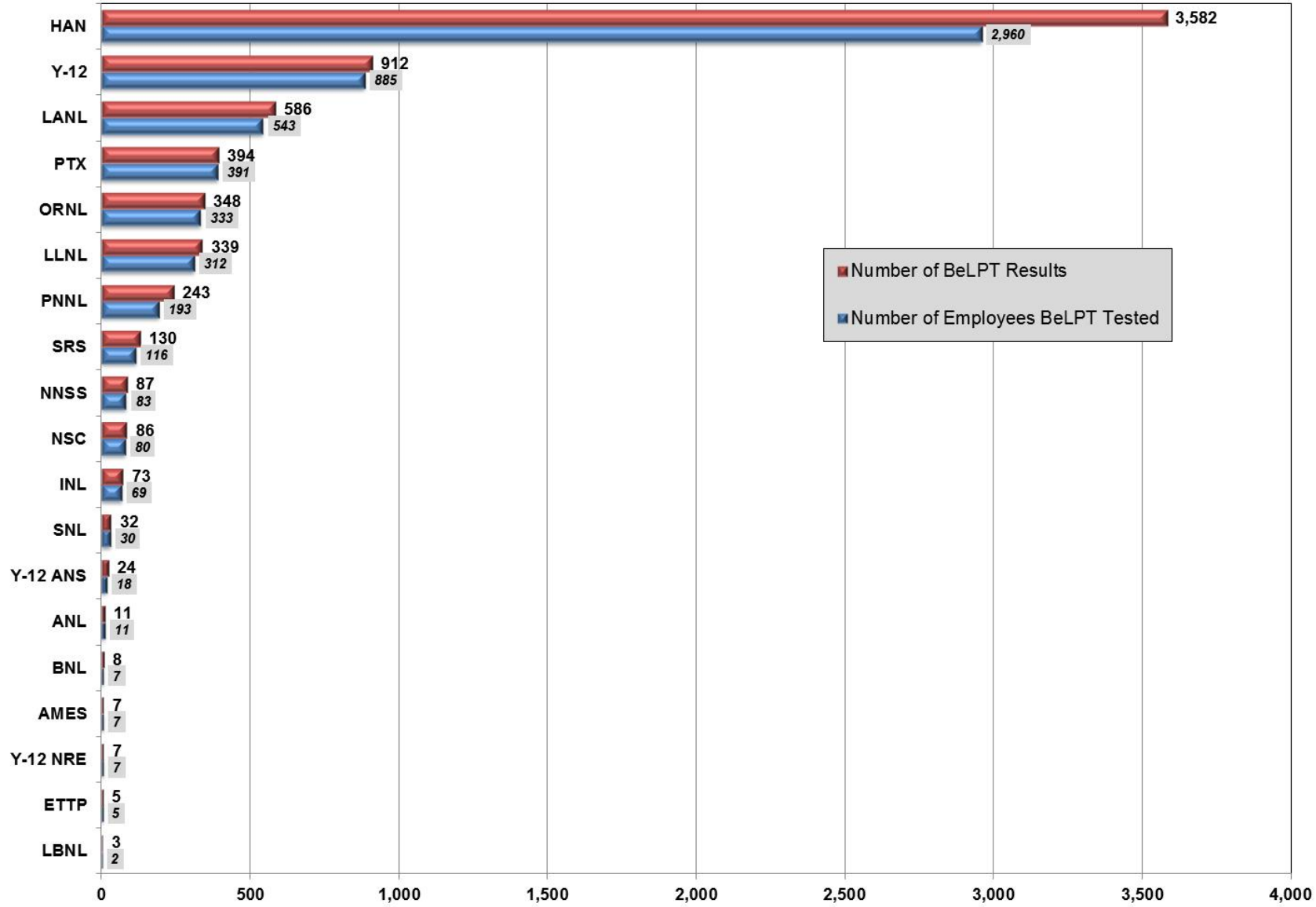
Work History Activity and BeLPT Status for 23,942 Beryllium-Associated Workers Screened Through 2016*

Work History Activity	Number of:		
	Employees with BeLPT Results	"Sensitized" Employees	Employees with CBD
Management	1,688	39	11
Administrative Support	1,045	30	10
In-House Professionals	1,595	36	14
Field Professionals	2,089	43	6
Technical Support	3,096	60	13
Service	1,389	28	12
Security and Fire	1,468	24	7
Crafts	4,137	96	36
Line Operators	2,706	71	23
Guests	64	0	0
Unknown	705	12	11
Not Reported	3,960	25	4
Totals	**23,942**	**464**	**147**

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

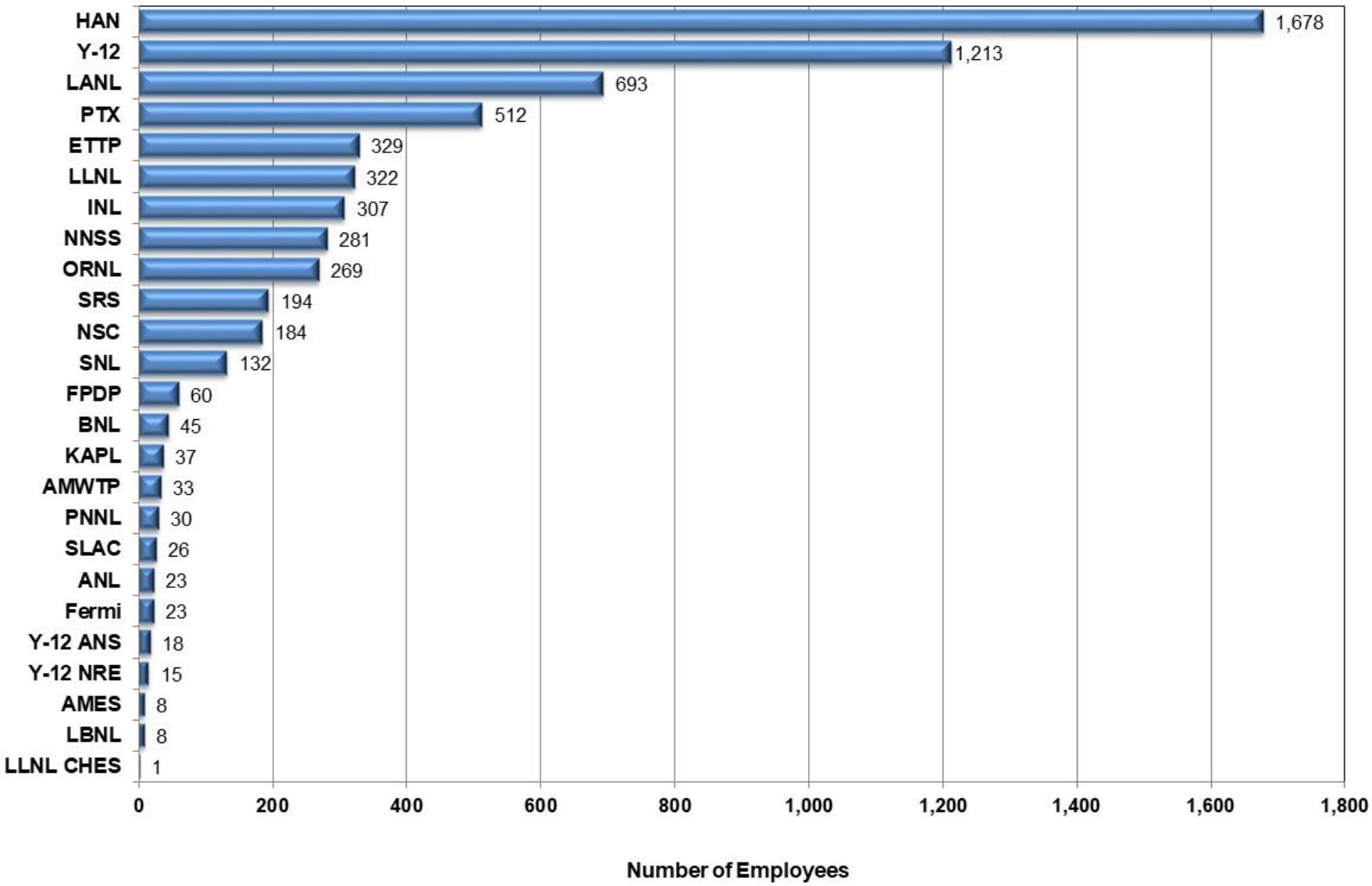
The above table lists beryllium sensitized or CBD diagnosed beryllium-associated workers through 2016 grouped by their work history activity, which is a high level rollup of job function.

Distribution of 6,877 BeLPT Results for 6,052 Employees by Reporting Organization for Calendar Year 2016



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 6,441 Beryllium-Associated Workers Exposure Monitored Through 2016*



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

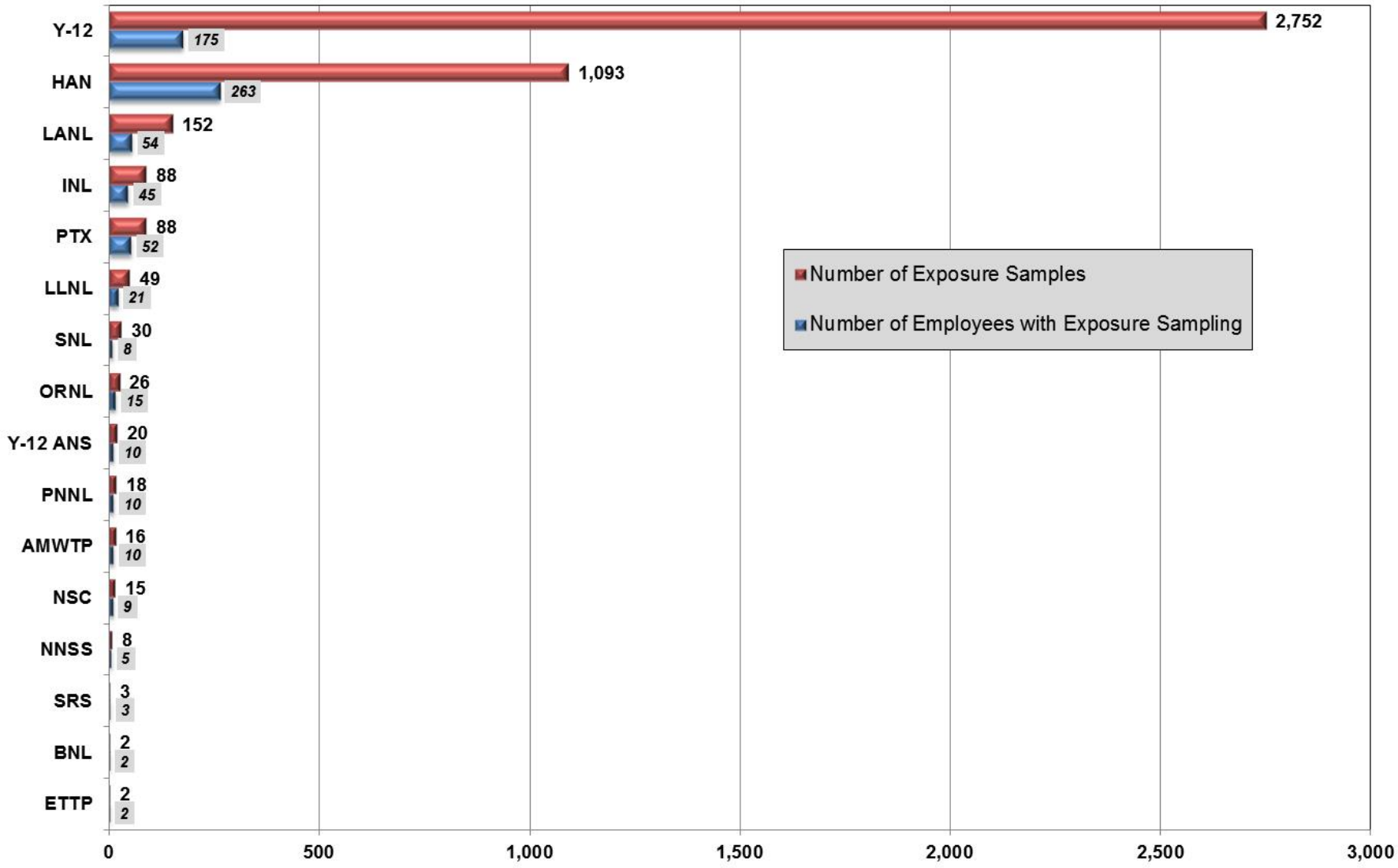
This chart shows the distribution of beryllium-associated workers by reporting organization who have been monitored for beryllium exposure.

Annual Number of Employees Exposure Monitored by Reporting Organization for 2007 – 2016

Reporting Organization	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
AMES			6	1	2			2		
AMWTP	4	4	4	2	2	2	1	1	18	10
ANL	3	1								
BNL	8	8	3	7	1	18		2	3	2
DOE-ORO										
ETTP	38		19	42	30	3	9	2		2
Fermi								1		
FPDP			9	47	3	5	4	5		
HAN	103	163	135	313	395	249	287	325	290	263
INL	81	49	57	44	39	5	42	45	55	45
KAPL	5	5	5	5	4	4	3	2		
LANL	106	56	73	55	44	44	31	79	31	54
LBNL		1			2		1	3		
LLNL	74	76	100	78	63	59	34	29	36	21
LLNL CHES					1					
NNSS	14	43	18	18	19	22	14	17	5	5
NSC	24	18	15	18	17	43	27	18	9	9
NSPS										
ORNL	53	46	48	44	47	46	58	24	20	15
PNNL							1	19	7	10
PTX	50	38	35	30	42	51	23	21	20	52
SLAC	2	2			2					
SNL	7		5	16	19	17	3	5	16	8
SRS	18	34	28	19	2	10	1	5	2	3
Y-12	225	216	307	435	362	244	237	219	204	175
Y-12 ANS									15	10
Y-12 NRE	3	4	10	8	5	4	5	4		

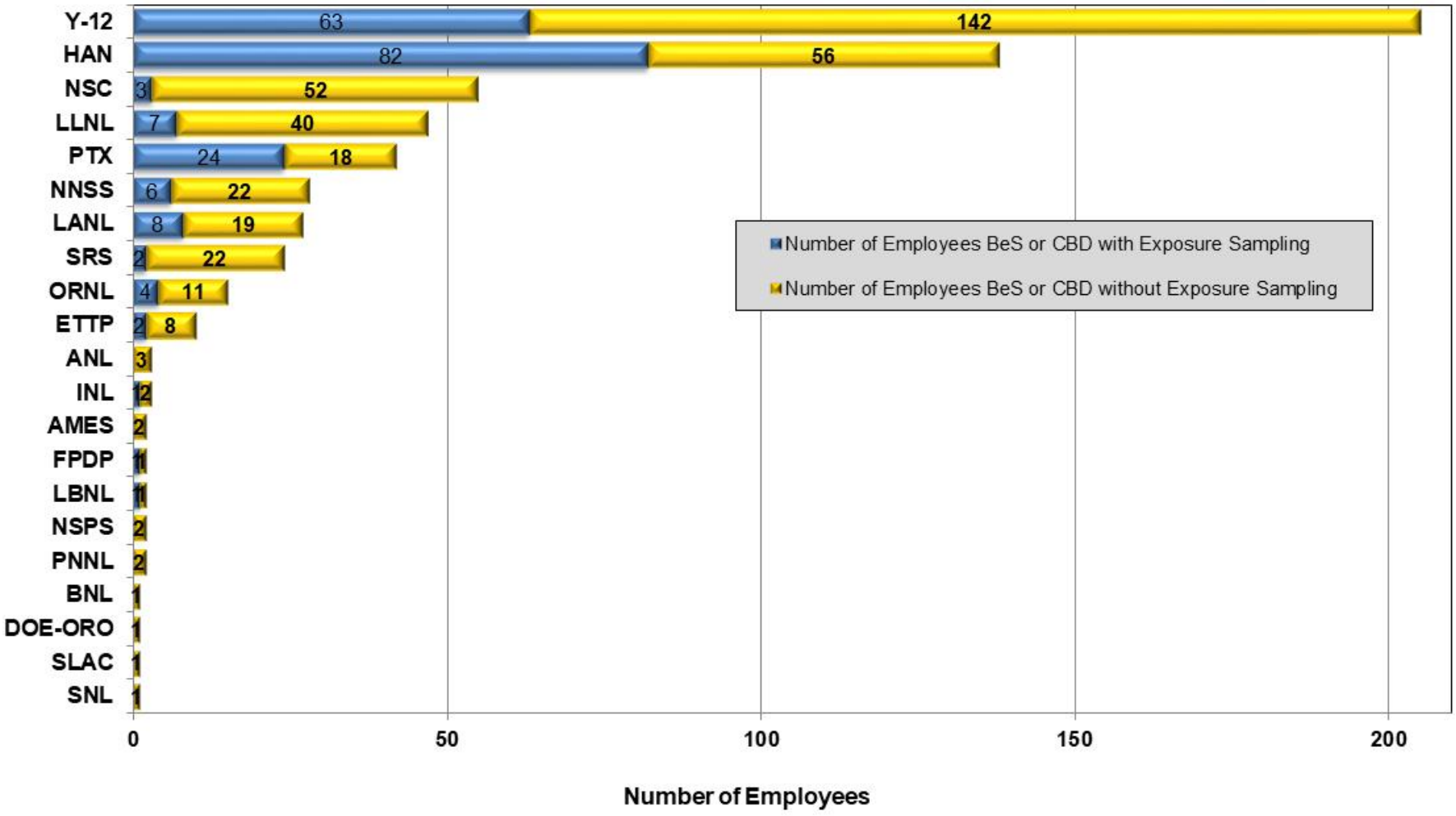
The table above shows the numbers of individuals by reporting organization whose exposures were monitored by an industrial hygienist at least once in each year in the past 10 years. Sixteen (16) reporting organizations provided exposure monitoring results with monitoring dates in 2016. Organization-specific totals for a given year may change from totals in previous annual reports due to late reporting and/or corrections.

Distribution of 4,362 Exposure Samples for 684 Employees by Reporting Organization for Calendar Year 2016



The chart above illustrates the distribution of exposure samples and employees monitored across 16 reporting organizations during 2016.

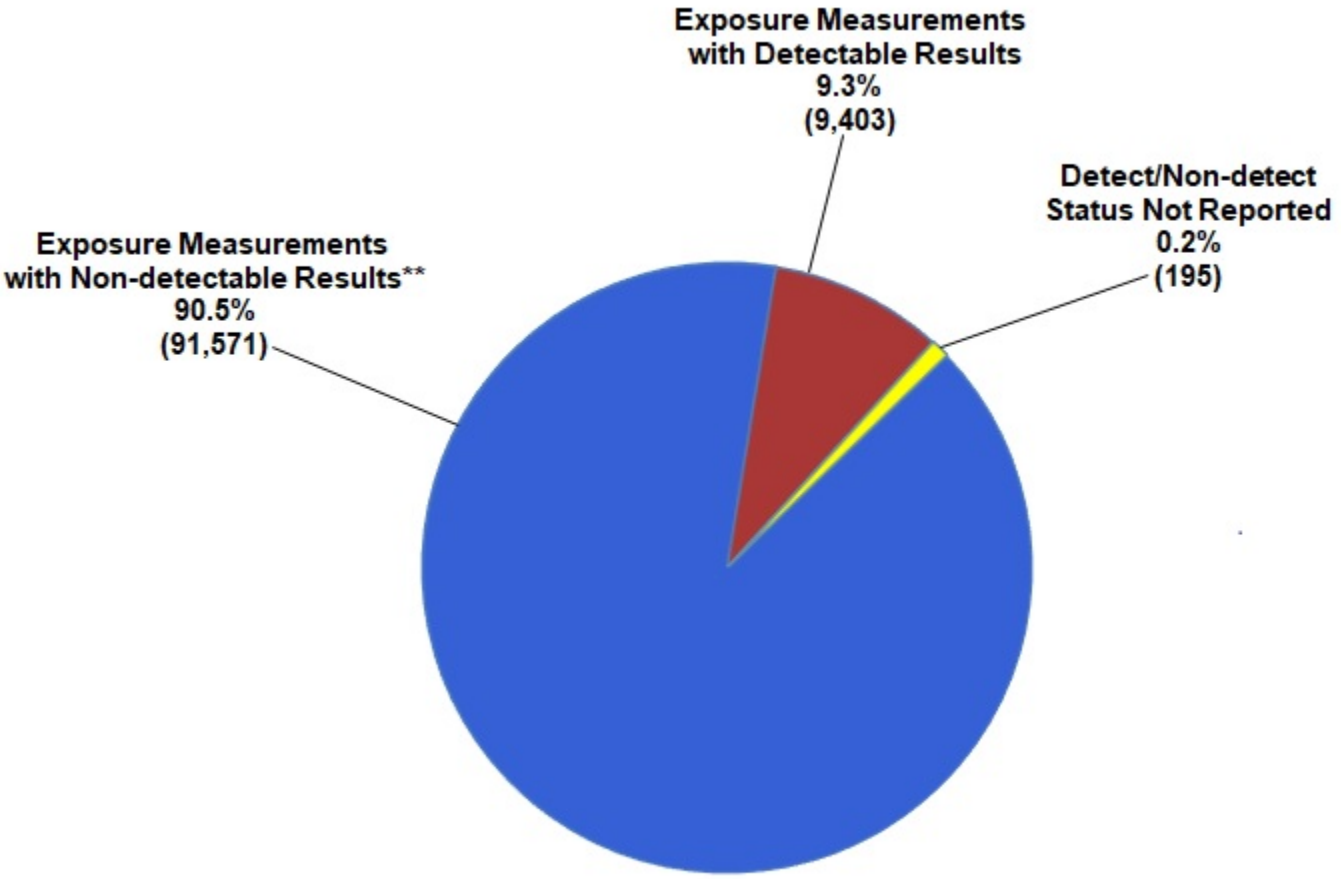
Distribution of Employees BeSensitized or CBD by Reporting Organization and Exposure Sampling Status Through 2016*



*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 407 (67 percent) of the 611 employees who are BeSensitized or diagnosed with CBD.

Distribution of 101,169 Reported Exposure Levels Through 2016*

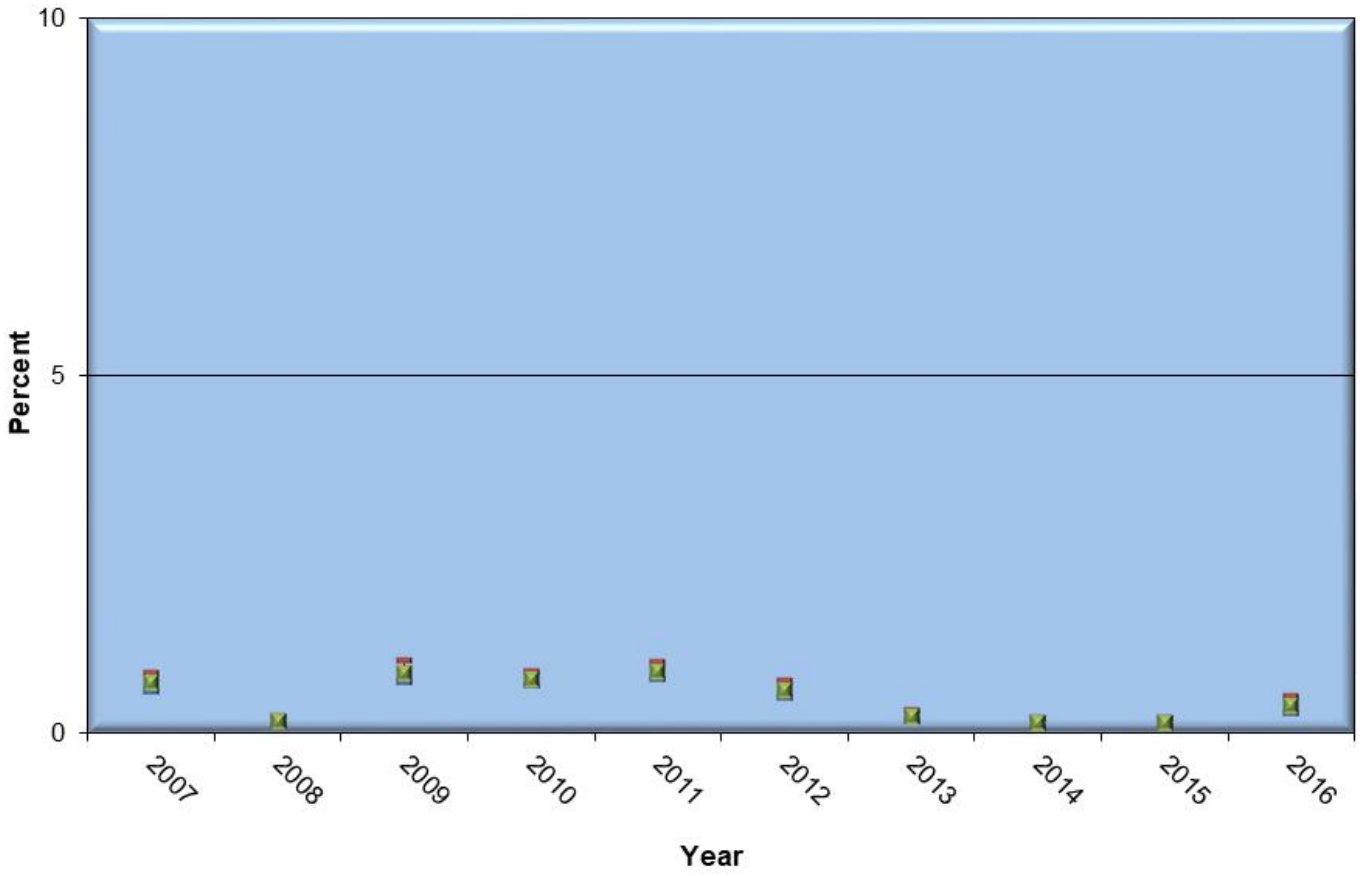


*Some reporting organizations have provided data that predate the 2002 start date of the Registry.
**Non-detectable indicates that analysis results were reported as less than the laboratory's reporting limit.

Of the 101,169 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 µg/m^3, which is one-twentieth to one-quarter of the action level of 0.2 µg/m^3.

DOE-wide Exposure Trend for 2007 – 2016

Percent Exceeding 0.2 µg/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 µg/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 µg/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 2007 – 2016 8-Hour Time Weighted Average Exposure Monitoring Results

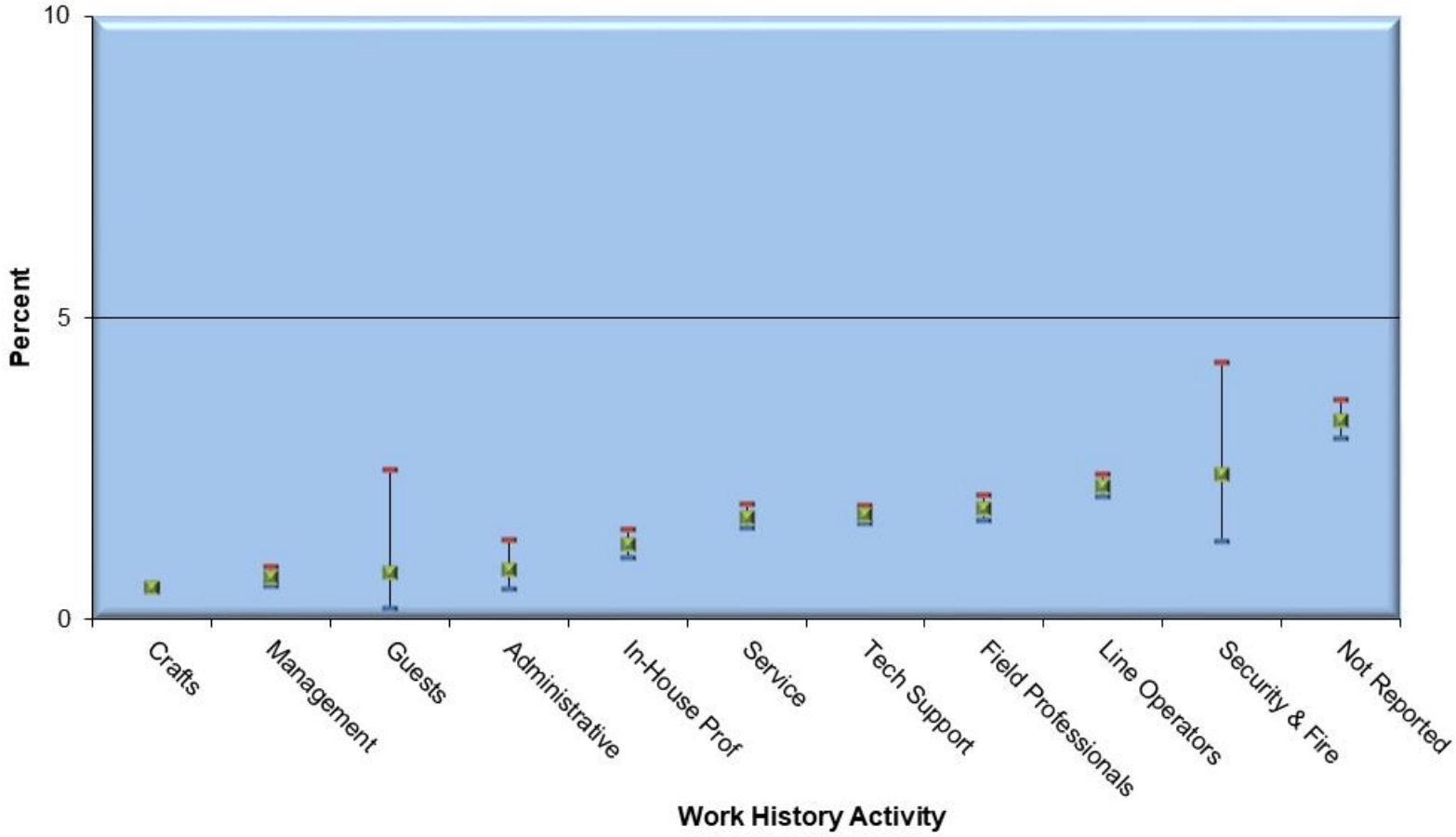
Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	All Years
Number of reported monitoring results	5,936	5,190	6,674	13,389	10,189	6,054	5,264	5,339	5,111	4,331	67,477
Number of detected values	732	453	273	624	523	302	213	174	220	205	3,719
Percent non-detects	87.7	91.3	95.9	95.3	94.9	95.0	96.0	96.7	95.7	95.3	94.5
Number of individuals monitored	817	760	876	1,180	1,100	826	781	822	730	681	4,269*
Arithmetic mean (EX) ($\mu g/m^3$)	0.010	0.004	0.163	0.052	0.094	0.031	0.004	0.002	0.003	0.007	0.015
Lower confidence limit of EX ($\mu g/m^3$)	0.009	0.004	0.049	0.029	0.046	0.015	0.003	0.002	0.002	0.004	0.013
Upper confidence limit of EX ($\mu g/m^3$)	0.012	0.005	0.541	0.092	0.192	0.067	0.006	0.003	0.003	0.013	0.017
Observed 95th percentile of data ($\mu g/m^3$)	0.021	0.016	0.005	0.009	0.009	0.007	0.005	0.004	0.004	0.004	0.010
95% upper tolerance limit of the 95th percentile ($\mu g/m^3$)	0.036	0.033	0.021	0.020	0.020	0.017	0.015	0.017	0.017	0.017	0.020
Largest value ($\mu g/m^3$)	12.513	1.774	11.762	79.330	18.023	4.013	0.804	0.876	1.847	8.865	79.330
Percent exceeding 0.2 $\mu g/m^3$ (F)	0.7	0.2	0.9	0.8	0.9	0.6	0.2	0.1	0.2	0.4	0.6
Lower confidence limit for F	0.6	0.1	0.7	0.7	0.8	0.5	0.2	0.1	0.1	0.3	0.6
Upper confidence limit for F	0.8	0.2	1.0	0.9	1.0	0.7	0.3	0.2	0.2	0.5	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 2007 through 2016 is 4,269.

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 $\mu g/m^3$ 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 2016 (Ranked by Percent Exceeding)*

Percent Exceeding 0.2 µg/m^3 Based on 95 Percent Confidence Limits



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

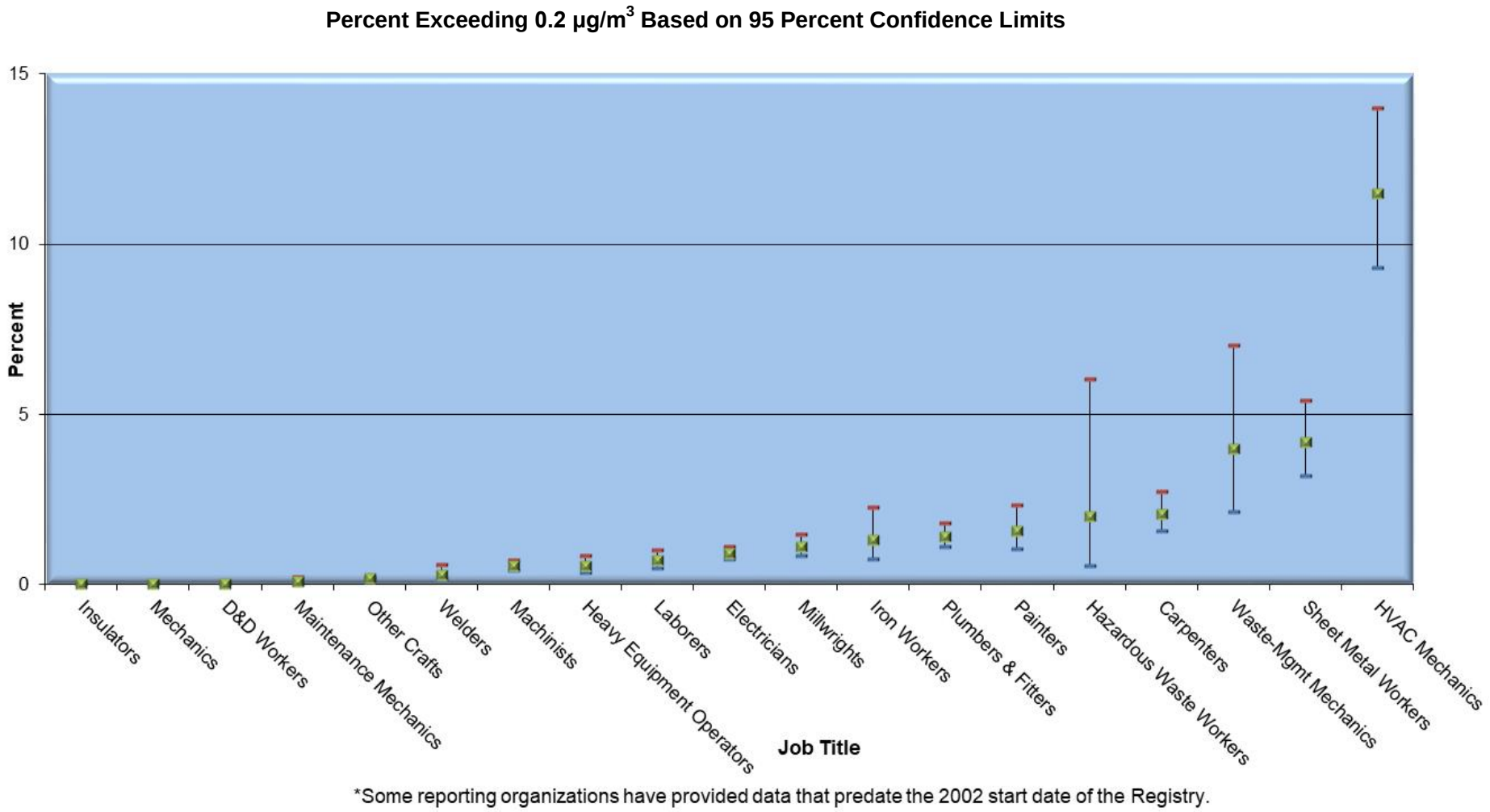
Shown above are exposure data grouped by work activity. The data are through calendar year 2016 and detailed data are presented on the following page. The work activities are the high level rollup of job functions used in the table "Work History Activity and BeLPT Status for 23,942 Beryllium-Associated Workers Screened Through 2016." 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 2016

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	922	44,839	6,471	97	3,650	10,759	4,073	262	7,532	13,585	5,123	97,313
Number of detected values	67	2,593	973	28	402	1,950	452	12	681	2,118	1,710	10,986
Percent non-detects	92.7	94.2	85.0	71.1	89.0	81.9	88.9	95.4	91.0	84.4	66.6	88.7
Number of individuals monitored	82	1,953	587	8	291	1,065	284	61	543	1,082	397	6,353
Observed 95th percentile of data (ug/m^3)	0.016	0.008	0.052	0.027	0.030	0.059	0.018	0.002	0.022	0.055	0.130	0.027
95% upper tolerance limit of the 95th percentile (ug/m^3)	0.050	0.050	0.087	0.291	0.050	0.100	0.050	0.990	0.051	0.080	0.170	0.053
Largest value (ug/m^3)	2.600	51.895	21.771	0.313	12.611	134.000	11.762	11.700	84.933	5.140	7.670	134.000
Percent exceeding 0.2 ug/m^3 (F)	0.8	0.5	1.8	0.8	1.2	2.2	0.7	2.4	1.7	1.7	3.3	1.3
Lower confidence limit for F	0.5	0.5	1.6	0.2	1.0	2.0	0.6	1.3	1.5	1.6	3.0	1.2
Upper confidence limit for F	1.3	0.6	2.1	2.5	1.5	2.4	0.9	4.3	1.9	1.9	3.6	1.3

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 2016 (Ranked by Percent Exceeding)*



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

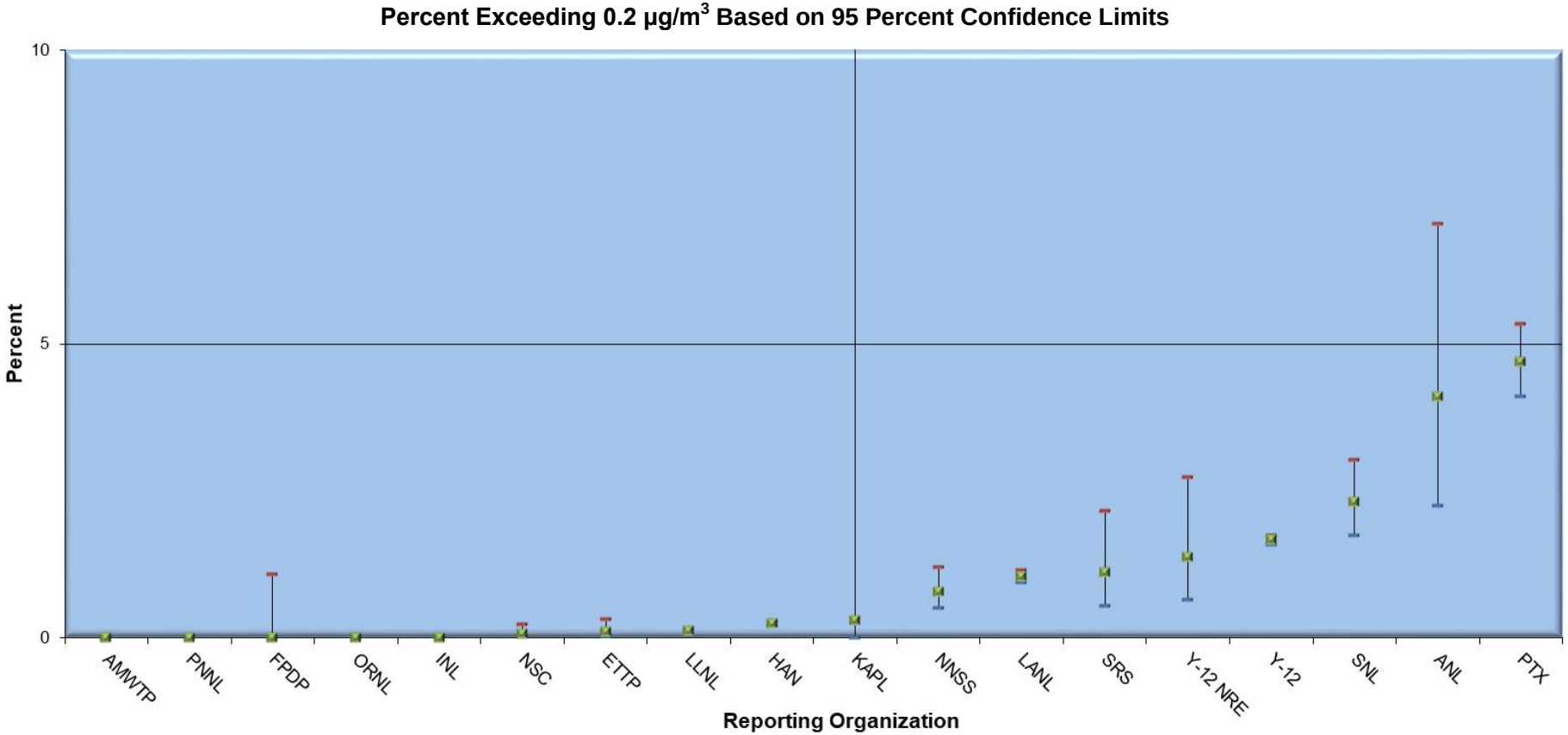
This figure displays differences in exposure level for individuals with job titles that were grouped together in the Craft work activity category. Detailed data are presented on the following page. Laborers, Electricians, Millwrights, Iron Workers, Plumbers & Fitters, Painters, Hazardous Waste Workers, Carpenters, Waste-Management Mechanics, Sheet Metal Workers, and HVAC Mechanics have exceedance rates higher than all Crafts combined (0.5 µg/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 2016 (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^3)	95% upper tolerance limit of the 95th percentile (ug/m^3)	Largest value (ug/m^3)	Percent exceeding 0.2 ug/m^3 (F)	Lower confidence limit for F	Upper confidence limit for F
Insulators	661	208	68.5	28	0.010	0.030	0.200	0	0	0
Mechanics	96	20	79.2	32	0.017	0.070	0.091	< 0.1	< 0.1	0.1
D&D Workers	1,076	154	85.7	130	0.017	0.037	0.234	< 0.1	< 0.1	< 0.1
Maintenance Mechanics	952	32	96.6	92	0.002	0.052	0.200	0.1	< 0.1	0.2
Other Crafts	21,764	386	98.2	238	0.005	0.017	6.314	0.2	0.1	0.2
Welders	1,072	36	96.6	38	0.007	0.021	0.356	0.3	0.1	0.6
Machinists	4,457	155	96.5	91	0.004	0.050	51.895	0.5	0.4	0.7
Heavy Equipment Operators	1,272	109	91.4	107	0.006	0.019	16.697	0.5	0.3	0.8
Laborers	1,692	78	95.4	247	0.009	0.053	10.340	0.7	0.5	1.0
Electricians	4,280	417	90.3	338	0.021	0.050	6.957	0.9	0.7	1.1
Millwrights	2,218	163	92.7	159	0.017	0.050	20.176	1.1	0.8	1.4
Iron Workers	276	92	66.7	31	0.143	0.263	1.847	1.3	0.7	2.3
Plumbers & Fitters	1,982	197	90.1	169	0.025	0.050	5.735	1.4	1.1	1.8
Painters	652	112	82.8	44	0.060	0.114	7.423	1.6	1.0	2.3
Hazardous Waste Workers	81	9	88.9	13	0.073	0.176	0.176	2.0	0.5	6.0
Carpenters	1,209	142	88.3	105	0.045	0.066	3.176	2.1	1.6	2.7
Waste-Mgmt Mechanics	147	17	88.4	15	0.093	1.290	2.390	4.0	2.1	7.0
Sheet Metal Workers	606	101	83.3	48	0.298	0.489	8.865	4.2	3.2	5.4
HVAC Mechanics	346	165	52.3	28	0.535	0.949	6.404	11.5	9.3	14.0
All Combined	44,839	2,593	94.2	1,953	0.008	0.050	51.895	0.5	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 2016 (Ranked by Percent Exceeding)*



*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 NRE, Y-12, SNL, ANL, and PTX were significantly higher than those for all organizations combined.

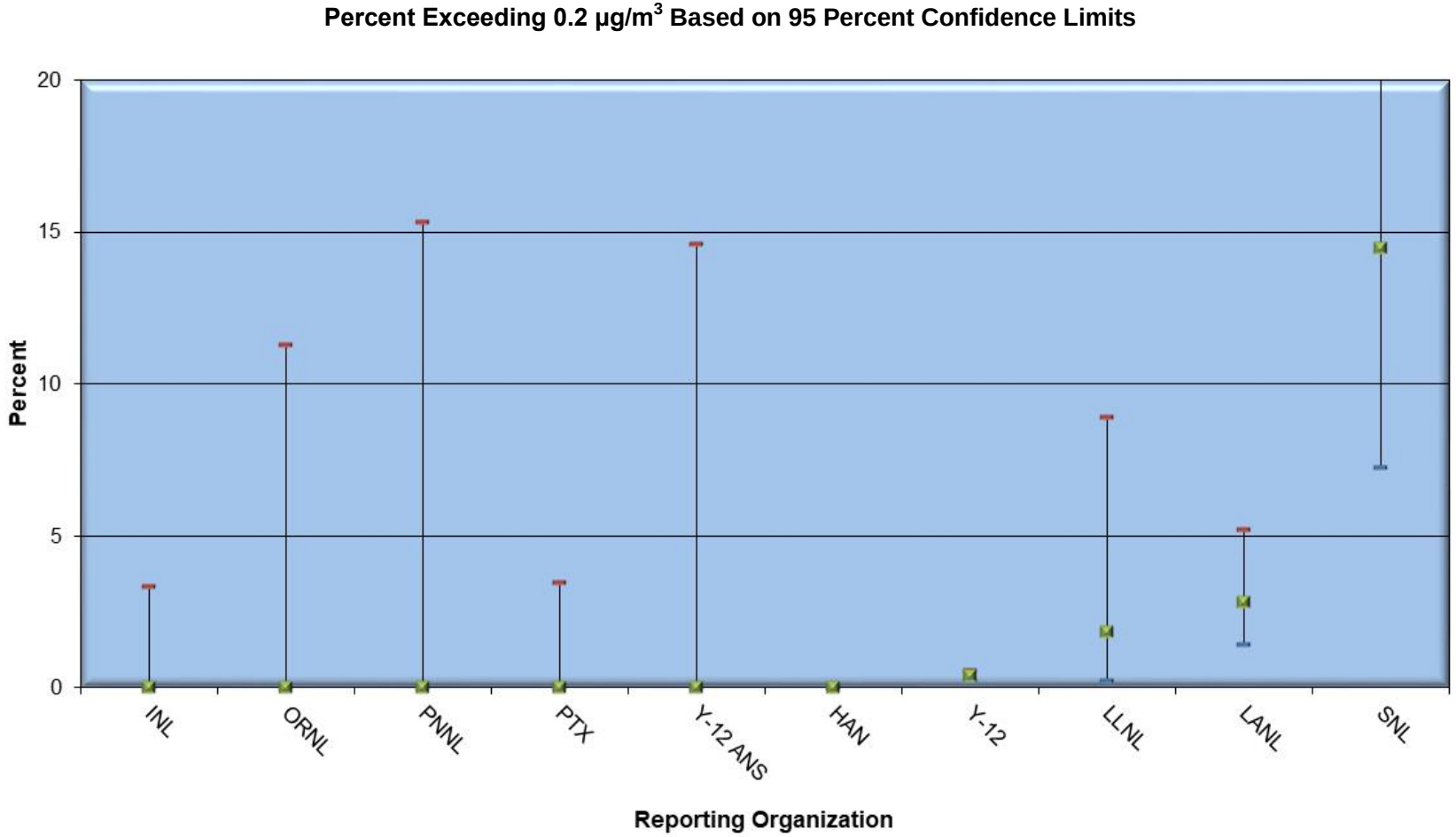
Results from AMES, BNL, Fermi, LBNL, LLNL CHES, SLAC, and Y-12 ANS were not included in this figure because of the small number of total samples and/or low percent exceeding the action level. Direct comparison with prior years' reports may be problematic due to late reporting and/or corrections.

Summary Statistics for 8-Hour Time Weighted Average Exposure Monitoring Results by Reporting Organization Through 2016

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^3)	95% upper tolerance limit of the 95th percentile (ug/m^3)	Largest value (ug/m^3)	Percent exceeding 0.2 ug/m^3 (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
AMWTP	141	77	45.4	33	0.005	0.010	0.036	0	0	0
ANL	155	18	88.4	23	0.145	1.100	2.390	4.1	2.3	7.0
BNL	92	0	100	45	0.090	NA	0.100	0	0	3.2
ETTP	905	32	96.5	297	0.007	0.080	2.264	0.1	0.0	0.3
Fermi	48	21	56.2	17	1.256	NA	4.800	15.8	9.4	24.5
FPDP	566	4	99.3	60	0.004	0.011	0.019	< 0.1	0	1.1
HAN	10,981	1,596	85.5	1,646	0.008	0.019	12.513	0.2	0.2	0.3
INL	1,753	257	85.3	307	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	12,822	2,586	79.8	693	0.045	0.057	19.450	1.0	0.9	1.2
LBNL	18	0	100	8	NA	NA	0.100	0	0	15.3
LLNL	6,669	1,172	82.4	322	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	1,101	85	92.3	281	0.014	0.052	0.317	0.8	0.5	1.2
NSC	1,651	18	98.9	182	0.002	0.148	0.196	0.1	< 0.1	0.2
ORNL	1,315	8	99.4	269	0.002	0.011	0.157	< 0.1	< 0.1	< 0.1
PNNL	107	10	90.7	30	0.003	0.004	0.004	< 0.1	0	< 0.1
PTX	2,290	273	88.1	497	0.236	0.365	134.000	4.7	4.1	5.3
SLAC	42	0	100	26	0.040	NA	0.010	0	0	6.9
SNL	860	284	67.0	132	0.073	0.120	2.800	2.3	1.7	3.0
SRS	350	22	93.7	193	0.026	0.072	0.320	1.1	0.5	2.2
Y-12	54,825	4,486	91.8	1,213	0.042	0.050	79.330	1.7	1.6	1.7
Y-12 ANS	45	20	55.6	18	0.010	NA	0.150	< 0.1	0	< 0.1
Y-12 NRE	291	15	94.8	15	0.009	0.039	1.111	1.4	0.6	2.7
All Combined	97,313	10,986	88.7	6,353	0.027	0.053	134.000	1.3	1.2	1.3

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 2016 (Ranked by Percent Exceeding)



While Sandia National Laboratories had the greatest percentage of reported exposure monitoring results exceeding the action level in 2016, 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 2016 or reported similar time weighted average values for detects and non-detects.

Results from AMWTP, BNL, ETTP, NNSS, NSC, and SRS 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 2016

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^3)	95% upper tolerance limit of the 95th percentile (ug/m^3)	Largest value (ug/m^3)	Percent exceeding 0.2 ug/m^3 (F)	Lower confidence limit for F	Upper confidence limit for F
AMWTP	16	16	0	10	0.004	NA	0.004	0	0	0
BNL	2	0	100	2	NA	NA	0.013	0	0	77.6
ETTP	2	1	50.0	2	NA	NA	0.063	0	0	77.6
HAN	1,078	20	98.1	262	< 0.001	0.020	0.089	< 0.1	< 0.1	< 0.1
INL	88	2	97.7	45	0.014	0.018	0.018	0	0	3.3
LANL	152	30	80.3	54	0.033	2.029	8.865	2.8	1.4	5.2
LLNL	45	6	86.7	21	0.032	NA	0.722	1.8	0.2	8.9
NNSS	8	8	0	5	0.003	NA	0.004	0	0	0
NSC	15	0	100	9	NA	NA	0.043	0	0	18.1
ORNL	25	0	100	15	0.007	NA	0.011	0	0	11.3
PNNL	18	0	100	10	NA	NA	0.004	0	0	15.3
PTX	85	0	100	50	0.018	NA	0.021	0	0	3.5
SNL	30	24	20.0	8	0.295	NA	0.490	14.5	7.3	25.4
SRS	3	0	100	3	NA	NA	0.004	0	0	63.2
Y-12	2,745	97	96.5	175	0.007	0.016	0.702	0.4	0.2	0.6
Y-12 ANS	19	0	100	10	0.010	NA	0.010	0	0	14.6
All Combined	4,331	205	95.3	681	0.004	0.017	8.865	0.4	0.3	0.5

The table above gives additional summary statistics for organizations reporting exposure data to the BAWR during 2016. Organizations that did not report data for calendar year 2016 are not included in this table.

Exposure Monitoring Results Above the 0.2 µg/m³ Action Level for Calendar Years 2016, 2015, 2014, and 2013

Calendar Year 2016:

Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, ug/m³	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		0.72	1000
Y-12	SUPPORT	Engineering Technicians	0.70	100
LANL	SHEET METAL WORKER	SHEET METAL WORKER	0.65	100
Y-12	SUPPORT	Millwrights	0.50	50
SNL	OPERATIONAL SUPPORT	Technician	0.49	50
HAN	WELDING	INSTRUMENT SPECIALIST	0.46	1000
HAN	WELDING	INDUSTRIAL HYGIENE TECH	0.46	1000
Y-12	PRODUCTION	Other Crafts	0.41	50
PTX	BERYLLIUM WORK	PRODUCTION TECHNICIAN	0.33	1
SNL	OPERATIONAL SUPPORT	Technician	0.32	50
PTX	BERYLLIUM WORK	PRODUCTION TECHNICIAN	0.31	1
SNL	OPERATIONAL SUPPORT	Technician	0.27	50
Y-12	SUPPORT	Engineering Technicians	0.26	100
Y-12	PRODUCTION	Engineering Technicians	0.26	50
SNL	OPERATIONAL SUPPORT	Technician	0.24	50
LANL	ENGINEERED SYSTEMS TEC	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	Laboratory Technicians	0.22	50

Calendar Year 2015:

Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, ug/m³	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	Other Laborers and General Services	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	Other Laborers and General Services	0.29	100
SNL	OPERATIONAL SUPPORT	Technician	0.25	100
SNL	OPERATIONAL SUPPORT	Technician	0.25	10
SNL	OPERATIONAL SUPPORT	Technician	0.24	100
SNL	OPERATIONAL SUPPORT	Technician	0.24	10
SNL	OPERATIONAL SUPPORT	Technician	0.24	100
SNL	OPERATIONAL SUPPORT	Technician	0.23	100
Y-12	SUPPORT	Other Laborers and General Services	0.22	100
SNL	OPERATIONAL SUPPORT	Technician	0.21	100
SNL	OPERATIONAL SUPPORT	Technician	0.21	100

Calendar Year 2014:

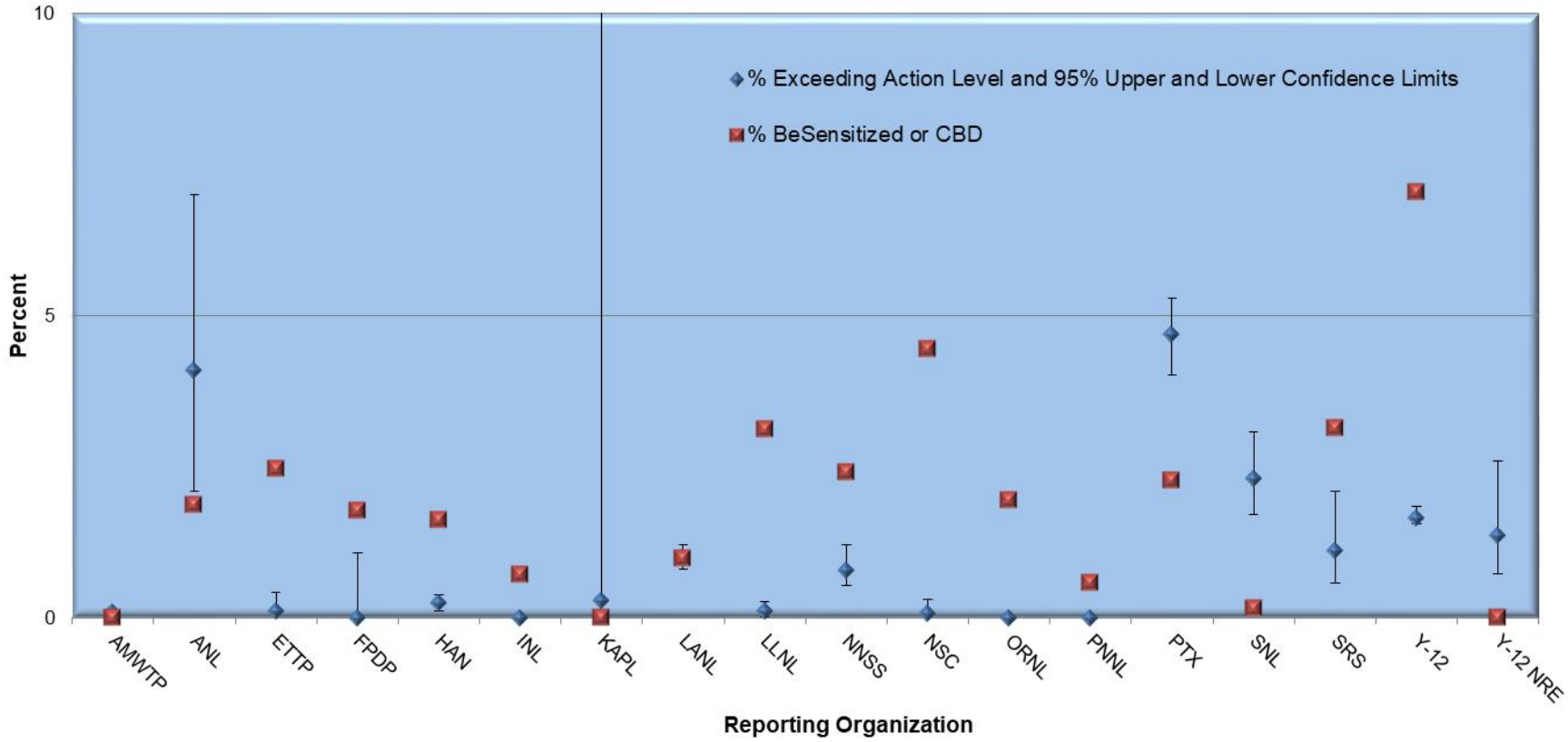
Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, ug/m³	Respirator Assigned Protection Factor
HAN		Vehicle and Mobile Equipment Mechanics	3.59	1000
Y-12	SUPPORT	Other Crafts	0.88	50
PTX	BERYLLIUM WORK	AREA MECHANIC	0.67	25
Y-12	SUPPORT	Plumbers and Pipefitters	0.65	100
Y-12	PRODUCTION	Other Crafts	0.62	1
Y-12	SUPPORT	Other Crafts	0.54	50
PTX	BERYLLIUM WORK	ENG TECH. I (WASTE OPERATION:	0.45	25
Y-12	SUPPORT	Laboratory Technicians	0.42	100
Y-12	PRODUCTION	Other Crafts	0.42	50
NNSS	Exposure Assessment	Miner	0.32	10
PTX	BERYLLIUM WORK	ASSOCIATE WASTE OPS TECH	0.31	25
LLNL	Decontamination	Sr. Technologist C/MS	0.28	1000
Y-12	SUPPORT	Millwrights	0.27	100
Y-12	SUPPORT	Other Crafts	0.27	50
Y-12	SUPPORT	Plumbers and Pipefitters	0.26	100

Calendar Year 2013:

Reporting Organization	Process Description	Job Title	8-Hour Time Weighted Average, ug/m³	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

Exceedances for 2016 or 2015 were greater than in 2014 or 2013 but fewer than in previous years. Twenty-three (23) samples exceeded the action level in 2016 compared with 24 in 2015, 15 in 2014, and only 7 in 2013. Nevertheless, the total number of reported exposure sampling results continued to decrease (page 23). In 2013 exceedances were primarily associated with waste operations work at Pantex Plant. In 2014 exceedances were primarily for support and production work at Y-12. And in 2015 exceedances were largely for operational support work at SNL. In 2016 most samples exceeding the action level were for 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 2016*



*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 = 0.087). 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.