

## **2015 Summary of U.S. Agricultural Confined Space-Related Injuries and Fatalities**

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### **Introduction<sup>1</sup>**

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This publication represents continued effort of Purdue's Agricultural Safety and Health Program to gain a better understanding of injuries and fatalities that occur inside agricultural confined spaces, including grain storage and handling facilities. This summary is based on data gathered, documented and entered into Purdue's Agricultural Confined Space Incident Database (PACSID). Support for this surveillance effort over the past four years has come from the U.S. Department of Labor's Susan Harwood Training Program. This support has allowed Purdue University to conduct expanded surveillance to capture a wide range of agricultural confined space cases including but not limited to entrapments<sup>2</sup> in grain, asphyxiations, entanglements, falls and electrocutions. The 2015 summary reflects this expanded effort and hopefully adds additional light on a problem that poses significant risk to agricultural workers.

No fewer than 47 fatal and non-fatal cases were documented in 2015. Of these, 25 (54%) were fatal and 51% of all cases were directly related to grain entrapments. To ensure continuity of the data record involving entrapments in grain and other free flowing agricultural material, and due to the high percentage of past fatal cases involving grain entrapment, special attention continues to be given to these incidents.

In addition to the cases documented in 2015, another 71 cases that occurred in previous years were added to the database due to ongoing discovery efforts. Also, five cases were removed from the database as they, upon further investigation, were found to be duplicates of other cases or did not occur in an agricultural confined space. The total number of cases documented between 1962

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<sup>1</sup>Partial support for this material was provided under grant number SH24885SH3 from the Occupational Safety and Health Administration, U.S. Department of Labor. It does not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsements by the U.S. Government.

<sup>2</sup>Flowing grain entrapments include both fatal engulfments and partial entrapments that require assistance in order for the victim to be extricated.

and 2015 and entered in the PACSID is 1,873. Of those, 1,156 (62%) cases were reported as fatal.

As noted in past summaries, the data presented do not account for all incidents involving agricultural confined spaces. There is no public record of these incidents due to the fact that there is no comprehensive or mandatory incident/injury reporting systems for most of agriculture; in addition, there has been reluctance on the part of some victims and employers to report non-fatal incidents. Based upon prior research, it is estimated that the documented annual cases represent approximately 70% of the total cases that have actually occurred annually in the Corn Belt.

## **2015 Summary of All Agricultural-Confined Space-Related Cases with Comparisons to Previous Years**

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In 2015, there were 24 documented grain entrapment cases, six falls into or from grain storage structures, six equipment entanglements (including augers), four asphyxiations, four drownings and three cases in which the victim was struck or pinned by a heavy object while working in an agricultural confined space (Figure 1). Grain entrapments accounted for 51% of the documented cases. For incident types with more than one case, asphyxiations and drownings constituted those incidents with the highest fatality rate reported at 75%, while grain entrapments ranked third with a 58% fatality rate. This is the first time since 2010 that the number of fatal cases exceeded the number of non-fatal cases for all confined space incidents. The decrease in the total number of cases is due to a significant drop in reported non-fatal cases, which dropped to 22 compared to 40 non-fatal cases in 2014 and 45 in 2013. Fatal cases for 2015 were 25 and can be compared against 31 in 2014 and 24 in 2013. The causes behind the significant drop in non-fatal cases is unknown; however, it is believed that most confined space incidents are under-reported, especially those resulting in non-fatal grain entrapments.

The 47 confined space cases represent a 34% decrease in number of cases from 2014, when 71 were recorded. In fact, this year was the lowest number of confined space cases since 2006 (Figure 2). The five-year average has dipped significantly to 60.4 cases per year, the lowest five-year average since 2008. This marks the first significant decrease since the five-year average started to steadily increase in 2002 from 36.8 cases per year. A significant contributing factor in the earlier increase in the frequency was not due to more incidents, but rather better documentation of incidents.

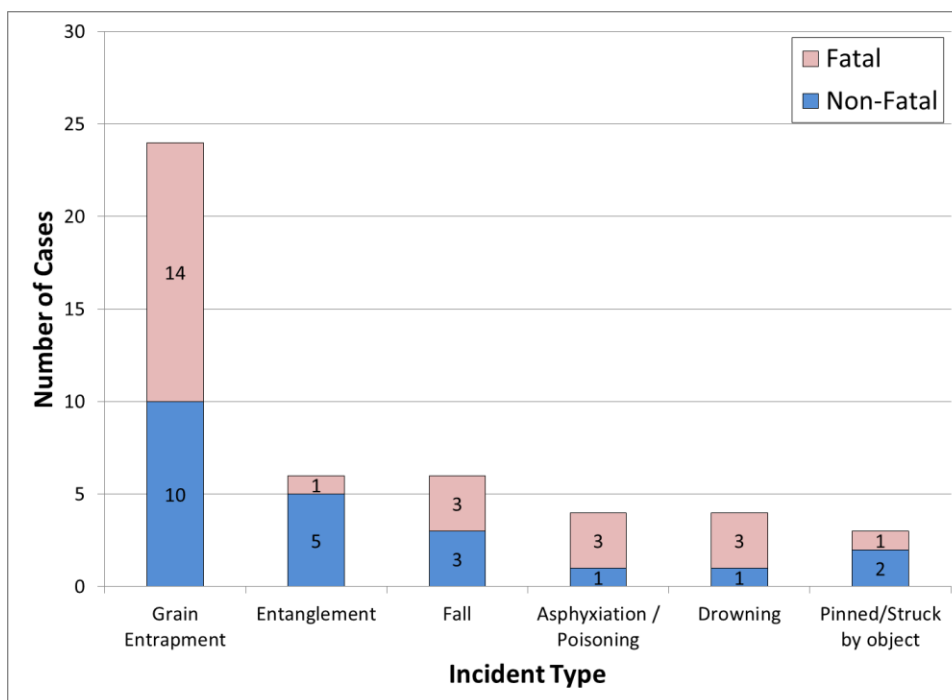


Figure 1: Distribution of 2015 agricultural confined space-related cases by type of incident.

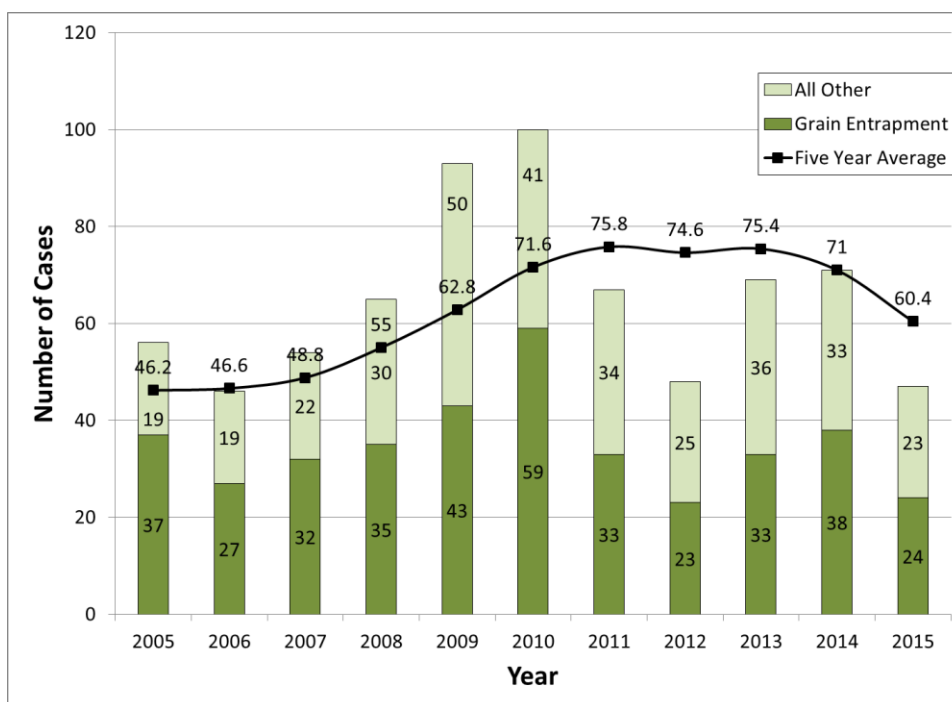


Figure 2: Number of annual confined space cases recorded between 2005 and 2015.

In 2015, the states with the most documented confined space cases of all types, including fatal and non-fatal, were Iowa (8) and Wisconsin (6). There were four cases each for Minnesota

and Nebraska and three cases in Montana and Ohio. Overall, incidents were documented in 20 states in 2015, similar to 2014. Figure 3 provides a geographic distribution of all documented cases in the PACSID, where the location and the sites were known for 2015. Until last year, Indiana led the nation in the number of documented confined space incidents due to the long history of conducting surveillance of these cases. Iowa surpassed Indiana in the number of cases last year.

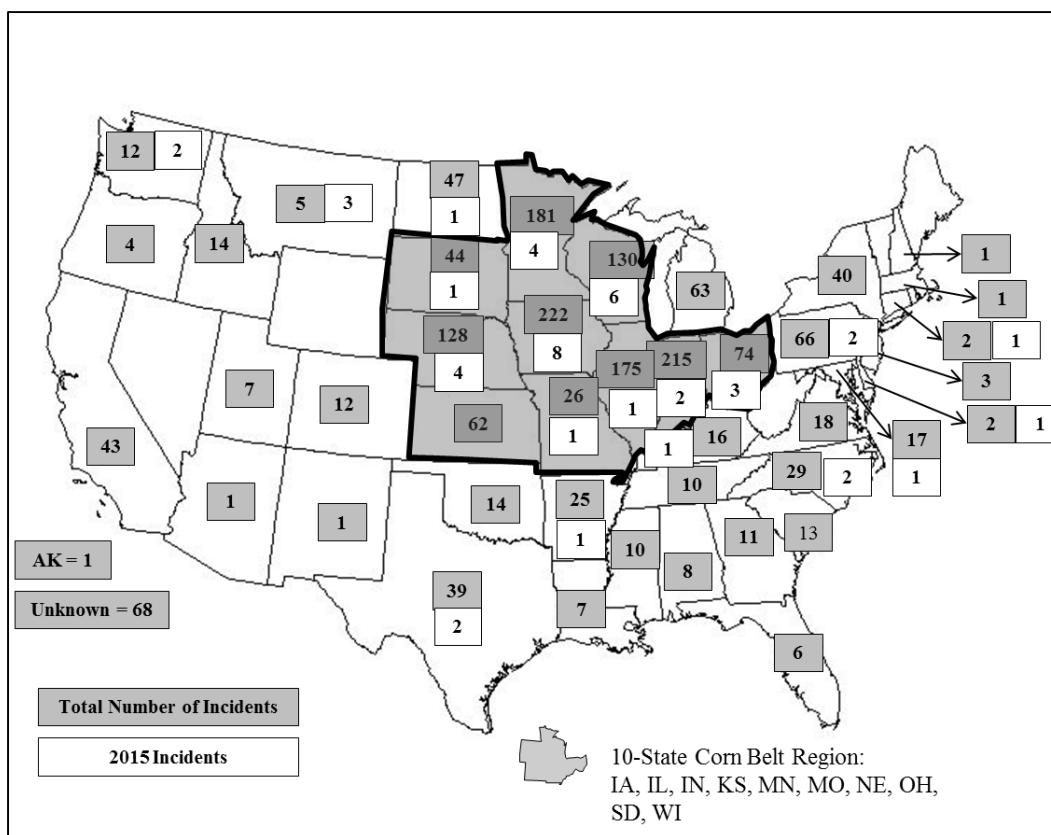


Figure 3: Geographic distribution of confined space cases for 2015 and previous years (n=1873).

There was only one case in 2015 in which the gender was female and one where gender was unknown, the remaining cases all involved males. Also, there were seven cases involving a child or youth under the age of 20, as shown in Figure 4. Overall, a specific age was known for 35 of the 47 victims in 2015, with the oldest victim being 86 and the youngest four years old. The average age was 44 years old, and the median age 40 (Figure 4). Those over the age of 60 accounted for 11 (23%) of the cases, reflecting the increasing average age of farmers in the U.S. As it was noted, a large number of the cases documented did not include the specific age of a victim.

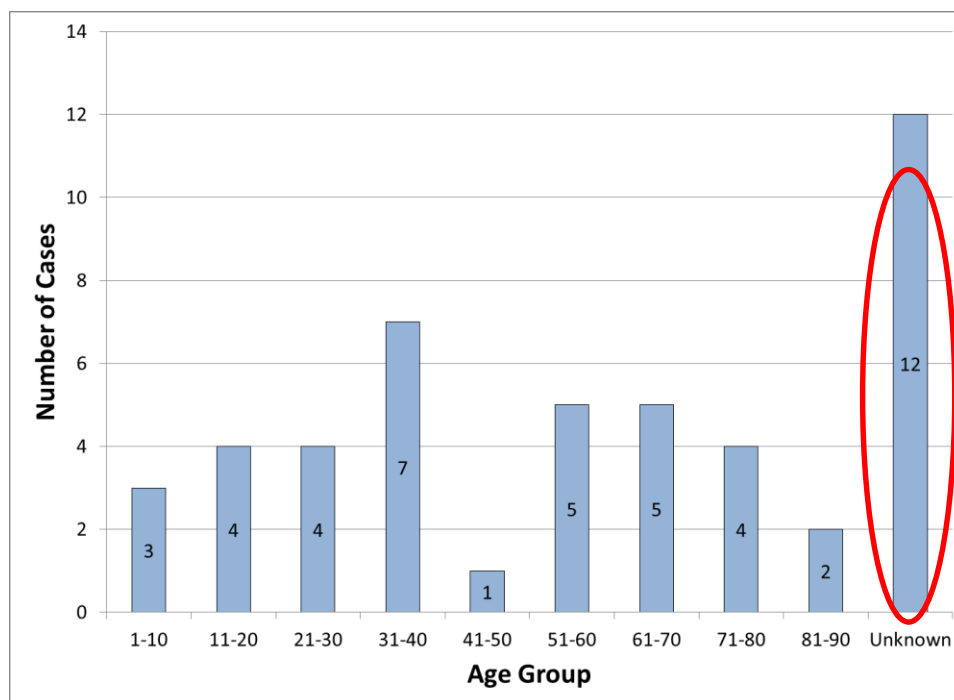


Figure 4: Age distribution of 2015 agricultural confined space incident victims by number of cases recorded.

## 2015 Summary of Grain Entrapments, with Comparisons to Previous Years

The 24 grain entrapment cases represent a 37% decrease in entrapments from 2014 when 38 entrapments were recorded. This is the lowest number of cases recorded since 2012. The five-year average dropped to 30.2 cases per year, which is significantly below the peak of 40.4 in 2011 (Figure 5) and the lowest five-year average since 2007. However, it must be noted that this is the first time since 2010 that the number of fatal cases exceeded non-fatal cases. For example, both 2012 and 2015 reported the similar number of grain entrapment cases (23 and 24 respectively); however, 2012 had a fatality rate of 35%, while 2015 fatality rate was 58%. Actually, 2015 represented the second highest number of fatal grain entrapments in the last five years (2014 having the largest with 18 cases in total). In 2015, the state with the most documented grain entrapments, fatal and non-fatal, was Iowa with seven cases total. Nebraska had four cases, North Carolina and Ohio had two each, and the remaining nine states had one each. Overall, entrapments were documented in 12 states in 2015. The majority of grain entrapment cases occurred in the Midwest (79%), similar to last year during which 87% occurred in the Midwest. This contrasts with 2013 in which only 61% of the cases occurred in the Midwest. Figure 6 provides a geographic distribution of all documented grain entrapment cases

contained in the PACSID where the location was known. Again, as noted earlier, Indiana continues to have the highest number of these cases, but the gap is rapidly closing with Iowa as more aggressive surveillance efforts have been made.

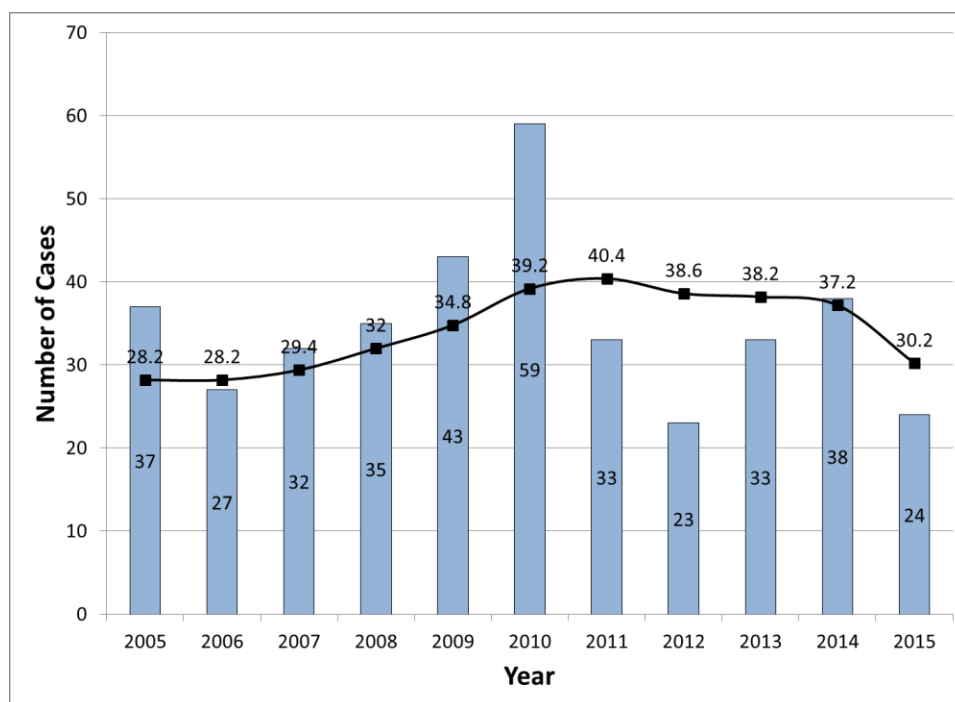


Figure 5 Number of annual grain entrapment cases recorded between 2005 and 2015.

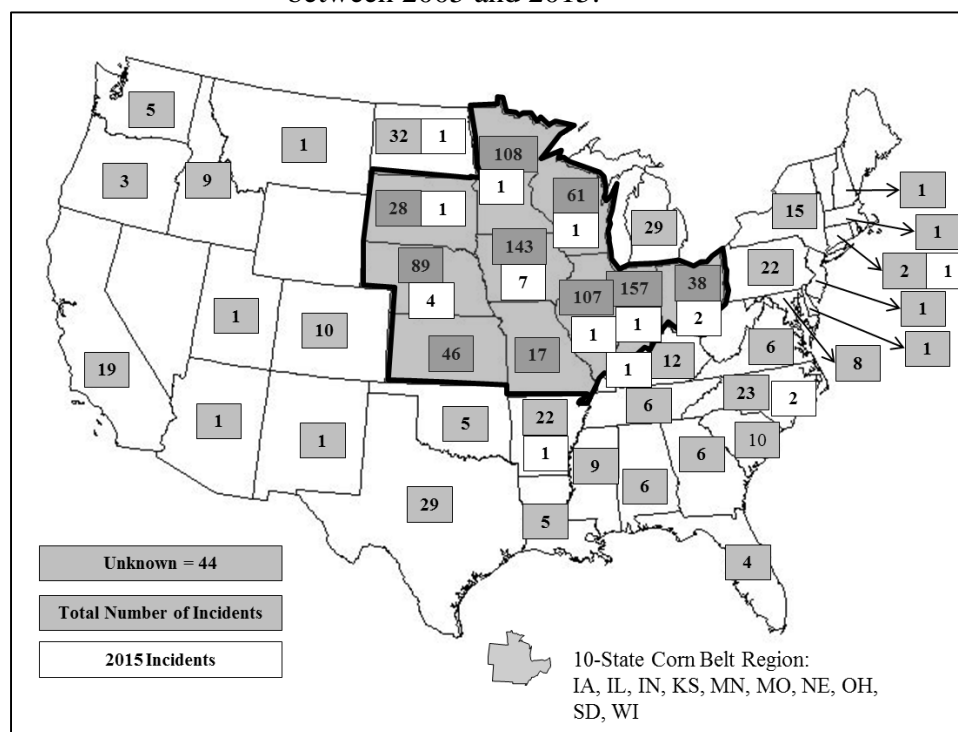


Figure 6: Geographic distribution of grain entrapment cases for 2015 and previous years (n=1143).

In 2015, there were 22 cases where the exemption status<sup>3</sup> of the facility with respect to OSHA regulations was known. Of those, 18 (82%) occurred on farms or other locations currently exempt from compliance with the OSHA Grain Handling Facilities Standards (29 CFR 1910.272), with the balance of four (18%) taking place at non-exempt commercial grain facilities. This is similar to 2014 in which 82% of all grain entrapment cases occurred at exempt facilities. It is important to note that there were only two cases in 2015 in which the exemption status was unknown; and it is believed that the majority of the unknown cases, based on historical data, have OSHA exempt status.

All documented victims were male. Also, there was only one documented case involving a youth under the age of 21, in contrast to 2014 in which there were four cases (Figure 7). Overall, a specific age was known for 18 of the 24 victims in 2015, with the oldest being 79 and the youngest 20 years old. The average age was 50 years old and the median age 52.5, very similar to 2014. In contrast to that year, all grain entrapments occurred in grain storage facilities, none were reported as occurring in grain transport vehicles.<sup>4</sup>

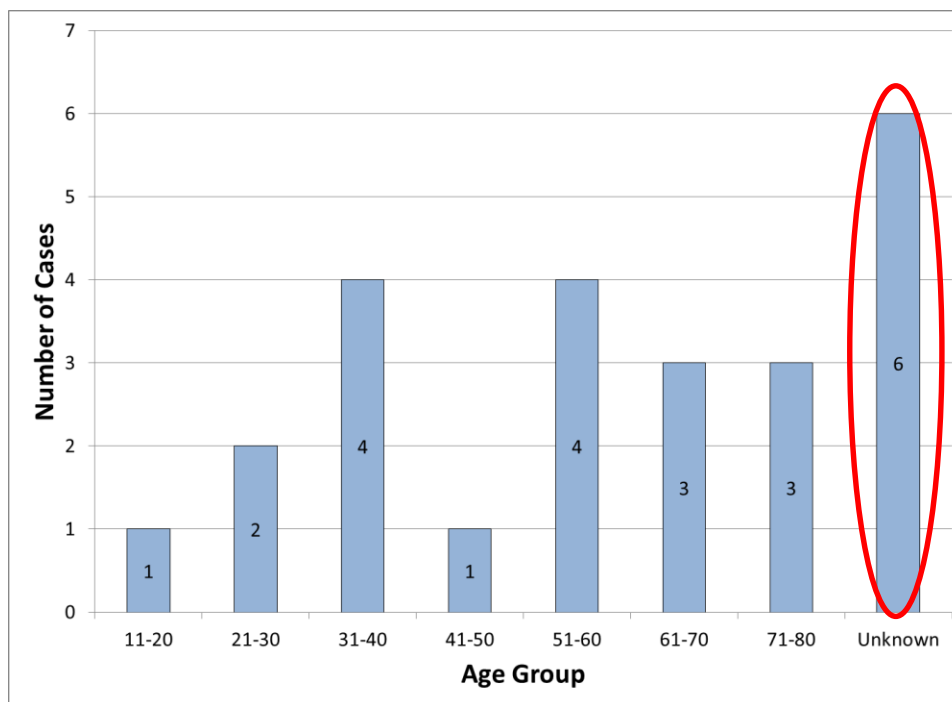


Figure 7: Age distribution of 2015 grain entrapment victims by number of cases recorded.

<sup>3</sup> Under the current provisions of the two OSHA workplace safety and health standards most relevant to agricultural confined spaces, most agricultural worksites, including most farms, feedlots, and certain seed processing operations are exempt from compliance.

<sup>4</sup> An incident was documented in Canada in which three young girls suffocated in a gravity flow grain wagon.

During 2015, the primary medium of entrapment, when identified, was corn (12 cases, 52%). Soybeans were the second most common grain with four cases (17%). As in past years, it should be noted that this summary does not reflect all grain-related entrapments, fatal or non-fatal, that have occurred. Currently, over two-thirds of grain storage capacity in the U.S. is found on farms that are exempt from the current OSHA injury reporting requirement standards.

## Summary of Documented Entanglements In and Around Agricultural Confined Spaces

Equipment entanglements in and around agricultural confined spaces represent the fourth largest group of confined space-related cases, with a total of 186 cases documented to date. This is behind grain entrapments (1,143 cases), falls (196 cases) and asphyxiation/poisoning (195 cases). However, when comparing all incident categories since 1990, entanglements represent the third highest injury type after grain entrapments (163 cases) and falls. A third of all entanglements resulted in death (Figure 8). The majority of entanglement cases were due to in-floor augers, sweep augers and silo unloaders, which represented 149 (80%) of all cases. The remaining cases occurred in a wide variety of settings including, but not limited, to feed grinder/mixers, grain dryers and feed/forage wagons.

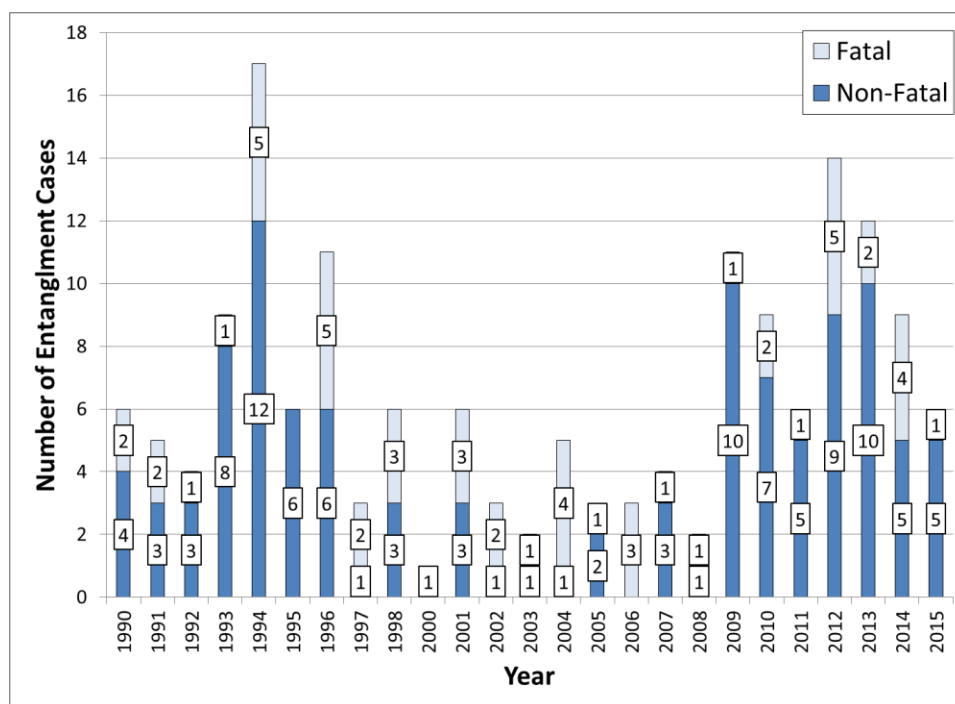


Figure 8: Number of annual entanglement cases recorded between 1990 and 2015.



## Summary of All Documented Agricultural Confined Space-Related Cases By Agent, Location, and Exemption Status

Figure 9 compares all cases currently documented in the PACSID with respect to type of agricultural confined space. As can be seen, those cases involving the storage, handling, and transport of grain and grain by-products accounted for the overwhelming majority of documented confined space-related cases, with 1,384 documented to date. The majority of these cases involved entrapment or engulfment in free-flowing agricultural materials, primarily grain. It is known that, due to less aggressive surveillance efforts, incidents involving manure storage and forage silos are significantly under-reported. Also under-reported are incidents involving entanglements and falls during the earlier years of PACSID, before the expanded surveillance effort began.

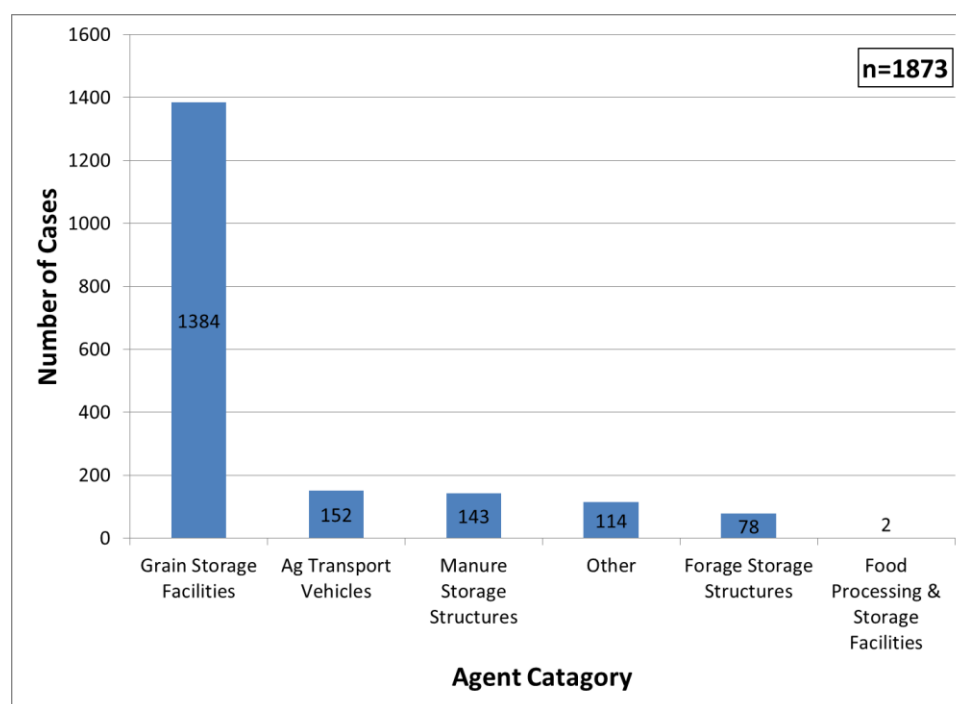


Figure 9: Agricultural confined space-related cases documented between 1962-2015 based on agent category.

The Midwest continues to represent the majority of all grain entrapment cases (79%), with the South coming in a distant second (13%). The majority of the cases in the Midwestern and Eastern regions are OSHA exempt cases (Figure 10). The South and West regions have more non-exempt cases. The large number of cases with unknown region is due to new entries from a

recently found OSHA report documenting grain-related cases from 1975-1983 that did not include the state.

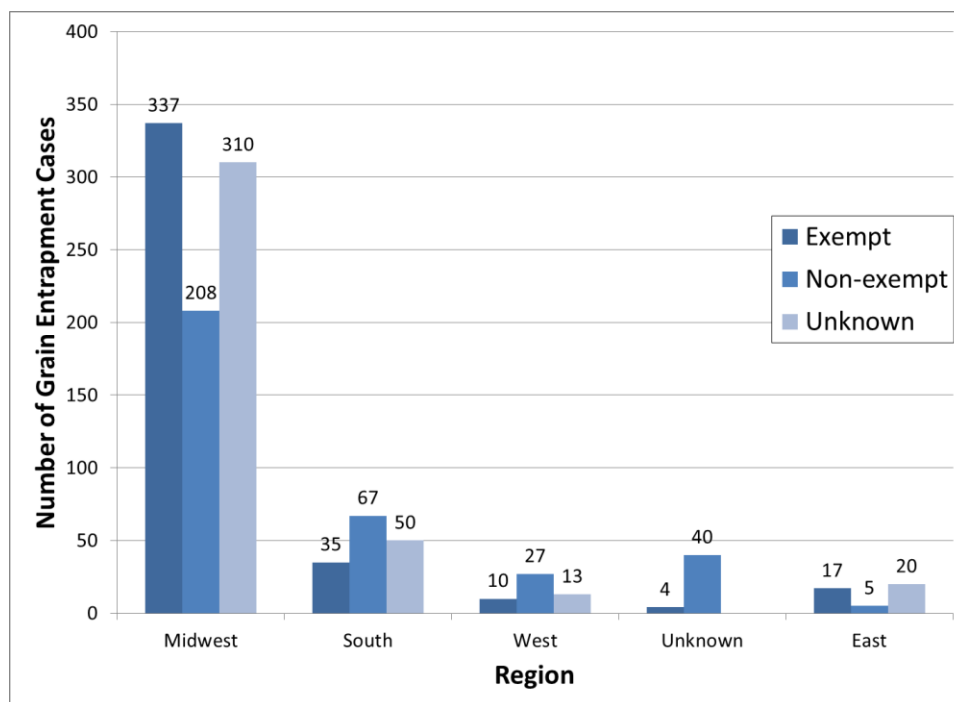


Figure 10: Grain entrapment cases documented between 1962-2015 based on region and OSHA exemption status.

The majority of the new cases added to the database in 2015 were non-exempt facilities (46 total). Most of the non-exempt cases were centered in two multi-year periods between 1975-1984 and 2010-2014. Lastly, the exempt cases were more evenly distributed across the 45-year period (Figure 11).

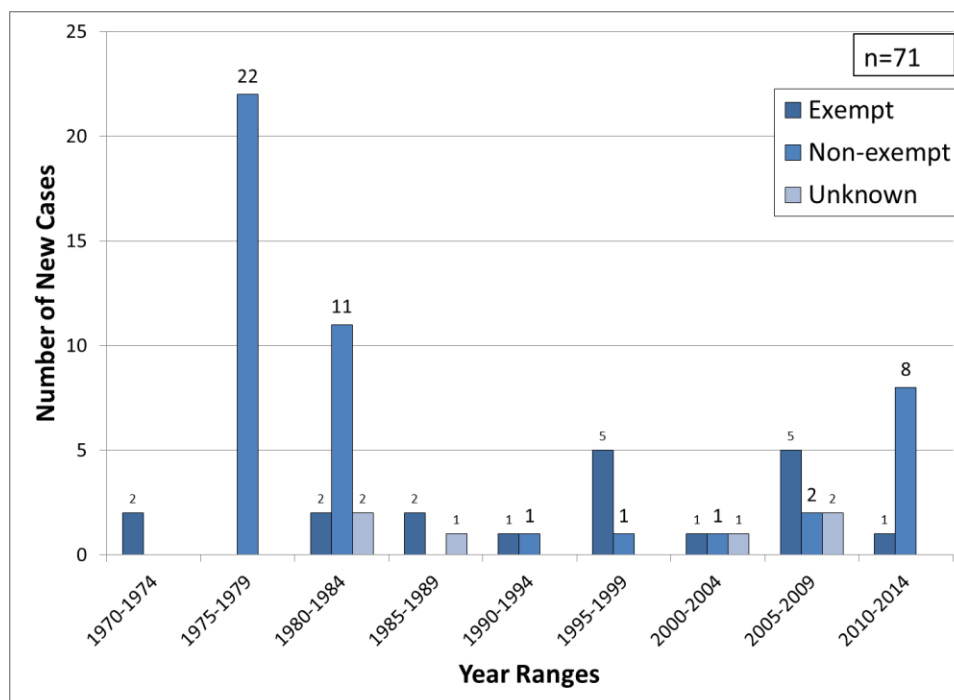


Figure 11: New grain entrapment cases documented between 1962-2014 based on region and OSHA exemption status.

## Comparison of Agricultural Confined Space Incidents with Other Hazardous Industries.

According to the U.S. Department of Labor's, Mining Safety & Health Administration (MSHA), there were 27 fatal mining incidents in 2015, the lowest number of recorded fatalities on record (MSHA, 2016). This is comparable to the 24 fatal agricultural confined space incidents recorded for 2015 (Figure 12). Comparing MSHA data to that collected for agricultural confined spaces provides interesting parallels. From 2004-2010, mining averaged 58.8 fatalities per year, while agricultural confined spaces averaged 36.7. After that, both industries experienced a similar drop in reported fatalities, with mining reporting an average of 37.2 per year and agricultural confined spaces reporting an average of 24.8 per year for the years of 2011-2015. This is a drop of 37% for mining incidents and 32% for agricultural confined spaces-related incidents. According to MSHA director Joe Main, the decline in mining incidents could be attributed to responses associated with the April 2010 disaster at Massey Energy's coal mine in

which 29 miners were killed (Jamasmie, 2016). This led to special impact inspections on mining facilities nationwide. Could the July 2010 disaster in which three boys were engulfed in corn (two died) in Mount Carol, Illinois, have produced similar effects which led to a 32% decline in confined space incidents? If so, can we expect the number of cases to rise again as the memory of these two incidents fade away, and when would this rise began and how quickly would the number of cases rise until it catches the public's attention again?

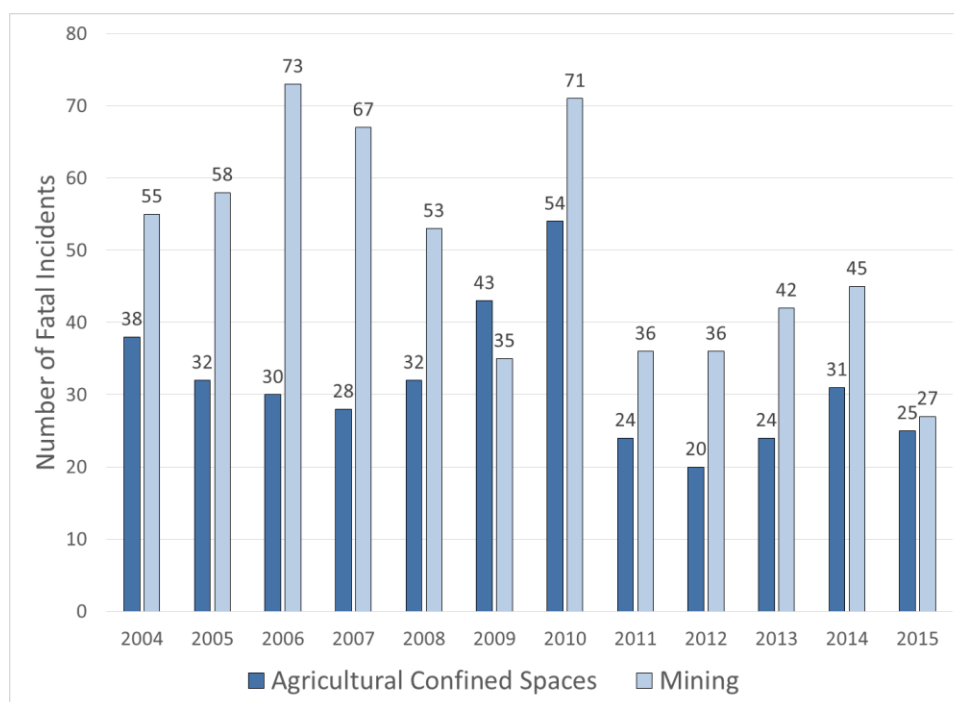


Figure 12: Agricultural confined spaces vs mining fatalities documented between 2004-2015.

## New Website

As part of the plan of work for the U.S. Department of Labor's Susan Harwood Grant, a new website on agricultural confined spaces has been developed and is currently accessible ([www.agconfinedspaces.org](http://www.agconfinedspaces.org)). This site is intended to be a resource for those conducting safety and health training in the area of agricultural confined spaces, with a special focus on grain storage handling and processing. Training resources are provided that are relevant to farm operators, young and beginning workers, current workers in the commercial grain industry, and emergency first responders. The site also includes an extensive bibliography of resources,

frequently asked questions, and related links. During 2015, the site provide 1,141 unique visitors with 5,419 page views.

## Published Works

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As the result of the analysis of the data gathered over the past four years, the following articles have been published. Full text of these articles are available at

[www.agconfinedspaces.org](http://www.agconfinedspaces.org).

Roberts, M. J. Field, W. E., Maier, D. E., Stroshine, R. L. Determination of Effort Required to Insert a Rescue Tube into Various Grain Types. *Journal of Agricultural Safety and Health*, 18:4, 2012.

Riedel, S. M. & Field, W. E. Summation of the Frequency, Severity, and Primary Causative Factors Associated with Injuries and Fatalities Involving Confined Spaces in Agriculture. *Journal of Agricultural Safety and Health*, 19(2), 83-100, 2013.

Field, W. E., Heber, D. J., Riedel, S. M., Wettschurack, S. W., Roberts, M. J., Grafft, L. J. Worker Hazards Associated with the Use of Grain Vacuum Systems. *Journal of Agricultural Safety and Health*, 20(3), 147-163, 2014.

Issa, S., Cheng, Y.H. and W.E. Field. Summarization of Injury and Fatality Factors Involving Youth and Grain Entrapment or Engulfment in Agriculture. *Journal of Agricultural Safety and Health*, 2015.

Roberts, M. J. Field, W. E., Maier, D. E., Stroshine, R. L. Determination of Entrapment Victim Extrication Force with and without Use of a Grain Rescue Tube. *Journal of Agricultural Safety and Health*, 21:2, 2015.

Issa, S.F., Cheng, Y.H., and Field, W.E. Summary of Agricultural Confined Space-related Cases: 1964-2013. *Journal of Agricultural Safety and Health*, 22(1), 1-14, 2016.

Cheng, Y.H. and W.E. Field. Summary of Auger-related Entanglements Occurring Inside Agricultural Confined Spaces. *Journal of Agricultural Safety and Health*. Accepted for publication, 2016.

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Jamasmie, C. (2016, 1 6). *Minig deaths in the U.S. fell to historic low in 2015*. Retrieved from mining.com:  
<http://www.mining.com/mining-deaths-in-the-u-s-fell-to-historic-low-in-2015/>

Mining Safety & Health Administration (MSHA). (2016, 1 21). *all mining fatalities by state by calendar year*. Retrieved from United States Department of Labor - MSHA Fatality Statistics:  
<http://www.msha.gov/stats/charts/allstates.pdf>

For additional information on this report, contact Professor Bill Field at 765-494-1191 or [field@purdue.edu](mailto:field@purdue.edu). In addition, refer to these sources for more information on this topic:

- [www.agconfinedspaces.org](http://www.agconfinedspaces.org)
- [www.grainsafety.org](http://www.grainsafety.org)
- [www.grainentrapmentprevention.com](http://www.grainentrapmentprevention.com)
- <http://apps.npr.org/buried-in-grain/>