

On-Farm Hazards and Accident Prevention

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Introduction

This fact sheet explores some on-farm hazards and presents tips for accident prevention. It also emphasizes the importance of considering safety first (Figure 1). According to the National Institute for Occupational Safety and Health (NIOSH), farming is considered one of the most hazardous and dangerous occupations in the United States.



Figure 1. Signs show farm dangers.

Farmers are at a relatively high risk for fatal and nonfatal injuries. It is important that farm workers should be made aware of potential hazards in day-to-day farm operations to reduce the possibility of injury or death.

Unfortunately, the number of fatal work injuries by major event in 2015 accounted for 4,824 cases, as shown in Table 1. Transportation incidents, the event with the most casualties among workers' fatal injuries, represented 42.6 percent of these fatalities. Falls/slips/trips, contact with objects and equipment and violence accounted for 800, 722 and 703 fatal occupational injuries, respectively.

Field Safety

According to the USDA, 21 million full-time and part-time jobs in the United States in 2015 were related to the agricultural and food sectors (<https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy.aspx>). Direct on-farm employment accounted for about 2.6 million of these jobs. As reported by the Centers for Disease Control and Prevention (CDC), approximately 472,000 youth performed farm work and about 259,000 youth were hired to work on U.S. farms in 2012 (<https://www.cdc.gov/niosh/topics/aginjury/>).

Table 1. Fatal occupational injuries by major event or exposure, 2015

Event or exposure	Number of fatalities
Violence and other injuries by persons or animals ^(a)	703
Transportation incidents ^(b)	2,054
Fires and explosions	121
Falls, slips, trips	800
Exposure to harmful substances or environments	424
Contact with objects and equipment	722
Total	4,824

Source: Bureau of Labor Statistics 2015 Census of Fatal Occupational Injuries.

^(a)Includes violence by persons, self-inflicted injury and attacks by animals.

^(b)Includes highway, non-highway, air, water and rail fatal occupational injuries and fatal occupational injuries resulting from being struck by a vehicle.

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A few field dangers cause many farm-related injuries and fatalities. In 2014, the CDC estimated that there were 58,385 adult farm injuries, as shown in Table 2. The number of agricultural work-related injuries declined from 87,503 in 2001 to 47,332 in 2009 and then, unfortunately, increased to 58,385 in 2014. Accordingly, every day about 160 agricultural workers suffer a lost-worktime injury. Moreover, 5 percent of these injuries result in permanent impairment. An estimated 14,000 youth were injured on farms; 2,700 of these injuries were due to farm work in 2012 (<https://www.cdc.gov/niosh/topics/aginjury/>). The primary cause of injury has largely remained unchanged, with persons, plants, animals, materials, tools, instruments, equipment and other causes responsible for the majority of work-related injuries in agriculture.

In 2013, the Bureau of Labor Statistics reported that 459 farmers and farm workers died from a work-related injury, resulting in a fatality rate of

21.7 deaths per 100,000 workers, which is about twofold that for the next highest industries of mining and transportation and warehousing (Table 3). Injury and death rates in almost every survey published are higher from April to September for agricultural work, when most farm activities occur.

In statistics reported in 1996 by the National Safety Council, the major causes of agricultural-related fatalities were tractors (37%) and agricultural machinery (17%), as shown in Table 4. Fatalities caused by tractors included tractor overturns, running over victims, jump-starting tractors, hitching equipment or folding equipment for road travel. Farm tractor accidents still remain the leading cause of death and injury on farms.

Fortunately, most modern tractors used for crop production have a roll-over protective structure (ROPS). The risk of serious injury from an overturn is lower if the operator fastens the seat belt on a

Table 2. National estimates of agricultural work-related injuries to adults (20 years and older) on U.S. farms

Year	2001	2004	2009	2012	2014
Total injuries	87,503	80,329	47,332	61,057	58,385

Source: Occupational Injury Surveillance of Production Agriculture Survey, 2001, 2004, 2009, 2012 and 2014.

Table 3. Selected unintentional injuries at work by industry (preliminary) in the United States, 2013

Industry division	Hours worked (millions)	Deaths ^(a)	Deaths per 100,000 full-time equivalent workers ^(a)
All industries	268,127	3,738 (-4%) ^(b)	2.8 (-7%)
Agriculture ^(c)	4,238	459 (-8%)	21.7 (-6%)
Mining ^(d)	2,508	153 (-14%)	12.2 (-22%)
Construction	16,972	770 (-1%)	9.1 (-5%)
Manufacturing	30,211	272 (-7%)	1.8 (-5%)
Wholesale trade	7,484	169 (-9%)	4.5 (-8%)
Retail trade	27,936	134 (-10%)	1.0 (-9%)
Transportation and warehousing	10,477	625 (-7%)	11.9 (-10%)
Professional and business services	31,046	349 (-3%)	2.2 (-8%)
Other services	12,429	132 (+8%)	2.1 (+5%)

Deaths are preliminary data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries. All other figures are National Safety Council estimates based on data from BLS.

^(a)Deaths include persons of all ages.

^(b)Numbers in parentheses represent the percentage change as compared to 2012.

^(c)Agriculture includes forestry, fishing and hunting.

^(d)Mining includes oil and gas extraction. -

Table 4. Factors involved in agricultural fatalities (1996 National Safety Council data)

Means of injury	Percent of agriculture-related fatalities
Tractor	37%
All other agricultural machinery	17%
Farm trucks or other vehicles	11%
Animals	6%
All other fatalities	29%

tractor equipped with ROPS. Practicing this safety habit may also reduce injury from traffic collisions. Operating a tractor, sprayer or combine too fast for conditions causes many overturns. Turning too short can cause an overturn. Misjudging the distance from an embankment can be serious because the bank may crumble under the weight of the tractor or implement. A fact sheet available from your county Extension office, FSA1026, *Tractor Safety Tips for Arkansas Producers* (<https://www.uaex.uada.edu/publications/pdf/FSA-1026.pdf>), has additional suggestions that may be useful for training farm labor. The following are a few tips that might help keep producers safe while performing farm activities.

- Whether calibrating a planter or sprayer or moving a combine, don't move equipment until you see that everyone is out of danger. Starting a tractor in gear from the starter terminal (jump-starting) is a common reason farm workers have been run over. Transmission interlocks prevent tractors from starting in gear, unless the safety is bypassed. A farm worker does not have enough time to jump out of the way of a tractor left in gear before the engine builds hydraulic pressure and the tractor rolls over the worker.
- Whenever noise prevents you from hearing someone speaking to you, stop the engine and what you are doing and move to where you can talk to clear up any confusion. Hand signals are easily misunderstood, unless both individuals understand the meaning of a hand movement in advance. It takes good communication and cooperation for two people to safely hitch heavy toolbars or towed equipment. Make sure signals are not confusing before moving the tractor to align the connection.
- Most tractor rollovers are the result of going too fast, turning too short or operating too close to embankments that may crumble under the weight. Injuries and death also occur from collisions with other vehicles when a tractor or other farm vehicle is operated on roads and highways.
- Combine entanglements are rare the first time the machine is choked and plugged. It is the fourth time, fifth time or later, when the operator is tired or irritated, is in a hurry and has a lapse in judgment. Vibration and excessive noise dull an alert person's sense to hazards. Since fatigue slows reaction time, rest breaks help refresh the body. Falls from combines, grain bins, etc., may be prevented with proper work platforms or sturdy ladders.
- Reservoirs and open irrigation distribution ditches may present concerns. Normally, a clear warning on a sign about the water hazard, unusual currents around culverts, etc., and potential bank washouts will caution outdoorsmen or others who may enter. Evaluate a location with respect to residences or public access to determine whether it may attract youngsters. Gates and fencing may be used around accessible areas to prevent ATV riders or children from getting into danger. Posting "no trespassing" signs or drowning warnings is primarily useful only for adults.
- A qualified electrician should routinely check electrical circuits on irrigation pumps and center pivot systems. Items to review are proper grounding and adequate circuit protection, including immediate replacement of circuit boxes damaged by electrical storms or circuit overheating. If a box has overheated or shorted, switching off the power may cause arcing and severe flash burns that may take months for merely partial recuperation. Always use the heel of your left hand to throw switch levers (you may wear a glove) and turn your face away to minimize hazard exposure as the control is moved.
- Be cautious when working around electrical circuits, especially when opening electrical control boxes and around any circuits that are "hot." Wasps commonly nest in and around electrical control boxes and may also appear from electric motor shrouds, gear head covers, power unit platforms, irrigation well sheds and irrigation pipe openings. In order to prevent an injury, it may be wise to keep wasp and hornet spray insecticide handy when working on irrigation wells. Stings are not only painful, they can be fatal for anyone severely allergic to insect stings. Further injury can also occur if a wasp startles you and causes you to jump away. A sudden reaction that puts you in contact with an unguarded drive gear or energized electric circuit may cause serious injury.
- Entanglements may occur with irrigation well power shafts if safety shields are not in place. In general, power takeoff (PTO) hazards are respected, but more emphasis needs to be placed on shielding unguarded power shafts on irrigation wells. Power shafts for tractors and well pumps should be shielded; any concentric sleeves that do not spin freely should be repaired or replaced. Power shaft covers can be obtained from suppliers to protect those doing maintenance around diesel, propane or electric power units.
- If a power unit is not securely mounted and anchored, vibrations may misalign the drive or break it loose from supports. A loose power unit may cause a dangerous swinging power shaft or other hazards due to broken electrical wires, fuel lines or battery cables. Power units and battery

Irrigation Safety

There are several potential dangers that can cause injury or even death when working on irrigation systems.

mounts should be securely anchored to a substantial support platform and routinely checked for stability. A secure latch to keep the clutch of the power unit in neutral is a good safety device. This can help prevent accidentally bumping and engaging the clutch when working close to the power unit.

- Typically, weather is very hot when irrigation is needed, and temperature and humidity may bring on heat stress. Anyone working in these conditions should drink plenty of fluids such as water and nutrient-replenishing drinks. Breaks and rest periods should be taken as needed to avoid heat stress, fatigue and exhaustion. Fatigue and exhaustion are health hazards and can also contribute to poor judgment, causing other accidents and injuries.

Traffic and Road Transportation Safety

The objective of increasing traffic and road safety awareness is to diminish the injuries, deaths and property damage resulting from accidents while traveling on public roads.

- National Highway Traffic Safety Administration recently reported that approximately 40 percent more fatal crashes and fatalities occur in rural areas compared to urban areas. Experiences over the last four years in crop areas of Arkansas seem to reinforce national statistics. Improvements such as wider road shoulders, adding warning signs for curves with poor visibility, updating narrow bridges and possibly adding crossbars at railroad crossings should reduce rural traffic accidents. In some situations, it may be possible to convince town, county, state or railroad officials to clear rights-of-way to allow better traffic visibility.
- More fatal work injuries in 2015 resulted from transportation incidents than from any other event. Roadway incidents alone accounted for about one out of every four fatal work injuries (<https://www.bls.gov/iif/oshwc/foi/cfch0014.pdf>).
- Railroad crossings are increasingly dangerous for operators of farm equipment. Some cabs may “tune out” the diesel train noise. In order to hear more effectively, reduce the speed of the cab fan and turn off the radio as you approach a crossing.

If you gear down well in advance, you can control the load, either to stop or to proceed when the track is clear. In some cases, either historical evidence and/or community effort may help to get the railroad company to add crossbars.

- Lock both brakes together and start onto roadways slowly. Go slowly enough to manage the momentum of the tractor with a full grain cart, grain drill or toolbar, particularly those that are raised overhead. Dump all of the grain from the combine into a grain car or truck prior to road travel to lower the center of gravity and increase the ability to maintain control in a sudden emergency. Always check traffic from both directions before making turns, especially left turns, to prevent collision, extensive damage and injury.
- Wide equipment, modern toolbars and combines typically require almost two normal traffic lanes. Motorists are often poor judges of the slow speed, width or weight of farm machinery traveling on roadways. Using an escort with flashing lights is probably the best way to alert motorists. Being diligent to keep slow moving vehicle signs, reflectors and taillights bright and clean will improve their visibility at night and during the day.

Grain Handling Safety

Flowing grain remains the number one cause of fatalities for grain handlers. Large or unstable quantities of grain can flow like liquids. Unlike water, which allows a person to swim, it is difficult or impossible for a grain handler to move if caught in grain flow. A grain handler can be buried in a few seconds if caught in grain flow, resulting in suffocation.

- The number of agricultural confined-space incidents in the United States between 2007 and 2015 totaled 307 cases, as reported by a Purdue University database (Table 5). Unfortunately, the ratio of the fatal cases to the total ranged between 36.7 and 58.3 percent. The majority of these cases were related to entrapment or engulfment in free-flowing grain. Other cases were related to machinery entanglement inside grain storage facilities or from asphyxiation due to toxic atmosphere in partially closed storage structures.
- Flowing grain and entanglement are the top causes of fatalities in grain handling facilities. Entanglement from moving fans, blades, augers, power takeoffs (PTOs), belts, gears and pulleys

Table 5. The number of nonfatal and fatal incidents related to grain entrapment in the United States (adapted from Issa et al., 2015)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
Nonfatal	15	17	22	26	19	11	20	21	10
Fatal	16	17	19	31	11	8	13	17	14
Total	31	34	41	57	30	19	33	38	24
Fatal/Total	51.6%	50.0%	46.3%	54.4%	36.7%	42.1%	39.4%	44.7%	58.3%

can severely injure, disfigure and cause limb amputation or death to workers.

- The entire body of a 6-foot-tall person can be completely engulfed within grain in about 30 seconds. Without immediate rescue, this person will suffocate.

Grain Bin Entrapment and Engulfment

The term **entrapment** implies an incident when a grain bin worker becomes buried in the grain beyond the point of self-extraction. On the other hand, the term **engulfment** implies an incident when a grain bin worker is completely buried or submerged beneath the surface of the grain. In many cases, grain entrapment leads to engulfment which, in turn, is fatal.

Causes of Grain Bin Entrapment

According to the Occupational Safety and Health Administration (OSHA), most incidents of entrapment suffered by grain handlers who have entered bins or silos resulted when:

- Grain handlers did not follow proper safety procedures.
- Grain handlers were without personal protective equipment.
- Grain handlers entered bins or silos while grain was flowing and equipment was running and were sucked under the grain. If a grain-probe or shovel is dropped in grain bin, the flow of grain should stop first before taking any action to retrieve the lost item.
- Grain handlers fell through bridged grain into an air pocket that was formed beneath spoiled grain (Figure 2).
- Grain handlers tried to break a vertical grain wall (Figure 3).

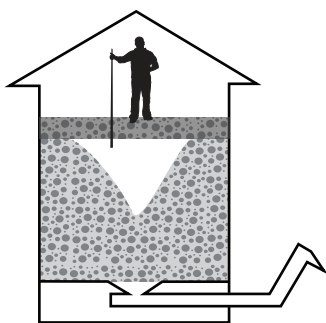


Figure 2. Bridged grain

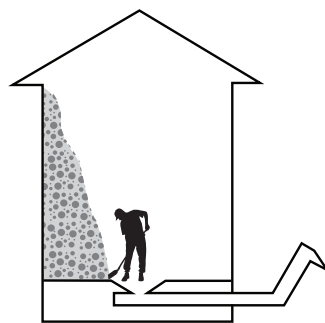


Figure 3. Vertical grain wall

Tips to Help Avoid the Danger of Grain Entrapment and Engulfment

Entrapment and engulfment incidents in grain bins are avoidable. The best prevention for grain engulfment is to avoid entering the grain bin. However, flowing grain incidents may also occur when loading and unloading trucks and bins, when

surface crusts collapse and when steep or vertical grain piles collapse. A fact sheet available from your county Extension office, FSA1010, *Grain Bin Entrapment and Engulfment Causes, Prevention and Rescue* (<https://www.uaex.uada.edu/publications/pdf/FSA-1010.pdf>), has additional suggestions related to grain bin handling safety. Following are a few tips that might help producers avoid the danger of grain entrapment and engulfment:

- Grain handlers should take into account all preventative safety measures including proper ladders, scaffolds, etc.
- Grain handlers should be able to use prearranged arm and hand signals due to difficulty hearing when grain handling or drying equipment is operating nearby.
- Grain handlers trying to rescue one victim should not endanger another person.
- Grain handlers should prepare appropriate breathing apparatus if the victim has been unable to get sufficient oxygen or has been breathing air containing grain toxins.

Grain Bin Entrapment Rescue Technique

Remember, entrapped persons need immediate help. It is much easier to help and successfully rescue the trapped person if you have an accident response plan. The trapped person should contact the helper waiting outside the bin immediately. It should be mentioned that pulling a trapped person from grain could be very difficult due to the friction forces transferred from the grain to the trapped person's body. Therefore, it is **not** advisable to winch a person from grain if the person is buried deeper than knee deep. This may cause joint dislocation, paralysis and other severe injuries. The grain must be removed from around the person to get him/her out. This can be done by creating a cofferdam around the person and bailing out grain with a vacuum or bucket. Grain cofferdams can be constructed by driving sheets of plywood around the person. They can also be constructed using plastic barrels. Currently, there are several commercially available grain rescue tubes. These tubes have linking pieces that are connected and driven into the grain to create a cofferdam. Commercial rescue tubes typically have steps on the inside to assist the victim in climbing out of the grain.

Confined Space Entry

Even a small amount of spoiled grain can produce millions of tiny mold spores, which easily become airborne when disturbed. Airborne mold spores can be inhaled through the nose and mouth, irritating sensitive lung tissue and, in some individuals, causing reactions so severe that hospitalization is necessary. Farmers working without respiratory protection inside a bin or other grain storage facility in which moldy grain is present are especially vulnerable to mold reactions. When handling any grain where

mold damage is present, the use of an appropriate respirator is essential. This applies even to truckers, scale operators and those supervising the dumping operations at an elevator.

After exposure to high concentrations of mold spores, it is important to change clothing (or use disposable overalls) to avoid bringing the mold spores home and exposing family members. If you do become ill after exposure to moldy grain, consult a physician and make him or her aware of your activities. Medical attention may be necessary in some cases.

Employee Safety

Employee safety is regulated by the Occupational Safety and Health Administration (OSHA). Only farms with 11 or more employees are required to meet all OSHA labor regulations. All growers, however, are required to comply with the following standards:

- Roll-over protective structure (ROPS)
- Slow moving vehicle (SMV) emblem
- Agricultural machinery guarding (of moving parts, i.e., PTOs, combine safety shields, auger inlet covers and other moving machinery guards)
- Temporary labor camps standards
- Hazard communication (right to know). If you are an employer and store farm diesel fuel, pesticides, etc., then labels, MSDS, information, training and a written Hazard Communication Program are required.

Regulations change periodically, so for the most current information, please refer to the following website: <https://www.osha.gov/index.html>. If your farm is under OSHA jurisdiction, OSHA requires reporting an accident within eight hours. A reportable incident is defined as hospitalization of three or more employees in one accident or a death of one or more employees. A toll-free phone number, 1-800-321-6742, is available 24 hours a day to report incidents. You can also report to the federal OSHA office in Little Rock at 501-224-1841, extension 226, during working hours.

General Precautions

The following are broad precautions that might help producers reduce hazards:

- Work can be done safely on equipment powered by electricity with a “lockout, tagout” approach. Anyone working with equipment powered by electricity should carry a lock with his personal key and tag. These are readily available from local electrical suppliers. Before starting work, always disconnect the power supply and lock the switch “off.” If you are interrupted or are not visible from the switch box, this key prevents

anyone reconnecting the electricity. You can remove the lock from the switch lever after completing the work. Always use the heel of your left hand to throw lever switches and turn your face away as you move the control to minimize burns from a flash fire.

- A federal regulation intended for personal safety prohibits anyone or any equipment from coming within 10 feet of an overhead power line. If field equipment or other traffic cannot maintain a 10-foot gap under the power line, request that your power supplier raises the power lines.
- Diesel-powered generators, electric-powered pressure washers, hand tools (drills, angle grinders, etc.) and welders should be adequately grounded. Grinders, drills and other electrical tools bouncing around in a truck tool box can develop “shorts.” If the electrical service entrance at the shop is grounded with an 8-foot ground rod (standard), all ground wire leads, including the extra grounding plug on power cords, should be connected to reduce the risk of electrocution when the short occurs. Use electric tools on dry soil, concrete, etc., to reduce the potential of a fatal current surge passing through your body.
- Someone on the farm should have current CPR training and certification. The local EMT, ambulance and fire department numbers should be posted by every permanent phone and programmed on “speed dial.” Every person on the farm should be prepared to call emergency rescue should an accident occur.
- Observe pesticide labels for proper use, mixing and disposal. Appropriate personal protective equipment is specified on the label. The label and Material Safety Data Sheet (MSDS) contain specific inhalation, dermal, ingestion and emergency information. These documents should be kept readily accessible so they can be referred to in case of an emergency. If a mishap occurs, use the label to help your physician and the Poison Control Center start proper treatment.
- Fire extinguishers on tractors and combines may also protect your safety and equipment investment. Dry chemical all-purpose 3A-40B:C or 4A-80B:C extinguishers are good choices for tractors and combines. Once a fire extinguisher is 10 years old, it is generally wise to replace it unless it exceeds requirements in a thorough test.

Have a Plan to Reduce Hazards

The following are few tips that might help plan to minimize hazards:

- Set long-range goals to eliminate hazards while finding safer ways to complete routine tasks.
- Assess the kinds of potential severe accidents and how frequently a person is exposed to that hazard.

- Develop a simple plan that you can follow to minimize these exposures.
- Serious consideration should be given to the risks of road collision, tractor overturn and a person being run over or crushed by farm equipment.
- Consider all aspects of your farming operation to identify potential hazards and then seek remedies.
- Make sure that another person knows where a lone worker is (if a person must work alone) and that regular contact is made.
- If a lone operator sees a hazardous situation, he/she should get help to resolve it as soon as possible.
- Everyone should be trained to contact the manager immediately about any serious safety concern.

Summary

- The previous suggestions are a start to help manage hazards and find ways to avoid them. These hazards are only highlights. Review your techniques and farm work sites in order to reduce potential hazards.
- A grower's leadership is the key to influencing employees and others on the farm. Employees must know that working safely is expected, for their welfare as well as that of their employer.

During the noncrop season, it is wise to make a careful hazard audit. Review the previous season's activities and field records to bring to mind hazards or incidents, especially considering situations when someone narrowly avoided serious injury. Making changes may save someone's life the next season.

- In most situations, equipment is not the underlying cause of an accident. A single thoughtless reaction can make you a victim. Never get in a hurry. Plan ahead to ensure there is enough time to do the job properly and safely.

Contacts That May Prove Helpful

Keep a list of these phone numbers at a very convenient place. Good places would be grain bin doors, electrical boxes, inside of the tractor cab, outside door of the workshop or the barn and nearby vicinity of a phone stand. Storing these contacts in your cell phone will be helpful. It is also suggested that these numbers should be on all possible prominent, easily visible areas. Making a sticker of it would be the best bet. Also, notify the location of grain bins or your hazardous workplace so local sheriff's office is advised to make their approach rapid and convenient. Table 6 shows some contacts that may prove helpful.

Table 6. Contacts That May Prove Helpful

Manager or supervisor of the facility		
Local phone number for ambulance service		
Emergency rescue		911 or a local sheriff's office
Fire department		
Poison Control Center		1-800-222-1222
Family physician		
Local electric power supplier		
County sheriff		
Local implement dealer	Assist with extrication	
Arkansas State Highway and Transportation Department	Oversize and overweight permits	501-569-2381
Commercial driver's license (CDL) info		501-682-1400
State Fire Marshal, Arkansas State Police	Fuel storage questions	501-618-8624
Arkansas State Plant Board		501-225-1598
Arkansas Department of Environmental Quality		501-682-0744
Liquefied Petroleum Gas (LPG) Board		501-683-4100

Other Sources

- Centers for Disease Control and Prevention. Agriculture Safety. <https://www.cdc.gov/niosh/topics/aginjury/> (Accessed on 4/21/2017).
- Issa, S., Y. Cheng and B. Field. 2015 Summary of U.S. Agricultural Confined Space-Related Injuries and Fatalities. https://extension.entm.purdue.edu/grainsafety/pdf/Space_Confined_Summary_2015.pdf
- USDA Economic Research Services. Ag. and Food Sectors and the Economy. <https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy.aspx>
- U.S. Bureau of Labor Statistics. 2015 National Census of Fatal Occupational Injuries. <https://www.bls.gov/news.release/pdf/cfoi.pdf>

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