

A. Grain Bin Safety Training Proposal: Specific Aims

We offer the following specific aims:

- 1) Reduce small space enclosure and grain bin accidents and deaths in the four-county region that The College serves.
- 2) Equip first responders in our region with life-saving knowledge and skills through four two-day training sessions.
- 3) Deploy follow-up surveys to assess participation demographics as well as strengths and weaknesses of the sessions to inform future training programming.

B. Background and significance to agricultural safety and health

Grain handling facilities, which include bins, elevators, tanks, and mills, define a farm's skyline as they sprout from the fields. These large facilities store and process bulk dry grains that eventually become fuel or food, and their complex internal components require a careful and informed approach to management. With ongoing financial pressures to produce strong annual yields, however, farmers may eschew safety precautions to address clogs and temperature issues more expediently inside grain bins and confined spaces. In other instances, workers may be unaware of the risks inherent in grain bin entry and the subsequent burden placed on first responders to execute rescues. A troubling rise in confined space incidents over the past few years underscores the need to equip first responders with life-saving skills and create a culture of safety awareness in rural communities.

The Occupational Safety and Health Administration (OSHA) defines grain handling as a high hazard industry due to the potential for falls, explosions, entanglement, and engulfment. Forgoing safety equipment or allowing an auger to continue running while inside a grain bin presents a significant safety threat to farmers and farm workers. With one wrong step, a worker could face suffocation or loss of limbs. Workers can trip walking across catwalks, fall from interior ladders, or lose consciousness due to noxious gases built up within a bin. To reduce the likelihood of grain bin incidents, it is critical that first responders know what precautions to take and how to execute a rescue using current practices. Because grain engulfment takes just 20 seconds, those rescue efforts need to be swift (TSGCinc.com). Grain engulfment rescues can last an average of 3.5 hours since first responders must reach remote farms and then navigate unknown bin layouts and technology systems (Brandon, 2016). By offering Specialized Confined Space and Grain Bin Rescue for first responders in rural communities, The College's experienced Fire Science instructors will help them to confront a confined space emergency more quickly, confidently, and safely.

While OSHA warns against entering operational grain bins, several factors may compel a farmer to take this risk. Moisture migration, for instance, occurs when disparities between air temperatures inside and outside of the bin create moist grain, which in turn causes spoilage and jeopardizes the grain around it. Grain that cakes on walls is excluded from the critical aeration process that cools stored grain and prevents mold or insect infestations. Temperature swings brought on by volatile weather patterns and climate change can increase the likelihood that grain will not dry properly and instead rot within the bin. Left unmitigated, these problems translate into lost revenue for farmers.

Consequently, farm workers will enter grain bins alone and unharnessed to fix mold-induced clogs or caking. Sadly, what may seem like efficient troubleshooting can degenerate into a life-threatening situation quickly. In a crusted grain bridge scenario, the grain at the top of an elevator will appear stable enough to support walking but conceal a cavity beneath it. If a worker walks across the crusted grain to

address a clog at the top of the bin, the layer can break, causing the worker to fall and be engulfed in a matter of seconds. If the auger sweeping grain across the bottom of the bin is running, the engulfed individual risks amputation as they descend under the force of the grain's pressure. In a vertical grain avalanche scenario, grain that has collected along the sides of the bin will avalanche toward a person and bury them at the bottom of the bin. Both the bridge and avalanche scenarios occur when spoiled grain sticks together to form areas that look deceptively secure, and both scenarios endanger not only the farm worker, but also a first responder untrained in confined space rescue.

The College's Fire Science program can field the expertise to fulfil an unmet need for small space and grain bin rescue training in southeast Nebraska. External providers from out of State have offered grain bin rescue training in The College's jurisdiction, but The College's Fire Science program has the curriculum, experience, and partnerships with regional first responders to serve the area with more consistency. The Fire Science program provides public education, responds to utility emergencies, and trains future first responders in Dodge, Douglas, Sarpy, and Washington counties in southeast Nebraska. Though Douglas County is home to Omaha, the state's largest city, the region remains rooted in agriculture. Sarpy County was among the state's top corn producers in 2020, yielding 202.1 bushels per acre (USDA.gov). In 2017, grain corn was the top crop in acres in the state, and over 22 million acres were devoted to crops including soybeans and wheat (USDA.gov). The high yields and rolling farmland mask a grim reality, however. With 23.1 deaths per 100,000 workers in 2019, farming is one of the most dangerous professions (Nebraskacorn.gov).

Purdue University's Agricultural Safety and Health Program, which maintains a Confined Space Incident Database (PACSID) to track agricultural safety cases, documented 2,404 cases between 1962 and 2020, of which 60% were fatal (Field, et al., 2020). The 35 fatal and non-fatal grain entrapment cases in 2020 mark a 52% increase from 2017, with 83% occurring in the Midwest. Nebraska has ranked among the top states for confined space incidents historically, though PACSID suggests that cases may be underreported nationally by as much as 30% (Field, et al., 2020). Mandatory incident reporting systems are not in place for most members of the agricultural community. Thus, collected data may not paint an accurate picture of just how endemic risky practices are in farming operations. Moreover, with the average age of a farmer at 58, younger workers will be shouldering a bigger brunt of high-risk work in the years to come (Field, et al., 2020). Of those classified by the USDA as young producers under the age of 35, 40% have 5 years or less of farm operations experience and therefore may be most susceptible to incidents.

The Fire Science program has held several recent grain bin trainings that alerted them to significant deficiencies in confined space rescue preparation among rurally-located first responders. Although the Farm Bureau distributed grain bin kits to rural fire departments across Nebraska, The College's instructors noted that many first responders were not clear how to use them, and some kits were still encased in plastic wrap. Further, instructors observed that many small departments were unfamiliar with routine procedures such as monitoring air quality, using harnesses, and initiating lockout-tagout to shut off machinery before entering a space. These observations informed the proposed structure for future training that provides both a refresher on basic protocol as well as training specific to grain bin rescue. Chiefs and Battalion Chiefs from area departments have expressed their support for The College's implementation of these Specialized Confined Space and Grain Bin Rescue trainings.

The intended impact of this project will be a reduction in confined space grain bin incidents and deaths, and increased awareness of grain bin safety practices and equipment. Data from 2020 shows that there were 35 grain entrapments, 4 asphyxiations, 12 equipment entanglements and 7 storage bin falls nationwide (Field, et al., 2020). Hands-on training will demonstrate the sense of physical restriction that occurs during an engulfment as well as the best practices for avoiding and diffusing these situations. The College's instructors, who bring over 100 years of combined experience as firefighters, will immerse session participants in the most effective protocol and in a format that permits ample practice.

The College's instructors will train participants in the use of entrapment rescue tubes, considered the best way to access and rescue someone trapped in a grain bin. They operate in much the same way as cofferdams, isolating a specific area from the material around it using sturdy, interlocking walls. When assembled, the walls help to reduce pressure on the trapped individual's torso from the onslaught of grain. Since the walls exist as separate pieces, they offer a flexible solution. Rescuers can cordon off an area near the perimeter of a bin, for example, or form a fully-enclosed tube to encase someone in the middle of a bin. Commercial panels' lightweight, minimal footprint makes them a convenient safety mechanism. During a rescue, the first responder will insert the panels around the trapped individual, being careful to allow enough perimeter around their limbs. If space permits, a responder may enter the walled area to begin removing grain, preferably with a drill-powered rescue auger, which offers the most efficient way to remove grain and release pressure from the trapped individual. The pressure from densely-packed grain can cause one to asphyxiate, even when buried below the chest.

Although participants can learn the entire rescue process during the sessions, instructors will encourage an iterative approach to training and urge attendees to repeat it the following year. By collaborating with rural agencies, The College hopes to enact a cultural shift so that annual confined space training is part of a holistic approach to community safety. The College will use press releases, newspaper articles, radio, TV news stations, and community programs to communicate about the training. Participating fire departments will also disseminate information to farmers, farm workers, and locations that they frequent to inform the farming community of the training and preparation for their fire fighters.

C. Methods or approach (Evaluation plan)

Recruitment efforts will target first responders, including volunteer or combination fire departments. Farmers or farm workers are permitted to watch training sessions, as well, but only emergency responders may participate. The College will reach out to rural departments to solicit hosts for the trainings and collaborate with the marketing team and communication channels to ensure that promotional materials and branding efforts are clear, consistent, and timely. Recruitment strategies will entail connecting with community agencies, regional events, trusted agricultural entities such as the USDA, state representatives, and seed companies, who maintain a strong presence in The College's

four-county area, to share information about the trainings. The College will issue social media blasts and press releases and reach out to organizations such as the Nebraska Corn Board and Farm Bureau to leverage their social media presence. Husker Harvest Days, an annual event in Grand Island, Nebraska connecting farmers with agricultural equipment suppliers, offers another effective space to promote the trainings. Finally, word-of-mouth communication from past participants will help make inroads into rural areas and engage new audiences.

Training will occur in two eight-hour sessions: one in the spring and another in summer. The first session will be a confined space refresher course designed to help participants gain proficiency with hazard assessment, air monitoring, safety equipment, and rescue. Participants will learn about the leading causes of death from confined space accidents and apply emergency response protocol in an actual safe entry. Topics covered include: use of emergency breathing systems; hazard reduction and monitoring techniques; application, maintenance, and limitations of rescue equipment; and emergency response planning. Training will be in-person and onsite at rotating locations throughout the four-county area.

The second session, timed just before harvest for optimum impact, will focus on grain bin rescue. In the classroom, instructors will share valuable terminology via PowerPoint and provide a tools and equipment orientation. Participants will get to feel the weight of one bushel of corn (56 lbs.) and test how out-of-condition grain damages air quality to grasp more fully the challenging conditions of a grain bin incident. Then the course will shift to the practical skills portion centered on grain bin rescue. At a cut station, participants will learn how to cut steel corrugated grain bin panels using a circular saw, and safely pry open the cut areas for patient removal. Using the grain bin rescue prop, participants will help assemble ground pads, probes, and panels around a mannequin and extract it from the bin. By using a mannequin rather than a live person as the patient, the training permits participants to take their time and become proficient with the equipment.

Training will cover three techniques for patient removal from a grain bin: removal through incisions on the side of the grain bin, through an existing point of entry on the sides, or from the top of the bin. The instructors will use ladders, platforms, or snorkel trucks as high entry points for patient removal, depending on the training location. The College will provide ear and eye protection, N-95 masks, helmets, and a harness for each participant. To be run safely, both sessions require three instructors due to the presence of running machinery, a cut station with saws and forcible entry tools, and a rope station used to move the trapped victim (mannequin) once freed from the grain. One instructor will serve as lead with two instructors assisting, and both sessions will conclude with time for questions, debriefing, and cleanup. Participants who complete both sessions receive a Grain Bin Rescue Certificate, but participants may choose to attend only one session.

The project's evaluation plan will involve administering a Likert-style survey at the conclusion of each training session. The survey will use a series of questions to assess engagement and ask participants if the training met expectations, as well as leave space for comments. Additionally, the survey will collect demographic information, such as age, gender, work setting, and contact information. The project investigator, Fire Science program instructors, and Dean of Health Careers will review

feedback to inform improvements of subsequent training sessions. A draft of the survey is included in the Appendix.

The success of the first specific aim (reducing incidents) will be measured by assessing incident reporting numbers. The College will engage with local fire departments to determine the number of grain bin rescues in the year following the training. Training enrollment numbers will indicate whether the second specific aim (equipping individuals with life-saving training) has been fulfilled. To improve survey completion, the follow-up survey will be administered immediately after training to meet the third specific aim (deploy evaluation surveys), and then evaluated to determine which populations remain underserved.

D. Anticipated benefits to agricultural safety and health

The proposed Confined Space and Grain Bin Rescue training offers significant benefits to agricultural safety and health in southeast Nebraska. Local fire departments need proper preparation to respond to grain bin entrapments or other farm incidents in uniquely challenging rural jurisdictions. Through focused and collaborative marketing, the Fire Science program intends to seek out first responders in these communities with the most at stake. Purdue's Agricultural Safety and Health Program indicates that 78% of cases in 2018 happened in places that are exempt from OSHA Confined Space or Grain Handling Facilities Standards. In 2014, U.S. Congress determined that grain facilities and the activities therein were classifiable as farming operations rather than commercial operations, and are therefore not subject to OSHA regulatory inspections. This exemption primarily applies to farms and feedlots with under 10 employees that produce and store their grain. Further compounding the risk of entrapment, aging grain bins on these properties may not be outfitted with modern safety equipment.

The College's instructors will emphasize practical safety measures during both sessions of the training so that first responders are more knowledgeable and may assist farm workers in their communities. For example, all individuals working in grain handling facilities should do routine checks for combustible gases, a result of grain dust concentration, as well as toxic gases, such as carbon dioxide, that can be caused by mold and fumigants trapped inside the bin. Workers entering grain bins should shut off vacuums and augers and wear harnesses or a boatswain's chair – and always alert individuals outside the bin to their whereabouts. Beyond the tactical elements of grain bin rescue training, The College's Fire Science program wants to demonstrate the value of pursuing ongoing safety education and strengthen partnerships with rural first responders.