

SAFETY ALERT

High Moisture New Crop Corn Has Potential to Generate Low Oxygen and High Carbon Dioxide (CO₂) Levels in Boot Pits, Bins and Basements

Recently we received a safety alert from the Grain and Feed Association of Illinois regarding safety issues on the new corn crop being harvested. The alert stated:

Be alert -- Potentially low oxygen levels!

“Some of our members test the oxygen level in their boot pits and bins prior to entry. We have heard some startling results centered around new crop corn. Reports have been filtering into the Association office of significantly elevated levels of carbon dioxide and reduced levels of oxygen in the boot pit, bins and areas adjacent to new crop corn storage. While we do not know the reason for this occurrence we wanted to alert you so you can take the necessary safety precautions.”

While we do not know if the corn crop in Wisconsin will exhibit these same problems, there is a high probability that it will. Information received from NGFA indicates that the post-harvest respiration of some new-crop harvested corn appears to be occurring rapidly after unloading; thus, leading to elevated levels of carbon dioxide (CO₂) and depleted oxygen levels – particularly in low-lying storage areas– both at farms and commercial facilities. These occurrences, which reports have linked primarily to high-moisture corn deliveries, have occurred over a period of **hours** rather than **days**. When handling a wet crop, it is possible that unusually high levels of carbon dioxide (CO₂) and low levels of oxygen may be present in areas where employees work, such as storage bins, boot pits, tunnels and basements.

As the peak fall harvest approaches, WABA wishes to remind members about prudent procedures to follow that can prevent grain from spoiling which can also create unloading problems such as bridged or caked grain or grain towers. Not only will these procedures help to maintain your productivity but they will also help protect employees from exposure to hazards and improve your safety efforts as well. Members also should consider sharing this information with farmer-customers to apprise them of this potential situation when storing new-crop corn in farm bins.

Aeration

Once stored, it is important to monitor grain for elevated levels of CO₂ both to minimize spoilage and protect employees. Elevated levels of CO₂ in localized pockets of a grain mass are attributable to a combination of factors, such as moisture content, presence of molds, insect infestation and temperature. Safe grain storage conditions are found at relative CO₂ concentrations between 400 and 500 parts per million (ppm). Levels present that are consistently around 1,000 ppm means a problem could be occurring. And consistent readings of 3,000 ppm or greater indicates spoilage is occurring. Using CO₂ sensors to detect and monitor CO₂ levels in the headspace of a storage structure or at the aeration fan outlets can provide an early warning about grain spoilage. Here are several management practices that, if applied, should minimize grain storage problems while protecting employee safety:

- Aerate as soon as possible after binning to remove harvest or dryer heat and to reduce grain temperature to 60° F.
- Maintain the grain, and monitor temperatures and aerate as needed.
- Cool to 40°F for winter storage.
- Maintain the grain-seal fan opening when the grain is cooled and ready for winter storage.

Atmospheric Testing

To ensure air quality is safe, management is advised to conduct atmospheric monitoring of all bins, boot pits, tunnels, basement areas and all other confined or enclosed spaces at their facility each and every time before employees enter to perform work. This cannot be stressed enough. The air **MUST** be tested because CO₂ and oxygen deficient air have absolutely no warning properties, meaning it is impossible to tell without testing. Testing is the only way to ensure the air is safe. Once the air has been tested and found to be safe, it is also recommended that at least one person wear the gas monitor in the space so the air can be continuously monitored for the duration of the work. Pockets of high concentration CO₂ gas can be accidentally released in a confined or enclosed space as grain or spill piles are disturbed. Should this happen, the monitor will go into alarm and the employees can safely exit before it is too late. Nearly 80% of all confined space fatalities in the United States are due to a hazardous atmosphere and unfortunately, 60% of those killed were would be rescuers resulting in a multiple fatality situation.

Most multi gas monitors do not have a CO₂ sensor installed. If you do not have a CO₂ sensor on your multi gas monitor you can still effectively test the air inside your spaces. CO₂ is an asphyxiant gas which means, the CO₂ gas itself is not considered toxic but the gas will displace or push out the normal oxygen concentration in the air we breathe. Breathing oxygen depleted air can lead to death by asphyxiation or suffocation. Therefore, the real hazard you are looking for is an oxygen deficient atmosphere which OSHA lists as below 19.5%. Most multi gas monitors have an oxygen sensor for conducting this test. Normal oxygen in air is generally 20.8% to 21%. If your oxygen readings are less than this then there is a good chance that CO₂ or some other potential toxic gases are elevated and displacing some of the oxygen. If the oxygen readings are 19.5% or lower then this is unsafe and entry should not take place. Some tips for atmospheric testing include:

- Make sure your gas monitor has been calibrated according to the manufacturer's recommendation and you have written documentation to show when it was last calibrated, who calibrated it and whether or not it passed.
- Make sure you perform a bump test before each day's use to ensure the gas monitor is working properly. The bump test needs to be documented by including the date, if the unit passed or failed and who performed the bump test. If the monitor fails the bump test it cannot be used until repaired by the manufacturer or a certified technician.
- The oxygen levels must be tested first and found to be within the acceptable ranges of 19.5% to 23.5%. The test for oxygen is performed first because most combustible gas meters and sensors will not provide reliable readings in an oxygen deficient atmosphere. Once the oxygen readings are acceptable then combustible gas readings are tested next because the threat of fire, explosion or both, is both a more immediate and more life threatening situation, in most cases, than toxic gases and vapors. The readings for toxic gases and vapors are performed last.
- For entries from the top such as a boot pit or tunnel, it is critical that the entire space be tested from the bottom all the way to the top. CO₂ is much heavier than air and the highest concentrations will be found near the bottom. This means that the lowest oxygen levels will be

found near the bottom as well. If you only put the monitor in the space part way, the oxygen reading may be normal near the top but deadly at the bottom.

- To obtain an accurate reading of the atmosphere in a space, your gas monitor should have either a built-in pump or a remote pump that can draw the air inside the space through a hose inserted into the space so the air is then passed over the sensors in the monitor. This way, the monitor can remain outside the space and the person performing the test will be able to obtain and record an accurate reading to determine if the air is safe prior to entry.

Grain Bin and Other Confined Space Entry

Do not enter a grain bin, storage unit or other confined space unless absolutely necessary. If it is necessary to have employees enter, commercial facilities are to follow the applicable practices found in the OSHA Grain Standard 29 CFR 1910.272 paragraph (g) and OSHA Standard 29 CFR 1910.146 on Permit Required Confined Spaces. Some of the key requirements these standards place on employers are:

- Completely isolate the bin or space from all hazards by emptying the contents as much as possible and disconnecting, locking and tagging out all mechanical, electrical, hydraulic and pneumatic equipment feeding or emptying the structure that presents a danger to persons while inside bins, silos, tanks and other spaces.
- Test the atmosphere within a bin, boot pit or other space for acceptable oxygen levels as well as for the presence of combustible gases, vapors and toxic gases. If the oxygen levels are not within normal limits and/or toxic gases are present above the alarm set point of your gas monitor, it may be necessary to provide forced air ventilation to make the atmosphere safe for entry. If the atmosphere cannot be maintained in a safe condition and employees will enter, they need to be provided with appropriate respirators. The only respirators approved for use in an oxygen deficient atmosphere are Self Contained Breathing Apparatus (SCBA) or an air line respirator. Consult with a safety professional to determine the appropriate respirator.
- Issue completed written entry permits before entry occurs. The permit will document all of the precautions taken to isolate the space as well as the atmospheric test results, the names of the persons entering the space, the attendant and much more. An entry supervisor must review the permit and visually verify that the bin or space is safe to enter and sign the permit authorizing entry.
- Equip persons entering bins, silos, boot pits or other spaces from the top with body harnesses attached to lifelines, or a boatswain's chair meeting OSHA requirements.
- Station an observer outside the space during entry operations who is "equipped to provide assistance" and trained in rescue procedures. Employers also are required to provide equipment for rescue operations.

WABA also recommends that you have a plan in place on how to address bin unloading problems that are also likely to occur. Sending employees into bins to clear plugged sumps, breaking up bridged or caked grain and other conditions expose employees to potentially fatal grain engulfment. Plans should be in place to address these problems without sending employees inside the bin. For more information on engulfment prevention, please view the WABA/OSHA Engulfment Webinar that will be on our website soon. If you haven't done so lately, now may be a good time to retrain employees on your bin and confined space entry program and procedures so everyone is familiar with them. Management must be diligent in the enforcement of these procedures and ensure employees strictly follow them. A short cut could lead to a disaster.

Members with any questions regarding this Safety Alert are encouraged to contact Jim Nolte, WABA Safety Director at 608-223-1111 or email at jim@wiagribusiness.org.