ATMOSPHERIC HAZARDS ASSOCIATED WITH OXYGEN-LIMITED STRUCTURES (SILOS) ON FARMS

Background:

A recent fatality at a dairy farm in Eastern Ontario occurred when a worker made an unplanned entry into an oxygen-limited structure (silo) and was immediately overcome by the hazardous atmosphere. An employer must take every precaution reasonable in the circumstances to protect workers from hazards associated with entering silos. The recommended precautions are set out below. Entry into silos should only occur following written plans or procedures for work in these areas.

Oxygen-limiting silos keep oxygen out of the silo to reduce the degradation of the feed stored in them and, in doing so, create an oxygen deficient atmosphere inside the silo. The silo is equipped with “breather bags”, which are open to the atmosphere either internally or externally, and which act as “lungs” to minimize silo pressure changes due to temperature variations throughout the day. In the warmth of the day, when the silo is heated by the sun, the gas trapped inside the silo expands and the bags “breathe out” and collapse. At night the silo cools, and the air inside contracts and the lungs “breathe in” and expand again. An oxygen-limited silo is sealed from the outside atmosphere, complete with a glass-lined coating inside and gasket bolts hold the side panels together. Typically, there are access hatches located at the bottom and at the top that are only large enough for a person to fit through. The release mechanisms for the access hatches must be manually removed to enable the hatch to be opened. A silo may vary in size ranging on average from 7 to 30 metres in height and from 6 to 12 metres in diameter. They are commonly used in dairy farming operations; however, they could be used in other agricultural applications for storage of corn feed, haylage or other feed. The feed is conveyed pneumatically and is blown through the top of the silo. Once full the silo is sealed tight.
Atmospheric Hazard:

These silos are intended to eliminate the oxygen content inside. Fermentation of the feed begins immediately. As fermentation progresses oxygen is used up. Fermentation consists of two stages: aerobic and anaerobic. The trapped oxygen in the silo is utilized during the aerobic stage then followed by the anaerobic stage. A critical time during the fermentation process occurs three to five days after the silo is filled during which time the oxygen is used up and nitrogen oxides reach their peak. The lack of oxygen is an imminent danger and can immediately overcome a person causing injury or death. Entry into oxygen-limited structures should be avoided by performing the task from outside the structure where possible; entry should be considered only when it is absolutely necessary to do so. Unplanned or inadvertent entries into these types of silos should never occur. The oxygen content will be reduced from normal atmospheric content of 20.9% to as low as 1%. In addition, other hazardous gases such as carbon dioxide, nitrogen dioxide, and methane may be present.

Some Relevant Legislative Requirements and Suggested Precautions:

- **Training & Supervision** – The employer shall under clause 25(2)(a) of the Occupational Health and Safety Act (OHSA) provide information, instruction and supervision to a worker to protect the health and safety of the worker, including information and instruction on the potential hazards related to oxygen-limited structures (silos). The employer shall under clause 25(2)(d) of the OHSA acquaint a worker or person in authority over a worker with any hazard in the work.

- **Work Procedures** – The employer shall under clause 25(2)(h) of the OHSA take every precaution reasonable in the circumstances for the protection of a worker which may include developing written safe work procedures to protect workers who may enter a silo that may have with hazardous atmospheres and train and supervise workers to follow the procedure.

- **Signage** – The employer shall under clause 25(2)(h) of the OHSA take every precaution reasonable in the circumstances for the protection of any worker, which may include posting a clearly legible and visible warning sign at the oxygen-limiting structure that warns people of the absence of oxygen, the possible presence of explosive and flammable agents, and toxic agents and to stay away from these areas.

- **Atmospheric Monitoring** – The employer shall under clause 25(2)(h) of the OHSA take every precaution reasonable in the circumstances for the protection of any worker, which may include prohibiting entry into the structure until monitoring has determined that a safe atmosphere exists. In addition to checking for silo gas odors or fumes near the structure, the employer should have procedures and equipment to evaluate the atmosphere inside the structure prior to every entry. Testing is to be carried out to ensure
that the atmospheric condition is safe for entry. Atmospheric monitoring should include oxygen content, concentration of explosive and flammable agents, and concentration of toxic air contaminants that may exist in the silo. Based on an adequate exposure risk assessment, continuous atmospheric monitoring may be required while work is being performed in the silo. All monitoring should be done using calibrated instruments that are in good working order, and are appropriate for the hazards identified in the assessment.

- **Entry Personal Safety Measures (Self-Contained Breathing Apparatus, Emergency Rescue Plan)** – The employer shall under clause 25(2)(h) of the OHSA take every precaution reasonable in the circumstances for the protection of a worker, including those circumstances in which it is deemed necessary for a worker to enter a silo in which atmospheric hazards may be present. Based on an adequate risk assessment, the protection of a worker against atmospheric hazards may require the worker to wear a properly fitted and functioning self-contained breathing apparatus (SCBA) and a safety harness attached to a life-line. The use of SCBA is necessary when the silo has an atmospheric condition that is immediately dangerous to life and health (IDLH) which may result in immediate injury or death. During the fermentation period, when gases may still be forming and oxygen levels may be low, the head space in the silo is considered to be IDLH. All respiratory equipment users should be trained in the care, use, limitations, and fitting of the respiratory equipment as part of an adequate respiratory protection program. An adequate emergency rescue plan should be in place for any entry to confined spaces such as oxygen-limited structures (silos).

- **Mechanical Ventilation** – The employer shall under clause 25(2)(h) of the OHSA take every precaution reasonable in the circumstances for the protection of any worker and under clause 25(1)(b) maintain equipment, material and protective devices in good condition. The employer should ensure that a structure has a ventilation system available for use in order to establish a safe atmosphere in a silo; air should be forced into the silo head space. The blower unit designed to deliver corn into the silo may provide adequate volume of forced air into the silo over time. Agriculture Canada recommends that the forage blower should run for at least 30 minutes for silos up to 55-foot diameter. Larger structures and large area volume above the silage may require more ventilation time prior to entry. The air blower should always be kept running while anyone is in the silo. Each structure is different and ventilation effectiveness should be determined by testing of relevant atmospheric hazards (oxygen content, explosive and flammable agents and toxic gases). It is also important that the ventilation system effectively ventilates all areas of the silo. Carbon dioxide and nitrogen dioxide are heavier than air. They can be present at high concentrations on the surface of the stored feed and in pockets within the silo and thus continue to be a hazard for an entrant.

- **Manufacturers’ Recommendations** – The employer shall under clause 25(2)(h) of the OHSA take every precaution reasonable in the circumstances for the protection of any worker, which may include following recommendations from the manufacturers of
limited-oxygen structures respecting measures and procedures for safe entry. The manufacturer may be contacted prior to any critical maintenance service or repair dealing with silo equipment. Any manufacturers’ recommendations and/or specifications relating to safe entry and to protecting the health and safety of a worker should be followed.

Legislative Requirements

The Ontario Occupational Health and Safety Act applies with some limitations and conditions, to all farming operations (O. Reg. 414/05) that have paid workers under the Act. It does not apply to a farming operation operated by a self-employed person who does not have paid workers.

For more information, contact:

- Workplace Safety & Prevention Services www.wsps.ca
- Ministry of Labour www.labour.gov.on.ca
- E-laws www.e-laws.gov.on.ca

or contact the Ministry of Labour Health & Safety Contact Centre at 1-877-202-0008.

Reference Material:

www.labour.gov.on.ca/english/hs/pubs/farming/gl_atmospheres.php

This Hazard Alert has been prepared to assist the workplace parties in understanding their obligations under the Occupational Health and Safety Act (OHSA) and the regulations. It is not intended to replace the OHSA or the regulations and reference should always be made to the official version of the legislation.

It is the responsibility of the workplace parties to ensure compliance with the legislation. This Hazard Alert does not constitute legal advice and no legal effect. If you require assistance with respect to the interpretation of the legislation and its potential application in specific circumstances, please contact your legal counsel.

While this Hazard Alert will also be available to Ministry of Labour inspectors, they will apply and enforce the OHSA and its regulations based upon the facts as they may find them in the workplace. This Hazard Alert does not affect their enforcement discretion in any way.

Remember that while complying with occupational health and safety laws, you are also required to comply with applicable environmental laws.

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