Advancing The Paradigm: Confined Spaces and The Uncharacterized Workspace

Neil McManus, CIH, ROH, CSP
NorthWest Occupational Health & Safety
North Vancouver, British Columbia, Canada
nwohs@mdi.ca www.nwohs.com

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Introduction

Most industrial workspaces reflect some attempt at accommodating occupancy by people. They contain a roof; walls; windows; a smooth floor; lighting; tempered air provided by a ventilation system; a rest area containing seating; and washrooms containing toilets, sinks, and possibly showers.

Many other workspaces are outdoors. They subject workers to the ultra-violet emissions and heat from the sun; rain; wind; snow; ice; irregular surfaces on which to stand and sit; portable toilet facilities containing at best a toilet, hand sanitizer, and a sink; and rest areas that include the cabs of trucks, service trailers and vehicles, and construction trailers, and possibly the ground. The primitive nature of these conditions is widely recognized and acknowledged.

Both types of workspace can contain a third level of workspace. These workspaces occur both indoors and outdoors. They are created from these workspaces by conditions requiring the shutdown and service of equipment. These workspaces often are unplanned and do not appear in drawings. They are sometimes created through dismantling equipment.

Over the years, regulators recognized that certain workspaces posed higher risk of harm than normal (McManus 1999, McManus 2004). Some of these types of workspace have come to be known as confined spaces, while others of similar geometry were labeled as trenches and excavations, and still others that posed similar hazards received no distinction through a label or other direct recognition of concern.

Confined spaces do not distinguish themselves by size, shape, or nature of work activity. Some are large; some are small; some are partly open; others are completely enclosed. Some house equipment; others store liquid and solid bulk materials. Chemical processes occur in others. Still other confined spaces fit none of these descriptions. Some confined spaces are intuitively obvious, even to uninformed observers, while others gain recognition only because of events that occur in them. Still others defy visual recognition and require application of investigative questions.

Over the years, workers have routinely entered confined spaces without preparation, sometimes with fatal consequences. Workers have been severely injured or killed during work external to confined spaces while preparing them for entry. First contact with the environment in confined spaces has led to fatal injuries because of hazardous conditions overlooked during assessment, or not eliminated or properly controlled during preparatory activity. Lastly, the work activity can create the hazardous condition, while conditions in the space following preparation otherwise could be completely harmless.

The first thing that sets many confined spaces apart from 'normal' workplaces is the function of the space. Confined spaces generally are not the type of place in which people work. While some people work in confined spaces every day, most people will never enter a confined space during their entire working lifetime.

Some workspaces are confined spaces because of design. They serve some function, such as containment of a chemical process or storage of bulk materials, or housing machinery. During normal conditions of operation, entry never occurs because entry cannot occur. There are various reasons why entry cannot occur. The contents could be pressurized and would spill out from the access opening. They could be highly toxic or could cause an immediate fire and explosion hazard. They could also be highly infectious. In other circumstances, while entry could occur by opening an access portal, the interior of the space could be so hot as to be lethal, or could pose an electrocution risk, or other situation that could result in death or serious traumatic injury. As well, some of these situations occur in workspaces that do not fit the legal definition for confined spaces.

Periodically, these structures and the equipment inside them require maintenance and replacement and improvement. Entry must occur in order to do these things. Preparation for entry leads to opening of spaces that meet the regulatory definition for confined spaces. Preparation for entry can create confined spaces from spaces that did not fit the legal definition. As well, preparation for work can create similar hazardous conditions and potential for harm in workspaces that do not fulfil the requirements of the definition.

Accidents that occur in confined spaces are very rare events. They are difficult to predict and very expensive to prevent. Minor mistakes lead to consequences that far outweigh the significance of the error. These accidents often are more severe than those that occur in normal workspaces. Like a trap that is set and ready to spring, the hazardous condition that causes the accident acts rapidly, often without prior warning. Accidents involving confined spaces commonly injure or kill more than one victim. After the accident has occurred, conditions often return to ‘normal’, as if nothing has happened.

Statistics published in the U.S. by the National Institute for Occupational Safety and Health (NIOSH 1994) indicate that engulfment caused about 65% of the fatal accidents that occurred in workspaces having the characteristics of confined spaces. Atmospheric hazards caused about 30%. This situation appears to have shifted toward atmospheric hazards in the years following publication of the document with regulatory intervention and emphasis toward preventing cave-ins and collapse of earthen walls from slumpage by sloping and shoring.

A critical aspect that sets confined spaces apart from 'normal' workspaces is the boundary surface. Boundary surfaces can prevent escape from a space. They can amplify or magnify hazardous conditions in some circumstances. This is especially the case with noise and other forms of energy that reflect off the walls. The boundary surface can increase the risk of electrocution by acting as a path to ground. The relationship between the individual, the boundary surfaces and the source of energy or contamination or other hazardous condition constitutes the major factor in the onset and outcome of accidents in confined spaces. The boundary surface need not be substantive or even contiguous. A chain-link fence or other enclosure can act as a boundary surface. The boundary surface can even be invisible, as is the case of the invisible envelope that surrounds robotic equipment and other machinery that operates in free space.

The term, confined space, is similar to a 'zipped' computer file. These two words unzip to identify 42 hazardous conditions recognizable from regulatory statutes that can occur in these workspaces, and for that matter, in other workspaces as well. Of the 42 hazardous conditions, 26 pertain to energy, some of

which can exist at hazardous levels (capable of causing immediate harm). The boundaries for inclusion under the term, confined space, reflect the phrases used in regulatory definitions. The definition is the property of the authority having jurisdiction over the situation.

A Paradigm That is Not Working

Attic spaces, crawlspaces, trenches and excavations and other structures have the geometric characteristics to satisfy the requirements of the definition of confined space. There are circumstances where the definition definitely should apply to these structures because of the hazardous conditions that are present or can develop. Precautionary measures that follow solely from application of the definition of trench or excavation do not provide a satisfactory level of protection to workers in these environments under these circumstances.

This situation highlights the problem created by the tendency to use the 'pigeon hole' or matrix as a technique for classification. The idea of the 'pigeon hole' is the same as the matrix of mail slots found in apartments and other similar locations and centralized community mail boxes. Each residence has its own mailbox, and in this analogy, its own classification.

The application of the analogy to the discussion highlights the tendency of regulators and inexperienced practitioners and others who seek exclusion from application of more rigorous regulatory requirements to categorize a situation into the box containing the least onerous of the requirements. This situation can lead to actions inappropriate and insufficient to the situation and underprotection of workers performing hands-on tasks in these workspaces.

Another disturbing situation is the number of accidents resembling those that occur in confined spaces, that happen in workspaces that do not fit conventional definitions for confined spaces. The environments in which these accidents occurred do not fit any of the available positions in the matrix of workplace definitions yet posed hazards far beyond the level of harm normally encountered in workplaces (Table 1).

Additional structures that pose similar issues include the interior of duct connected to airhandling and air heating units. These ducts often are entered through doors of partial height. The doors open outward on the upstream side of the fan and inward on the downstream side. Inward pressure on the upstream side and outward pressure on the downstream side of the fan causes the doors to slam shut when opened.

Opening the doors requires extreme effort and is not easily achieved by an individual who is injured. The individual can remain entrapped in these structures until help arrives. Noise associated with ventilating equipment, coupled with isolation of the equipment, can severely impair the summon for help.

Other examples include satellite wastewater treatment systems and some types of wells. Satellite wastewater treatment systems can fit inside a shipping container. Entry occurs through a door of normal size from an above-ground structure. The interior of the structure is contiguous with the atmosphere above the wastewater. Depending on conditions and off-gassing from the influent, the atmosphere in these structures can be or can become life-threatening.

Some types of wells are known as 'blowers and suckers' in the well-drilling business. These wells are known to exist throughout North America. They have the ability to inhale atmospheric air under high pressure conditions and to exhale gas under low pressure conditions. The exhaled gas can be highly oxygen-deficient. Some of these systems are used to air-condition homes, while others supply potable drinking water. Some of the drilled water wells are housed in buildings that contain pumps and other equipment. Exhalation in some locations is strong enough to force stones from the well.

The process of inhalation and exhalation is known to occur in mining. This involves rock containing sulfides and carbonates. The sulfide reacts with oxygen to form sulfates. This reaction removes oxygen from inhaled air. The sulfate formed in this reaction is acidic and can react with carbonates in the rock to form carbon dioxide. The processes are well known in mining and influences mine ventilation. These emissions can also create hazardous conditions during processing of water from mine drainage and

tailings. Emissions can occur in buildings containing equipment that handles these waters.

Table 1
Accidents in Uncharacterized Workspaces

Location	Description
drum mold	The victim inserted head and shoulders into the mold (50 cm diameter by 80 cm deep) and was overcome by vapor from the perchloroethylene that he used to wipe the surfaces.
waist-high paint mixing pot	The victim bent over into the pot while standing on the floor and was overcome by vapor from the methylene chloride that he used to clean the interior.
shaft of a dumbwaiter	The victim opened the door to determine the location of the car and was struck by it.
sand-mixing machine	The victim reached into a side hatch to repair a bearing and was struck by the blades when the drive motor started accidentally.
empty 200 L (55 gal) drums	The hazardous (ignitable/explosive) atmosphere contained in these drums caused about 16 % of fatal welding and cutting accidents.
open-topped degreaser	The victim reached in over the top of the degreaser (2 m x 3 m x 1.5 m high) to recover a part that had fallen in and was overcome by the solvent-rich, oxygen-deficient atmosphere.
enclosure of an abrasive blasting machine	The operator walked in through the access door to retrieve a part that had fallen and was asphyxiated by the nitrogen atmosphere used to inert the interior.
enclosure of industrial robot	The maintenance worker was struck by a robot in the train unrelated to the robot on which he was performing instruction.
sand quarry	Slumpage of sand at the working face of an embankment buried a front-end loader.
mine tailings reclamation	Four people died from a hazardous atmosphere inside a sampling shed (2 m by 3 m by 2.5 m high) entered through a door of normal size.
office	A carpet layer sealed-off the ventilation system, as well as gaps in walls and doors, to contain solvent vapors from adhesive used to anchor carpet tiles and was overcome by toluene vapor.

Source: McManus 1999.

Traditional definitions for confined spaces have focused on the geometry of structures, and not on conditions. This then begs the questions: what exactly is a confined space and how should management of the hazardous conditions occur?

The test for effectiveness of a particular definition is simple: does it encompass all of the workspaces in which the hazardous conditions common to confined spaces exist or could develop? This is not always the case with definitions used in present regulatory and consensus standards. Definitions that do not encompass the unusual workspaces in which people work and are at risk of serious harm serve no one.

A major difficulty with the management of hazardous conditions in confined spaces is the fluid nature of the problem. A seemingly minor change or error or oversight in preparation of the space, selection or maintenance of equipment, or work activity, can change the status of conditions from innocuous to life-threatening. The work activity itself can create the problem. A space rendered innocuous by preparatory activity can become life-threatening because of hazardous conditions created during the work.

Regulators impose significant requirements on workspaces deemed to meet the definition of confined spaces. One result from this situation, literally, is criminalization of the term, confined space. The term, confined space, strikes fear into organizations because of the considerable administrative and technical burdens imposed by regulations onto workspaces that receive this label. The incentive not to label a particular space as a confined space, therefore, is considerable. This situation has distorted the manner in which confined spaces should be viewed.

This reality creates considerable incentive to downgrade the classification. Managers see cost savings. Regulators themselves create exclusions where they have realized that the regulatory framework has created inappropriate requirements, such as atmospheric testing where this is completely pointless. This situation also creates the Philadelphia lawyer syndrome of selective application of regulatory requirements, looking for loopholes and weak links, exploiting differences in viewpoint of 'qualified persons', and making minimal changes to meet the letter of regulation but not the spirit.

Regulators themselves are part of the problem. This has occurred through creation of terms that downgrade confined spaces to lower levels of concern. Such terms include enclosed space, excluded confined space, exempted confined space, low hazard space, and non-permit confined space, among others. This approach fails to acknowledge the 'moving target' aspect of hazardous conditions.
The reality is that people continue to die in similar numbers year over year in accidents involving confined spaces. They also continue to die in other workspaces of similar geometry covered in other regulations or that have similar hazardous conditions and are not directly covered in regulations. Many of these accidents are eerily repetitive. This begs the question about how to solve the problem.

The Uncharacterized Workspace

As discussed earlier, the current approach to regulation forces workspaces into 'pigeon holes' or a matrix based on definitions, for example, trenches and excavations. Expectations within the definitions fail to consider all work activities. Unconsidered work activities have resulted in development of hazardous conditions and unaddressed risk of harm.

The pertinent questions are, what hazardous conditions does a particular workspace pose, what harm can arise and what must we do to eliminate or to at least control them? The classification is irrelevant to safety. Provision of safety requires a practical mechanism to ensure that hazardous conditions existing or created in all workspaces receive due care and attention. That is, we need to establish 'the right reasons to do the right things'.

The critical reality in all accidents is the 'golden hour', as taught in classes on emergency first aid. The 'golden hour' reflects the observation that survival of victims of serious traumatic injury is considerably enhanced when they are moved from a workspace to the operating room in a hospital within one hour of the occurrence of the accident. Otherwise, the risk of death from shock is significantly increased. Extrication from workspaces is often not considered in planning can consume considerable time. Traffic on roadways delays response and increases transport time.

Viewed in the context of this discussion, confined spaces are a subset of a larger group of workspaces that fit the description of uncharacterized workspaces. This term also includes trenches and excavations, and workspaces that pose similar hazardous conditions and are not captured by the definition of confined space. This would include machinery spaces and enclosures that surround industrial robots and barriers that surround unguarded machinery that operates in free space.

Uncharacterized workspaces are workspaces in which there is a reasonably foreseeable risk of harm from

a hazardous condition that may exist or may develop. Hence, change the paradigm to require hazard assessment and work procedures for all workspaces that are uncharacterized. Under this scenario, the qualified person performs a hazard assessment and recommends measures to eliminate or control hazardous conditions. The qualified person prepares a written procedure for work to be performed. The assessment identifies probable accidents, proposes means to mitigate them, and focuses on the needs of the victim.

References

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