Prevention through Design: Eliminating Confined Spaces and Minimizing Hazards

Guidance Document

Developed by the AIHA® Confined Spaces Committee

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Protecting Worker Health

Among international regulations and a variety of consensus standards, there are multiple definitions for what constitutes a confined space. One practical definition describes a confined space as a space that is large enough for workers to enter, has limited or restricted means for entry or exit, and is not designed for continuous occupancy.

Many confined spaces present unusual risks, such as hazardous atmospheres, entrapment, engulfment, toxic or corrosive residues, and moving machinery. Confined spaces with hazards typically require extra precautions for entry that may include, but would not be limited to, a permit process, air monitoring, ventilation equipment, a safety attendant, retrieval equipment, an emergency procedure, and a rescue team.

Based on these considerations, prevention-through-design reduces risk by eliminating the need to enter confined spaces, eliminating hazards within those spaces, and changing space configurations so they no longer are confined spaces. This approach makes completing work within a given space safer. It sometimes can eliminate the need to perform the work under the restrictions of a confined space entry program.

For instance, in the case of a utility pit that qualifies as a confined space, replacing the access ladder with a standard stairway and handrail eliminates the aspect of restricted entry or exit and eliminates designation of the pit as a confined space. Similarly, providing lighting and positive ventilation in a vault can make it suitable for continuous occupancy and eliminate designation as a confined space.

Not all confined spaces can be reconfigured to avoid that classification. Still, aspects of those spaces can be changed to eliminate the need for entry or to reduce their inherent hazards and make working in them safer. As an example, attaching flexible tubing to a sump pump can enable retrieval of the pump without having to enter the sump. Or, installation of decking above free-standing liquid in a manhole could eliminate the engulfment hazard.

This document addresses ways for avoiding the need to enter confined spaces, making confined space entry safer, and eliminating confined space classification altogether through good design. The end result is permanent improvement with less need for special precautionary measures.

BACKGROUND

In 2007, the National Institute for Occupational Safety and Health (NIOSH) began its prevention-through-design initiative. NIOSH recognized that one of the best ways to reduce occupational injuries, illnesses, and fatalities throughout the work environment is to eliminate or minimize hazards during the design phase. The basic principles of this approach also can be applied during retrofitting of existing facilities.

Confined spaces are a specific facet of the work environment that presents unique hazards and requires special attention. Fatalities in confined spaces continue to occur with regularity.

The Bureau of Labor Statistics' Census of Fatal Occupational Injuries showed that confined space fatalities in the United States averaged 81 per year during the period of 2011 through 2016 where confined spaces were listed as either the primary or secondary cause of a death, and the total was 488 deaths. The state of California recorded seven confined space fatalities in 2011 alone, prompting the state to launch a confined space entry emphasis program the following year.

This guidance document is the result of an initiative by the American Industrial Hygiene Association's Confined Spaces Committee to apply the NIOSH prevention-through-design concept specifically to confined spaces. These spaces do not occur randomly: they are the result of intentional design choices and the subsequent construction of equipment, facilities, and infrastructure. Although confined spaces typically are not intended for human occupancy, workers still must enter them to perform work such as inspection, setup, cleaning, and repair.

The goal of the Confined Spaces Committee is to reduce the risk of working in and around such spaces by providing specific recommendations and concepts for improved design. However, it is the end-user's responsibility to follow design criteria outlined in applicable regulations and industry standards.

1. EITHER AVOID CREATING OR ELIMINATE EXISTING CONFINED SPACES.

Make the confined space too small to bodily enter.

This principle has limited applicability, but some spaces can be partitioned or otherwise broken into multiple compartments that are too small for a person to get inside. For example, a large compressed air receiver could be filled with a honeycomb lattice to prevent entry without affecting function as an air reservoir. Inability to enter due to size keeps employees out of harm's way and eliminates classification as a confined space.

Provide unrestricted access and egress.

Workers should be able to enter and exit the space without hindrance. They should not have to contort their bodies, crawl, or use their hands to climb.

- Provide large access openings, such as standard doorways, through which workers can pass easily and quickly. Provide standard overhead clearances so that workers can stand in the space whenever possible.
- Install standard steps with handrails in lieu of ladders or spiral staircases. Steps allow safer, unrestricted entry and exit from the space.
- Provide sufficient aisle clearances within the space, and provide clear access to openings and exits. Locate pipes, ducts, and other equipment so that workers do not have to climb over, under, around, or through them.
- Provide multiple access openings at regular intervals in long spaces, such as crawl spaces and tunnels, to ensure that employees' ability to exit the space is not hampered by distance.
- House equipment in enclosures above ground with standard doorways for access rather than placing equipment in vaults below grade.

Make the space suitable for continuous human occupancy during normal use.

Some confined spaces, such as utility vaults, need only minor modification to make them much safer and to eliminate classification as confined spaces.

- Install continuous-operation or door-switched mechanical ventilation to control air quality and temperature in confined spaces. If a confined space is dependent on ventilation for human occupancy, install an alarm to indicate when ventilation is not working, and consider installing appropriate fixed-gas detection equipment with an alarm to verify air quality.
- Install adequate fixed lighting in the space. Place light switches at entrances.
- Seal the space to prevent water intrusion and/or ensure proper drainage to prevent accumulation of free-standing liquid.
- Ensure that mechanical equipment is guarded properly and that electrical equipment is sealed correctly.
- Guard open-sided edges, floor holes, wall holes, and any other hazards that may cause falls.

2. ELIMINATE THE NEED FOR ENTRY INTO CONFINED SPACES.

Modify the space or the equipment it contains to avoid entry:

- Install critical equipment (valves, gauges, etc.) that requires periodic operation, inspection, or maintenance outside the space so that entry will not be necessary.
- Extend valve handles so they can be operated from outside the confined space.
- Use flexible components and install retrieval systems for items that are located at the bottom of the confined space (e.g., sump pump) so they can be removed and serviced without entry.
- Install extension tubes and fittings to make lubrication possible from outside the confined space.
- Install catch baskets at the bottoms of tanks or other spaces that can be raised to retrieve fallen parts, to prevent the need to enter the confined space.
- Use drones with cameras and/or onboard gas detection/monitoring systems.

- Use remote monitoring systems (cameras, gas detection, leak detection, wireless meter readers, etc.) to obtain information while outside the space.
- Select mechanical equipment for maximum service life and minimal maintenance requirements, to reduce the number of entries required. Over the long term, the additional cost of such equipment may pale in comparison to the cost of routine confined space entry.
- Install viewing and cleaning ports in tanks and other equipment, so that the interiors can be seen and cleaned without entering the space.

3. MAKE ENTRY IMPOSSIBLE.

Prevent access to confined spaces that never need to be entered.

- Make access openings too small for a person to fit through.
- Seal openings by welding or similar means.
- Block openings by permanently installing bars or grating across them.

4. ELIMINATE OR REDUCE THE RISK DURING ENTRY.

Eliminate or minimize health hazards.

- Prevent infiltration and accumulation of organic debris that could decompose and lead to oxygen deficiency or the generation of toxic gases.
- Prevent moisture and water intrusion that could cause rusting and lead to oxygen deficiency. If this is not possible, use materials that do not rust; otherwise, seal materials with a rust preventer.
- Eliminate the placement of piping or conduit containing hazardous materials, gases, chemicals, or sewage in the confined space. Where pipes are present in the space, use welded joints to prevent leakage. If that is not possible, provide the means to drain, purge, and blank any piping.
- Provide ventilation ports at regular intervals if there is potential for a hazardous atmosphere, and provide openings at opposing ends of the space to facilitate complete and effective ventilation.
- Seal or screen any openings to the space as needed, to keep out insects and other animals.
- When possible, select and install equipment with low noise ratings or provide noise reduction on existing equipment.
- Remove or seal any asbestos-containing materials within the confined space.

Eliminate or minimize safety hazards.

- Install sumps and pumps to prevent accumulation of free-standing liquid, such as groundwater.
- If free-standing liquid cannot be eliminated, install elevated flooring where possible to isolate that engulfment hazard.
- Ensure all electrical equipment is properly enclosed, grounded, and approved for the particular environment (e.g., Class I equipment for flammable gas and vapor environments, Class II equipment for combustible dust environments).
- Install ground-fault circuit interrupters (GFCIs) in wet areas or where highly conductive surfaces are present.
- Ensure that all energy sources in the space can be locked out and residual energy dissipated, ideally from outside the space.
- Where ladders are needed for access, install fixed ladders made from rustproof materials and strong enough to hold the maximum intended load. Install climbing devices wherever possible.
- Protect all open-sided floor edges, floor holes, wall holes, and similar hazards with standard railings and toe boards.
- Provide permanent anchor points where fall protection equipment is needed.
- Use nonslip flooring materials where possible.
- Provide self-closing, swinging gates at the top access openings to fixed ladders.

- Ensure that the means of entry does not pose a hazard. Use mechanical devices to lift or open heavy in-ground doors or manhole lids. Use lighter composite lids if possible. Make sure doors will not swing shut in windy conditions.

5. DESIGN TO FACILITATE RESCUE.

Provide features that will make rescue easier and quicker:

- Install platforms of sufficient size to accommodate rescue personnel and their equipment at the access openings when those openings are elevated above floor level.
- Ensure adequate space around floor-level access openings to accommodate rescue personnel and their equipment.
- Ensure adequate overhead clearance for use of a tripod or davit arm retrieval system during vertical entries. If there is not sufficient clearance, install a permanent anchor point (with at least 5000 pounds static load capacity) above the opening, to which a pulley or winch can be attached for rescue.
- Provide multiple openings into the space, preferably at different locations for better access to all areas of the space.
- Ensure openings are at least 24 inches square or 24 inches in diameter.
- Install multiple large release hatches at the bottoms of sloped hoppers and silos that could be opened to quickly empty those structures in case of engulfment.

References

American National Standards Institute and American Society of Safety Professionals

ANSI/ASSP Z117.1: Safety Requirements for Entering Confined Spaces.

ANSI/ASSP Z590.3: Guidelines for Addressing Occupational Risks in Design and Redesign Processes.

National Fire Protection Association

NFPA 350: Guide for Safe Confined Space Entry and Work.

NIOSH

Prevention through Design. www.cdc.gov/niosh/topics/PTD/.

OSHA

OSHA 29 CFR 1910.146: Permit-Required Confined Spaces.

OSHA 29 CFR 1910.252 (c)(4): Ventilation in Confined Spaces.

OSHA 29 CFR 1915, Subpart B: Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment.

OSHA 29 CFR 1926, Subpart AA: Confined Spaces in Construction.