01350

Special Project Procedures

This document provides design standards only, and is not intended for use, in whole or in part, as a specification. Do not copy this information verbatim in specifications or in notes on drawings. Refer questions and comments regarding the content and use of this document to the Yale University Project Manager.

CONTENTS

A. Summary

This section includes design criteria for equipment location and installation, working in confined spaces, emergency power, and central building utility metering systems.

B. Designing Safe Mechanical and Support Spaces

1. General

The purpose of these design guidelines is to aid the design, consulting, and contracting community working on Yale University projects to design and build mechanical and support spaces that are inherently safe for construction, operation, and maintenance. By designing safe mechanical and support spaces, the designer can eliminate or minimize confined spaces or design confined spaces that are more easily and safely accessed. These guidelines focus on the design of safe mechanical and support spaces by avoiding the hazards associated with such spaces. Such hazards include:

- Inadequate dimensions, entries, and exits
- Toxic atmosphere or oxygen deficiency
- Moving parts
- Electrical shock hazard
- Heat and chemical hazards
- Structural hazards that can cause injury

- Combustible dust
- Irritant or corrosive agents
- Moisture or water
- Noise and vibration
- Surface residues making the floor unsafe for walking

2. Design Guidelines

a. Allocate sufficient space within the building footprint for utilities and for mechanical, electrical, telecommunications, and other equipment, including mechanical rooms, rather than designing such features as vaults, hatches, and tunnels outside of buildings.

b. Design mechanical rooms large enough for the intended equipment, with:
   - sufficient distances and clearances for each piece of equipment,
   - sufficient work area around the equipment,
   - sufficient space for removal of equipment components for repair and replacement, and
   - sufficient space for removal of the entire unit for replacement.

c. Design access doors, corridors, ventilation, lighting, and other mechanical room components to meet applicable code requirements while also designing safe working conditions. Requirements for safe working conditions must apply to both normal and emergency operating conditions.

d. Design entries, exits, ventilation, and other mechanical room components with consideration for the conditions inside the room, as well as conditions inside adjacent spaces.

e. Design mechanical rooms with the proper penetrations and seals for cable and piping entries to prevent the penetration of such things as water, moisture, fumes, gases, and heat.

f. Design appropriate doors, rather than hatches, for mechanical rooms and support spaces.

g. Lay out equipment in the mechanical rooms and support spaces for safe service and repair under normal and emergency operating conditions. Ensure that there are sufficient distances and clearances for each piece of equipment, sufficient work area around the equipment, space for removal of equipment components for repair and replacement, and removal of the entire unit for replacement.

h. Design mechanical rooms and support spaces with adequate lighting, ventilation, insulation, noise attenuation, drainage, flood alarms, means of communication, and other safety measures to ensure safe working conditions under normal and emergency operating conditions.

i. Locate cable splicing and other items that require periodic inspection and service within the building, rather than outside of the building in a confined space.

j. Locate utilities distribution systems equipment that require periodic inspection and service within the building rather than outside of the building in a confined space.

k. Provide adequate spacing of equipment, piping, and cables and a safe working environment for their installation, inspection, and service under normal and emergency working conditions. Provide coordination drawings in the design documentation; the coordination and layout of equipment in mechanical rooms and support spaces should not be left to the construction manager.

C. Designing Confined Spaces

1. General

a. Confined spaces can pose serious health and safety hazards to persons performing inspection, service, maintenance, or related activities. Use the following information about confined spaces in the building design, construction, and renovation process to eliminate such spaces or, where not feasible, to design confined spaces that are more easily and safely accessed. Also, follow OSHA standards.

b. OSHA's standard on confined spaces (29 CFR Part 1910.146) defines a confined space as one that meets all of the following criteria:
   - Large enough and so configured that it can be entered to perform work
   - Has a limited or restricted means of entry or exit
   - Is not designed for continuous employee occupancy

c. Some common examples of confined spaces include below ground electrical vaults that are accessed by ladder, various tanks and pits, boiler interiors, and crawlspaces. For more information, refer to applicable OSHA publications and the OSHA web site: http://www.osha-slc.gov/SLTC/confinedspaces/.

2. Types of Confined Spaces and Basic Design Options

The following paragraphs describe the major types of confined spaces, including the type of space, typical hazards, and the means for minimizing or eliminating the hazards. One of the most frequent safety issues associated with confined spaces involves entry and exit (access). Additionally, the materials introduced into confined spaces and the operations performed with them can create unsafe conditions by releasing toxic materials (for example, welding, cleaning, painting) or reducing oxygen levels below safe levels. Such hazards are possible within any confined space, as is the nearly ever-present danger of an oxygen-deficient environment.

a. Telecommunication or Electrical Distribution Vaults

(1) Telecommunication and electrical distribution vaults typically consist of a below-ground, poured-concrete vault, accessible by a grade-level access hatch. Depending upon inner depth, portable ladders or a fixed rung ladder are used to reach the base.

(2) Although telecommunication and electrical distribution vaults rarely contain hazardous processes (provided the electrical cabling is sheathed or is enclosed in conduits), their physical location below-grade carries the risk of oxygen deficiency, falls during entry or exiting, and water accumulation. Operations performed in, and materials introduced into, these spaces can also create unsafe conditions by releasing toxic materials (for example, welding, cleaning, painting) or by reducing the oxygen level below a safe level.

(3) Basic safety design options include:

- Incorporating new vaults as part of a building basement, providing a full-size door to eliminate the confined space (preferred).
- Ensuring an access or hatchway diameter of no less than 30" (36" or larger is preferred for equipment and materials transfer).
- Providing an OSHA-compliant fixed stairway or ladder with an extendable grab bar or rail.
- Grading the floor and including a small sump pit to collect any water seepage that accumulates within the space and permit easier pump-down before entry. The sump pit should be located away from the ladder base.

b. Electrical Transformer Vaults

(1) Electrical Transformer Vaults are very similar in structure to telecommunications or electrical distribution vaults, but with the added potential hazard from electricity during periodic manual interactions with switches.

(2) Basic safety design options include all those for telecommunications or electrical distribution vaults, plus:

- A minimum clearance of 36" from all breakers, switches, and other components
- Passive ventilation of space to avoid accumulations of ozone or an oxygen-deficient atmosphere
- Providing vaults with frequent need for access with permanent, moisture-protected lighting
- Placing transformers and switch gear away from access doors or hatches

c. Steam Distribution Systems

(1) Steam distribution systems include large horizontal and vertical pipe chases (some are tunnel sized), valve access vaults, and condensate return pits.

(2) The hazards associated with these steam distribution system components include all those for telecommunications or electrical distribution vaults, plus exposure to very high levels of heat and humidity and the potential for exposure to steam leaks and possible steam explosions.

(3) Basic safety design options include all those for telecommunications or electrical distribution vaults, plus:

- Maximizing clearances from all steam pipes and other obstructions, both to provide greater distance from hot surfaces and to reduce head and face injuries.
- Ventilating the space to reduce heat and humidity loads. For vaults, the preferred method is the use of a dual-pipe or duct system to induce convective airflows. For tunnels, provide outdoor access grilles or panels at regular tunnel intervals to enhance natural airflows through individual tunnel sections.
- Ensuring that all pipes that must be stepped over in order to reach a confined area have metal guards around the insulation, and/or steps and platforms.

d. Power Plants

(1) Power plants contain a large number and wide variety of confined spaces due to their complex and interconnected operational systems. Some examples of confined spaces in the power plants include:

- Boilers
- Turbines or generators
- Liquid storage and other types of tanks
- Water and cooling towers
- Numerous pits and recessed floor or grade channel ways
- Large ventilation system components (for example, ductwork, filter houses, plenums)

(2) The hazards in specific power plant confined spaces vary by system. However, access in many power plant spaces is difficult due to elevated heights and narrow entry or exit ways, and should be designed with ease of access and safe maintenance in mind.

e. Elevator Systems

(1) Building elevator systems consist of a vertical elevator shaft, a motor or service room, and a pit at the bottom of the elevator shaft.

(2) Hazards associated with elevator systems include:

- Elevator shaft: access hazards, physical hazards from moving cables and counterweights, fall hazards.
- Motor or service room (those located in rooftop penthouses or other locations without an ordinary door entry): physical hazards from the cable winding, potentially exposed mechanical components on the motor and gear shafting, and electricity, including an accumulation of ozone in poorly ventilated rooms.
- Pit: access hazards, oxygen deficiency, falling objects, and possible drowning from engulfment in accumulated water.

(3) Basic safety design options include:

- The installation of a lockable door, rather than a hatch to both the shaft and pit
- Fall protection attachment points for shaft work
- Passive or active ventilation of the motor or service room
- Fixed permanent lighting for the motor or service room
- Machine and equipment guarding where possible on exposed moving motor and gear or winding parts

f. *Sump Pump and Sewage Ejector Pits*

(1) Although the liquid materials to be pumped vary, sump pump and sewage ejector pits share many common features. Both consist of concrete or lined pits, often with a liquid holding tank and pump (either submersible or remote). These pits are generally located below-grade in a basement area or outdoors inside a vault. Access is typically made by either a metal grating cover, solid hatch, or manhole cover. Some of these systems possess a fixed ladder.

(2) Hazards include oxygen deficiency, the potential for accumulation of toxic vapors (including those from materials discharged to domestic waste lines), falls during entry or exit, and possible drowning from engulfment in liquid.

(3) Basic safety design options include:

- The installation of remote pumps, or pumps that can be easily retrieved without requiring pit entry (also requires means for pump retrieval or attachment of retrieval means)
- The installation of permanent fixed ladders
- A means of valving-off and locking-out water or wastewater inputs into the pit during entry
- Lockable access to prevent unauthorized entry

g. HVAC Systems

(1) Many larger HVAC systems contain remote supply air plenums, larger diameter ductwork, filter and coil "houses," mechanical rooms, and related components that qualify as confined spaces. These remote areas are often elevated in height with restrictive means of access.

(2) The most common hazards of HVAC confined spaces are restricted access, vertical shafts and plenums or ducts, and mechanical and electrical energy sources.

(3) Basic safety design options include:

- Providing fall protection for elevated walkways (preferably railings)
- Guarding exposed mechanical elements (for example, belts and drive shafts)
- Installing adequately-sized drains for condensate collection pans and basins
- Providing adequate clearance around all moving parts, electrical transformers, high voltage switches, and other similarly hazardous systems
- Providing adequate access space and clearance space for repairs and movement of new or replacement equipment
- Providing fixed ladders or stairs (preferred) for air supply intake plenums and related building "moats"
- Providing filter rooms and mechanical rooms with permanent, moisture-protected lighting
- Installing true doors rather than hatches, where possible
- Lockable access to prevent unauthorized entry

h. Crawlspaces and Chases

(1) Although not generally identified as confined spaces, a variety of crawlspaces, pipe chases, ceiling plenums, and related areas require periodic entry for inspection and repair. Difficult access to these spaces, coupled with their general layout, can create significant confined space hazards.

(2) The majority of hazards associated with crawlspaces and chases pertain to restricted access, entrapment, and head and face injuries from obstructions and falls, either directly to the individuals entering these areas or indirectly by dropping tools or other objects. In certain cases (for example, some pipe chases), high-pressure steam can also be a hazard if piping is leaking or a valve is damaged.

(3) Basic safety design options include:

- Eliminating crawlspaces wherever possible. Where crawlspaces are necessary, maximize their cross-sectional area and minimize obstructions.
- Installing floor gratings in large vertical pipe chases at each entry point or grade.
- Installing permanent, fixed ladders in large building-wide pipe chases.
- Providing designated access hatches for above-ceiling MEP system components that will likely require regular service (for example, VAV mixing boxes).

i. Tanks and Vessels

(1) A wide variety of tanks and vessels are used for storage, collection, and distribution, including fuel tanks, boiler vessels, and wastewater neutralization tanks, as well as tanks used for the temporary retention of domestic water, chilled or cooling water, and those used in research applications (for example, liquid nitrogen bulk storage and the van de Graff accelerator at WNSL). The confined nature of these kinds of spaces is generally well understood by service and maintenance staff. Those tanks that are located below-ground (for example, many fuel tanks) have limited or no direct means of entry, except after partial excavation.

(2) The hazards associated with tanks and vessels include their material contents or residue, atmospheric hazards (oxygen deficiency, toxicity, flammable or explosive) and access (including falls upon entry or exit).

(3) Basic safety design options include:

- Boltable or lockable access to prevent unauthorized entry
- A means of removing the contents prior to entry
- Fixed ladder and railing access systems for elevated tanks requiring regular entry or inspection
- A means for remote assessment of contents level
- A means for valving-off and locking-out inputs into the tank or vessel during entry

j. Miscellaneous Areas

Several other areas and locations present access problems that can create confined space and related hazards, including tunnels, platforms, and some attic areas where fall hazards can exist because of inadequate or non-existent railings, the absence of a fixed ladder or stairway, or very low clearance within the space. These kinds of issues are best addressed by providing standard means of access (preferably stairs), incorporating hand and toe rail protections, and installing larger entry ways or doors instead of hatches.

3. Basic Design Guidance

a. The most effective means of reducing the hazards associated with a confined space (as well as the long-term operational and procedural requirements associated with these spaces) is to eliminate the confined space from the start. Depending upon the space, this can be accomplished by several means, including:

- incorporating the space as an element of a building,
- providing a true full-size door instead of a hatch or manhole for access, and
- installing a stair rather than a ladder.

b. Where these steps are not feasible, the following is a brief listing of good design practices that can significantly reduce the hazards associated with most confined spaces.

(1) Provide as-built drawings of all confined spaces, showing all penetrations and systems contained within them.

(2) Ensure space is sufficiently large to provide adequate clearances.

(3) Design the space to be linear in configuration, with a clear line of sight.

(4) Minimize obstructions and penetrations to provide clear and safe paths of travel.

(5) Adopt a standardized hinged and counterweighted cover in lieu of ordinary manhole covers or large grates.

(6) Ensure that access ways are sufficiently large to accommodate anticipated supplies and equipment transfers into and out of the space.

(7) Provide a means of fall protection, preferably through the use of railings and gratings.

(8) Provide a safe and easy means for collecting and removing accumulated water in below-grade vaults, using sloped flooring and small sump pits away from the ladder landing.

(9) Where possible, provide quality fixed ladders. Follow OSHA guidelines.

(10) Install moisture- or weather-protected fixed lighting in frequently-accessed spaces.

(11) Provide a means for passive or active ventilation for especially hot or humid locations and all other locations with anticipated atmospheric hazards.

(12) Provide an easily accessible means for locking or tagging out power supplies and liquid inputs to the space to prevent accidental engulfment, electrocution, or physical injury during entry.

4. Design Document Review and Approval

a. Yale University departments assigned to project reviews review all phases of the design documentation, giving special attention to safe design and the elimination of confined spaces.

b. If a confined space is unavoidable, the project manager must obtain approval of the design from the managers of the departments servicing the confined space —Yale University Facilities group and/or Telecommunications.

c. Submit the final design documentation to Yale University's Office of Environmental Health and Safety for review and approval to ensure the design of safe mechanical, support, and confined spaces.

D. Emergency Power

1. Usual Essential Plumbing System Power Requirements

a. Storm water pumping systems.

b. Sewage ejectors.

c. Laboratory waste lift station.

d. Booster water pumping systems.

2. Usual Essential Fire Protection System Power Requirements

a. Fire and jockey pumps and control panel.

b. Sprinkler system controls.

c. Smoke evacuation system.

3. Usual Essential HVAC System Power Requirements

a. Energy Management and Control System, each field cabinet (stand-alone control panel), the control air compressor and dryer, and any electric controls for systems on emergency power.

b. Laboratory hood exhaust fans and fume hood controllers.

c. Air handling supply and exhaust fans, and chilled water circulating pump and controls for servicing specialized HVAC equipment and systems.

d. Emergency power required to prevent crystallization in absorption water chillers during a power failure.

e. Central system heating equipment.

f. Ventilation equipment and controls for emergency generator rooms.

g. Refrigeration system and controls for food storage freezers.

4. Usual Essential Electrical System Power Requirements

a. Emergency lighting.

b. Fire alarm system.

c. Circuits for health care services and critical equipment support.

d. Security and emergency paging system.

e. Critical communication services.

5. System Design Considerations

a. Because of the odor take generator exhaust to the roof whenever possible.

b. Locate louvers to provide unobstructed air intake and exhaust. Size them per the manufacturer's recommendations.

c. Verify code and facility fuel requirements for an extended run time.

E. Equipment Installation

1. The contractor is responsible for notifying all sections or individuals identified by the project manager at least three days before the disruption of utilities.
2. The contractor must provide the Yale University Physical Plant Control Center with a 24-hour emergency telephone number.
3. During installation, the contractor must have personnel who are available for immediate response in case of emergency (for example, broken pipes or interrupted electricity).

F. Central Building Utilities Metering System

1. The Central Co-Generation Plant provides electricity, steam or condensate, and chilled water to the Yale University buildings. The Sterling Power Plant generates steam and chilled water for the Yale University School of Medicine and New Haven Hospital. Electricity is purchased from the local utility company, United Illuminating. The Yale University Facilities group manages the respective generation and distribution systems.
2. The objective of the Central Building Utilities Metering System (CBUMS) is to provide real-time monitoring, alarm reporting, on-line diagnostics, and report generation for billing, energy management, and engineering relevant to the utilities systems. CBUMS is an integral part of the Yale University real-time facilities network called Maxnet.
3. The CBUMS meters installed throughout the buildings communicate with their servers via serial communication and industry-standard communication drivers. The servers reside on the Campus Ethernet backbone, sharing information with other servers connected to Maxnet.
4. Engineers and managers within the Yale University Facilities group have direct access to all information residing on the Maxnet. Clients within or outside of the University can access the data available on the Maxnet by Netscape browser. Interested parties can look up the information via the internet.
5. For CBUMS utility metering connections, contact Yale University. See the Yale University website for the appropriate department.