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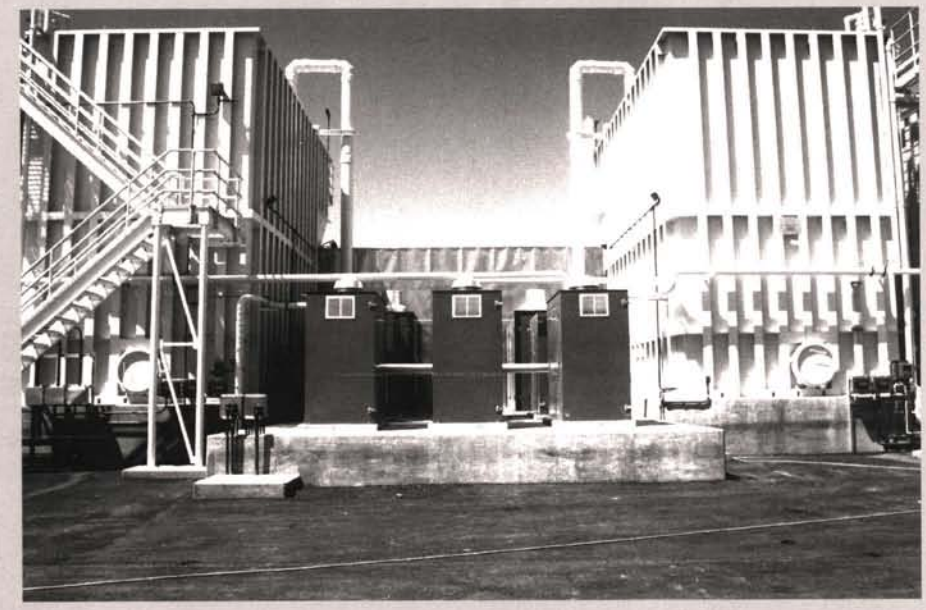
Places For People In Hazardous Environments



Technical Supplement – Functional Buildings & Control Rooms – Volume XIII

Places For People In Hazardous Environments

An industrial workplace establishes the environment within which personnel and equipment function. Properly engineered, it provides safe and productive space. Properly constructed, it segregates personnel from potentially harmful or dangerous processes and materials.

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- Functional Buildings
- Control Rooms
- Equipment/Enclosures

Safe, comfortable, and efficient work areas can often be furnished within a classified or otherwise hazardous site. Properly engineered, functional building structures can accommodate most exterior or interior site conditions without the need to significantly alter production or process methods.

Control rooms can be situated near the process being monitored. Quality assurance laboratories and administrative personnel can be located convenient to the manufacturing operation.

Functional building interiors can be designed to withstand industrial use, yet provide a comfortable and attractive workplace.

Personnel and equipment within the control rooms are isolated from high temperatures, dirt and noise. The building is self-contained, complete with emergency power systems, housing the computerized operating system at this automated cement batch plant.

Personnel and Equipment In Harsh Environments

Functional buildings are readily matched to a variety of challenging site conditions. Engineered to be application specific, they are often factory fabricated and shipped disassembled for quick installation. These provide cost effective tools to resolve challenging work conditions:

Consistent product quality and production efficiency is improved by controlling the work environment. Monitoring process operations become more effective when personnel are in close proximity to the production equipment.

Protecting personnel and equipment from excessive noise, vibration, temperature extremes and airborne dust is an often necessary prerequisite in establishing a suitable work environment. Additionally, providing a uniform and precisely controlled climate for critical processes or equipment reduces failure and shortens maintenance cycles.

Occupied Space In Hazardous Areas

Planning new facilities within or adjacent to hazardous occupancies demands special care and attention to the design of occupied space. Areas where highly flammable materials are stored, used, or processed and areas in which highly combustible manufacturing is done are *classified* according to the building codes. Area classification is the delineation of space that poses a potential hazard.

Special regulations apply to this category including the requirement for non-combustible flooring, liquid-tight construction, spill control, secondary containment, fire resistant walls and roofs, as well as limitations in height and floor area.

Occupancy separation is mandated segregating these classified areas from adjacent uses. Classified area locations within buildings and within property sites are often limited.

Those environments which contain explosive, poisonous or otherwise harmful liquids, vapor or flammable particulate are classified as **H-Occupancies**. The engineering and construction of these classified areas initiate the implementation of materials and erection methods which are prescriptive and closely regulated by the building codes.

Other adverse conditions such as high noise levels, high temperatures, objectionable concentrations of dust and odors, or corrosive environments may also require protection. In contrast to area classification, under some circumstances, worker safety can be improved with alternative technology as well as administrative controls and work procedures. Regulation may be by agencies as OSHA, by insurance carrier requirements, or mandated by a company's own personnel policies and production requirements.

Understanding Building Codes

Functional building design and construction is regulated by a variety of standards and model building codes. These establish an acceptable construction and operating procedure for specific H-Occupancy classified areas. These are formally adopted by the local building authorities and become an important part of the building department requirements.

Two of the most common fire and life safety codes which address safe methods of construction are the Uniform Building Code (UBC) and the Uniform Fire Code (UFC):

The Uniform Building Code defines hazardous environments as Group H-Occupancies. These classified areas are characterized by an unusually high degree of explosion, fire or health hazard. The specific hazardous occupancy is based (1) on the particular operation conducted within the area or, (2) on the types and quantities of hazardous materials present.

Group H-Occupancies are further categorized by Division. Divisions 4, 5, and 6 define the hazard in terms of the process and/or quantity of material present. Divisions 1, 2, 3, and 7 define the hazard in terms of the type of materials contained within the structure.

SUMMARY: UBC Group H-Occupancies

Division 1	High explosion hazard materials
Division 2	Moderate explosion and accelerated burning hazard
Division 3	Highly combustible solids/liquids and water reactive materials
Division 4	Vehicle repair
Division 5	Aircraft hangers
Division 6	Semiconductors and hazardous production materials (HPM)
Division 7	Health hazardous materials e.g. toxic, irritants, corrosives

The Uniform Fire Code is a companion to the UBC. It specifically addresses the minimum acceptable standards for fire prevention and protections, material handling and storage, manufacturing and processing equipment specifications, ventilation, and fire safety procedures within the buildings such as egress.

Because of the broad spectrum of hazardous materials and varying site conditions, other codes and regulations may frequently apply to any given situation:

The NFPA has a complete series of codes covering all aspects of fire hazards. Information on area classification is contained in several:

NFPA 70 —	The National Electrical Code (NEC)
NFPA 497A —	Classification of Class I Hazardous Locations for Electrical Installation in Chemical Process Plants
NFPA 497B —	Classification of Class II Hazardous Locations for Electrical Installation in Chemical Process Areas
NFPA 497M —	Classification of Gases, Vapors and Dusts for Electrical Equipment in Hazardous Locations
NFPA 30 —	Flammable and Combustible Liquids Code

API publishes a series of codes addressing the petrochemical industries which include:

RP-500	— Recommended practices for Classification of Locations for Electrical Installations at Petroleum Facilities
RP-2003	— Protection Against Ignitions Arising Out of Static Lightning and Stray Currents

OSHA prescribes compulsory employee safety practices, manufacturers are required to provide Material Safety Data Sheets (MSDS) in the routine course of business, insurance carriers regulate potentially unsafe practices as part of their risk reduction programs and the National Fire Protection Agency publishes many related code book which impact the design and use of functional buildings and control rooms.

Fire Safety

The National Fire Protection Agency is a non-profit national organization. It publishes hundreds of nationally recognized standards and recommended practices each specifically directed towards protecting lives and property by reducing the potential hazards due to fire. Two of the most often referenced standards for the design of occupied buildings in hazardous environments are the National Electrical Code (NEC) and NFPA 496: Purged and Pressurized Enclosures for Electrical Equipment.

The NEC designates hazardous locations as areas where high fire or explosion hazards may exist due to gases, vapors, flammable liquids, or combustible particulate. The locations are further defined by *Class*, *Division*, and *Group*.

NEC Hazardous Location Classes	
Class 1 locations	Flammable gases or vapors
Class 2 locations	Combustible dust
Class 3 locations	Ignitable fibers or flying

Each class has two divisions:

Division 1 defines a danger which is present at all items. *Division* 2 defines a danger which is not present in the normal course of operations but may arise from a reasonably foreseeable event.

Each division is further classified by *group* which further describes the hazard in terms or particular material characteristics and methods for reducing potential hazards.

Determining Area Classification

1. Define the process from raw materials through finished product.
2. Determine quantities, pressures, and temperatures during each of the production stages.
3. Investigate potential source of leaks of combustible or detonable materials.
4. Specify the area at each potential leak which is potentially hazardous.
5. Specify the locations of potential process leaks and determine their impact on areas adjacent to the process area.
6. Note any special circumstances: For instance, the material's behavioral characteristics of the hazardous material (e.g. vapors lighter or heavier than air, liquid, particulate, etc.) or alternative processes or materials available which might reduce the hazard potential.

NEC Requirements

The National Electrical Code (NEC) requires special electrical services in all classified hazardous locations. Often referred to as *explosion-proof* or *dust-proof*, the specifics or hazardous electrical design are outlined in Article 500 of the code.

NEC electrical requirements in a hazardous environment generally include:

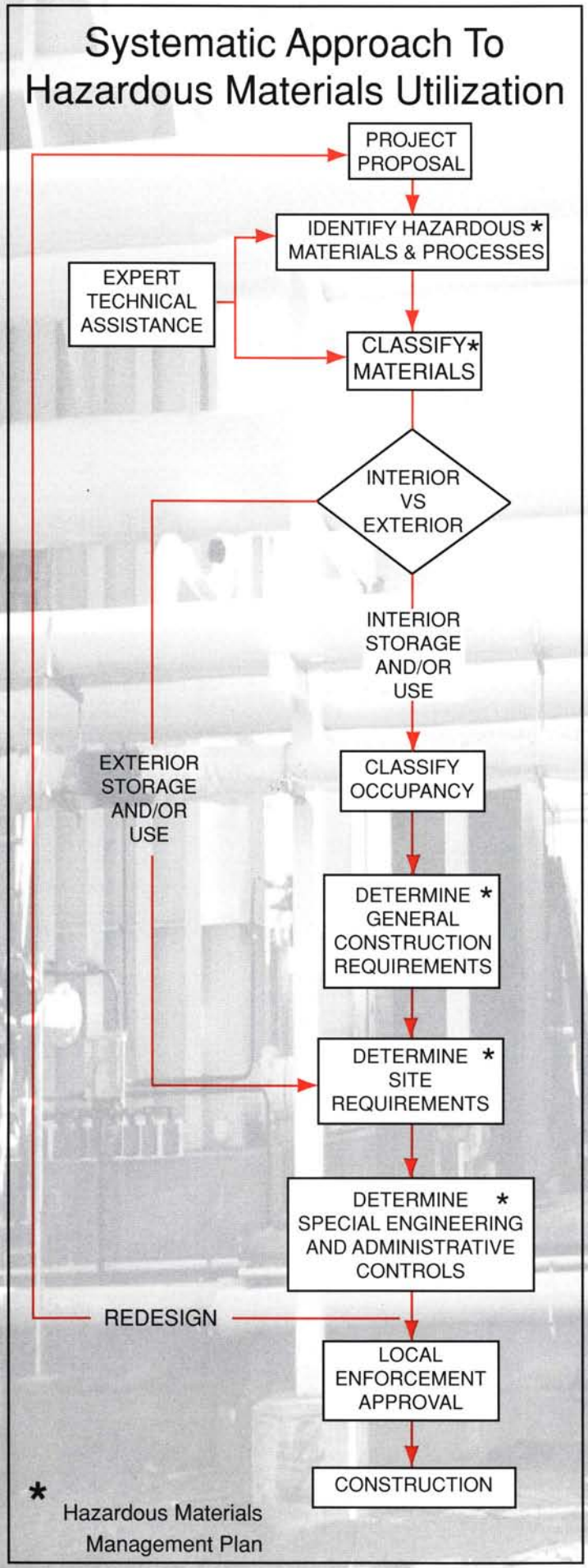
- Rigid conduit
- Exceptional grounding continuity
- Explosion/dust proof fittings, devices, fixtures, and motors

Electrical materials and components rated for use in classified areas, although effective, can be expensive and difficult to install, access, or modify.

For instance, instrumentation and control systems may contain arcing devices. Heater elements can become a source of ignition. Telephone systems, radios, and cellular phones used in classified area must be listed. Very few communication radios are listed for use in Group A (acetylene) or Group B (hydrogen) applications; pressing the transmit button in the presence of a leak could set off an explosion.

Codes require two seals to prevent process liquids or vapors from traveling through conduit systems. Some electrical devices have dual seals while others require the use of the conduit seals.

Vehicles are typically not acceptable and common tools such as welding torches, electrical drill motors, and concrete chipping tools cannot not be used until the area has been rendered non-hazardous.



NFPA Purging Of Enclosures

It is often advantageous to *purge* a hazardous enclosed space. The purging may reduce or eliminate health risk and enable the reclassification of the area to a new, less critical, and less demanding NEC designation.

Purging is the process of supplying an enclosure with a clean non-contaminated air supply. This air supply must be maintained at a sufficient flow and positive pressure necessary to reduce and maintain an acceptable safe level of a dangerous gas, vapor or particulate concentration.

Purging for electrical purposes is defined in NFPA 496. The three primary classifications are:

Type X purging reduces the NEC classification within an enclosure from Division 1 to non-classified or non-hazardous.
Type Y purging reduces the NEC classification within an enclosure from Division 1 to Division 2.
Type Z purging reduces the NEC classification within an enclosure from Division 2 to non-classified or non-hazardous.

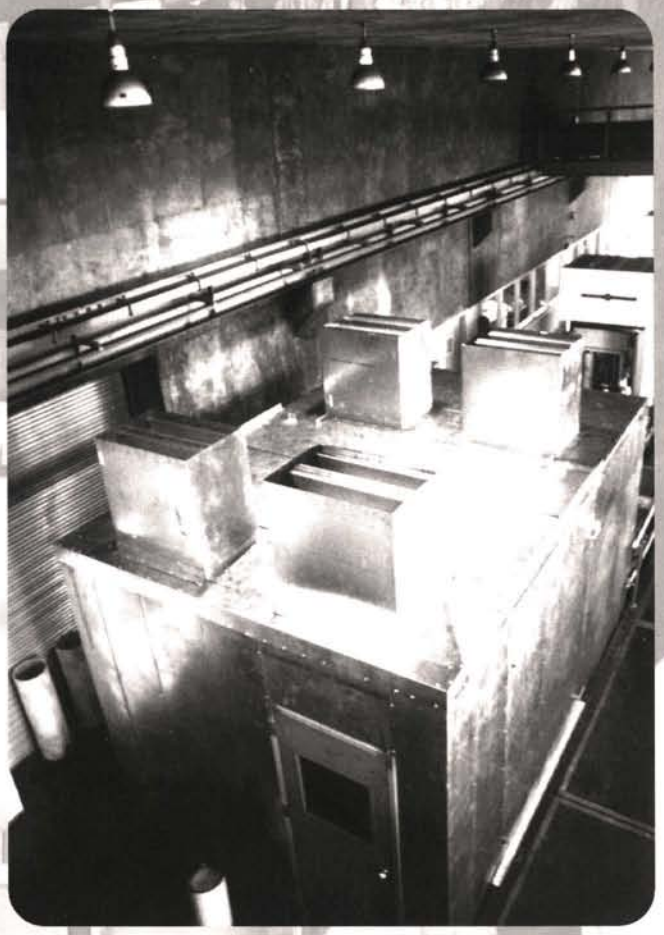
Properly purging a room or enclosure consists of providing supply air either properly filtered or from a remote non-classified area. The airflow pressurizes the sealed building and provides the necessary air changes through pressure relief dampers or protected openings. Airflow through the openings, including doors, must be designed to provide the Code required face velocity. The blower providing the supply air must be protected from power outage by an uninterruptable power supply, either on standby or an emergency power source.

Room over-pressure is monitored by a Magnehelic gauge linked to an alarm system which will be triggered upon a sustained under-pressure condition.

Typical examples of the effective use of Type Z purging is within PLC (programmed logic control) or computerized control rooms in chemical processing plants. Control rooms are usually initially classified as Class 1, Division 2. It is impractical to install explosion-proof computer equipment, however. Also, it would be a disadvantage economically to install Class 1, Division 2 electrical services throughout the interior of the new control room.

Properly purging the control room enables the use of standard wiring methods. Instrumentation, controls and standard plant and office equipment can be safely used. Further, the potential health hazard to the occupants which might be imposed by continuous low levels or accidental high concentrations of air-borne contaminants is reduced.

Functional Building Engineering And Construction



Safety from fire hazards are reflected in the material and egress regulations listed within the building codes. While each application is unique in terms of building or room performance, the following will directly impact all projects:

The materials of construction in a hazardous location must be non-combustible. Additionally, fire rated area separation walls may be needed to establish a new occupancy within an existing building or site. Doors as well as windows must have a fire rating compatible with the wall construction specified.

Most control rooms must typically provide two approved methods of egress.

Ventilation systems including ductwork must conform to the standards established for both the occupancy within and outside the new structure. Wall penetrations may, for example, have to be fire rated. Equipment sizes are critical due to the relatively large volumes of air necessary in an over-pressure system which, in turn, must be filtered, balanced, and conditioned.

Control rooms may need to be elevated within environments containing "heavier than air" gases or vapors. This can often be easily accomplished and at the same time enhance visibility of operations and access to process equipment.

Functional Building Layout Checklist

Defined during the preliminary engineering phase, the building or enclosure system must:

- Provide protections from **dust and noise** infiltration establishing a clean, quiet efficient work place.
- Place **windows and doors** strategically to permit quick access and visibility to critical areas and allow rapid exit during emergency situations.
- Include ample **electrical power**, power distribution systems, communication and remote surveillance devices. Consideration should include necessary dedicated circuits, special voltages and devices.
- Locate **controls and monitors** as necessary for their efficient use.
- Supply **conditioned air** which will reliably maintain necessary temperatures and humidity.
- **Comply** with local building and safety codes.

Functional Building & Control Rooms

Cost Effective

Functional buildings are a valuable engineering tool to accommodate a hazardous environment while locating controls and personnel where they can be most productive. Clearly, implementing this tool successfully requires information and guidance beyond that provided in this short supplement. It is important to seek qualified engineering assistance to completely define the scope of work during the planning stages. This effort will be quickly recovered by avoiding unnecessary delays and assuring a timely and satisfactory completion.