Ethanol Fixed Facilities: Assessment and Guide

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ASSOCIATION

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The safety statements, procedures, and guidelines contained in this guide are current as of the publication date. Prior to using the safety statements, procedures, and guidelines contained in the guide, it is advised that you confirm the currency of these statements, procedures, and guidelines with the appropriate controlling authorities.

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Ethanol Fixed Facilities: Assessment and Guide

Introduction

The International Association of Fire Chiefs (IAFC) have developed this guide for emergency response professionals likely to be called out in response to an ethanol emergency at an ethanol manufacturing facility. It is also for the operators and designers of these facilities to assist them in considering their preparedness for potential emergencies relating to this product.

The reason this guide is necessary is that the hazards associated with polar solvents such as ethanol are different from the more familiar hydrocarbon fuels and, as such, additional education is likely to prove beneficial.

Ethanol production in the United States has grown to 9 billion gallons and is projected to grow to 15 billion gallons by the year 2015 as a result of the Federal Government's Renewable Fuel Standard. Production facilities have been established in more than twenty-four states to meet these demands. Transportation of this product is currently by rail and highway. Pipeline transportation is currently being studied, but is not in existence at this time.

This massive growth has brought significant changes to the U.S. fire service. This alternative fuel comes with some challenges for the fire service. You may have a production facility, storage and blending terminal, or a transportation corridor in your jurisdiction. This guide has been developed to assist you in understanding the issues and challenges of preparing and responding to a fixed facility or transportation incident involving ethanol.

Developing a strong relationship with key players is critical for a safe and competent response to the facility. These key players will provide important information to sharpen your competencies in crafting effective emergency preplans and operations at emergencies. By having meetings early in the construction stage of a facility or maintaining discussions with established ones, the role of both your department and facility in planning, expectations, capabilities, and emergency response will provide the most beneficial assistance as you complete this assessment.

Establishing a Strong Relationship With the Facility

You bring experience and training in emergency response, but most responders do not get the same experience in dealing with chemical process facilities with these unique hazards. The facility will often have employees such as environmental employees, safety and health employees, engineers, plant electricians, and maintenance employees that may bring a considerable amount of knowledge of the facility, containers and equipment, its

processes, and hazardous materials used and produced in the facility. Do not hesitate to reach out to the staff at your local facilities for assistance.

Request that the facility supply an adequate amount of fire fighting foam (Aqueous Film Forming Foam-Alcohol Type Concentrate [AFFF-ATC]) to your fire department for use at their facilities or for transportation containers that are involved with incidents on or off the plant property that involve their production or waste products. History and experience has shown that emergency incidents can and will occur on site or with cargo trucks and tank cars leaving the property. This foam concentrate can be stored at the plant or at your fire station(s) for your use to assist them.

Ethanol 101: Types of Ethanol Manufacturing Plants

The production of ethanol or ethyl alcohol from starch or sugar-based feed stocks is among human's earliest ventures into value-added processing. While the basic steps remain the same, the techniques have been considerably refined in recent years, leading to a very efficient process. There are two production processes: wet milling and dry milling. The main difference between the two is in the initial treatment of the grain.

In dry milling, the entire corn kernel or other starchy grain is first ground into flour, referred to in the industry as "meal," and processed without separating out the various component parts of the grain. The meal is slurried with water to form a "mash." Enzymes are added to the mash to convert the starch to dextrose, a simple sugar. Ammonia is added for pH control and as a nutrient to the yeast.

The mash is processed in a high-temperature cooker to reduce bacteria levels ahead of fermentation. The mash is cooled and transferred to fermenters where yeast is added and the conversion of sugar to ethanol and carbon dioxide (CO_2) begins.

The fermentation process generally takes about 40–50 hours. During this part of the process, the mash is agitated and kept cool to facilitate the activity of the yeast. After fermentation, the resulting "beer" is transferred to distillation columns where the ethanol is separated from the remaining "stillage." The ethanol is concentrated to 190 proof using conventional distillation and then is dehydrated to approximately 200 proof in a molecular sieve system.

The anhydrous ethanol (ethanol with less than 1 percent of water) is then blended with about 2.5–5 percent denaturant (such as natural gasoline [there are a number of flammable or combustible liquids that could be used, gasoline is the most common]) to render it undrinkable and thus not subject to beverage alcohol tax. It is then ready for shipment to gasoline terminals or retailers.

The stillage is sent through a centrifuge that separates the coarse grain from the solubles. The solubles are then concentrated to about 30 percent solids by evaporation, resulting in Condensed Distillers Solubles (CDS) or "syrup." The coarse grain and the syrup are then dried together to produce Dried Distillers Grains with Solubles (DDGS), a high quality, nutritious livestock feed. The CO_2 released during fermentation is captured and sold for use in carbonating soft drinks and beverages and manufacturing dry ice (see Figure 1).

Note: Emergency responders need to know the hazards of CO_2, CO_2 cargo trucks, and rail tank cars, since they may respond to incidents involving them.

Figure 1: Ethanol Production—Dry Mill Process 2

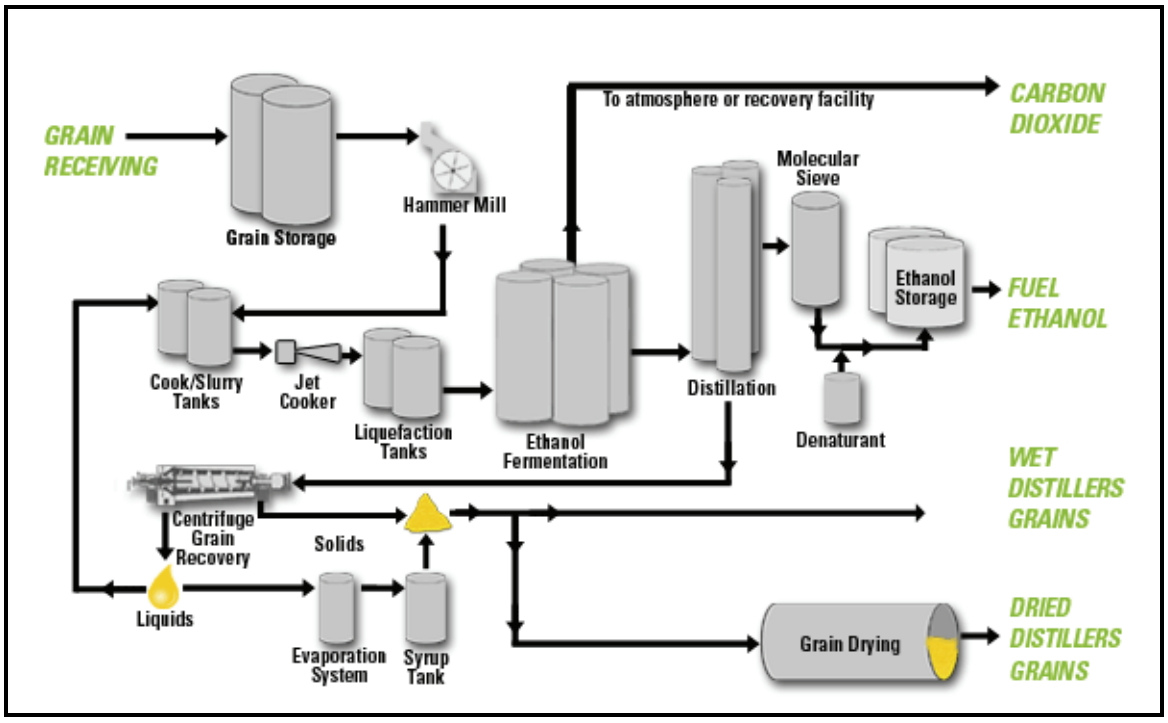
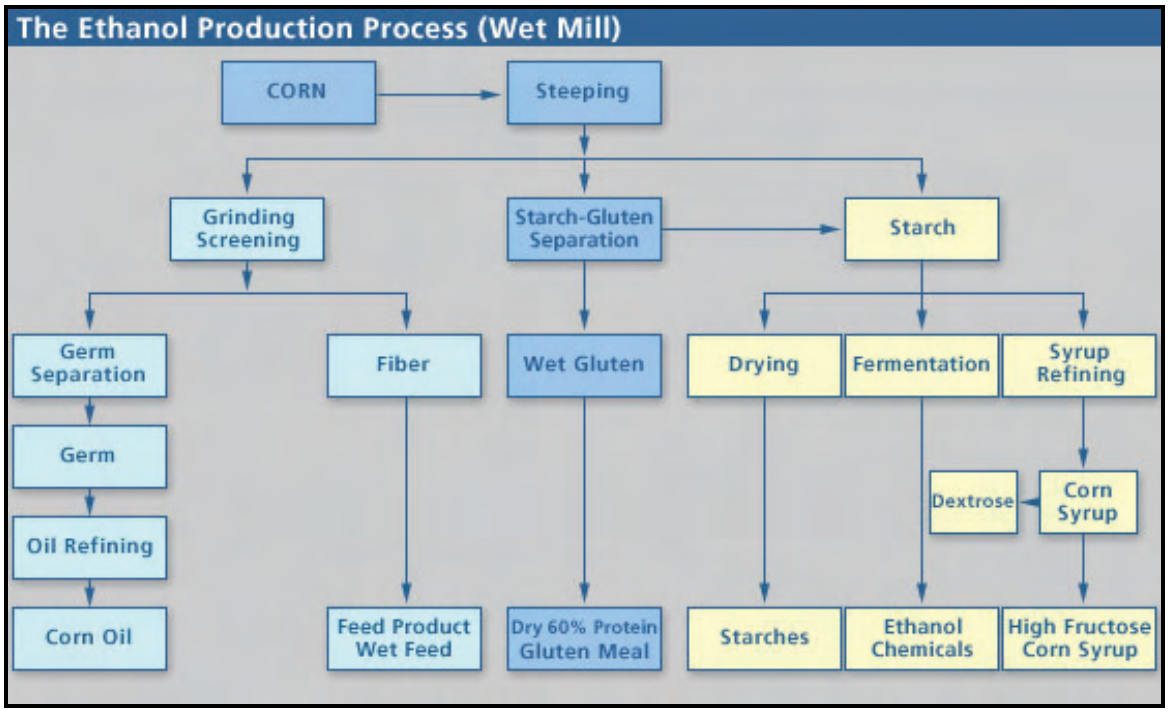


Figure 2: Ethanol Production Process—Wet Milling



In wet milling (see Figure 2), the grain is soaked or “steeped” in water and dilute sulfurous acid for 24–48 hours. This steeping facilitates the separation of the grain into its many component parts.

After steeping, the corn slurry is processed through a series of grinders to separate the corn germ. The corn oil from the germ is either extracted on-site or sold to crushers who extract the corn oil. The remaining fiber, gluten, and starch components are further segregated using centrifugal, screen, and hydroclonic separators.

The steeping liquor is concentrated in an evaporator. This concentrated product, heavy steep water, is co-dried with the fiber component and is then sold as corn gluten feed to the livestock industry. Heavy steep water is also sold by itself as a feed ingredient and is used as a component in Ice Ban®, an environmentally friendly alternative to salt for removing ice from roads.

The gluten component (protein) is filtered and dried to produce the corn gluten meal coproduct. This product is highly sought after as a feed ingredient in poultry broiler operations.

The starch and any remaining water from the mash can then be processed in one of three ways:

- fermented into ethanol,
- dried and sold as dried or modified corn starch, or
- processed into corn syrup.

The fermentation process for ethanol is very similar to the dry mill process described previously.

Common Plant Layout: Associated Hazards Common to Each Area

Although there are many bio refinery design and construction styles, all facilities share these common areas. Each area will have unique hazards. These hazards will be outlined for your consideration as you assess your jurisdiction's abilities.

- Administration building:
    - Common construction will be lightweight wood frame construction with a truss roof. If this building has a basement the floors will likely contain trusses. This building may have an alarm and/or a sprinkler system.
    - Occupancy is administrative and office support employees. The building is commonly occupied Monday through Friday during normal office hours.
    - The Administration building is the primary location of Material Safety Data Sheet (MSDS) information.
- Grains/Feed stock:
    - This area will be the receiving area for the feed stock such as grain.
    - This area will contain silos and grain bins for storage.
    - It may also likely contain basements/tunnels for moving feed stock in conveyors and grain legs.
    - Typical employee occupancy will be two to five employees.

- Hazards of this area will include:
    - engulfment in grain bin and flat storage areas (confined space hazards),
    - grain dust,
    - entanglement in augers and conveyors, and
    - moving rail cars.
- The grains area is likely to be rated Hazard Class II for electrical equipment due to the combustible dust hazard potential.

- Process building (evaporation, distillation, and dryers):
    - This is the area of the facility where the process of fermentation, evaporation, distillation, and drying of remaining solids will occur. Some facilities may have all of these areas under one large building; others may have these process areas in separate buildings and some processes such as the fermenters and distillation could be located outside of the process building.
    - The construction of these buildings would be classified as Type II Fire Resistive.
    - Some areas may be five to ten stories in height.
    - Occupancy by employees will occur 24 hours each day. The number of employees, contractors, and visitors will generally be much greater Monday through Friday 7 a.m. to 7 p.m.
    - Some facilities will have these buildings fully protected by automatic and deluge sprinkler systems capable of delivering approximately 2,500 gallons per minute (gpm). The fire protection system will likely have a building that houses the fire pump and backup generator for power failure. The fire pump may be a diesel fire pump instead of electric; in that case there may be no generator.
    - The process area may have standpipe systems located throughout.
    - The sprinkler system and standpipe system may have foam delivery capability.
    - The process building will contain numerous hazardous materials, some in large quantities. Common hazardous materials found in this area will be ethanol and corrosives such as sulfuric acid (H_2SO_4) and sodium hydroxide (NaOH). Anhydrous ammonia may enter this area via pipe from a storage tank located outside.
    - It is critical that you identify what hazardous materials, storage container types, and quantities are located at the facility in your jurisdiction. This information will be used in your assessment and preplans for a release.

- The fermentation process produces large amounts of CO_2 that can displace oxygen.
- Physical hazards may include high-temperature liquids and steam, electrical, heights, mechanical, and permit-required confined spaces.
- Non-sparking and intrinsically safe equipment is required.
- The dryer area may be an area you are called to respond to for a fire in the dryer system. Organic materials build up in the duct work of the dryers and are a common source of fires at facilities. Advice on tactics from facility representatives is important here. These systems commonly operate at low oxygen levels and opening doors in the duct work may likely intensify a smoldering fire.
- The dryer system will likely have a steam and water extinguishing system built into the dryers and associated duct work. These items will be an important piece of your preplan.

- Motor Control Center (MCC) rooms:
  - The MCC is the location of the main electrical control for process functions such as mixer, pump, and conveyor motors in a facility. A typical facility will have two to four MCC rooms. The MCC room is not meant for continuous employee occupancy (confined space).
  - The MCC rooms will contain several banks of high voltage 480 volt (V) buckets.
  - Hazards of the MCC rooms would be typical hazards of high voltage, including electrical shock and arc flash potentials.
  - It is common to have high voltage transformers (600 V) adjacent to or in the MCC rooms.
  - The MCC room is the location for the application of locks in the event of controlling energy in a lock out/tag out situation.
  - MCC rooms may have halon, CO_2, or alternative fire extinguishing systems.
- Tank farm/bulk storage:
  - The tank farm area of a typical facility will contain six tanks that range in capacity of approximately 500 gallons to 1 million gallons. The fire department must become familiar with types of storage tanks, products involved, capacity of storage tanks, and any spill or fire protection systems. The tank farm area is rated Hazard Class I. Use of intrinsically safe equipment in this area is required.
  - It is common to have the following tank contents and capacities:
    - Ethanol (Ethyl Alcohol) United Nations' (UN) 1170: Capacity 175,000 gallons

        - Denatured Ethanol (95%) UN 1987: Capacity 1 million gallons
        - Gasoline (Denaturant) UN 1203: Capacity 60,000 gallons
        - Corrosion Inhibitor UN 1993: Capacity 500 gallons
    - The tank farm will be surrounded by containment berms sufficient to contain 110 percent of the largest tank within the area.
    - Piping may have fusible links to isolate the piping in the event of a fire.
    - The tank farm may have fixed protection foam application piping into the tanks for the delivery of foam in the event of a fire.
    - The tank farm may have semi-fixed protection devices in the form of monitor nozzles with foam eductor tubes applied to fire hydrants located around the tank farm for the application of foam.
    - The tank farm may have detection and monitoring systems.
- Ethanol load out (rail and highway):
    - Ethanol load out is the area where rail tank cars and highway cargo tanks are loaded with denatured ethanol for shipment.
    - This area is also the area for delivery of denaturant (usually gasoline).
    - Hazards in the load out area would include a flammable atmosphere.
    - This area is classified Hazard Class I. Use of intrinsically safe equipment and tools is required in these areas.
    - Static electricity control includes grounding and bonding procedures.
    - The area may have both automatic fire detection and fire suppression systems. The fire suppression system should have the capability to deliver fire fighting foam.
    - What types of cargo trucks use this facility and what are their capacities and inherent hazards?

Assessment of the Facility's Emergency Response Capabilities

Having a clear understanding of what the facility's expectations of local emergency responders is critical. In most cases the facility will rely on local emergency responders for fire, medical, rescue, and hazardous materials emergency response. Just as important is your understanding of what specific roles and duties the facility's employees may have during an emergency. Also, if your department does not provide services such as confined space rescue or hazardous materials technician-level response, this will need to be communicated to the facility management.

Mutual aid/regional response agreements may help in filling gaps or the facility may need to contact a private provider of these technical services.

As part of your preplan you must have knowledge of the facility's Emergency Action Plan (EAP). This will be of great assistance during an actual response. It will aid in quickly establishing a unified command and may provide accurate information on the nature of the incident and accountability of employees. In the following section you will find information and a checklist on EAPs, alarm systems, and the facility's role during an emergency response.

The most important aspect of hazardous materials response at a facility is planning for emergencies through the development of an Emergency Response Plan (ERP) or an EAP. For example

- Hazardous materials response equipment:
    - What appropriate equipment does the facility have on site for use in the event of a release of hazardous materials?
    - Is the equipment available for use? Equipment that may be of use during an emergency release would be containment, neutralization, and product transfer.

In addition, the community of emergency response organizations, together with the ethanol industry, has provided information and assistance to many local fire departments with facilities in their jurisdiction.

Emergency Action Plan (EAP) and Alarm System Checklist

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- **Review of the Facility EAP**

  An EAP is a written document required by Occupational Safety and Health Administration (OSHA) standards. The purpose of an EAP is to facilitate and organize employer and employee actions during workplace emergencies. Well-developed emergency plans and proper employee training (such that employees understand their roles and responsibilities within the plan) will result in fewer and less severe employee injuries and less structural damage to the facility during emergencies. A poorly prepared plan will lead to a disorganized evacuation or emergency response and result in confusion, injury, and property damage.

- **Alarm System/Evacuation**

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  The employee alarm system will provide warning for necessary emergency action or reaction time for safe escape from either the employees' workplace or immediate work area as provided in the EAP. An employee alarm system can be any piece of equipment and/or device designed to inform employees that an emergency exists or to signal the presence of a hazard requiring urgent attention. National Fire Protection Association (NFPA) 72, *National Fire Alarm Code*, requires a fire alarm signal to be distinctive in sound from other signals and states that it cannot be used for any other purpose.

  The two most common types of alarms are audible and visual devices.

  It is important to determine the following:

  - conditions under which an evacuation would be necessary;
  - conditions under which it may be better to shelter-in-place;
  - a clear chain of command and designation of the person authorized to order an evacuation or shutdown;
  - specific evacuation procedures, including routes and exits;
  - procedures for assisting visitors and employees to evacuate;
  - designation of which, if any, employees will remain after the evacuation alarm to shut down critical operations or perform other duties before evacuating;
  - a means of accounting for employees after an evacuation; and
  - special equipment for employees.

Safety Checklist

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- **Safety design built into facilities:** Ethanol manufacturing facilities have many safety designs and features built into the plant. Your local jurisdiction and/or state may have specific codes and regulations for hazardous materials, fire, and life safety. Facilities are typically engineered and designed to follow nationally recognized codes and standards as well as insurance carrier requirements even if the jurisdiction does not have adopted codes or standards. The following is a list of some of the common features built into many facilities. You should become aware of the specific systems in the facility in your jurisdiction, including:
    - **Sprinkler system**
    - **Standpipe system**
    - **Hydrant system**
    - **Water supply system**
    - **Backup generators for power failure**
    - **Dryer fire extinguishing system**
    - **Alarm system**
    - **Containment systems**
    - **Container relief devices**
    - **Emergency showers**
    - **Foam system(s) and foam concentrate supplies**
    - **Static electricity control (grounding and bonding)**
    - **Material Safety Data Sheet (MSDS) locations**

Facility Fire Brigade Checklist

☐ • **Fire Fighting: Fire Brigade**

A fire or explosion is the most common type of emergency for which the facility must plan. A critical decision when preplanning is whether or not the facility has an organized fire brigade. Determining the response capability of the brigade is a vital key to preplanning, especially since the capabilities for fire brigades can range from fully trained firefighters with a high level of response capabilities to brigades consisting of only employees trained to use nothing more than a fire extinguisher.

☐ • **Assessment of the facility's response capabilities: Define their role at the facility and at an off-site transportation incident:**

- **Number of personnel required for a response:**
  - **Fire**
  - **Hazardous materials**
  - **Technical rescue**
  - **Emergency medical**
- **Training of personnel:**
  - **National Incident Management System (NIMS) Incident Command System (ICS) 700, 100, 200, 300, and 400**
  - **Hazardous Materials Response: 472 compliant operations and/or technician**
  - **Class B fire behavior, fighting tactics, application, and equipment**
  - **Technical rescue: confined space, bin rescue, and rope rescue (high angle)**
  - **Control of hazardous energy Lock Out/Tag Out (LOTO)**
- **Relationships/Mutual aid/automatic aid agreements:**
  - **Fire and rescue**
  - **Hazardous materials**
  - **Technical rescue**
  - **Law enforcement**
  - **Emergency management**
  - **Public works**

        - **Utilities: electrical, gas, and water**
        - **Non-governmental agencies: rail**
    - **Standard Operating Procedures (SOP) for a facility response:**
        - **Implement specific and comprehensive SOPs for a response to the facility and transportation incidents by rail and highway.**
        - **Implement specific and comprehensive SOPs to maintain responder safety for hazardous materials fire, emergency medical and technical rescue response.**
        - **Implement specific and comprehensive SOPs for interacting and establishing a unified command with facility personnel, other public safety, and non-governmental agencies.**
        - **Utilize NIMS/ICS.**
        - **Incorporate the firefighter accountability system. The system should be able to track the location and function of personnel at a large facility including multi-stories and levels and potentially covers a large geographical area.**
    - **Communication plan:**
        - **Ability to communicate with agencies, the facility, and government officials**
        - **Intrinsically safe equipment**
    - **Equipment:** Any special equipment will be dependent on what your jurisdiction mission will be for responses at the facility. Whether your jurisdiction will be providing technical rescue or hazardous materials response and at what level (operations/technician) will drive your need for some of the equipment listed:
        - **Personal Protective Equipment (PPE): chemical resistant, technical rescue**
        - **Alcohol-resistant foam**
        - **Foam application equipment**
        - **Air monitoring equipment**
        - **Intrinsically safe radios Hazard Class I/Division I**
        - **Product control materials**

- **Decontamination**
- **Technical rescue**

☐ • **Hazardous Materials Release: Level of Hazardous Waste Operations and Emergency Response (HAZWOPER) Training? Awareness (Incidental Release), Operations, or Technician:**

- **What is the facility's level of response capabilities? If using contractors, what is the contractor's level of response capabilities?**
- **Does the facility have a private contractor on retainer?**
- **What equipment does the facility have available? If using contractors, what equipment does the contractor have available? What are the levels of response time?**
- **Does the facility have alcohol-resistant foam and equipment on site?**
- **Confined space rescue: What service will provide OSHA required confined space rescue service at the facility?**
- **What service will provide other technical rescue such as grain bin and high angle?**
- **Does the facility have Emergency Medical Services (EMS), Cardiopulmonary Resuscitation (CPR)/first aid, and an Automated External Defibrillator (AED) on site?**

☐ • **Preplanning for the facility:** A risk-based response planned on facts and science and potential circumstances gathered through preplanning with facility personnel:

- **Fire/Explosion**
- **Hazardous materials release on site in the processing area or load out area into a truck or tank car:** Incidents may occur just off the site property involving trucks and tank cars also.
- **Medical**
- **Confined space**
- **Severe weather (tornado, extreme winds, rain, lightning, etc.):** Severe weather can "hit' a plant and do damage causing an emergency response.
- **Establishing unified command with a unified ICS with the facility personnel**
- **Locations of Material Safety Data Sheet (MSDS) information**

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- **Table-top and full-scale exercises:** As earlier mentioned, we may have many years of experience and training to guide us during emergency responses, but these facilities bring many challenging hazards that we have not experienced. Conducting table-top and full-scale exercises at the facility in your jurisdiction can bridge this gap.

  These exercises will develop decision making skills and identify areas of opportunity in your SOPs, training, and equipment. They will also assist the facility in the evaluation of their EAP and preparedness for an emergency at their facility.

  It is recommended that fire brigade and facility representatives develop exercises based on incidents that are likely to happen at this type of facility. Dryer fires, corrosive spills with a contaminated employee, a confined space rescue, or an ethanol release and fire are all examples of realistic incidents.

Fire Department Checklist

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- **Assessment of the facility's response capabilities: Define their role at the facility and at an off-site transportation incident:**
  - **Number of personnel required for a response:**
    - **Fire**
    - **Hazardous materials**
    - **Technical rescue**
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Glossary and Acronyms

Denatured Ethanol: Denatured alcohol is ethanol to which poisonous and foul-tasting chemicals have been added to make it unfit for drinking. There is more than one recipe for denaturing alcohol; some add methanol or isopropanol, some gasoline, and so on.

Ethyl Alcohol: This can also be called **ethanol, grain alcohol**, or **alcohol.** A member of a class of organic compounds that are given the general name **alcohols**; its molecular formula is C_2H_5OH. Ethyl alcohol is an important industrial chemical; it is used as a solvent, in the synthesis of other organic chemicals, and as an additive to automotive gasoline (forming a mixture known as an **ethanol**).

E85: E85 is an alcohol fuel mixture that typically contains a mixture of up to 85 percent denatured fuel ethanol and gasoline or other hydrocarbon by volume.

DDGS: Dried Distillers Grain with Solubles is the remainder of the corn kernel after the starch is removed during the process of making ethanol. The wet feed product is dried using large drum driers. DDGS moisture averages 9 percent to ensure flowability.

Hazard Class I Location: According to the National Electrical Code (NEC), there are three types of hazardous locations. The first type of hazard is one which is created by the presence of *flammable gases or vapors* in the air, such as natural gas or gasoline vapor. When these materials are found in the atmosphere, a potential for explosion exists, which could be ignited if an electrical or other source of ignition is present. The NEC writers have referred to this first type of hazard as *Class I*. So, a *Class I Hazardous Location* is one in which *flammable gases or vapors* may be present in the air in sufficient quantities to be explosive or ignitable. Some typical Class I locations are:

- petroleum refineries and gasoline storage and dispensing areas;
- dry cleaning plants where vapors from cleaning fluids can be present;
- spray finishing areas;
- aircraft hangars and fuel servicing areas; and
- utility gas plants and operations involving storage and handling of Liquefied Petroleum Gas (LPG) or natural gas.

  All of these are Class I gas or vapor hazardous locations. All require special Class I hazardous location equipment.

Hazard Class II Location: The second type of hazard listed by the NEC is those areas made hazardous by the presence of combustible *dust*. These are referred to in the NEC as *Hazard Class II Locations*. Finely pulverized material, suspended in the atmosphere, can cause as powerful an explosion as one occurring at a petroleum refinery. Some typical Class II locations are:

- grain elevators;
- flour and feed mills;
- plants that manufacture, use, or store magnesium or aluminum powders;
- producers of plastics, medicines, and fireworks;
- producers of starch or candies;
- spice-grinding plants, sugar plants, and cocoa plants; and
- coal preparation plants and other carbon handling or processing areas.

International Association of Fire Chiefs (IAFC): The IAFC provides leadership to career and volunteer chiefs, chief fire officers, and managers of emergency service organizations throughout the international community through vision, information, education, services, and representation to enhance their professionalism and capabilities.

International Liquids Terminal Association (ILTA): ILTA's mission is to provide its members with essential informational tools to facilitate regulatory compliance and improve operations, safety, and environmental performance.

Renewable Fuels Association (RFA): The national trade association for the U.S. ethanol industry, the RFA promotes policies, regulations, and research and development initiatives that will lead to the increased production and use of fuel ethanol.

Appendix

A

Applicable Building Codes and Recognized Standards

The following lists of codes and standards are not all inclusive. Your local jurisdiction or state and federal agencies may have additional regulations relevant to a facility. Also, the facility's insurance carrier will likely require you to follow certain standards and codes. The codes and standards listed are meant to assist your jurisdiction as it evaluates its level of preparedness and identifies gaps. It is always a best practice to use nationally recognized standards as benchmarks in your evaluation.

International Code Council (ICC) Codes and Standards

ICC makes every effort to provide current, accurate code adoption information, but in some cases jurisdictions do not notify ICC of adoptions, amendments, or changes to their codes. To ensure you have accurate information, please contact the jurisdiction directly. The International Code State and Jurisdiction Adoption Charts are works in progress. The information contained herewith has been provided by individuals involved in local jurisdictions and state legislatures.

- Chapter 9 Fire Protection Systems:
    - Section 903 Automatic Sprinkler Systems
    - Section 907 Alarm and Detection System
- Chapter 10 Means of Egress and Exits
- Chapter 13 Combustible Dust-Producing Operations
- Chapter 27 Hazardous Materials:
    - Section 2703 General
    - Section 2704 Storage
    - Section 2705 Use, Dispensing, and Handling
- Chapter 31 Corrosive Materials:
    - Section 3103 General Requirements
    - Section 3104 Storage
    - Section 3105 Use
- Chapter 34 Flammable Liquids:
    - Section 3403 General Requirements
    - Section 3404 Storage
    - Section 3405 Dispensing, Mixing, and Handling
    - Section 3406 Special Operations. Bulk Plants, Terminals, and Transfers
- Appendix B Fire Flow Requirements
- Appendix C Fire Hydrant Location and Distribution

National Fire Protection Association (NFPA) Codes and Standards

NFPA codes, standards, recommended practices, and guides are developed through a consensus standards development process approved by the American National Standards Institute (ANSI). Use of NFPA documents for regulatory purposes should be accomplished through adoption by reference. Users of NFPA codes and standards should consult applicable federal, state, and local laws and regulations.

- NFPA 10 *Standard for Portable Fire Extinguishers*
- NFPA 11 *Standard for Low-, Medium-, and High-Expansion Foam*
- NFPA 13 *Standard for the Installation of Sprinkler Systems*
- NFPA 14 *Standard for the Installation of Standpipe and Hose Systems*
- NFPA 30 *Flammable and Combustible Liquids Code*
- NFPA 61 *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*
- NFPA 70E *Standard for Electrical Safety in the Workplace*
- NFPA 77 *Recommended Practice on Static Electricity*
- NFPA 472 *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*
- NFPA 704 *Standard System for the Identification of the Hazards of Materials for Emergency Response*
- NFPA 1620 *Recommended Practice for Pre-Incident Planning*
- NFPA 1670 *Standard on Operations and Training for Technical Search and Rescue Incidents*

Appendix

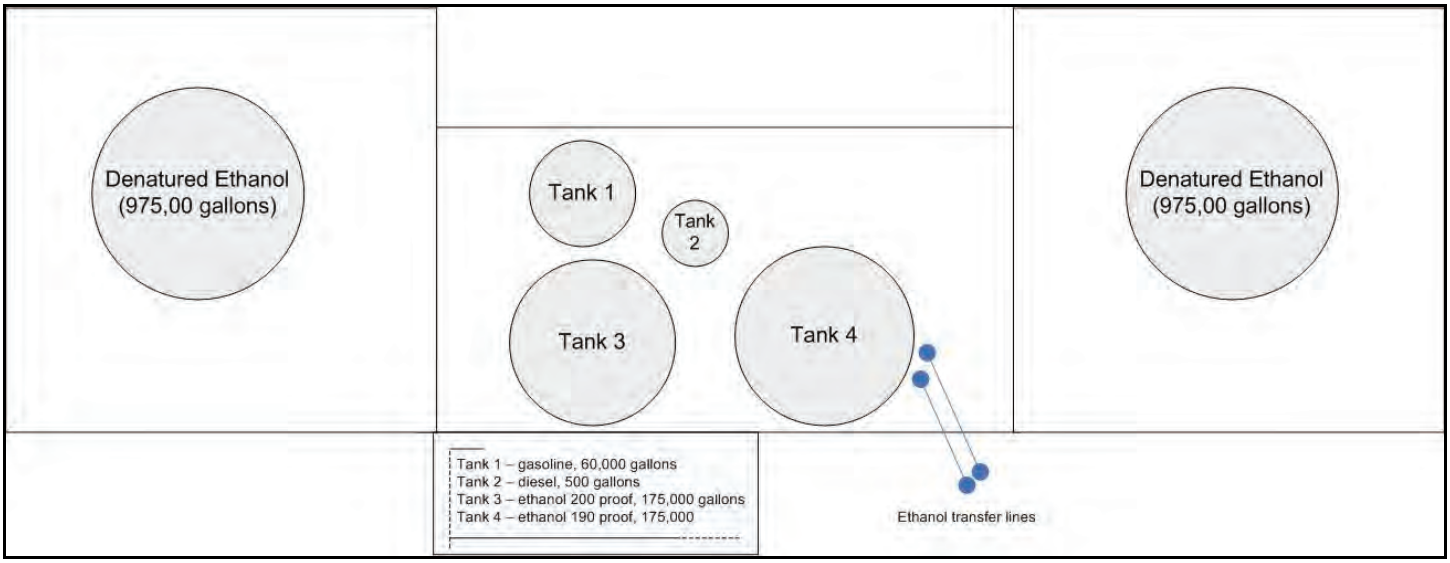
B

Preplan Example

Tank Farm

Occupancy	Outside, 2–3 max persons working in area
Fixed Fire Suppression System	None; foam is best method of extinguishment
Chemical Hazards	• Denatured Ethanol UN 1987 • Undenatured Ethanol UN 1170 • Gasoline UN 1203 • Corrosion Inhibitor UN 1993 • Diesel Fuel UN 1202
Electrical Hazards	All work/equipment used in area should be non-spark generating, intrinsically safe
Notes	• Significant volume of flammable material: evacuate and prevent spreading • All tanks are surrounded by containment berms • Ethanol tanks are equipped with fusible links for isolation of piping from tanks in the event of a fire

Figure 3: Tank Farm



Grain Dryers

Occupancy	General plant occupancy: • 12–15 people M–F, 8–5 • 4–7 people minimum 24 hrs/day
Fixed Fire Suppression System	**External:** Building sprinkler system with heat sensing heads, fed off of main fire pump **Internal:** • Steam snuffing (requires steam generation) • Manual water quench system, fed off the process water pump & distillate tank (#900)
Chemical Hazards	• Dry distillers grain and grain dust • Natural gas
Electrical Hazards	All work/equipment used in area should be authorized equipment only
Notes	• System is designed to starve fire of oxygen, *do not open any access doors* • Steam-generating boiler • X=fire extinguisher

Figure 4: Gas Dryer

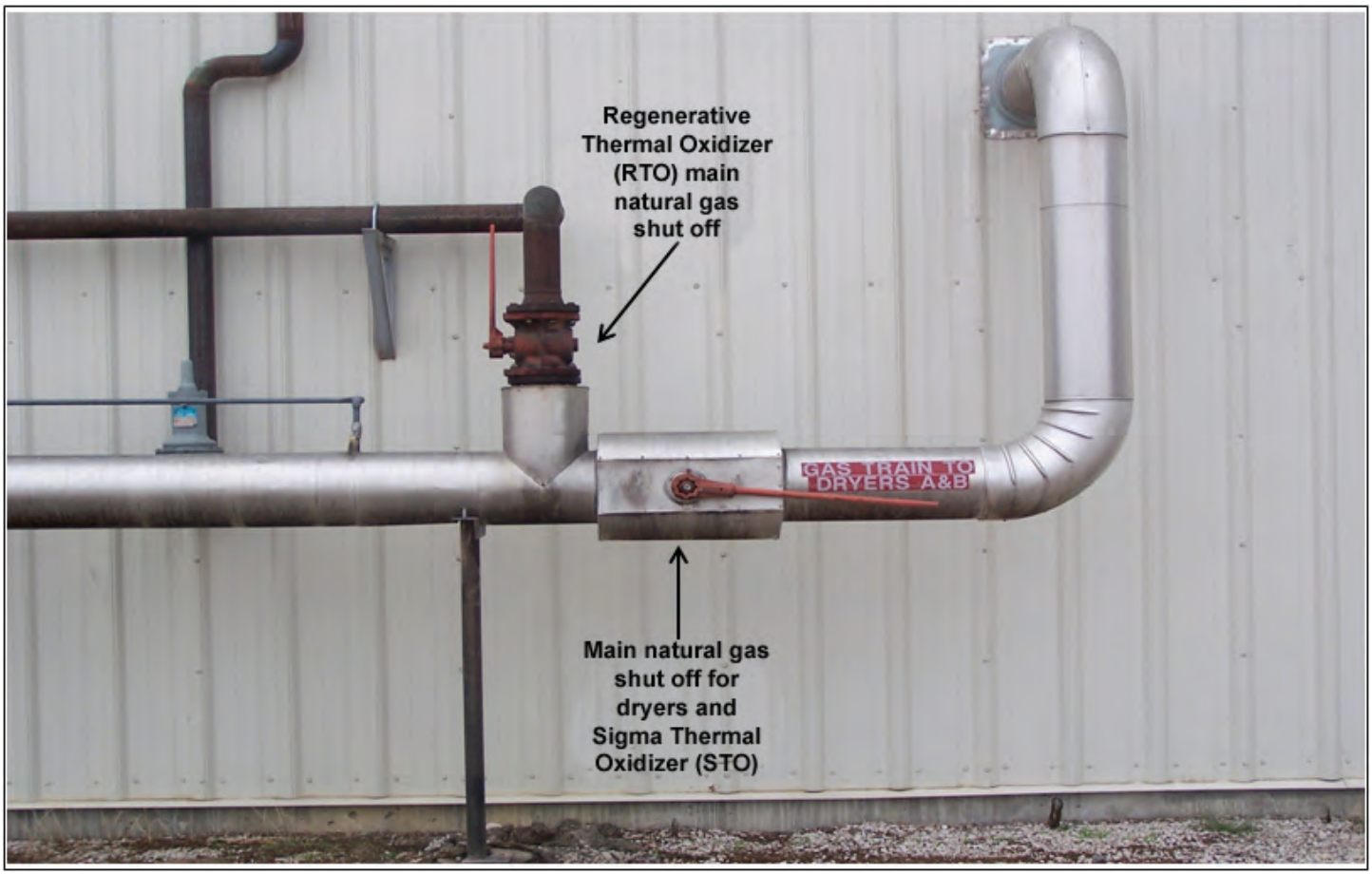
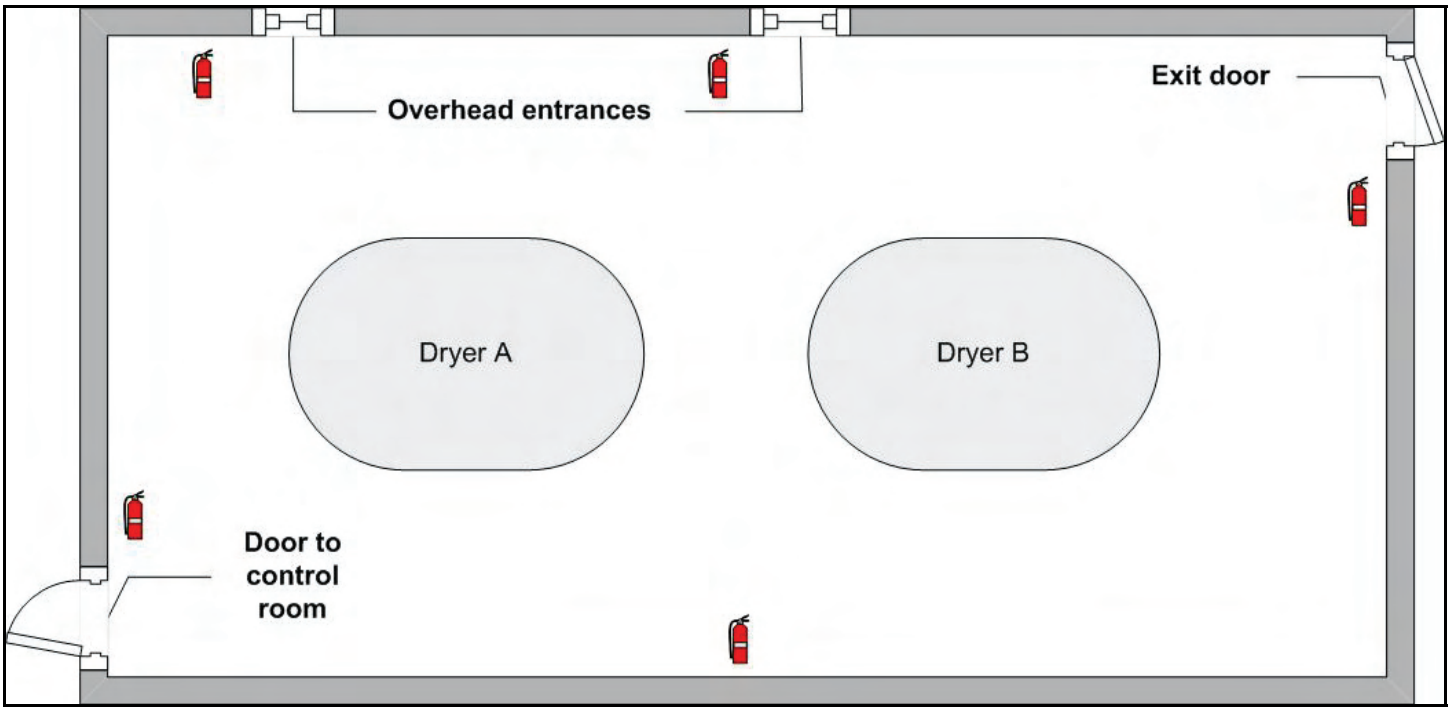


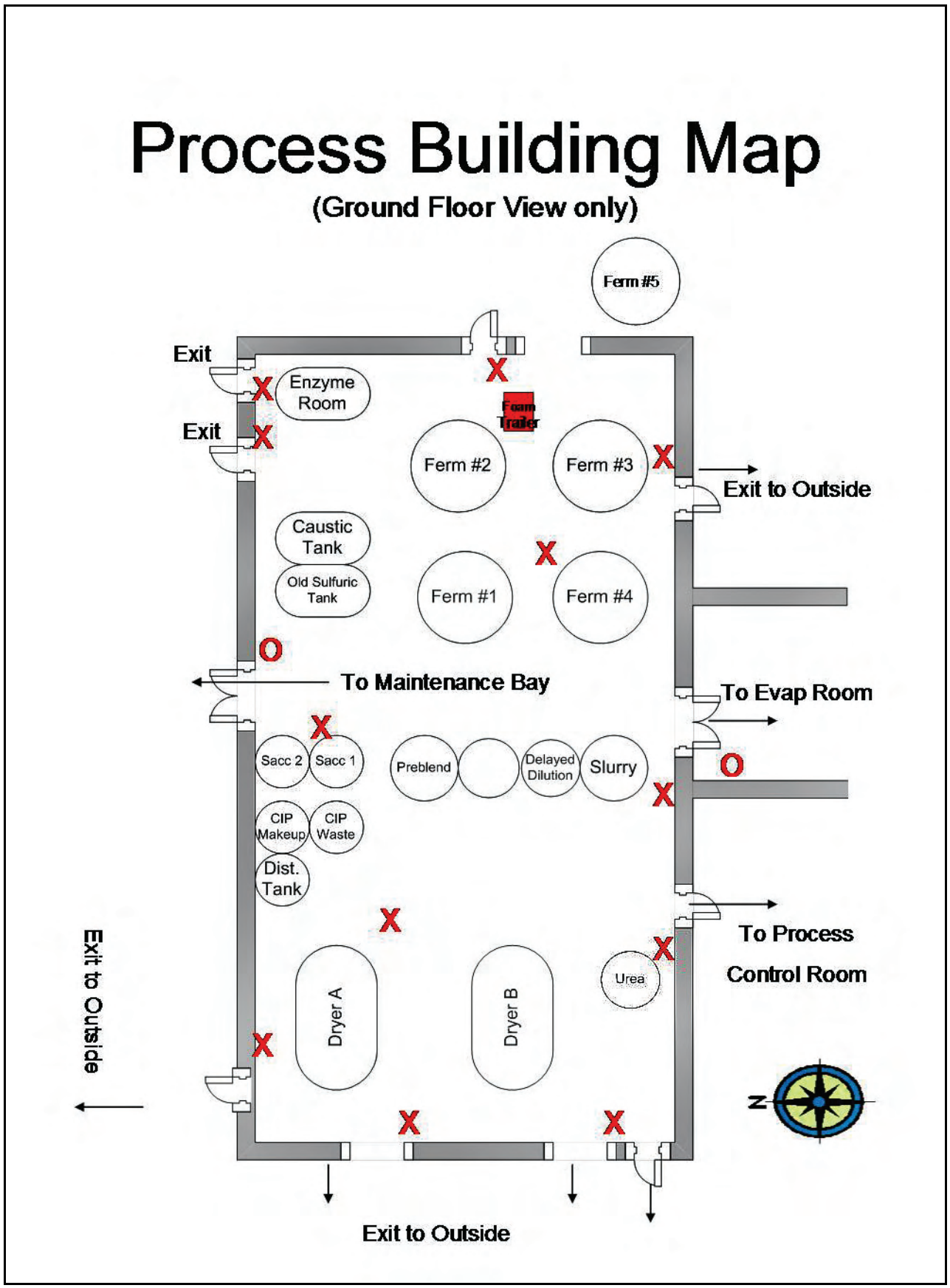
Figure 5: Grain Dryer



Process Building

Occupancy	General plant occupancy: • 12–15 people M–F, 8–5 • 4–6 people minimum 24 hrs/day
Fixed Fire Suppression System	**External:** Building sprinkler system with heat sensing heads, fed off of main fire pump Class B standpipes available
Process Facility	The building is 5 stories tall
Chemical Hazards	• Hot liquids • Alcohol UN 1170 • Enzyme • Liquid urea UN 1357 • Sulfuric acid UN 2796 • Sodium hydroxide UN 1824 • Carbon dioxide (CO_2) UN 1013
Electrical Hazards	• All work/equipment used in area should be authorized equipment only • 480 volt motors in the work area
Notes	• Fermenters are under pressure and are producing CO_2; without operation of air scrubbing system, CO_2 will be present in process building • Tanks are designed for pressure relief • X – notes live fire • O – notes Class B standpipes

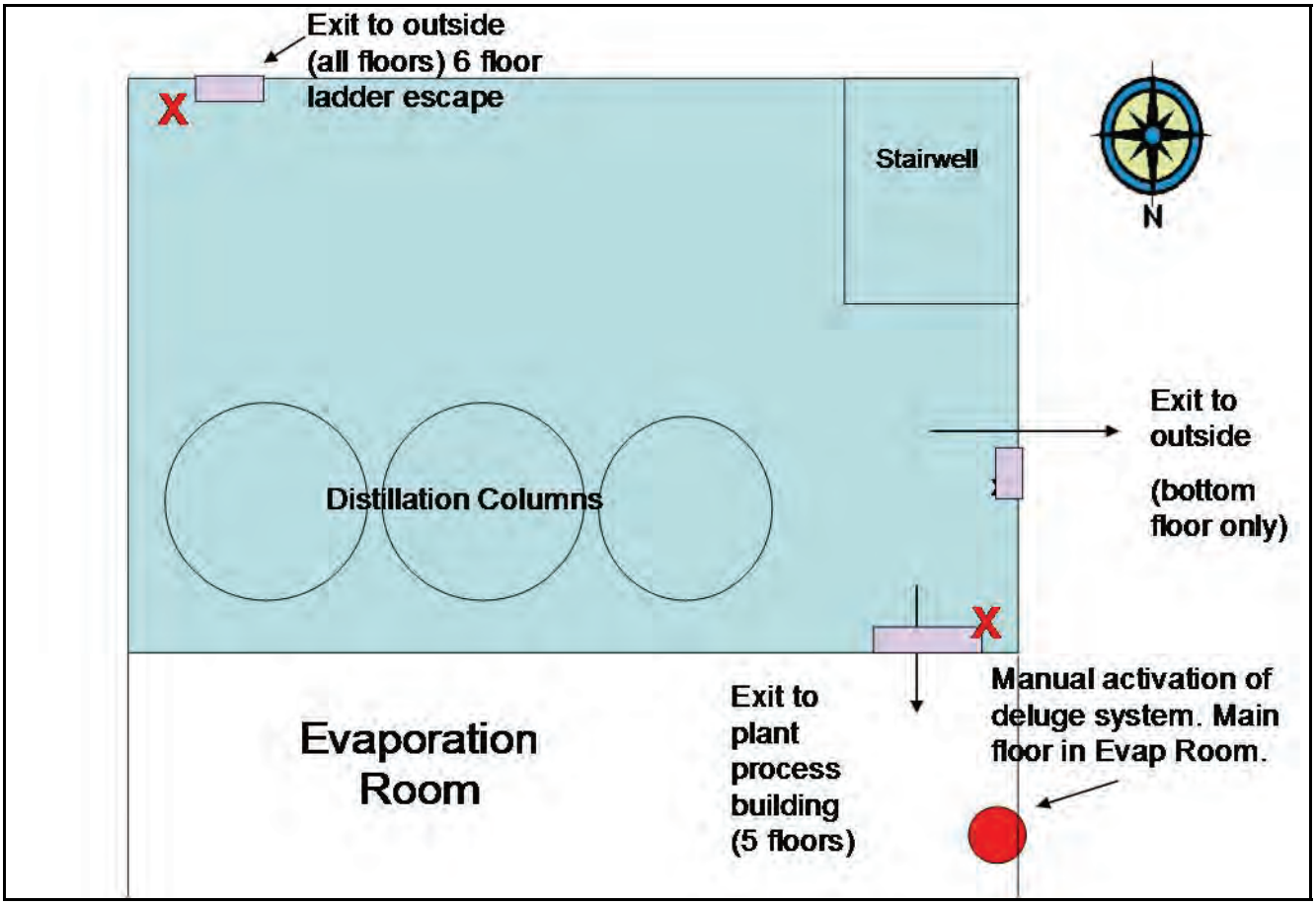
Figure 6: Process Building Map



Distillation Building

Occupancy	General plant occupancy: • 12–15 people M–F, 8–5 • 4–7 people minimum 24 hrs/day
Fixed Fire Suppression System	**External:** Building deluge system with heat sensing heads, fed off of main fire pump
Chemical Hazards	Ethanol UN 1170
Electrical Hazards	• All work/equipment used in area should be non-spark generating, intrinsically safe • No electric tools/cords without special instructions • 480 volt motors in the work area
Notes	• Any fire in area should use deluge system and focus on evacuation, containment from other buildings • Distillation spans six floors, accessible by grating and stairways (each floor has outside fire escape)

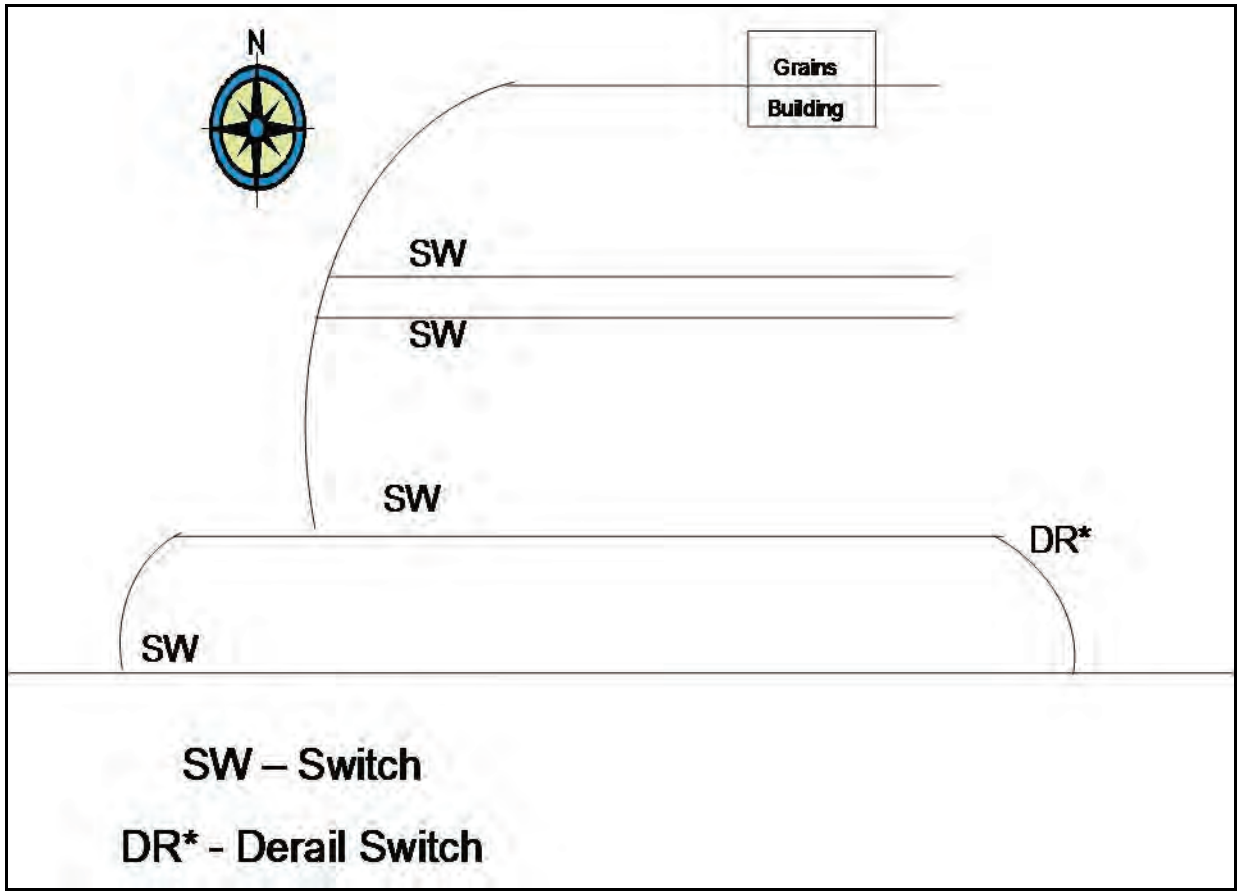
Figure 7: Distillation Building



Rail

Chemical Hazards	• Gasoline UN 1203 (denaturant) • Denatured Ethanol UN 1987 • Ethanol Vapors (empty cars) • Dried Distillers Grains (DDG) • Dehydrated Germ
Ethanol Rail Car Inventory Denatured – UN 1203 Ethanol – UN 1987	• Maximum cars (empty): 61 cars • Maximum cars (loaded): 25 cars
Denatured Ethanol	29,000 gallons denatured ethanol/car (UN 1987)
DDG	100 tons/car – DDG/Dehydrated germ

Figure 8: Rail



Fire Pump and Hydrants

Pump	• 2,000 gallons per minute (gpm) minimum • 120 pounds per square inch (psi) • 200 horsepower (HP) motor
Activation	• Automatic activation when system pressure falls below 130 psi • Can be manually activated from controller • Must have electricity, fed from fire pump transformer
System	Jockey pump maintains system pressure at 140–155 psi
Notes	In case of power outage, emergency generator must be started to supply power to the fire suppression system

Figure 9: Common Components of a Typical Ethanol Production Facility

Legend	
X	Approximate location of fire hydrants
O	Approximate location of fire department sprinkler connections
1	Admin building
2	Cooling towers
3	Anhydrous ammonia tank
4	Maintenance building
5	Process area
6	Grain storage
7	Ethanol rail loadout
8	Tank farm

Appendix

C

List of Common Hazardous Chemicals in Bulk Storage

The following chemicals is only a partial list of those commonly found in ethanol facilities. We have provided the United Nations' (UN) numbers and 2008 *Emergency Response Guidebook* (ERG) numbers for reference. More detailed information can be found on the Material Safety Data Sheet (MSDS) for each material. Consult with the facility in your jurisdiction for the specific vendor's MSDS.

- Anhydrous ammonia (NH_3):
  - Guide # 155
  - UN 1055
- Ethyl alcohol:
  - Guide # 127
  - UN 1170
- Gasoline:
  - Guide # 128
  - UN 1203
- Sodium hydroxide (NaOH):
  - Guide # 154
  - UN 1824
- Sulfuric acid (H_2SO_4):
  - Guide # 137
  - UN 1830

Appendix

D

Additional Checklists

We have included additional checklists here that you can copy and take with you when you visit an ethanol facility. Make notes as necessary in the spaces below each item. We recommend that when you return from the ethanol facility you make a copy and keep it in this manual for safe keeping and additional reference.

Emergency Action Plan (EAP) and Alarm System Checklist

☐

- **Review of the Facility EAP**

  An EAP is a written document required by Occupational Safety and Health Administration (OSHA) standards. The purpose of an EAP is to facilitate and organize employer and employee actions during workplace emergencies. Well-developed emergency plans and proper employee training (such that employees understand their roles and responsibilities within the plan) will result in fewer and less severe employee injuries and less structural damage to the facility during emergencies. A poorly prepared plan will lead to a disorganized evacuation or emergency response and result in confusion, injury, and property damage.

- **Alarm System/Evacuation**

☐

  The employee alarm system will provide warning for necessary emergency action or reaction time for safe escape from either the employees' workplace or immediate work area as provided in the EAP. An employee alarm system can be any piece of equipment and/or device designed to inform employees that an emergency exists or to signal the presence of a hazard requiring urgent attention. National Fire Protection Association (NFPA) 72, *National Fire Alarm Code*, requires a fire alarm signal to be distinctive in sound from other signals and states that it cannot be used for any other purpose.

  The two most common types of alarms are audible and visual devices.

  It is important to determine the following:

  - conditions under which an evacuation would be necessary;
  - conditions under which it may be better to shelter-in-place;
  - a clear chain of command and designation of the person authorized to order an evacuation or shutdown;
  - specific evacuation procedures, including routes and exits;
  - procedures for assisting visitors and employees to evacuate;
  - designation of which, if any, employees will remain after the evacuation alarm to shut down critical operations or perform other duties before evacuating;
  - a means of accounting for employees after an evacuation; and
  - special equipment for employees.

Safety Checklist

☐

- **Safety design built into facilities:** Ethanol manufacturing facilities have many safety designs and features built into the plant. Your local jurisdiction and/or state may have specific codes and regulations for hazardous materials, fire, and life safety. Facilities are typically engineered and designed to follow nationally recognized codes and standards as well as insurance carrier requirements even if the jurisdiction does not have adopted codes or standards. The following is a list of some of the common features built into many facilities. You should become aware of the specific systems in the facility in your jurisdiction, including:
    - **Sprinkler system**
    - **Standpipe system**
    - **Hydrant system**
    - **Water supply system**
    - **Backup generators for power failure**
    - **Dryer fire extinguishing system**
    - **Alarm system**
    - **Containment systems**
    - **Container relief devices**
    - **Emergency showers**
    - **Foam system(s) and foam concentrate supplies**
    - **Static electricity control (grounding and bonding)**
    - **Material Safety Data Sheet (MSDS) locations**

Facility Fire Brigade Checklist

☐

- **Fire Fighting: Fire Brigade**

  A fire or explosion is the most common type of emergency for which the facility must plan. A critical decision when preplanning is whether or not the facility has an organized fire brigade. Determining the response capability of the brigade is a vital key to preplanning, especially since the capabilities for fire brigades can range from fully trained firefighters with a high level of response capabilities to brigades consisting of only employees trained to use nothing more than a fire extinguisher.

- **Assessment of the facility's response capabilities: Define their role at the facility and at an off-site transportation incident:**
  - **Number of personnel required for a response:**
    - **Fire**
    - **Hazardous materials**
    - **Technical rescue**
    - **Emergency medical**
  - **Training of personnel:**
    - **National Incident Management System (NIMS) Incident Command System (ICS) 700, 100, 200, 300, and 400**
    - **Hazardous Materials Response: 472 compliant operations and/or technician**
    - **Class B fire behavior, fighting tactics, application, and equipment**
    - **Technical rescue: confined space, bin rescue, and rope rescue (high angle)**
    - **Control of hazardous energy Lock Out/Tag Out (LOTO)**
  - **Relationships/Mutual aid/automatic aid agreements:**
    - **Fire and rescue**
    - **Hazardous materials**
    - **Technical rescue**
    - **Law enforcement**
    - **Emergency management**
    - **Public works**

        - **Utilities: electrical, gas, and water**
        - **Non-governmental agencies: rail**
    - **Standard Operating Procedures (SOP) for a facility response:**
        - **Implement specific and comprehensive SOPs for a response to the facility and transportation incidents by rail and highway.**
        - **Implement specific and comprehensive SOPs to maintain responder safety for hazardous materials fire, emergency medical and technical rescue response.**
        - **Implement specific and comprehensive SOPs for interacting and establishing a unified command with facility personnel, other public safety, and non-governmental agencies.**
        - **Utilize NIMS/ICS.**
        - **Incorporate the firefighter accountability system. The system should be able to track the location and function of personnel at a large facility including multi-stories and levels and potentially covers a large geographical area.**
    - **Communication plan:**
        - **Ability to communicate with agencies, the facility, and government officials**
        - **Intrinsically safe equipment**
    - **Equipment:** Any special equipment will be dependent on what your jurisdiction mission will be for responses at the facility. Whether your jurisdiction will be providing technical rescue or hazardous materials response and at what level (operations/technician) will drive your need for some of the equipment listed:
        - **Personal Protective Equipment (PPE): chemical resistant, technical rescue**
        - **Alcohol-resistant foam**
        - **Foam application equipment**
        - **Air monitoring equipment**
        - **Intrinsically safe radios Hazard Class I/Division I**
        - **Product control materials**

- **Decontamination**
- **Technical rescue**

☐ • **Hazardous Materials Release: Level of Hazardous Waste Operations and Emergency Response (HAZWOPER) Training? Awareness (Incidental Release), Operations, or Technician:**

- **What is the facility's level of response capabilities? If using contractors, what is the contractor's level of response capabilities?**
- **Does the facility have a private contractor on retainer?**
- **What equipment does the facility have available? If using contractors, what equipment does the contractor have available? What are the levels of response time?**
- **Does the facility have alcohol-resistant foam and equipment on site?**
- **Confined space rescue: What service will provide OSHA required confined space rescue service at the facility?**
- **What service will provide other technical rescue such as grain bin and high angle?**
- **Does the facility have Emergency Medical Services (EMS), Cardiopulmonary Resuscitation (CPR)/first aid, and an Automated External Defibrillator (AED) on site?**

☐ • **Preplanning for the facility:** A risk-based response planned on facts and science and potential circumstances gathered through preplanning with facility personnel:

- **Fire/Explosion**
- **Hazardous materials release on site in the processing area or load out area into a truck or tank car:** Incidents may occur just off the site property involving trucks and tank cars also.
- **Medical**
- **Confined space**
- **Severe weather (tornado, extreme winds, rain, lightning, etc.):** Severe weather can "hit' a plant and do damage causing an emergency response.
- **Establishing unified command with a unified ICS with the facility personnel**
- **Locations of Material Safety Data Sheet (MSDS) information**

☐

- **Table-top and full-scale exercises:** As earlier mentioned, we may have many years of experience and training to guide us during emergency responses, but these facilities bring many challenging hazards that we have not experienced. Conducting table-top and full-scale exercises at the facility in your jurisdiction can bridge this gap.

  These exercises will develop decision making skills and identify areas of opportunity in your SOPs, training, and equipment. They will also assist the facility in the evaluation of their EAP and preparedness for an emergency at their facility.

  It is recommended that fire brigade and facility representatives develop exercises based on incidents that are likely to happen at this type of facility. Dryer fires, corrosive spills with a contaminated employee, a confined space rescue, or an ethanol release and fire are all examples of realistic incidents.

Fire Department Checklist

☐

- **Assessment of the facility's response capabilities: Define their role at the facility and at an off-site transportation incident:**
  - **Number of personnel required for a response:**
    - **Fire**
    - **Hazardous materials**
    - **Technical rescue**
    - **Emergency medical**
  - **Training of personnel:**
    - **National Incident Management System (NIMS) Incident Command System (ICS) 700, 100, 200, 300, and 400**
    - **Hazardous Materials Response: 472 compliant operations and/or technician**
    - **Class B fire behavior, fighting tactics, application, and equipment**
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    - **Control of hazardous energy Lock Out/Tag Out (LOTO)**
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    - **Hazardous materials**
    - **Technical rescue**
    - **Law enforcement**
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    - **Public works**
    - **Utilities: electrical, gas, and water**
    - **Non-governmental agencies: rail**
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- **Utilize NIMS/ICS.**
- **Incorporate the firefighter accountability system. The system should be able to track the location and function of personnel at a large facility including multi-stories and levels and potentially covers a large geographical area.**

- **Communication plan:**
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  - **Intrinsically safe equipment**
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