

ELECTRICAL SAFETY **IN HAZMAT ENVIRONMENTS**

COURSE OUTLINE

- **In a HAZMAT environment, everyday things such as electricity can become alien and dangerous.**
- **Normally an invisible part of daily life, electricity can:**
 - Ignite many hazardous materials.
 - Create fast-moving fires that are hard to control.
 - Make certain HAZMATs explode.
- **Ideally, electricity should be kept far away from HAZMAT substances at all times. Unfortunately, this is not always possible.**
 - Some manufacturing processes create flammable or explosive atmospheres in areas where electricity powers equipment or lights.
 - Also, hazardous materials emergencies often occur in electrified areas, such as when HAZMAT railroad tank cars crash into power lines.
- **In this program, you will learn general rules for staying safe around electrical power in HAZMAT environments, no matter what kind of conditions you encounter.**
 - We'll begin by considering worst-case scenarios, specifically, how electricity behaves when it's out of control.
- **Typically, uncontrolled electrical energy can produce three types of effects:**
 - Arcs.
 - Sparks.
 - High temperatures.
- **An "arc" is an electrical discharge crossing a gap between two points. These can occur in circuits that are:**
 - Overloaded.
 - Subject to voltage spikes.
 - Inadequately grounded.
- **Arcs produce heat that can ignite combustible materials. They also increase the risk of electrocution.**

- **"Sparks" are incandescent particles.**
 - They emit visible light as a result of being heated.
- **A malfunction that produces sparks is very serious.**
 - Sparks can indicate high-voltage arcing.
 - The higher the voltage, the greater the danger of fire, explosion or electrocution.
 - A spark can also be carried by air currents to other areas, causing fires a great distance away.
- **Because sparks glow due to heat, the more sparking occurs, the hotter the surrounding area becomes.**
 - This leads us to the next effect that uncontrolled electricity can have... high temperatures.
- **Electric lines that don't have enough insulation for the power they are carrying can radiate heat.**
 - The higher the voltage and the poorer the insulation, the greater the temperature.
- **While arcs and sparks produce high temperatures, an electrical line can also overheat without arcing or sparking. This can be caused by:**
 - Worn insulation.
 - Increasing the voltage of the line above the recommended safety limits.
- **Arcs, sparks and high-temperature electrical lines are particularly dangerous in locations that contain hazardous substances.**
 - Dealing with electricity in HAZMAT areas can lead to complex situations.
 - Fortunately, many of these issues are covered by the National Electrical Code (NEC).
- **The NEC is the primary source for electrical standards in the United States, and contains guidelines for electrical use in all environments where hazardous materials are located.**
 - The NEC divides hazardous materials areas into three classes, each with its own electrical specifications.

- **The three NEC HAZMAT area classes are:**
 - Class I: Where electricity could ignite airborne flammable gases and vapors, or cause them to explode.
 - Class II: Where airborne combustible dust is present.
 - Class III: Where ignitable materials are present, but are not airborne in sufficient quantities to catch fire.
- **Class I areas include:**
 - Refineries.
 - Chemical manufacturers.
 - Hospitals.
- **These sites contain flammable gases and vapors which can be ignited by unshielded electrical devices.**
 - In spite of these dangers, there are safe ways to work with electricity in these areas.
- **One of the most effective ways is through "engineering controls", which use technology to reduce workplace hazards.**
- **Since all electrical devices from large machinery to pocket flashlights contain circuitry, it is critical that you use approved equipment for the area you are working in.**
- **Electric devices with moving parts such as mechanical relays can produce arcs.**
 - This makes them unsuitable for Class I sites.
 - For this reason, Class I sites need to be equipped with "intrinsically safe" systems.
- **Also known as "non-incendiary systems", these are electronic circuits that carry out the same function as their mechanical counterparts... but without producing sparks.**
- **Devices with these features are always marked with a label that identifies them as being "intrinsically safe".**
 - If a piece of equipment is not marked "intrinsically safe", it should not be used in a Class I site.

- **The only drawback to intrinsically safe systems is that they must be designed for specific atmospheres.**
 - This is because different substances have different flashpoints.
 - An intrinsically safe electrical system that is safe in one HAZMAT environment might not be safe in another.
 - Due to the broad range of chemicals used by industry, the NEC has not specified a "lowest common denominator" intrinsically safe system for use in all hazardous environments.
- **Other engineering controls include specialized enclosures that can actually suppress explosions.**
 - If something inside one of these containers explodes, the damage would be contained, and the outside air will not be heated to the point that it ignites.
 - These explosion-proof cases are not necessarily gas-tight or vapor-tight, but they are flame-tight, which means that fire cannot escape from them.
- **Other engineering controls isolate machinery from Class I hazardous atmospheres to prevent fires and explosions from occurring. These controls fall into three broad categories:**
 - Hermetic seals made of metal or plastic.
 - Encapsulating seals of tar, wax or epoxy.
 - Oil immersion, which uses a layer of oil as a barrier against flammable or explosive atmospheres.
- **As important as engineering controls are in Class I environments, they are only one part of the safety picture. "Work practices" are equally important.**
 - Together with engineering controls, they form a total system of preventive measures.
- **Work practices are administrative methods for isolating workers from hazardous materials.**
 - While engineering controls deal with technology, work practices involve operating procedures.
- **In Class I environments, the two most common work practices are:**
 - Purging.
 - Inerting.

- **Both of these remove flammable or explosive gases from the local atmosphere.**
 - Purging uses non-flammable gases called "purgatives" to flush flammable atmospheres from enclosed spaces.
 - The amounts of purgatives that are required vary with the molecular weights of the substances being removed.
 - Carbon dioxide and nitrogen are commonly used as purgatives, because they are inert and react with very few other chemicals.
 - The National Electrical Board and OSHA also permit the use of positive-pressure air as a purgative, provided that safeguards are taken against ventilation failure.
- **Purging can sometimes cause problems, however.**
 - In some cases, purged flammable gases or vapors can ignite after they are vented to the outside air.
 - So it is critical that these gases are vented safely away from ignition sources.
- **The other common Class I work practice, "inerting", consists of adding a nonflammable gas to the atmosphere in order to displace oxygen.**
 - The object is to reduce the percentage of oxygen in the atmosphere to the point that it is too low to support burning.
 - The precise amount of oxygen reduction that is necessary depends on the substances that are involved.
 - For chemical-specific information on effective oxygen-reduction levels, consult the SDS for the substance in question.
- **However, inerting may cause problems in confined spaces because it can remove so much oxygen that the air becomes unbreathable.**
 - This condition is called an "oxygen-deficient" atmosphere.
- **Before anyone enters an inerted space, it must be tested to see if it can support life. If it can't, the entrant must wear:**
 - An OSHA-approved, supplied-air respirator (SAR).
 - A harness.
 - A lifeline.
- **Entrants must be monitored at all times by an attendant outside of the confined space.**
 - A rescue team must also be available in case of an emergency.

- **While Class I sites are complex work environments that present many hazards, Class II areas pose different risks.**
 - In Class II sites, airborne combustible dust is the primary threat.
- **This is why electrical equipment that is used in Class II areas must be both:**
 - Dust-tight.
 - Resistant to overheating when covered with dust.
- **Devices that meet both of these criteria are referred to as "dust-ignition-proof".**
 - Hermetic sealing, encapsulation and oil immersion can all be used to keep machines free of ignitable dust.
- **Work practices can also prevent electrical accidents in Class II environments.**
 - Of these procedures, the most common is pressurization.
 - Similar to purging, this uses a pressurized inert gas or clean air to periodically blow dust out of the area.
 - Unlike purging, however, pressurization cannot bring an area to a safe level once dust is inside...it is a preventive measure only.
- **If dust gets inside the area, it must be removed through manual means, using a broom or a non-sparking shovel.**
 - Never use a vacuum cleaner (it's motor might produce a spark that could ignite flammable or explosive materials).
- **Be careful! Removing dust could also cause some of it to become airborne in the process, making the atmosphere more hazardous.**
 - If this occurs, electrical power sources will need to be switched off and the dust removed by high-volume fans.
- **Purging and inerting are used infrequently in Class II environments, since both can stir up even more dust, and cause it to become airborne.**
 - If these methods are used, the air pressure must be kept low, to prevent the dust from being stirred up.

- **So far, we've looked at site classes that involve significant amounts of airborne contaminants. Class III sites are different.**
 - At these locations, the air doesn't contain ignitable materials in sufficient quantities to catch fire.
 - In these areas, the concern is flammable deposits that may build up on floors, counters and equipment.
 - This is why high surface temperatures are the primary concern in Class III areas.
- **Keeping machine temperatures down can be achieved in several ways:**
 - The equipment room can be kept cool and well-ventilated (this also reduces dust in the area).
 - Machinery can be insulated and be run within safe operating temperatures.
- **No matter what measures are used, however, fan-cooled motors should not be installed in Class III areas.**
 - Combustible fibers could clog the fan, shutting it down.
 - This could cause the motor to overheat, resulting in a fire or an explosion.
- **Although the three classes of HAZMAT areas that we've been discussing are different in many ways, they do have some things in common:**
 - No matter what class a HAZMAT environment belongs to, all of its wiring and electrical equipment must be installed in accordance with the National Electrical Code.
 - Electrical equipment used in these locations must also be approved by Underwriter's Laboratories (UL), or another testing organization recognized by federal authorities.
- **Most of the time, following safety regulations, observing safe work practices and using appropriate engineering controls can keep accidents from occurring.**
 - There are times, however, when you may encounter accidents involving electricity and hazardous materials that have already occurred.
 - These situations must be brought under control quickly.
- **We've seen how hazardous materials can react to electricity in various ways.**
 - Some catch fire or explode easily.
 - Many are excellent conductors, increasing the danger of electrocution.

- **But even if released chemicals do not react to electricity, uncontrolled electrical sources at the site are dangerous in themselves.**
 - This is why one of the primary objectives in an emergency is to immediately cut the power.
- **You may be able to do this by switching off circuit-breakers, but not if the breakers are located in a flammable atmosphere!**
 - In these circumstances, an arc could occur, igniting the air.
 - If you have any doubts about the local atmosphere, get out fast and have the power shut off remotely, by the electric company.
 - Until the electricity is turned off, no one... not even responders... should enter the site.
- **Everyone must be kept a safe distance from the area until the power shut-off is confirmed by someone in authority, such as the Incident Commander.**
 - A "table of initial isolation and protective action distances" can be found in the Emergency Response Guidebook.
- **When first responders are allowed in an electrical hazard area, they must use monitoring and sampling equipment that is designed to prevent ignition.**
 - These devices guard against ignition by using technologies such as intrinsically safe systems and hermetic seals.
- **As we've seen, the presence of electricity at a HAZMAT site makes the area even more dangerous.**
 - But by following proper procedures, you can stay safe in these situations.

*** * *SUMMARY* * ***

- **Uncontrolled electrical energy can produce three major effects, all of which can heat materials above their flashpoints:**
 - Arcs.
 - Sparks.
 - High temperatures.
- **The National Electrical Code (NEC) divides HAZMAT areas into three classes:**
 - Class I (containing flammable gases and vapors).
 - Class II (airborne combustible dust is present).
 - Class III (ignitable materials are present in small quantities).
- **Electrical hazards in these areas can often be managed through engineering controls and work practices.**
- **One of the primary objectives in a HAZMAT emergency is to cut the power immediately.**
- **Until someone in authority confirms that the power is shut off, everyone... including first responders... must stay a safe distance from a HAZMAT area.**
- **In a HAZMAT environment, everyday things like electricity can become alien and dangerous... but that doesn't mean they are uncontrollable.**
- **Know the safety rules, follow them without exception, stay on your toes... and you will stay alive!**