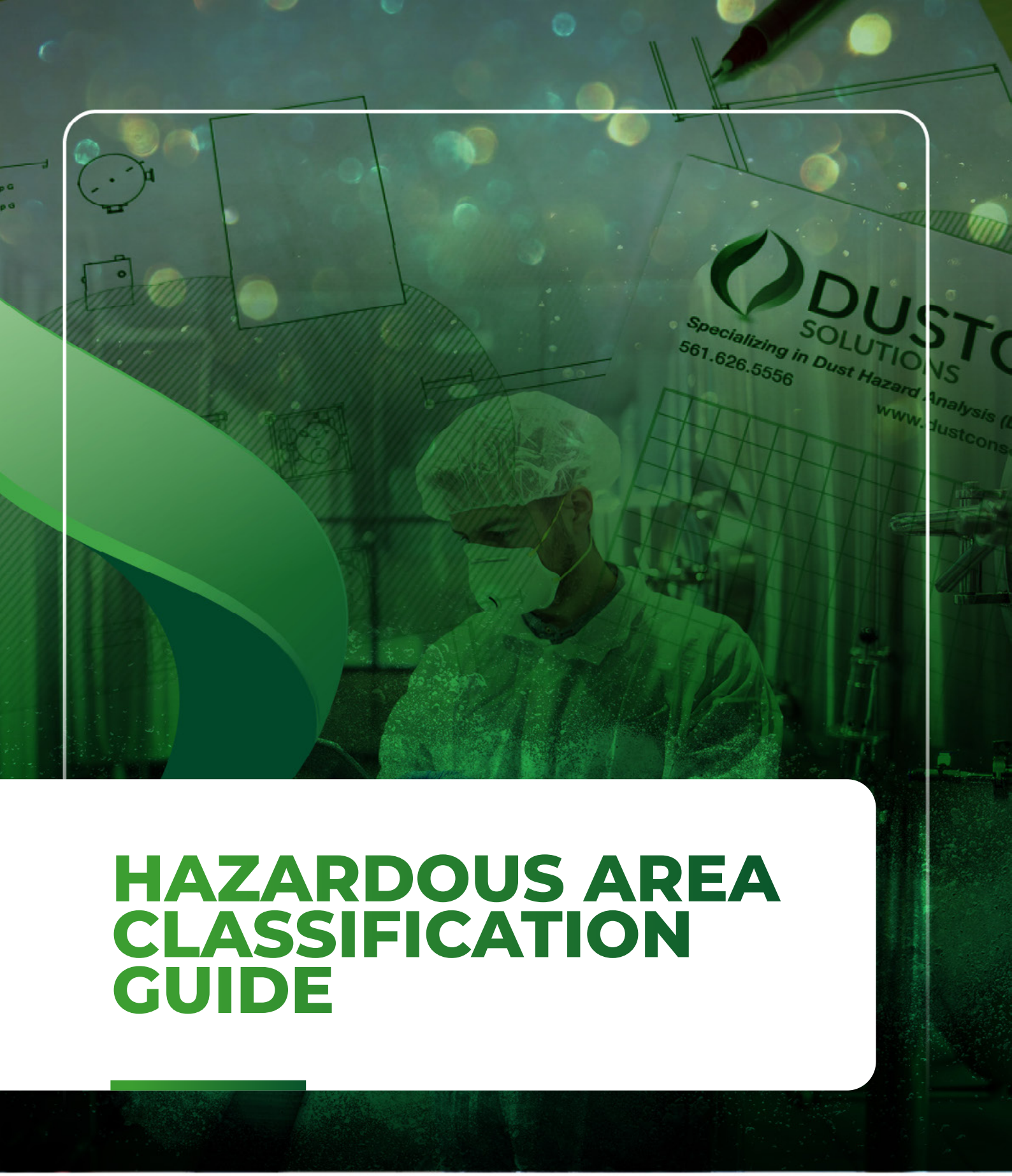

HAZARDOUS AREA CLASSIFICATION GUIDE

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DUSTCON SOLUTIONS

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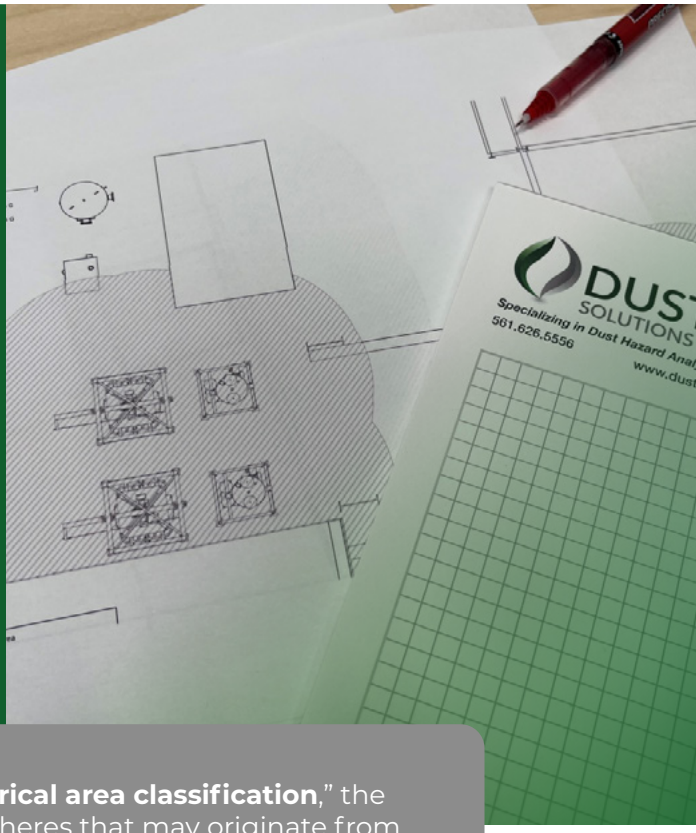


Commonly referred to as an "**electrical area classification**," the HAC focuses on explosible atmospheres that may originate from gases, liquids, vapors, combustible dust, or ignitable fibers.

Once hazardous areas are identified and documented, uncontrolled ignition risks can be addressed and minimized to reduce property damage and worker injury or death. This guide will help you understand what an HAC is, why it's important, and how Dustcon Solutions can help you comply with the various requirements surrounding electrical classification.

"Hazardous Area Classification" is the term used by the National Fire Protection Association (NFPA) in their standards documents to describe such a safety assessment.

While an HAC is often thought of as dealing strictly with electrical hazards, there is a wide array of ignition sources that can spark a fire or explosion in a plant environment. Therefore, rather than applying the term "electrical classification," the broader term "hazardous area classification" is used by safety professionals, authorities having jurisdiction (AHJs), and rule-making entities such as the NFPA, American Petroleum Institute (API), and International Electrotechnical Commission (IEC) that recognize the broader hazards (including electrical equipment) that are present in a typical processing plant.

HAC Purpose and Guiding Principles

The purpose of an HAC assessment is to determine the extent to which electrical classification is required and to define the boundaries between various classified areas.

The process includes a detailed review of the hazardous materials handled, the equipment handling those materials, and the process conditions involved within each area of the plant to define and document such boundaries. Typical results of an HAC include plot drawings (and elevation drawings if necessary) with markings indicating the location and extent of classification and an accompanying report describing the methodology, analysis, and rationale that led to the resulting classification boundaries.

A documented HAC assessment is required by various standards, codes, and recommended practices to make processes safer and adhere to industry best practices. With so many standards and guidelines, it can be challenging to know what requirements apply to your facility and how to meet them. That's where experts specializing in HAC services can help. An expert consultant can guide you on which standard or directive should be followed for your circumstance and walk you through the process of developing the HAC results. For clients who have already completed a Dust Hazard Analysis (DHA) in compliance with NFPA 652, an HAC assessment is often a required next step in the safety management process. While a DHA covers combustible dust hazards, the HAC identifies electrical ignition hazards potentially posing as ignition hazards within a plant or process that must be addressed.

Guidance documents for completing an HAC

The primary documents that may be referenced when completing an HAC in the United States include NFPA 70, NFPA 497, NFPA 499, NFPA 33, API 500, IEC 60079-10-1, and IEC 60079-10-2. Below is a brief review of each document and how it applies to the HAC process.

NFPA 70 National Electric Code (NEC)

Addresses safe electrical design, installation, and inspection to protect people and property from electrical hazards in the United States. (Note that this covers Class I, Class II, and Class III hazardous locations.)

NFPA 497 Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

Addresses recommended criteria to determine ignitibility hazards in chemical process areas using flammable liquids, gases, or vapors to assist in the selection of electrical systems and equipment for safe use in Class I hazardous (classified) locations.

NFPA 499 Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

Addresses recommended criteria to determine ignitibility hazards in chemical process areas where combustible dusts are produced, processed, or handled to assist in the selection of electrical systems and equipment for safe use in Class II hazardous (classified) locations.

NFPA 33 Standard for Spray Application Using Flammable or Combustible Materials

Addresses Class I and Class II hazardous locations as it relates specifically to spray booths for applications like powder coating and liquid paint spray.

American Petroleum Institute Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities (API 500)

Provides guidelines for the classification of locations at petroleum refineries, production and drilling areas, and pipeline transportation facilities as it relates to the selection and installation of electrical equipment. (Note that API 500 document is limited in scope to Class I locations; does not address combustible dust or ignitable fibers.)

International Electrotechnical Commission Standard on Explosive Atmospheres - Part 10-1: Classification of Areas - Explosive Dust Atmospheres (IEC 60079-10-1)

Focuses on the identification and classification of areas in which hazards from flammable gas or vapor may arise. This international standard sets forth the Zone system which differs from the Class/Division system more common to North America. (Note that Part 10-1 is limited in scope to flammable vapors or gases; does not address combustible dust hazards.)

International Electrotechnical Commission Standard on Explosive Atmospheres - Part 10-2: Classification of Areas - Explosive Dust Atmospheres (IEC 60079-10-2)

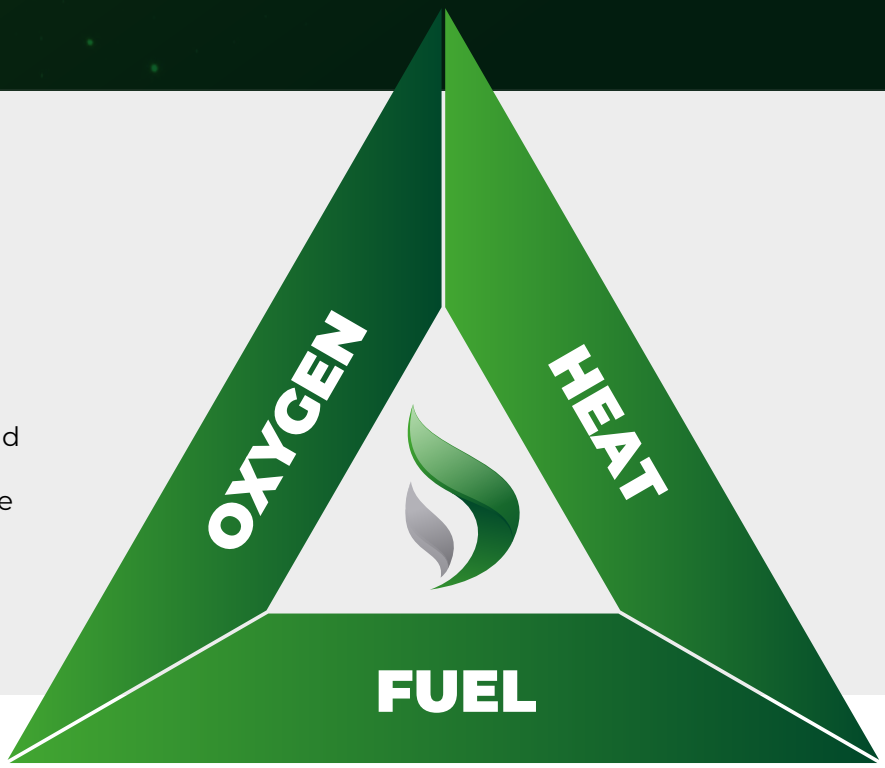
Focuses on the identification and classification of areas in which hazards from explosible dust may arise. This international standard sets forth the Zone system which differs from the Class/Division system more common to North America. (Note that Part 10-2 is limited in scope to dust hazards; does not address flammable vapors or gases.)

Hazardous area classification elements

If your facility handles flammable or combustible materials, you are most likely already aware that following codes, standards, and designs that take these hazards into account is the most responsible way to ensure safety.

From a facility's conceptual and planning stages, through the design phase, and into operation and emergency response, the efforts to address hazards and ensure long-term plant operations are often prioritized but may require additional expertise for full compliance.

The basic fire triangle shows the three elements needed sustain combustion: **1) oxygen in the air, 2) a fuel source,** and **3) an ignition (heat) source**. Indeed, many process materials have physical characteristics allowing for combustion to occur if the material is allowed to form a cloud in the air. Eliminating one of the three elements of the fire triangle can prevent combustion, for example by eliminating a fuel or ignition source in the area.

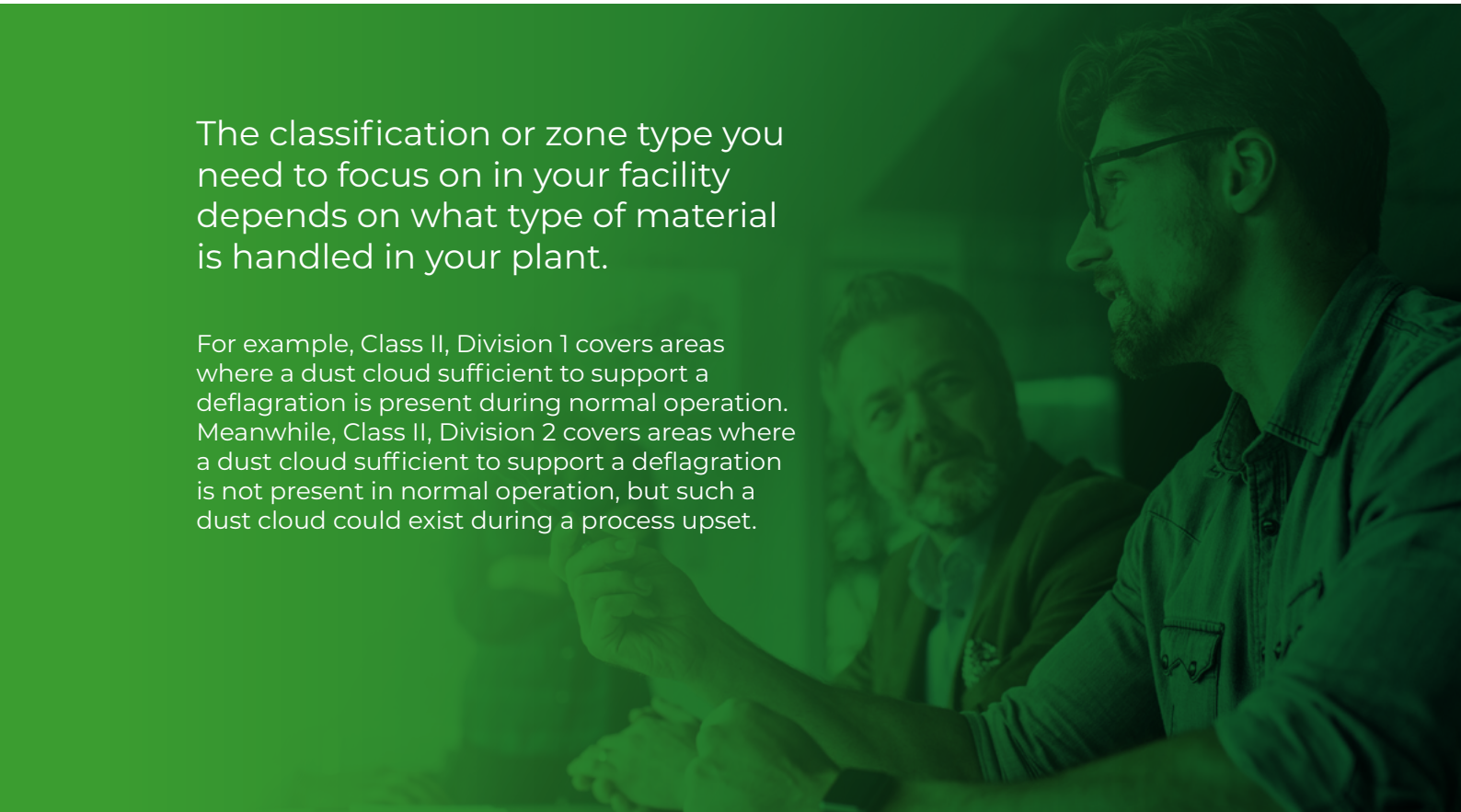


In some cases, permanent ignition sources exist, for example in electrical equipment such as motors, lights, and hot surfaces from a dryer or other equipment that may contribute to a fire. Ignition hazards stemming from electrical equipment can be addressed by ensuring that appropriate equipment types are used, and that the equipment is suitable for the process materials being handled in that area.

Within the HAC report, parts of the facility where there is a possibility or risk of a fire or explosion are typically referred to as a "hazardous location" or "classified area." To determine what electrical equipment can be used in a certain hazardous location, the HAC uses one of two classification systems.

The two main systems used to classify these hazardous areas are the Class/Division system and the Zone system. The NEC Class/Division system is primarily used in North America and the IEC Zone system is more typically used internationally. The comparison chart below shows the Class/Division system and Zone system organized by material type.

Comparison of NEC Class/Division System to IEC Zone System			
Material Type	**Presence of Hazard**	**Class / Div. System**	**Zone System**
Gases & Vapors	Continuously	Class I / Div. 1	Zone 0
	Intermittently		Zone 1
	Under abnormal circumstances	Class I / Div. 2	Zone 2
Combustible Dust	Continuously	Class II / Div. 1	Zone 20
	Intermittently		Zone 21
	Under abnormal circumstances	Class II / Div. 2	Zone 22



The classification or zone type you need to focus on in your facility depends on what type of material is handled in your plant.

For example, Class II, Division 1 covers areas where a dust cloud sufficient to support a deflagration is present during normal operation. Meanwhile, Class II, Division 2 covers areas where a dust cloud sufficient to support a deflagration is not present in normal operation, but such a dust cloud could exist during a process upset.

Who needs an HAC?

A typical manufacturing operation where flammable gases, vapors, dusts, and fibers are handled will likely have one or more hazardous areas where fuel, oxygen, and heat are all present to potentially create a fire or even an explosion hazard (if containment and dispersion are also present).

Operators, plant management, and plant staff can avoid fire and explosion incidents by following equipment design best practices and anticipating what electrical safety risks may be present in a facility by performing the HAC assessment where necessary. This assessment is required to effectively prevent ignition of flammable and combustible materials and provides significant benefits over the life of a plant, including cost savings and improved worker safety.

In North America, the primary document that experts turn to is NFPA 70 The National Electric Code (NEC). This standard defines the classification of hazardous locations within a facility. To provide more detailed guidance, the NFPA also publishes NFPA 497 and NFPA 499 which are Recommended Practice documents for the classification of locations handling flammable gases/vapors and combustible dust, respectively. Additionally, NFPA 70 sets forth the requirements related to design and labeling of electrical enclosures and motors that can operate safely in classified areas.

The chart below shows the Class/Division system for processes handling either gases and vapors or combustible dust.

Class I / Division 1 & Division 2 / Group A-D is shown based on the material's explosive properties. For Class II / Division 1 & Division 2 / Group E-G is shown based on the material's ignition temperature, electrical conductivity, and thermal blanketing effect. In contrast, Class III / Division 1 & Division 2 aren't further separated into Groups. This is because fibers and flyings don't generally create an explosion hazard, though accumulation of this type of material may result in a very fast-moving fire.

Electrical Classification according to National Electric Code (NFPA 70)		
Class	**Division**	**Group**
Class I = Gases & Vapors	Div. 1 = Present in Normal Operation Div. 2 = Present in Abnormal Conditions	**Group A** = Acetylene
		Group B = Hydrogen
		Group C = Ethylene
		Group D = Propane
Class II = Combustible Dusts	Div. 1 = Present in Normal Operation Div. 2 = Present in Abnormal Conditions	**Group E** = Metal Dusts (e.g. Aluminum, Magnesium)
		Group F = Carbonaceous Dusts (e.g. Coal)
		Group G = Other Combustible Dust (e.g. Flour, Grain, Wood, Plastics, Chemicals, etc.)
Class III = Fibers or Flyings	Div. 1 = Present in Normal Operation Div. 2 = Present in Abnormal Conditions	(not grouped)

Differences between the DHA and HAC:

As discussed previously, the completion of a dust hazard analysis (DHA) may trigger the need for an hazardous area classification (HAC). Note that the DHA is different from the HAC in scope, intent, and level of detail:

DHA

Dust Hazard Analysis

- Focuses on determining if and where combustible dust hazards — such as fire, flash fire, and explosion hazards — exist within the facility.
- Looks at all possible ignition sources and scenarios, including open flame, electrical, electrostatic, mechanical friction, chemical action, hot work, and others.
- Identifies existing safeguards in the form of engineering controls and management systems.
- Recommends additional safeguards where needed, including improvements to administrative controls and new engineering controls.
- Briefly discusses electrical requirements, but doesn't detail them, whereas an HAC provides a more detailed review of all electrical classification areas/equipment.

HAC

Hazardous Area Classification

- Focuses specifically on possible ignition of a flammable atmosphere due to an electrical failure and is required for both flammable vapor and combustible dust applications.
- Determines whether electrical classification is required and defines the boundaries between various classified and unclassified areas.
- Includes a detailed review of each area of the plant to define and document such boundaries.
- Outputs one or more plot drawings (and elevations if applicable), which show the classified areas and includes an accompanying report describing the rationale.
- Covers electrical equipment as the main focus, but other ignition sources may be present and be addressed within the final report.

The bottom line is that for client sites handling combustible dust in North America, a DHA report will make general recommendations about the required electrical classification in a plant. Typical recommendations (for dust handling facilities) would be for all electrical equipment to be classified as Class II / Division 2 / Group G in areas where combustible dust is handled. The value of going further with an HAC Assessment is that it allows for a more nuanced understanding of where electrical equipment needs to be upgraded and where current unclassified areas can be maintained. This is important as upgrading electrical enclosures, motors, lighting, and other equipment and systems can be a very expensive endeavor.

HAC Preparation and Process

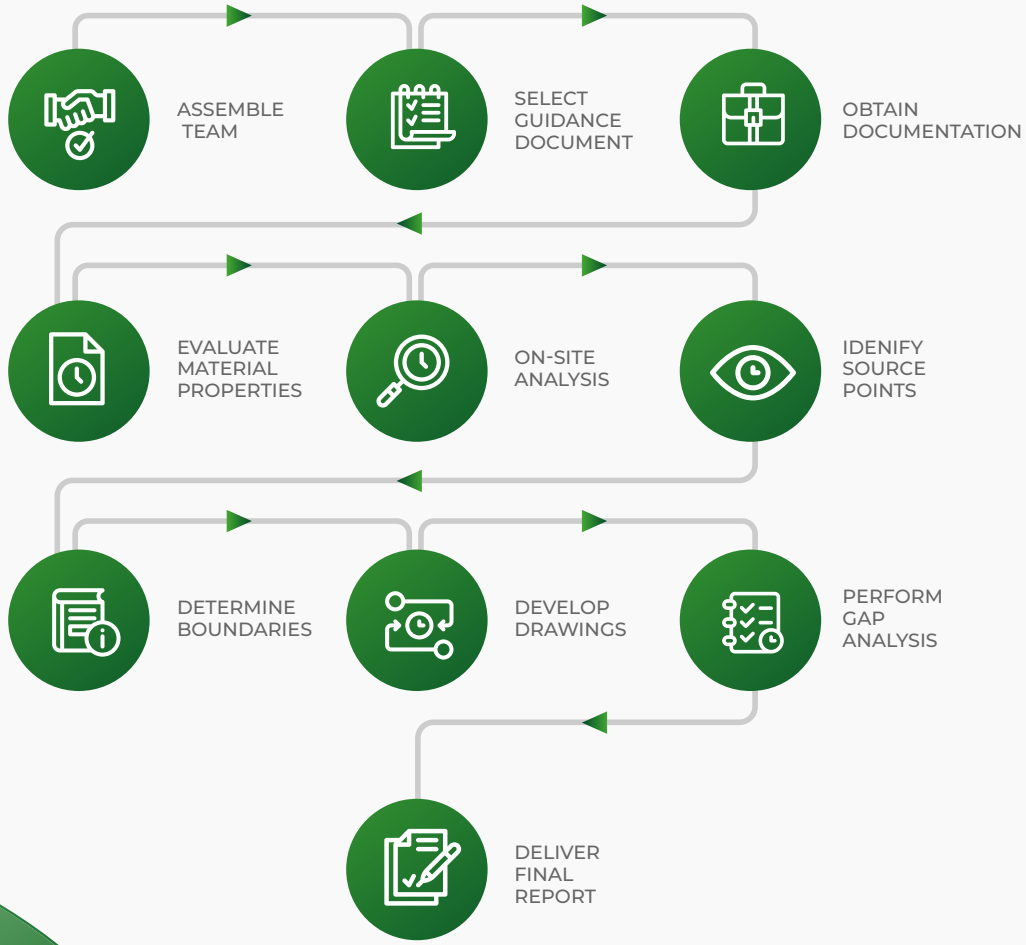
Some companies may have internal staff members qualified to execute an effective HAC assessment, but most organizations do not have the expertise in-house and prefer to hire outside consultants to lead the HAC on their behalf.

As with any process safety activity, the assessment should be performed by a team of individuals with intimate knowledge of the flammability of the process materials in the area being studied and the process equipment in which those materials are handled.

The team should also understand the relevant codes, standard, or recommended practice that apply to the situation to ensure the requirements for electrical equipment are properly adhered to.

An HAC may take anywhere from a couple of weeks to several months to complete, depending on the scope and complexity of the process/facility. Below is a standard HAC process flowchart for working with a consultant, keeping in mind that timeframes may vary.

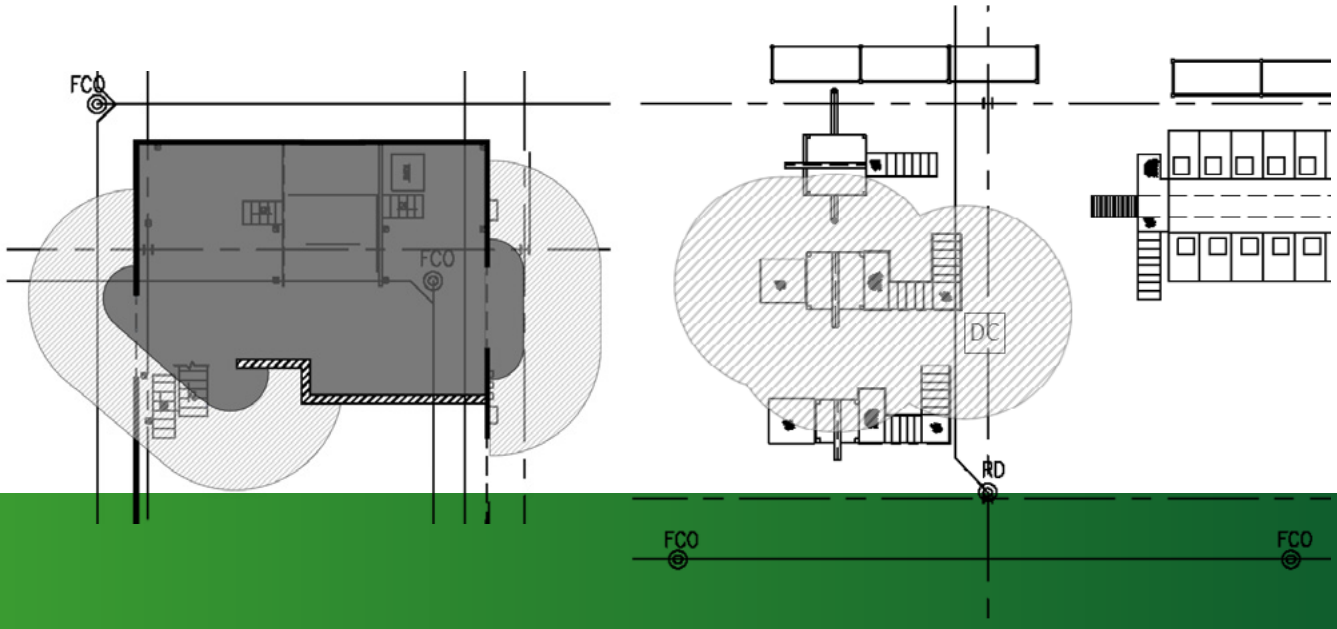
HAZARDOUS AREA CLASSIFICATION STEPS



Completed HAC and Next Steps

On completion, you will have an HAC drawing that establishes and describes the classified and unclassified areas of the facility. From this document you can determine and effectively communicate what electrical equipment is suitable for each area with additional information on acceptable equipment available from the relevant standards document or code that was selected for the HAC. Performing a gap analysis during the HAC process will identify where current electrical equipment is unsuitable for a certain location or if the equipment is improperly installed.

Follow up may be required to replace or repair equipment to conform to the relevant safety requirements. In contrast to identifying under-protected areas, your HAC may also reveal over-protected locations with rated equipment beyond what is necessary. In these situations, a simpler, less expensive option would suffice and using the information to make the most economical and safe choices for your process and facility is the intrinsic value of the hazardous area classification exercise.



Once the initial process has identified necessary changes to comply with hazardous area classification requirements and all the identified risks have been addressed, the task falls to staff at the facility to properly store the HAC data and keep it up to date. Simply storing the information and making certain that it's available will make the process of accessing or updating the HAC documentation much easier in the future.

Whenever a process undergoes changes, the management of change process must be performed, and the HAC documentation updated accordingly.

Safety consulting from Dustcon Solutions

Dustcon Solutions has a strong process safety and compliance background with more than 50 years of combined consulting experience and specialized expertise in conducting HACs and other assessments. Compliance and safety is integral to our business, which has more than 20 years of active involvement in the dust explosion protection industry as well as membership on the NFPA Technical Committees responsible for the latest standards pertinent to combustible dust explosion prevention.

Our consultants can provide the following services to help you with compliance and plant safety:

Hazard Analysis	+ Dust Hazard Analysis (DHA) + Hazardous Area Classification (HAC) + Process Hazard Analysis + Compliance Audits
Dust Testing Services	+ Explosibility & Combustibility Screening + Explosion Severity Testing (KSt, Pmax) + Ignition Sensitivity (MIE, MEC, MIT, etc) + Special Hazards Testing (self-heating)
Combustible Dust Training & Program Development	+ Customized Training Programs + Management Systems Development + Process Safety Management Support
Other Services	+ Incident Investigation + Special Expert Services + Explosion Protection Design + Project Management Support

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