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International Worker Safety Regulations Regarding Explosive Atmospheres

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1. Introduction

Atmospheres can be potentially explosive due to the possible presence of dust, vapor or gas that is likely to ignite and explode under certain conditions. Regulations related to explosive atmospheres fall into two categories:

- For equipment manufacturers
- For equipment users in the workplace

Regulations for equipment manufacturers cover equipment and protective systems intended for use in potentially explosive atmospheres and contain essential health and safety requirements and conformity assessment procedures, to be applied before products are placed on the market.

Regulations for equipment users deal with minimum requirements for improving the level of health and safety protection of workers potentially at risk from explosive atmospheres. These regulations apply to workplaces where explosive atmospheres can exist, for example, factories where flammable liquids or gases are present or where flammable dusts are produced in the process. They complement the responsibilities of manufacturers and set out the responsibilities of employers.

This white paper will address various international laws and regulations pertaining to the certification of electrical and non electrical equipment and machinery used in working conditions defined as explosive atmospheres. It will provide an overview or basic understanding of the legal requirements for electrical and mechanical machinery that may be used in these conditions.

2. Worker Safety and Explosive Atmospheres

Worker safety is both a legal and moral imperative for all employers. There are a variety of hazards that can present themselves to workers on a daily basis, especially if workers are laboring under hazardous conditions. There are a variety of hazards such as:

Safety

Safety hazards encompass any type of substance, condition or object that can injure workers. In many types of workplaces they can include spills on floors, walkways blocked by cords or boxes,

falls from heights, machinery with moving parts, confined spaces and electrical hazards such as frayed cords.

Biological Hazards

Biological hazards come from organisms, including people, animals and plants, and threaten human health. Examples of these hazards include mold, sewage, blood and bodily fluids. These dangers can result in diseases and allergic reactions and limit or end an employees' ability to work.

Chemical Hazards

Chemicals can be toxic, corrosive, flammable and combustible. As such, they can pose health risks to workers and become hazards if workers inhale, ingest or absorb them through their skin. Chemical hazards can cause acute and chronic harm. Acute/short term harm such as burns, irritation and vomiting, or chronic/long term issues, such as asthma, liver damage and cancer.

Physical Hazards

Physical hazards include activities or natural substances in a work environment that pose health risks. Extreme temperatures, poor air quality, excessive noise and radiation in the workplace can all harm workers, potentially causing respiratory problems, hearing loss, cancer or even death.

Ergonomic

Ergonomic related musculoskeletal disorders (MSDs) account for 33% of all employee injury and illness cases. These types of hazards occur when repetitive work, the type of work, or a certain position strains the body. These are the most difficult hazards to spot because they occur over time and are not often immediately recognized.

All of these hazards can be found in the workplace. However, this white paper will focus on one particular hazard, "explosive atmospheres" and the various legislation and standards encompassing this hazard.

An explosive atmosphere is defined as a mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapors, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture. Explosive atmospheres occur when flammable gases, mist, vapors or dust are mixed with air, creating a risk of explosion.

These atmospheres can be found throughout all industries, from chemical, pharmaceutical and food, to power generation and wood processing. Many workplaces may contain, or have activities that produce, explosive or potentially explosive atmospheres. Examples include places where work activities create or release flammable gases or vapors, such as vehicle paint spraying, or in workplaces handling fine organic dusts such as grain flour or wood. These areas may also be known as hazardous areas or hazardous locations.

In the course of review of the laws and regulations it has been found there is no one accepted standard or even terminology. The term “Hazloc” may be used as an abbreviation for hazardous location and the abbreviation ”ATEX” for explosive atmospheres. These terms tend to be regional, Hazloc in North America and ATEX in Europe. Additionally it has been found that different regions also use/require different marking and labeling of products.

Specific industries that are known for potential explosive atmospheric conditions are:

- Food production
- Synthetic manufacturing
- Chemical manufacturing
- Woodworking
- Power generation
- Metal processing
- Gas and oil industry
- Recycling facilities
- Mining industry

Electrical equipment and machinery under the scope of regulations includes:

- Explosion proof enclosures
- Gas and flame detection
- Motors, generators, and turbines
- Adjustable speed drives
- Lighting
- Industrial control panels and assemblies
- IT displays and handheld electronics
- Industrial controls
- Large equipment assemblies (skids)
- Liquid pumps
- Machinery

3. Countries

3.1. International Regulations

The International Labor Organization (ILO) is a specialized agency of the United Nations dedicated to employment and social issues. International Labor Standards (ILS) have been developed for labor administration, employment policy, working time, wages, social security, migrant workers and special categories of workers. However, more than half relate to occupational safety and health (OSH) issues.

International labor standards (conventions and recommendations) and the other instruments on OSH (codes of practice and guidelines) aim at ensuring and promoting a safe and healthy working environment.

The ILO's "Model code of safety regulations for industrial establishments for the guidance of governments and industry" serves as a template for countries looking for a guide for drafting laws or regulations for the improvement of safety conditions in industry settings. Regulations 114-116 give specific requirements for electrical equipment used in explosive atmospheres.

3.2. International Electrotechnical Commission System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres (IECEX)

Electrical, non-electrical, electronic and mechanical equipment intended for use in potentially hazardous environments must be evaluated for its impact on overall safety.

The International Electrotechnical Commission System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres (IECEx) System is an international voluntary system for the safety of electrical equipment installed in a potentially explosive atmosphere. It is similar to the IECEE CB scheme and is based on the IEC 60079 (electrical equipment) and IEC 80079 (non-electrical equipment) series of standards facilitated by the TC31 technical committee.

The IECEx Scheme, which addresses the use of both electrical and electronic equipment and mechanical equipment in explosive or potentially explosive environments, is used in over 26 countries including China, India, Korea and South Africa. IECEx Certified Equipment Scheme is a voluntary compliance system designed to assess and certify multiple aspects of potentially hazardous environments.

There are five countries in the world that have written IECEx into their national legal requirements as an accepted alternative to the national certification (albeit with some minor restrictions):

- Australia
- New Zealand
- Singapore
- India
- Israel

3.3. European Union

The European Union has promulgated several directives regulating this specific worker hazard, known as the ATEX directives. Electrical, non-electrical, electronic and mechanical equipment intended for use in potentially hazardous environments must be evaluated for its impact on overall safety. The directives apply to electrical as well as mechanical equipment and apply to gases, vapors, mists and dust atmospheres. The directives are:

Directive 2014/34/EU

This directive covers equipment and protective systems intended for use in potentially explosive atmospheres. The directive defines the essential health and safety requirements and conformity assessment procedures, to be applied before products are placed on the EU market.

Directive 99/92/EC

Also known as 'ATEX 137' or the 'ATEX Workplace Directive' this looks at the minimum requirements for improving the health and safety protection of workers potentially at risk from explosive atmospheres.

Directive 94/9/EC

Known as 'ATEX 95' or 'the ATEX Equipment Directive', Directive 94/9/EC is focused on the approximation of the laws of Members States concerning equipment and protective systems intended for use in potentially explosive atmospheres.

The ATEX regulations apply to both electrical and mechanical equipment, and protective systems for use on the surface, below ground and on fixed offshore installations. The ATEX regulations separate equipment into two groups:

- Group I – equipment intended for use in underground parts of mines, and to those parts of surface installations of such mines liable to be endangered by fire, damp and/or combustible dust
- Group II – equipment intended for use in other places liable to be endangered by explosive atmospheres

The ATEX directive requirements are mandatory throughout the European Economic Area (EEA), which comprises EU member nations as well as Iceland, Norway, Switzerland and Liechtenstein. A key difference between the ATEX directives and the IEC standard is that ATEX is a mandatory legal requirement for equipment in hazardous locations and IEC is only a certification of safety. IEC has been adopted into legal legislation in other countries.

North America

The US and Canada follow the same approach when defining and testing equipment. One of the main differences between the ATEX and HAZLOC regulations is that the ATEX directives scope includes both electrical and non-electrical equipment while the US and Canada only address electrical equipment.

The US National Electrical Code (NEC) and the Canadian Electrical Code (CEC) define hazardous locations as:

“An area where a potential hazard (e.g., a fire, an explosion, etc.) may exist under normal or abnormal conditions because of the presence of flammable gases or vapors, combustible dusts or ignitable fibers or flyings.”

Hazardous location standards can be categorized into 2 systems: Standards for the Division System and the Zone System.

The Class/Division/Group system is based on Article 500 of the National Electrical Code (NEC) and rules J18-000 to J18-072 of the Canadian Electrical code (CEC) where:

- Classes - defines the general nature of the hazardous material in the surrounding atmosphere
- Divisions - defines the probability of hazardous material being present in the surrounding atmosphere
- Groups - defines the type of the hazardous material in the surrounding atmosphere

The Zone system is based on Article 505/506 of the National Electrical Code (NEC) and Rules 18-000 to 10-074 of the Canadian Electrical Code (CEC), which follows the international method of area classification as developed by the International Electrotechnical Commission (IEC).

- Zones - defines the general nature (or properties) of the hazardous material - if it's gas or dust, and the probability of the hazardous material in the surrounding atmosphere
- Groups - defines the type of the hazardous material and (partly) the location of the surrounding atmosphere

All this information becomes particularly important when labeling of products is done.

3.4. United States

In the U.S, the Occupational Safety and Health Administration (OSHA) sets jobsite requirements based on a web of safety standards developed by industry standardization organizations like the National Fire Protection Association (NPFA) and American Petroleum Institute (API).

OSHA Publication 3073 defines a hazardous location as areas where flammable liquids, gases or vapors or combustible dusts exist in sufficient quantities to produce an explosion or fire. In hazardous locations, specially designed equipment and special installation techniques must be used to protect against the explosive and flammable potential of these substances.

Hazardous locations defined by these organizations use hazard classes and division groups. The three hazard classes – Class I, Class II, and Class III – categorize locations based on the type of substance in the atmosphere.

- Class I flammable gases: acetylene, hydrogen, ethylene, propane, and methane
- Class II combustible dust: metal dust, carbonaceous dust, and others dust like flour, grain, wood, and plastics
- Class III fibers and flyings: fibers and flyings

The regulations overseeing this topic can be found at:

- 46 CFR § 111.106-3 - General requirements
- 29 CFR 1910 - Occupational Safety and Health Standards
- 29 CFR 1910.94 - Occupational Safety Standards for Ventilation
- 29 CFR 1926.57 - Occupational Health and Environmental Controls - Ventilation
- NFPA 70/70E - National Electric Code/ Electrical safety in the workplace

In the United States, equipment must meet the National Electrical Code (NEC) ANSI/NFPA-70 and specific NFPA and ANSI standards.

3.5. Canada

The legislated requirements concerning electrical installations in hazardous locations are contained in the Canadian Electrical Code (CEC).

The hazardous location classification system in use in Canada for areas containing vapors of flammable liquids is the “Zone” system. The zone system is slightly different from the previous “Division” system of classification, which remains in use for areas containing combustible dusts and ignitable flyings.

The regulations overseeing this can be found at:

- R.S.C., 1985, c. L-2, Part II Occupational Health and Safety Canada Labour Code
- SOR/86-304 Canada Occupational Health and Safety Regulations
- CEC - Canada Electrical code

In Canada, equipment must meet the Canadian Electrical Code (CEC) CSA C22.1. and CAN/CSA 22.2 standards, many which have been adopted from IEC standards.

3.6. Mexico

The regulations overseeing this topic can be found at:

- Federal Labor Law
- Federal regulation of safety, hygiene and work environment
- NOM-001-SEE-2012 Electrical Installations (use)
- NOM-001-STPS-2008 Buildings, locales, installations and workplace areas – Safety Conditions
- NOM-005-STPS-1998 Relating to the safety and hygiene conditions in the work centers for the handling, transport and storage of dangerous chemical substances
- NOM-033-STPS-2015 Security conditions for carrying out work in confined spaces

The few voluntary standards used are adoptions of IECEx standards.

South America

Many countries in Latin America have no local standards of their own and accept international and national IECEx, ATEX and FM approval. Argentina and Brazil have adopted IEC requirements as well as their own marking and labeling.

3.7. Argentina

In Argentina, the regulation regarding the protection of workers exposed to risks derived from work in Explosive Atmospheres is mainly set forth in the IRAM 60.079 Standard, which constitutes an identical transposition of the IEC 67.079 Standard.

The purpose of this standard is to protect the safety and health of workers exposed to risks inherent to work in ATEX zones, through the application of corrective measures aimed at reducing the risk of explosion due to the presence of flammable substances and explosives as gases or vapors.

The regulations overseeing this topic can be found at:

- Resolution 4/2017 National Registry Specialists in Classification of Hazardous Areas
- Law 19.587, of April 21, 1972, Health and Safety at Work Law
- Chapter 18 of Title V of Decree No. 351/79 Flammability Hazards
- Law 24,557, of October 3, 1995 Occupational Hazards

The IRAM 60.079 Standard gives the essential criteria for assessing the risk of explosion and provides guidance so that the design and operation parameters of the activity reduce said danger.

3.8. Brazil

In Brazil, equipment intended for use in Explosive Atmospheres requires mandatory third-party certification to confirm compliance with the relevant INMETRO decrees (Portarias). INMETRO is the government department responsible for standardization and authorization of certification bodies. The relevant legislation for Explosive Atmospheres Equipment is Portaria INMETRO / MDIC number 179 from 2010/05/18.

The regulations overseeing this topic can be found at:

- Decree-Law No. 5,452,1943 Approves the Consolidation of Labor Laws

- MTb Ordinance No. 3.214 Approves the Regulatory Standards - NR - of Chapter V, Title II, of the Consolidation of Labor Laws, relating to Occupational Safety and Medicine
- Law 6514 of December 22, 1977, Consolidation of Labor Laws (CLT)
- Portaria No. 179, 2010 Requirements for the Conformity Assessment of Electrical and Electronic Equipment Designed for Explosive Atmospheres

Brazil IMETRO references NBR versions of the IEC standards noting they are adopted without deviation.

Asia

3.9. China

The laws governing worker safety including explosive atmospheric conditions are:

- The Standardization Law, and its implementation rules - all safety related standards (e.g. Ex) are defined as mandatory - mandatory standards must be complied with, otherwise it is forbidden to manufacture, sell or import products
- The Product Quality Law, and its rules, relevant regulations - industrial products relating to personal and property safety must comply with national mandatory standards
- The Production Safety Law, and its rules, relevant regulations - the design, installation, usage, maintenance and rebuild of safe equipments/products must comply with national standards
- Special Equipment Safety Law of the People's Republic of China, 2013 (Order of the President of the P.R.C. No. 4)
- Work Safety Law of the People's Republic of China

China has established complete explosive atmosphere standard systems, including gas/dust and electrical/non-electrical, all are compulsory standards. Most of them are identical/ equivalent to IEC/EN standards. China has broken their standards into 3 categories:

- GB 12476 series for dust
- GB 3836 series for gas
- GB 25286 series for non-electrical equipment

3.10. Japan

The current Industrial Health and Safety Law in Japan requires Group II explosion-protected electrical equipment to be certified by a recognized testing and inspection body.

The laws covering explosive atmospheres are:

- Industrial Safety and Health Act
- Labor Standards Act
- Cabinet Order No. 318, August 19, 1972 Order for Enforcement of Industrial Safety and Health Act
- Ministry of Labour Ordinance No. 32 of September 30, 1972 Ordinance on Industrial Safety and Health
- The Ministry of Health, Labour and Welfare Notification No. 16, 1969 Constructional Requirements for Electrical Equipment for Explosive Atmospheres

3.11. South Korea

Under the Industrial Health and Safety Act, the Korea Occupational Safety and Health Agency (KOSHA), it is required that explosion proof electrical components be KCs Ex certified. KOSHA requires the KCs Ex certification for all explosion proof electrical components.

The Korean Agency for Technology and Standards (KATS) is an official representative of the IECEx in Korea. Similar to other countries, this Korean agency accepts an Ex Test Report (ExTR) and/or an ATEX Report as a basis for issuing national certification.

The KCs mark was established to ensure the fundamental safety in the design and manufacturing of hazardous machinery and protective equipment in dangerous workplaces. The ultimate goal is to protect the health and safety of workers by preventing accidents.

The laws covering explosive atmospheres and worker safety are:

- Industrial Health and Safety Act (K-ISHA)
- Law No. 3532, 1981 Occupational Safety and Health Act

South Korea has adopted IECEx standards.

4. Conformity Marking

Each country or region is responsible for labeling electrical and/or mechanical equipment according to their individual requirements, including country specific conformity symbols like the CE (EU) or IM (INMETRO - Brazil) marks. In addition to these conformity marks specific

product labeling per that countries adopted standards will be necessary, examples are given below.

Markings requirements from some areas include:

- NEC/CEC – US and Canada
- ATEX – Europe
- INMETRO – Brazil
- ANZEx – Australasia

4.1. IECEx

- IECEx (electrical equipment - gas atmosphere)
- Ex explosion protection marking
- db type of protection (flameproof enclosure, level of protection „db“)
- eb type of protection (increased safety, level of protection „eb“)
- IIC equipment group (electrical equipment group II, subgroup IIC (typical gas: hydrogen), intended for use in areas where an explosive gas atmosphere is to be expected, other than mines susceptible to firedamp)
- T4 temperature class (max. surface temperature 135 °C)
- Gb equipment protection level (EPL Gb; equipment with high protection level)

4.2. European Union

ATEX (electrical equipment gas atmosphere)

- CE marking and number of the notified (monitoring) body (0158 = DEKRA EXAM GmbH) (not for equipment category 3)
-  Explosion protection symbol
- II - equipment group (equipment for use in hazardous areas, other than mines susceptible to firedamp)
- 2 - equipment category (category 2)
- G - explosive atmosphere (gas, vapor or mist)

4.3. US/Canada

US/Canada (electrical equipment), NEC Article 500

- Class I .....Hazard category
- Division I .....Area classification
- Groups A, B, C & D.....Hazardous atmosphere category (gas or dust grouping)
- T6 .....Temperature classification

NEC Article 505

- Class I .....Hazard category
- Zone 1 .....Area classification
- AEx.....Explosion-protection standard
- e.....Method of explosion protection
- IIC .....Hazardous atmosphere category (gas or dust grouping)
- T6 .....Temperature classification

5. Conclusion

While safety standards for equipment use in explosive atmospheres are similar throughout the world, there is still no uniform global standard. Therefore, products sold in different countries will require different certifications and labels. Different explosion risk environments will also require different markings and labeling symbols on the product labels and packaging.

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