Hazardous Locations

A look at Hazardous Locations Product Certification

Presented By
Jeremy Neagle
Assistant Chief Engineer
Hazardous Locations Products
Cortland, NY

Intertek– Arlington Heights, Il
27 April 2010
Objectives of this presentation

This presentation is an overview of Hazardous Locations product certification. By the end of this presentation you should be able to understand the following:

Part 1 – Intertek – Hazloc Overview
Part 2 – Tips to Minimize Time and Cost of a Certification Project
Part 3 – Explosion Safety History
Part 4 – Hazardous Locations Overview
Part 5 – ATEX
Part 6 – IECEx
Part 7 – Closing/Q&A
PART 1
Intertek – Hazloc Overview
Intertek’s Hazardous Location Credentials

OSHA accredited Nationally Recognized Testing Laboratory (NRTL) for Listing in the U.S.
Standards Council of Canada accredited Certification Organization (CO) and Testing Organization (TO) for Listing in Canada
UKAS Accredited Notified Body for the ATEX Directive (94/9/EC)
IECEx Certification Body (CB) and Test Laboratory (TL)
Full Hazloc Training provider, including an Accredited COMPEX Training Center
Site Safety Services provider (Risk Assessment, Area Classification and Inspection)
Hazardous Location Technical Services

Product Certification
- US/CAN – cETLus Listing
- ATEX – EU and other adoptive regions (Middle East, etc.)
- IECEX – Members Countries of the International IECEX Scheme

Field Evaluations/Inspections

Site Services
- Consultancy
- Inspections and Risk Assessments (Assemblies or Plant)
- Audits & Certification

Training
- Open session
- Tailored
PART 2
Tips to minimize the time and cost of a certification project
18-056 Non-essential electrical equipment

(1) No electrical equipment shall be used in a hazardous location, unless the equipment is essential to the processes being carried on therein.

(2) Service equipment, panelboards, switchboards, and similar electrical equipment shall, where practicable, be located in rooms or sections of the building in which hazardous conditions do not exist.
Designing for Hazardous Locations

What Market?
• Canada, US, ATEX…etc

What Classification?
• Class I, II, III Division 1, 2
• Zone 0, 1, 2

What Protection Technique?
• How have you designed the product

What Environmental conditions?
• Indoor or Outdoor Use (NEMA or Type rating)
• IP
• Extended ambient temperature range

ATEX or IECEx?
• Do you operate a Registered Quality System (ISO 9001)
Preliminary design review

• A Preliminary Design Review is a brief review of the critical areas of a products design intended to identify major non-compliances.

• Preliminary Design Reviews can minimize certification time and cost.

• In most cases the cost of the PDR can be credited against the complete evaluation project.
How to prepare a checklist to successfully test and certify a product

✓ Schematic/wiring diagrams
✓ P&ID
✓ BOM/Critical component list
✓ Product manuals/literature
✓ Certification details (environmental conditions, temperature ranges, Hazloc rating)
✓ Product and component samples as necessary
✓ Description of how product was designed to comply
All drawings and documentation should be official documents under a document control program. Specifically, each document should contain:

- A title block showing the manufacturer’s name
- Unique drawing number
- Revision level

Draft or unreleased drawings may be used for initial evaluation, but officially released drawings are necessary for completion of certification reports.
Drawings and Documentation

Typical drawings include:

- Block diagrams
- Control/Installation drawings
  - Intrinsic Safety Control drawings should be in accordance with ISA RP12.02.02
- Instruction/Operation/Maintenance manuals
- Electrical schematics
- Wiring diagrams
- Printed Circuit Board component layout and trace artwork
  - Showing trace routing, plating thickness, PCB thickness, ‘stack-up’, minimum track width
  - Scaled artwork or Gerber files may be provided
- Assembly/Sub-assembly drawings
- Bill of materials showing component details
  - Including component manufacturer’s name, model number, ratings, and approval status
- Marking drawings
  - Including marking method and location
- Casting/Machining drawings
  - Including critical physical dimensions with tolerances, wall thickness, thread specifications with gauging/tolerance
How to avoid costly delays

• Conduct a PDR to identify major issues and get on the same page with the evaluating engineer
• Set up drawings and documentation such that only critical aspects are controlled
• Complete Certification Agreements/FUS paperwork prior to completion of product evaluation
• Commit to a schedule as soon as possible
Aspects of equipment design which affect compliance

• IS/NI systems, incorrect assumption of ‘simple apparatus’, non-certified I.S. apparatus, control drawing details
• Wiring methods, conduit/cable seals, flammable process fluid seals, etc.
• Incorrect holes, threading/gauging or modifications to X.P. enclosures
• Energized equipment prior to purge cycle
Use of non-certified components

US/Canadian components
ATEX components
Non-certified components

Some components of simple design may be evaluated for use in the product, but often the necessary technical details can’t be obtained.

In many cases it may be more cost effective to replace the component with a Listed version.
PART 3
Explosion Safety: A Brief History
In 1913, a methane explosion at Universal Colliery, in Senghenydd, South Wales, killed over 400 miners.

The subsequent investigation found that the signaling system, consisting of a pair of bare wires connected to a bell at the surface, was capable of igniting a flammable mixture of methane and air.

The explosion safety industry was born, followed by a long evolutionary process in the safety of workers in potentially explosive atmospheres.
Subsequent research in Germany, UK, US and around the world lead to the development of many of the Hazardous Location protection techniques used today.
Affected Industries

Where might you find a Hazardous Location?

Any industry that processes, uses or manufactures materials that may give rise to a flammable atmosphere (gas, mist, liquid, dusts or even small fibers) may have a Hazardous Location. Such industries/processes include:

- Oil and Gas Drilling
- Petrochemical Refining and Processing
- Fuel Storage
- Chemical manufacturing
- Automotive Manufacturing
- Water Treatment
- Power Generation
- Pharmaceutical
- Distilleries
- Food manufacturers
- Aviation
- Military
- Painting
What is an explosion?

An explosion is any uncontrolled combustion wave.
Explosion Properties

In order to create an explosion there has to be fuel (for example an explosive gas such as hydrogen or methane), an oxidizer (such as the oxygen in air) and a source of ignition energy (for example, a hot surface or an electrical spark).

These three items are commonly referred to as ‘the fire triangle’
Explosion Properties

Where fuel and oxygen (normally the oxygen in air) are present in the workplace, potential ignition sources must be rendered safe to an acceptable level for the risk.
Explosion Properties

- At a critical concentration called the **most easily ignitable concentration (MEIC)**, the amount of energy required to cause ignition is minimal.

- The critical energy at the MEIC is called **minimum ignition energy (MIE)**.
Gas, Vapor and Mist

Most flammable gasses, vapors and mists must be mixed with oxygen to make them burn. There is about 20-21% oxygen in the air we breathe. Mixtures of a flammable gas and certain percentages of air will burn if ignited.

Too much or too little oxygen, the mixture will not ignite. The upper and lower concentrations of gas in atmospheric air, by volume, are known as their explosive or flammability limits.
Explosion Properties

**Lower Explosive Limit (LEL)**

The concentration of flammable gas or vapor in air, below which the gas atmosphere is not explosive.

**Upper Explosive Limit (UEL)**

The concentration of flammable gas or vapor in air, above which the gas atmosphere is not explosive.
# Examples of Explosive Limits

<table>
<thead>
<tr>
<th>Substance</th>
<th>LEL (%)</th>
<th>UEL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Propane</td>
<td>2</td>
<td>9.5</td>
</tr>
<tr>
<td>Ethylene</td>
<td>2.7</td>
<td>34</td>
</tr>
<tr>
<td>Acetylene</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>4</td>
<td>75.6</td>
</tr>
</tbody>
</table>
Explosive Atmosphere

Gas Groups (IEC Method)

The gases are divided into two groups:

**Group I** for mines susceptible to methane (firedamp).

**Group II** for explosive gases for locations other than mines; group II is further divided into three sub-divisions (groups):
**Explosive Atmosphere**

**IIA**, for atmospheres containing Propane or gases of an equivalent hazard.

**IIB**, for atmospheres containing Ethylene or gases of an equivalent hazard.

**IIC**, for atmospheres containing Hydrogen, Acetylene or gases of an equivalent hazard.
Explosive Atmosphere

Gas Groups (NA Method)
The gases are divided into four groups:

A, for atmospheres containing Acetylene or gases of an equivalent hazard.

B, for atmospheres containing Hydrogen or gases of an equivalent hazard.

C, for atmospheres containing Ethylene or gases of an equivalent hazard.

D, for atmospheres containing Propane or gases of an equivalent hazard.
Temperature Class

The **auto-ignition temperature** is the temperature, in °C, at which a gas will ignite spontaneously without another source of ignition.

Because these temperatures do not correspond with the gas groupings, a **temperature classification** was established.
Temperature Class

The resulting temperature class for the substances listed previously are shown below:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Temp Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>T1</td>
</tr>
<tr>
<td>Propane</td>
<td>T1</td>
</tr>
<tr>
<td>Ethylene</td>
<td>T2</td>
</tr>
<tr>
<td>Acetylene</td>
<td>T2</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>T1</td>
</tr>
</tbody>
</table>
## Temperature Class

<table>
<thead>
<tr>
<th>Temperature Class</th>
<th>Max Temp limit (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>450</td>
</tr>
<tr>
<td>T2</td>
<td>300</td>
</tr>
<tr>
<td>T3</td>
<td>200</td>
</tr>
<tr>
<td>T4</td>
<td>135</td>
</tr>
<tr>
<td>T5</td>
<td>100</td>
</tr>
<tr>
<td>T6</td>
<td>85</td>
</tr>
</tbody>
</table>
Dusts

Around 50 explosions are reported per year, ranging from small deflagrations to building destroying detonations which lead to large numbers of fatalities. They are usually associated with the grain and mining industries, however they can occur whenever a process uses particulate materials, either as feed stocks, intermediates or products.
There are a few basic rules to observe to see whether a dust is capable of causing a dust explosion:

- The dust must be combustible.
- The dust must be capable of becoming airborne.
- The dust concentration must be within the explosive range.
- An ignition source must be present.
- The atmosphere must contain sufficient oxygen to support and sustain combustion.
Dust cloud explosions can only occur if the dust concentration is within certain limits.

This is analogous with the concept of upper and lower flammable limits of mixtures of gas (or vapors) and air.

In general the lowest concentration of dust that can give a dust explosion is around 50-100g/m³ and the maximum is 2-3kg/m³.

These limits are dependent on the particular chemical in question and on the particle size distribution; however they are included here to give an idea of the orders of magnitude involved.
Primary and Secondary Explosions

The concentrations needed for a dust explosion are rarely seen outside of process vessels, hence most severe dust explosions start within a piece of equipment (such as mills, mixers, screens, dryers, cyclones, hoppers, filters, bucket elevators, silos, aspiration ducts, and pneumatic transit systems). Explosions in these areas are known as Primary Explosions.

Secondary explosions occur when dust, which has accumulated in other areas (such as above ceilings or on roof trusses), is thrown into suspension by the primary explosion and then ignited.
### Dust Properties that affect the Dust Explosion Hazard

<table>
<thead>
<tr>
<th>Dust</th>
<th>Ignition Temp Deg C (cloud)</th>
<th>Ignition Temp Deg C (layer)</th>
<th>Ignition Energy mJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>610</td>
<td>170</td>
<td>60</td>
</tr>
<tr>
<td>Flour</td>
<td>470</td>
<td>300</td>
<td>80</td>
</tr>
<tr>
<td>Tea</td>
<td>510</td>
<td>300</td>
<td>100</td>
</tr>
<tr>
<td>Grain</td>
<td>510</td>
<td>300</td>
<td>80</td>
</tr>
<tr>
<td>Cocoa Power</td>
<td>580</td>
<td>460</td>
<td>80</td>
</tr>
<tr>
<td>Cellulose</td>
<td>520</td>
<td>410</td>
<td>80</td>
</tr>
</tbody>
</table>
Protection Techniques

A variety of protection techniques are available to mitigate the risks posed by potential ignition sources.

The protection technique(s) employed should be selected based on their compatibility with the product or process.
EXPLOSIONPROOF/FLAMEPROOF

Standards: UL 1203/IEC 60079-1

Flamepath
Explosion Testing
INTRINSIC SAFETY

Standards: UL 913/IEC 60079-11
PURGED AND PRESSURIZED ENCLOSURE

Standards: NFPA 496/IEC 60079-2
INCREASED SAFETY

Standard: IEC 60079-7
OIL IMMERSION

Standard: IEC 60079-6
POWDER/SAND FILLING

Standard: IEC 60079-5
ENCAPSULATION

Standard: IEC 60079-18
Type n Protection (Non-incendive)

Standards: ISA 12.12.01/IEC 60079-15

Non sparking/arcing parts
Restricted breathing
Simplified pressurization
Energy limited apparatus

Sealed or encapsulated device
Enclosed break
Hermetically sealed
Non-incendive component
PART 5
ATEX (94/9/EC)
What is ATEX?

ATEX
is a set of European Directives relating to Hazardous Area Installations and spells out a set of Essential Health & Safety Requirements (EHSR’s)

ATEX 95/100a (94/9/EC) - Equipment
ATEX 137 (1999/92/EC) - Installations
Why was ATEX introduced?

To ensure that manufacturers adhere strictly to the latest European Normatives (EN Standards) with respect to design construction & certification.

When Did the ATEX Directive Go Into Effect?

The ATEX Directive took effect on a voluntary basis on March 1, 1996. Effective July 1, 2003, all products placed on the market or put into service in the EU for use in potentially explosive atmospheres must comply with the ATEX directive.
CE Marking

The CE Marking is a legal requirement for products covered by one or more of the EU directives stipulating its use.

CE is a TRADE issue, not a safety issue.

Conformity European
When does CE apply?

Within the Community, the free movement of electrical equipment follows when equipment complies with certain safety requirements recognized in all Member States.

The compliance of electrical equipment may be presumed from the affixing or issue of marks or certificates.
What does CE imply?

Equipment may be placed on the market only if, having been constructed in accordance with good engineering practice in safety matters in force in the Community, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made.
What does CE imply?

Equipment may be placed on the market only if, having been constructed in accordance with good engineering practice in safety matters in force in the Community, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made.
The Main CE Directives

LVD (2006/95/EC)
EMC (2004/108/EC)
Machinery (2006/42/EC)
PED (97/23/EC)
ATEX (94/9/EC)
Before being placed on the market, equipment must have affixed to it the CE marking attesting to its conformity to the provisions of this Directive, including the conformity assessment procedures.

Where equipment is subject to other Directives concerning other aspects which also provide for the affixing of the CE marking, the latter shall indicate that the equipment in question is also presumed to conform to the provisions of those other Directives.
CE Requirements, Cont.

Compliance with the Essential Health and Safety Requirements of each Directive must be demonstrated.

Harmonized standards may be used to show presumption of conformity to some of these EHSR’s.
ATEX Equipment Types

Equipment
Protective Systems (Flame Arrestors etc.)
Safety Devices (Intrinsic Safety Barriers etc.)
Components
Equipment Categories

The ATEX Directive, in Annex I, defines five categories of equipment:

- **M1 and M2** (mining use)
- **CAT 1, CAT 2, and CAT 3** (non-mining use)

The categories relate to the likelihood of the presence of an explosive atmosphere. The classification of equipment into categories enables precautions to be taken that are appropriate for the risk.
## Equipment Categories vs. Area Classification

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat 1, M1</td>
<td>Zone 0, 20</td>
</tr>
<tr>
<td>Cat 2, M2</td>
<td>Zone 1, 21</td>
</tr>
<tr>
<td>Cat 3</td>
<td>Zone 2, 22</td>
</tr>
</tbody>
</table>
It is Mandatory for a Quality Assurance Notification (QAN) Certificate to be issued for CAT 1 and CAT 2 electrical equipment and CAT 1 non-electrical equipment.

The Notified Body responsible for the QAN can be identified by a 4 digit number under or adjacent to the CE Mark.
ATEX 94/9/EC Certification

Product Certification – Electrical

Categories 1 & 2 (M1 & M2)
- Certification of equipment by Notified Body
- Certification of Quality System by Notified Body

Category 3 – Self Declaration by manufacturer
- Internal Control of Production

Product Certification – Non-Electrical

Category 1 & M1
- Certification of equipment by Notified Body
- Certification of Quality System by Notified Body

Category 2 & M2 – Requires a Technical Dossier to be lodged with a Notified Body

Category 3 – Self Declaration by manufacturer
- Internal Control of Production
Conformity Assessment Procedures [ATEX (94/9/EC)]

- Equipment of Groups I & II Categories M1 & 1 and Autonomous Protective Systems
  - EC Type-examination by NB [Annex III]
  - Production QA by NB [Annex IV] or Product Verification by NB [Annex V]
  - Conformity to Type Tests by NB [Annex VI]
- Equipment of Groups I & II Categories M2 & 2
  - Internal combustion engine or Electrical equipment
    - Yes
    - EC Type-examination by NB [Annex III]
  - Internal control of production (Manufacturer’s declaration) [Annex VIII]
- Equipment of Groups II Category 3
  - Internal control of production (Manufacturer’s declaration) [Annex VIII]
Example of ATEX Marking Requirements

ABC Analytical Ltd

Any Street, Birmingham. UK

K 0359  Ex  II 2 GD  T = 135°C

Model 246 controller

Serial No. 12345/03

Ex d [ia] IIIB T4
ITS10ATEX45678X

Do not open when energized or when a flammable atmosphere is present.
PART 6
IECEx Scheme
IECEx Scheme

Multilateral Certification Scheme used to obtain National Certification in participating member countries.

- Ex Equipment Certification
- Ex Personnel Certification
- Ex Service Facility Certification
IECEx Scheme

Member countries:
IECEx Scheme - Equipment

Requires:

• Evaluation and Testing by IECEx TL to IEC standards. IECEx TL issues an IECEx Test Report (TR).

• IECEx CB conducts an audit of the Quality Management System of the manufacturer. IECEx CB issues a Quality Assessment Report (QAR).

• TR is endorsed by CB and is used in conjunction with the QAR to create IECEx Certificate of Conformity (CoC).
IECEx Scheme

Benefits:

- Reduces time to market
- International confidence in product
- One international database of certified products
IECEx Scheme

Challenges:

- IECEx CoC is not solely accepted for National Certification by many member countries.
- Most member countries have extensive national deviations to the base IEC standards (including using different editions of the base standard).
- Limited availability of IECEx certified components.
PART 7
Summary & Closing

Many of the topics discussed today were covered only briefly.

If you wish to discuss any of these topics further, or if you would like a tailored training session relevant to your specific products please contact us for details.