An Overview of Hazardous (Classified) Location Area Electrical Classification

by

David Wechsler

April 3, 2003
Area Electrical Classification

Installation of Electrical Equipment

Hazardous Area
- Explosion proof
- Pressurized
- Oil Immersion
- Non incendive
- Hermetically sealed
- Intrinsic Safety

Electrical Apparatus Certifications, Listings Markings
Area Electrical Classification

What's involved with it?
Risk Assessment
What is an Area Electrical Classification?

Risk based methodology used to quantify material characteristics with potential electrical ignition sources resulting in the objective of reducing a fire/explosion potential.

Areas found to be applicable are considered “hazardous (classified) locations”.

Overview EAC by David Wechsler 4
Location Electrical Classification Team

Develop Classification Team Procedural Plan that defines:
- Objectives Electrical Classification
- Team Members and responsibilities
- Documentation of Classification work
The Area Electrical Classification Team

- Assemble team

Minimum 3 people with expertise levels -
Operations - process
Electrical - maintenance and design
Process Safety
Location Electrical Classification Team

Maintain well documented, complete, area Electrical Classification information that is readily available.

Suggestion: Use dated Classification Drawing to reflect Specific Materials and their Material Group, AIT
Notes if the classification is different from “Standard” criteria
Notes to link supportive information
i.e., purged building
The Fire Triangle

The Hazardous (Classified) Location Methodology

Fuel
Class I, II, etc.

Oxygen
Atmosphere

Ignition Source
Electricals
Data Collection

What are the processing conditions?

What materials are used?

Where are the materials used?

How are the materials used?

Are there any ignition sources, actual or potential, in the area?

Note: Not all potential ignition sources are electrical in nature. Example, High pressure steam lines.
Data Collection

Example of some forms for data collection:

| Flammable material | DEG | Variability | Vapour pressure at 35°C | Relative density of gas or vapour in air | Ignition temperature | Group and 
temporary code | Any other relevant information and remarks |
<table>
<thead>
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<table>
<thead>
<tr>
<th>Plant:</th>
<th>Area:</th>
<th>Flammable material</th>
<th>Variability</th>
<th>Ignition temperature</th>
<th>Group and temporary code</th>
<th>Any other relevant information and remarks</th>
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</table>

Notes:
- Normally, the value of vapour pressure is given, but in the absence of data, it is assumed to be 100 kPa.
- For example, 100 kPa.

1 C - Continuous; B - Binary; P - Primary.
2 Quote the number of N in part 1.
3 D - Dry; L - Liquid; LQ - Liquid gas; S - Solid.
4 N - Natural; A - Artificial.
5 See Annex B.
Assessment of Risk

What is the Risk?

The Fire Triangle

- Presence of fuel in the atmosphere
- Oxygen
- Ignition Source

Mitigation as needed - Electrical Apparatus selection

Not much control over
the Standards World

US OSHA
NEC

Canada
CEC

ATEX
CENELEC

IEC
Comparison
Classification Methodologies

• “Class, Division”
  – Class I, Division 1
  – Class I, Division 2
  – Unclassified
  – Group A
  – Group B (hydrogen)
  – Group C (ethylene)
  – Group D
  – T Code T1, T2, T2A-D, T3, T3A-C, T4-A, T5, T6 (450-85 C)

• “Zone 0”
  – Zone 0
  – Zone 1
  – Zone 2
  – Unclassified
  – Group IIC
  – Group IIC
  – Group IIB
  – Group IIA
  – T Code T1-T6
    (450-85 C)
Division System

Division 1

Division 2

Zone System

Zone 1

Zone 2

Zone 0
HazLoc Classification based upon the NEC

I. Definitions and Explanations
   A. Class I, II, III - Define the material
   B. Divisions- Address the risk; probability and frequency the material being present in hazardous (ignitable) concentrations.

Division 1 - Present frequently
Division 2 - Present only under abnormal operations
Unclassified - Not likely to be present at all
NEC Group B(D) Clarification

Example, NFPA 497 Selected Class I Chemicals

<table>
<thead>
<tr>
<th>Material</th>
<th>CAS No.</th>
<th>NEC Group</th>
<th>Flash point °C</th>
<th>AIT °C</th>
<th>%LFL</th>
<th>%UFL</th>
<th>Vapor Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Styrene</td>
<td>100-42-5</td>
<td>D</td>
<td>31</td>
<td>490</td>
<td>0.9</td>
<td>6.8</td>
<td>3.6</td>
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<tr>
<td>Isoprene</td>
<td>78-79-5</td>
<td>D</td>
<td>-54</td>
<td>220</td>
<td>1.5</td>
<td>8.9</td>
<td>2.4</td>
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<tr>
<td>Butadiene</td>
<td>106-99-0</td>
<td>B*D</td>
<td>-76</td>
<td>420</td>
<td>2</td>
<td>12</td>
<td>1.9</td>
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</table>

Note: B*D means this material exhibits properties that places it into the Group B category. However, permission to use Group D electrical equipment is given, provided all conduit ½ in. and larger is sealed. This is a design choice and for classification purposes the area(s) where this material is used should be reflected as Group B*D locations.
NFPA 497 - Process Equipment

Effects of Size Pressure Flow

<table>
<thead>
<tr>
<th>Process Equipment</th>
<th>Small/ Low</th>
<th>Moderate</th>
<th>Large/ High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (gallons)</td>
<td>&lt; 5000</td>
<td>5000 - 25000</td>
<td>&gt; 25000</td>
</tr>
<tr>
<td>Pressure (psi)</td>
<td>&lt; 100</td>
<td>100 - 500</td>
<td>&gt; 500</td>
</tr>
<tr>
<td>Flow Rate (gpm)</td>
<td>&lt; 100</td>
<td>100 - 500</td>
<td>&gt; 500</td>
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</table>
### NFPA 497 Effects of Size Pressure Flow

<table>
<thead>
<tr>
<th>Process Equipment</th>
<th>Small/Low</th>
<th>Moderate</th>
<th>Large/High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Press</td>
<td></td>
<td></td>
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<tr>
<td>Flow</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>

#### Diagram

- **A**: Source (0) → 25' → 3' → 10' → 15' → 50' → 100'
- **B**: Small/Low ✓ Moderate ✓ Large/High ✓
- **C**: Small/Low ✓ Moderate ✓ Large/High ✓
Classification Documentation

Classification Drawing should contain:

a) Specific chemical(s), AIT, Group information
b) Notes regarding classification details
c) Approvals with signatures for
   Process Engineering
   Manufacturing
   Control Systems/Electrical
   Safety
d) Dates for drawing, Revisions, and sign-offs
## Combustible Dust - Ignitible Fiber Zone

**New NEC proposal**
(under consideration)

<table>
<thead>
<tr>
<th>Existing:</th>
<th>Proposed:</th>
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<tbody>
<tr>
<td>NEC Article 502 - Combustible Dusts</td>
<td>NEC Article 506 - Zone 20, 21, and 22 Locations for Flammable Dusts, Fibers, and Flyings</td>
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<tr>
<td>NEC Article 503 - Ignitible Fibers</td>
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<tr>
<td>Class II, Division 1</td>
<td>Zone 20</td>
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<tr>
<td>Division 2</td>
<td>Zone 21</td>
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<tr>
<td>Unclassified</td>
<td>Zone 22</td>
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<tr>
<td>Groups E, F, and G</td>
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<tr>
<td>Class III, Division 1</td>
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<td>Division 2</td>
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</table>
Area Electrical Classification

Electrical Apparatus Considerations

**Hazardous Area**
- Explosion proof
- Pressurized
- Oil Immersion
- Non incendive
- Hermetically sealed
- Intrinsic Safety

Electrical Apparatus Certifications, Listings Markings
the Standards World

US OSHA
NEC

Canada
CEC

ATEX
CENELEC

IEC
Decisions, decisions....

Zone 0

Division

Class I

Affecting:
Instrumentation Control Systems
Area Electrical Classification
Equipment, Installation, Maintenance

Intrinsic safety

Explosion-proof
Pressurized
Equipment Type Comparisons
Electrical Code

- US Electrical Code
  - Class, Division
    - Explosion proof
    - Pressurized
    - Oil Immersion
    - Non incendive
    - Hermetically sealed
    - Intrinsic safety (partial)

- IEC Electrical Codes
  - Zone 0
    - Flameproof
    - Pressurized
    - Oil Immersion
    - Non sparking
    - Encapsulated
    - Intrinsic safety (full)
    - Increased safety
    - Special protection
Installation Consideration Comparisons

US Electrical Code
• Conduit with Explosionproof seals
• Cable Tray
• Thread type and engagement
• Wire gauge/ampacity
• Grounding/bonding

IEC Electrical Codes
• Cable, with Cable glands
• Cable Tray
• Metric Thread type and engagement
• Wire gauge/ampacity
• Earthing
Equipment selection

Some considerations -

What is the application?

What is the best functional apparatus within cost considerations?

Installation and wiring/cabling method?

Is the apparatus available as being “suitable” for the Area Electrical Classification?
Is the apparatus “suitable” for the Area Electrical Classification?

Suitability of identified equipment may be determined by one of the following:
(1) Equipment listing or labeling

(2) Evidence of equipment evaluation from a qualified testing laboratory or inspection agency concerned with product evaluation

(3) Evidence acceptable to the authority having jurisdiction such as a manufacturer's self-evaluation or an owner's engineering judgment
Cross-Fertilization of Electrical Apparatus

Can IEC electrical apparatus be installed as a general rule in a US Class I, Division 2 location?

Answer: Highly probable

Can IEC electrical apparatus be installed as a general rule in a US Class I, Division 1 location?

Answer: Only if you are one of those unique folks that daily enjoys running 25 miles, when the temperature exceeds 101F and the humidity exceeds 88%, you might find a way, but not as a general installation rule.
the Standards World

US OSHA NEC

Canada CEC

ATEX CENELEC

IEC
Electrical Equipment Markings

United States

Underwriter Laboratory Listing

Factory Mutual Approval

Canada

Canadian Standards Approval Certification
Equipment Marking

**CENELEC & IEC**

**EEx ia IIC T4**

- Certified to the CENELEC standard
- Explosion protected
- Protection concept (IS)
- Apparatus Group (gas)
- Temperature classification

**IP or Ingress Protection Codes**

<table>
<thead>
<tr>
<th>First numeral</th>
<th>Protection Against solid bodies</th>
<th>Second numeral</th>
<th>Protection Against liquid</th>
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<td>0</td>
<td>No protection</td>
<td>0</td>
<td>No protection</td>
</tr>
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<td>1</td>
<td>Objects greater than 50 mm</td>
<td>1</td>
<td>Vertically dripping water</td>
</tr>
<tr>
<td>2</td>
<td>Objects greater than 12 mm</td>
<td>2</td>
<td>Angle dripping water</td>
</tr>
<tr>
<td>3</td>
<td>Objects greater than 2.5 mm</td>
<td>3</td>
<td>Sprayed water</td>
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<tr>
<td>4</td>
<td>Objects greater than 1.0 mm</td>
<td>4</td>
<td>Splashed water</td>
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<tr>
<td>5</td>
<td>Dust-Protected</td>
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<td>Water jets</td>
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<td>6</td>
<td>Dust-Tight</td>
<td>6</td>
<td>Heavy seas</td>
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<td>7</td>
<td>Effects of immersion</td>
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<tr>
<td></td>
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<td>8</td>
<td>Indefinite immersion</td>
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Protection Code
- d Flameproof
- ia Intrinsic Safety
- e Increased Safety
- p Pressurization
- n Non-incendive
- s Special
Equipment Marking

US - IEC

AEx ia IIC T4

Protection Code

da Flameproof
ia Intrinsic Safety
e Increased Safety
p Pressurization
n Non-incendive
s Special

Temperature classification
Apparatus Group (gas)
Protection concept (IS)
Explosion protected

IP or Ingress Protection Codes

<table>
<thead>
<tr>
<th>First numeral</th>
<th>Protection Against solid bodies</th>
<th>Second Numeral</th>
<th>Protection Against liquid</th>
<th>IP vs NEMA</th>
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<td>2</td>
<td>Objects greater than 12 mm</td>
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<td>Angle dripping water</td>
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<td>3</td>
<td>Objects greater than 2.5 mm</td>
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<td>Sprayed water</td>
<td>64</td>
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<tr>
<td>4</td>
<td>Objects greater than 1.0 mm</td>
<td>4</td>
<td>Splashed water</td>
<td>65</td>
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<td>5</td>
<td>Dust-Protected</td>
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<td>Water jets</td>
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<td>Dust-Tight</td>
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<td>Heavy seas</td>
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<td>7</td>
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<td>8</td>
<td>Indefinite immersion</td>
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ATEX Marking

ID-Number of Notified Bodies

Equipment Group

Zone 0

0102 II 1 G Ex
EXLUX 6008/142-8 Example for type of series
R. Stahl Example for Manufacturer
EEx de IIB T4 Example for type of explos. protection
PTB 96 ATEX 2144X Example for test number

ATEX 100

EN 50014

Zone 1

0102 II 2 G Ex
EEx ia IIC T4 Example for type of explos. protection
PTB 96 ATEX 3844X Example for test number

Zone 2

0102 II 3 G Ex
EEx n IIA T4 Example for type of explos. protection
PTB 96 ATEX 3244X Example for test number

Gas (G) or Dust (D)

Category
## Certifications

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<thead>
<tr>
<th>Country</th>
<th>Applicable Certification</th>
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<tbody>
<tr>
<td>USA</td>
<td>Nationally Recognized Testing Laboratory (NRTL) - example: FM, UL, ETL</td>
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<tr>
<td>Canada</td>
<td>Standards Council of Canada certified body - example: CSA</td>
</tr>
<tr>
<td>Europe</td>
<td>ATEX - EU Notified Body</td>
</tr>
<tr>
<td>Australia</td>
<td>ANZEx scheme for certification body</td>
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</table>
The certification “mark” will drive where the electrical apparatus may be installed.

While an objective is to be able to have globally acceptable markings, there currently is none yet.
Area Electrical Classification

Installation of Electrical Equipment

Hazardous Areas

- Explosion proof
- Pressurized
- Oil Immersion
- Non incendive
- Hermetically sealed
- Intrinsic Safety

Electrical Apparatus Certification, Listings, Markings

Questions:?
The Speaker - Dave Wechsler is a Global Process Safety Technology Leader located at the Dow Chemical Freeport TX facility. He is also the Technical Resource Leader for Dow's Global Electrical Area Classification Technical Resource Network which is the core group that addresses area classification issues for the Dow Chemical Company locations, globally. Dave is the Principle American Chemistry Council, formerly CMA, representative on the NEC CMP-14 responsible for the Chapter 5 Hazardous (Classified) Locations Articles, and on the Electrical Equipment in Chemical Atmospheres (EECA) that is responsible for NFPA 496, 497 and 499, as its former vice chairman. A senior member of ISA, Dave is also very active on SP12 and many of its hazardous locations committees. He is also a member of the ANSI/IEC -Technical Advisory Group working with IEC standards representing "user" interests.