“Making Safe Waves in Hazardous Areas”

John Hartley
Managing Director - Extronics Limited.

Extronics is represented locally by Extech Safety Systems.
Contact Gary Friend - gary@extech.co.za - 0833098200
Overview

- Background
- Market Growth & Drivers
- What is the potential issue with RF in hazardous areas?
- Why are radio waves dangerous in hazardous areas?
- Which protection concepts can be deployed?
- What can be done to mitigate against the hazards?
- New Solutions & Developments
Introduction of RF in Hazardous Areas

- UK government instructed research approx. 40yrs ago
- Resultant findings led to acceptable safe RF limits
- Various approval standards now use this information:
  CLC/TR50427, BS 6656, EN 60079, IEC 60079
- Various methods & protection concepts now available
- Restrictive product choice / performance
Dramatic Growth in Wireless Deployments

- The Wireless LAN equipment and WiFi phone market is forecast to exceed $7 billion by 2017.
- Data volumes forecast to increase 10 fold in the same period.

Infonectics Research & AT&T
Market Drivers

- More certified client devices; mobile phones, tablets etc.
- MIMO technology – works well in multipath environments, plant structures etc.
- Wireless location & tracking platforms
- WiFi based plant maintenance & inspection
- “Mobile worker”
Ignition of a hazardous area can be caused by spark due to short circuits or inadequate creepage and clearance between conductors.

Ignition is also caused by the heating effect of components conducting electrical current when not adequately power rated.

Protection by various concepts including enclosures (Ex d) or encapsulation (Ex m).

Alternatively certified Z2 (safe in normal operation).
What is the electrical hazard?

- Wireless radio devices can fault, and pass on the hazardous condition to the antenna.
- Hazardous AC / DC / transient faults can exceed energy threshold limit of 50uJ for Group IIC (EN60079-0: 6.6.1)
RF in hazardous areas (defined as 9kHz – 60GHz) can induce currents in metallic structures and may cause sparking if there is a gap in the structure.

Dissipated power may be sufficient to ignite a flammable atmosphere if the radio wave is strong enough.
Columns and pipes, tanker loading stations and cranes can act as an antenna.

The flanges connecting the pipes to the column, the loading arm near the track and the crane hook is the discontinuity or the point where incendive sparks may occur.
6.6.1 Radio frequency sources

The threshold power of radio frequency (9 kHz to 60 GHz) for continuous transmissions and for pulsed transmissions whose pulse durations exceed the thermal initiation time shall not exceed the values shown in Table 4. Programmable or software control intended for setting by the user shall not be permitted.

**Table 4 – Radio frequency power thresholds**

<table>
<thead>
<tr>
<th>Equipment for</th>
<th>Threshold power W</th>
<th>Thermal initiation time µs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>6</td>
<td>200</td>
</tr>
<tr>
<td>Group II A</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>Group II B</td>
<td>3.5</td>
<td>80</td>
</tr>
<tr>
<td>Group II C</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Group III</td>
<td>6</td>
<td>200</td>
</tr>
</tbody>
</table>
Wireless in Hazardous Areas – What is the Hazard with RF?

For pulsed radar and other transmissions where the pulses are short compared with the thermal initiation time, the threshold energy values $Z_{th}$ shall not exceed those given in Table 5.

<table>
<thead>
<tr>
<th>Equipment for</th>
<th>Threshold energy $Z_{th}$ μJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>1 500</td>
</tr>
<tr>
<td>Group IIA</td>
<td>950</td>
</tr>
<tr>
<td>Group IIB</td>
<td>250</td>
</tr>
<tr>
<td>Group IIC</td>
<td>50</td>
</tr>
<tr>
<td>Group III</td>
<td>1 500</td>
</tr>
</tbody>
</table>

NOTE 1 In Tables 4 and 5, the same values are applied for Ma, Mb, Ga, Gb, Cc, Da, Db, or Dc equipment due to the large safety factors involved.

NOTE 2 In Tables 4 and 5, the values for Group III are adopted from Group I and not based on experimental results.

NOTE 3 In Tables 4 and 5; the values apply in normal operation, provided that the user of the equipment does not have access to adjust the equipment to give higher values. It is not necessary to consider possible increases in power caused by faults, due to the large safety margins involved and the strong likelihood that RF amplifiers will rapidly fail if a fault occurs that significantly increases the output power.
Existing Methods of Protection...

- Ex d enclosure with antenna mounted behind window
Pros & Cons of Ex d Window Enclosures

- Low investment for R&D & certification
- Reduced radiated power at high frequencies due to signal attenuation through glass and surrounding enclosure.
- Only directs RF power through window
- Shadows / black spots for coverage
- Large Footprint
- Heavy & bulky solution
Existing Methods of Protection...

- Ex d antennas
- Antennas are certified explosion proof
  - Designed to withstand explosion
  - Use the thread as a flame path
  - Impact / UV resistant
  - Thermal assessment (T-Class)
Pros & Cons of Ex d Antennas

- Must be notified body assessed
- Ex d must be mounted directly to Ex enclosure or Ex conduit – limits installation options
- Limited choice on the market
- Hot work permit to power down equipment & replace antenna
**Existing Methods of Protection...**

- Ex e antennas
- Antennas are certified ‘increased safety’
  - Use creepage and clearance – ensures no sparks occur between elements / PCB trace
  - Impact / UV resistant
  - Thermal assessment (T-Class)
Pros & Cons of Ex e Antennas

- Performance not impaired by protection concept
- Must be notified body assessed
- Ex’e’ antenna must be terminated in safe area (Ex’d’ enclosure) install via glands.
- Limited choice on the market
- Hot work permit to power down equipment & replace antenna
Existing Methods of Protection...

- Antennas are certified Ex m
  - Antenna element is encapsulated
  - Impact / UV resistant
  - Thermal assessment (T-Class)
Pros & Cons of Ex m Antennas

- Must be notified body assessed
- Only work well at lower frequencies
- Antenna must be terminated in safe area (Ex’d’ enclosure) install via glands.
- Limited choice on the market
- Hot work permit to power down equipment & replace antenna
Existing Methods of Protection...

- Gas detectors: limit RF power in hazardous conditions
Pros & Cons of Gas Detectors

- Allows high power RF transmissions
- Needs system approval from notified body
- No AC / DC transient protection when power limit activated
- Limited or no coverage during hazardous periods
- Cannot be used for mission critical applications
Intrinsic Safety Methods...

- Fully certified radio transmitter device such as VHF radio with IS leaky feeder antenna output
- Use of certified IS barrier:
  - Zener / Shunt
  - Galvanic isolation (high pass / band pass filter or tuned filter circuit)
Pros & Cons of IS circuits:

- Allows use of most standard antennas
- Allows ‘hot swap’ of antennas
- Some circuits do not work or perform poorly e.g. isolation transformers or zener barriers
- Some barriers require high integrity earth – costly to install
- Some filter circuits can let through unsafe energy levels from transients so are component U approved rather than apparatus approved and require further notified body assessment
How do we protect our RF Outputs?

Intrinsically Safe RF Galvanic Isolator

- Band pass - safe ‘let through’ energy for IIC
- Protects against all known hazardous AC, DC and transient faults
- No notified body radio assessment
- Use with non-certified antennas
- For use in Group I & II and Zone 0, Zone 1 & Zone 2
- Makes any RF output intrinsically safe
Using 1.2/50µS transient with 1500Vpk

Calculated let through energy of 1.2pJ

24µW transient peak
Assessment of IS RF Circuits

- Typically there are 2 types of IS RF circuit;
  - Vmax, Imax and Pmax safety parameters – assessed as a conventional IS circuit with heating effect of power into the load and cable parameters being required
  - No Vmax, Imax and Pmax parameters – Only RF power needs considering

- Antennas are classified as “simple apparatus”

- Compliance to the General Ex Requirements should be adhered to and consideration of the antenna as a static electricity hazard and materials of construction such as aluminium being used.
Safe RF Deployment in Hazardous Areas

- Check RF hardware max power output (device datasheet)

**EN60079-0**, 6.6.1: Max Tx power can be software limited, but it must not be possible for the user to override this

- Check antenna gain (device datasheet)
- Cable losses can be taken into account
- Calculate max RF threshold power for gas group:
  
  \[ \text{Tx output (dBm) + antenna gain (dBi) - losses (dB)} \]

  **IIC** = 2W(33dBm), **IIB** = 3.5W(35.4dBm), **IIA** = 6W(37.7dBm)
Antenna Gain Must not be Forgotten

- Extronics RF link budget calculator is a simple tool to not only calculate maximum link distances and data rate throughput but also whether the EIRP at the antenna is safe to use in a hazardous area.

<table>
<thead>
<tr>
<th>Transmitter output power (dBm)</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable Loss</td>
<td>2.5</td>
</tr>
<tr>
<td>-Length (m)</td>
<td>2</td>
</tr>
<tr>
<td>-Connector Loss (dB)</td>
<td>0.5</td>
</tr>
<tr>
<td>Antenna Gain (dBi)</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total Transmit (dBm)</strong></td>
<td>35.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max Safe EIRP in Ex Areas</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Group IIIC</td>
<td>32</td>
</tr>
<tr>
<td>Gas Group II</td>
<td>36</td>
</tr>
<tr>
<td>Gas Group IIA</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Approx. Climate Propagation Losses (Wf)</th>
<th>dB/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drizzle (0.25mm/hr)</td>
<td>0.001</td>
</tr>
<tr>
<td>Fog (0.1 g/m³)</td>
<td>0.001</td>
</tr>
<tr>
<td>Heavy Rain (25mm/hr)</td>
<td>0.005</td>
</tr>
<tr>
<td>Excessive Rain (150mm/hr)</td>
<td>0.01</td>
</tr>
<tr>
<td>Snow</td>
<td>0.01</td>
</tr>
<tr>
<td>Sandstorm</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Summary

- Rapid Growth in Wireless Deployment inc Hazardous Areas
- Changes in standards have clarified RF deployment
- New galvanic isolators allow non-certified radio transmitters to be used
- Opens up a range of devices for hazardous areas
- Connecting the industrial ‘Internet of Things’
Any Questions?

Extronics is represented locally by Extech Safety Systems.
Contact Gary Friend - gary@extech.co.za - 0833098200