Containerized Flammable and Combustible Liquids

RIPA 2016 Technical Conference
April 26, 2016

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Fire Risk Factors - Impact on Ignition Probability, Fire Growth, and Fire Control

- Liquid properties – physical, combustion, and self-reactivity
- Ignition potential and liquid classifications
- Container types and failure mechanisms
Container Selection

When considering the peril of fire, why does it matter?
Container Style & Type
Some Considerations

Electrostatic Dissipative (ESD)

Fire Resistive Performance

Relieving Style or Non-Relieving Style Steel

Permeability of Non-Polar Liquids into Plastic

UL Listed and Non-Listed
Container Selection - Issues to Consider

When utilized with flammable or combustible liquids:

- Risk of ignition when filling, emptying, or moving containers
- Fire performance of filled containers – Failure Mode
- Once ignited, ability of sprinkler systems to mitigate the effects of fires
Combustion of Flammable & Combustible Liquids Can Include:

- Pool Fires
- 2D & 3D Spill Fires
- Jetting
- Ruptures
Fire codes, Regulations, Standards, and Guidelines Users May Encounter in U.S.

- National Fire Protection Association – NFPA 30
- International Fire Code – IFC Chapter 57
- Insurance Company Requirements
- OSHA – 1910.106
- DOT/UN - 49 CFR
# NFPA & IFC Liquid Classifications

<table>
<thead>
<tr>
<th>NFPA Classification</th>
<th>Flash Point</th>
<th>Boiling Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class IA Flammable Liquid</td>
<td>&lt; 73 °F (22.8 °C)</td>
<td>&lt; 100 °F (37.8 °C)</td>
</tr>
<tr>
<td>Class IB Flammable Liquid</td>
<td>&lt; 73 °F (22.8 °C)</td>
<td>≥ 100 °F (37.8 °C)</td>
</tr>
<tr>
<td>Class IC Flammable Liquid</td>
<td>≥ 73 °F (22.8 °C) &amp; &lt; 100 °F (37.8 °C)</td>
<td>-</td>
</tr>
<tr>
<td>Class II Combustible Liquid</td>
<td>≥ 100 °F (37.8 °C) &amp; &lt; 140 °F (60 °C)</td>
<td>-</td>
</tr>
<tr>
<td>Class IIIA Combustible Liquid</td>
<td>≥ 140 °F (60 °C) &amp; &lt; 200 °F (93 °C)</td>
<td>-</td>
</tr>
<tr>
<td>Class IIIB Combustible Liquid</td>
<td>≥ 200 °F (93 °C)</td>
<td>-</td>
</tr>
</tbody>
</table>
# U.S. Dept. Of Transportation
## Liquid Classifications

<table>
<thead>
<tr>
<th>Class 3 Liquids</th>
<th>Flash Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable Liquid</td>
<td>&lt; 140 °F (60 °C)</td>
</tr>
<tr>
<td>Combustible Liquid</td>
<td>≥ 140 °F (60 °C) &amp; &lt; 200 °F (93 °C)</td>
</tr>
</tbody>
</table>

Additionally, the U.S. DOT further defines the degree or level of danger as follows:

<table>
<thead>
<tr>
<th>Class 3 Packing Groups</th>
<th>Flash Point</th>
<th>Initial Boiling Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>I – Great Danger</td>
<td>-</td>
<td>≤95 °F (35 °C)</td>
</tr>
<tr>
<td>II – Medium Danger</td>
<td>&lt;73 °F (23 °C)</td>
<td>&gt;95 °F (35 °C)</td>
</tr>
<tr>
<td>III – Minor Danger</td>
<td>≥73 °F, ≤140 °F (≥23 °C, ≤60 °C)</td>
<td>&gt;95 °F (35 °C)</td>
</tr>
</tbody>
</table>
Some Significant Fire Losses

- Sandoz Fire, Schweitzerhalle, Switzerland, 1986
- Sherwin-Williams Fire, Ohio, 1987
- Chemie-Pack Fire, The Netherlands, 2011
- Magnablend Fire, Texas, 2011

Images are screen captures from online news sources.
Sandoz
Schweizerhalle, CH - 1986
Sherwin-Williams
Dayton, Ohio - 1987
Magnablend
Waxahachie, TX - 2011
NFPA 30 Quantity Limits - “Unprotected Storage” of Plastic and Composite Containers

<table>
<thead>
<tr>
<th>Liquid Class</th>
<th>Plastic Containers</th>
<th>Rigid Nonmetallic IBC’s and Composite IBC’s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum Storage Height (ft.)</td>
<td>Maximum Total Quantity per Pile or Rack Section (gal)</td>
</tr>
<tr>
<td>IA</td>
<td>5</td>
<td>660</td>
</tr>
<tr>
<td>IB</td>
<td>5</td>
<td>1,375</td>
</tr>
<tr>
<td>IC</td>
<td>5</td>
<td>2,750</td>
</tr>
<tr>
<td>II</td>
<td>10</td>
<td>4,125</td>
</tr>
<tr>
<td>IIIA</td>
<td>15</td>
<td>13,750</td>
</tr>
<tr>
<td>IIIB</td>
<td>15</td>
<td>13,750</td>
</tr>
</tbody>
</table>

NP: Not permitted.
### NFPA 30 Quantity Limits - “Unprotected Storage” of Metal Containers

<table>
<thead>
<tr>
<th>Liquid Class</th>
<th>Maximum Storage Height (ft.)</th>
<th>Maximum Total Quantity per Pile or Rack Section (gal)</th>
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<th>Maximum Total Quantity (gal)</th>
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<tr>
<td>IA</td>
<td>5</td>
<td>660</td>
<td>660</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td>IB</td>
<td>5</td>
<td>1,375</td>
<td>1,375</td>
<td>7</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>IC</td>
<td>5</td>
<td>2,750</td>
<td>2,750</td>
<td>7</td>
<td>4,000</td>
<td>4,000</td>
</tr>
<tr>
<td>II</td>
<td>10</td>
<td>4,125</td>
<td>8,250</td>
<td>7</td>
<td>5,500</td>
<td>11,000</td>
</tr>
<tr>
<td>IIIA</td>
<td>15</td>
<td>13,750</td>
<td>27,500</td>
<td>7</td>
<td>22,000</td>
<td>44,000</td>
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<tr>
<td>IIIB</td>
<td>15</td>
<td>13,750</td>
<td>55,000</td>
<td>7</td>
<td>22,000</td>
<td>88,000</td>
</tr>
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</table>

NP: Not permitted.
Chapter 16 has a total of 12 tables specifying sprinkler system design criteria for various liquid classes, container types, storage heights and arrays, as well as ceiling heights.

- There are 7 tables specific to metal containers.
- There are 5 tables specific to plastic containers.
- There are an additional 2 tables in Appendix D specific to plastic containers.
Full-Scale Sprinkered Fire TEST @ UL
Flammable and Combustible Liquids in Plastic Intermediate Bulk Containers (IBC’s) & Drums

- A number of manufacturers produce materials containing various soluble solvent mixtures and water

- These blends can be treated as “less-hazardous” liquids allowing us to develop effective and reliable sprinkler system design criteria.
Additional Testing Opportunity

Flammable and Combustible Liquids in Plastic Intermediate Bulk Containers (IBC’s) & Drums

Phase I – Ignition & combustion properties of various aqueous organic solutions - Completed

Phase II – Additional testing including large-scale sprinklered fire tests – Not yet funded
The DOT Dilemma

• Transportation focused, does not consider storage

• Containers must pass physical tests, e.g., pressure test, drop test, etc.

• Explicit fire testing of container is not performed for DOT approval

• Allows flammable liquids in plastic IBC’s and has no jurisdiction over storage

• OK to Ship But Not OK to Store?
OSHA 29CFR 1910.106


• Silent on electrostatic ignition risks that are addressed in the Recognized and Generally Accepted Good Engineering Practices contained in NFPA 77, Recommended Practice on Static Electricity.

• 29 CFR 1910.106 also does not address the fire performance of containers storing ignitable liquids.
Some Useful Links

http://www.youtube.com/watch?v=yZO0C1nO_6s

http://www.youtube.com/watch?v=EekafP5Lr4

http://www.youtube.com/watch?v=y3pvEtva40Q

http://www.nfpa.org/ibc

http://www.hse.gov.uk/research/rrhtm/rr564.htm
Questions?

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Thank you!