Flexible Gas Piping - Evolving Technology & Industry

NARUC Annual Meeting
Austin, Texas
November 8, 2015
Flexible Gas Piping

• **Corrugated Stainless Steel Tubing (CSST)**
  – Flexible
  – Continuous lengths

• **Jacketed**
  – Yellow CSST - insulative
  – Black CSSTs – arc protective designs

• **Fittings**
  – Field attachable
  – Transition to NPT
1983 GRI Residential Gas Piping Program
  - Innovative piping systems
  - Gas competitiveness
  - Japanese technology

AGA 1-87 Requirements for CSST

ANSI LC 1-1991

Harmonized w/ CSA in 1997

ANSI LC 1 /CSA 6.26 2014
CSST Benefits

- ~75% fewer joints than rigid
- Productivity
- Seismic/settling
- Gas competitiveness w/ electric
- Increased gas utilization
Industry Lightning Experience

• 2003 – Frisco, TX
• 2006 – Class action – enhanced warnings
• 2009 – NFPA 54 direct bond
• 2013 – GTI report, Bonding Effectiveness
• 2015 – NFPA 54-2018 Public Inputs
Industry Safeguards

- Yellow CSST Installation Safeguards
  - Direct-bond
  - Separation
  - Chase Exclusion
- Protective Jacketed CSST
  - ICC-ES PMG listing criteria
    - LC1024 (2010)
    - LC1027 (2011)
Lightning Test for Protective Jacketed CSST

- Accredited lightning testing laboratory
- Lightning generator delivers defined charge to sample
Lightning Tests and Listings Utilized by the CSST Industry

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LC1024 (Coulombs)</th>
<th>LC1027 (Coulombs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Charge</td>
<td>4.5 C</td>
<td>36 C</td>
</tr>
<tr>
<td>Min. Peak Current (Amps)</td>
<td>1,000 A</td>
<td>30,000 A</td>
</tr>
<tr>
<td>Test Charge Basis</td>
<td>Assumption of 2 coulomb maximum transient arcing energy w/in building</td>
<td>50th percentile of negative lightning flashes measured @ ground *</td>
</tr>
</tbody>
</table>

* Informed from SAE ARP5412B Aerospace Recommended Practice, ‘Aircraft Lightning Environment and Related Test Waveforms’
Lightning Strikes
Magnitude and Frequency

Negative Flash to Ground
Parameter: Cumulative Charge Transfer

Informed from SEA ARP5412B Aerospace Recommended Practice,
*Aircraft Lightning Environment and Related Test Waveforms*
Industry Tests for Protective Jacketed CSST

Sec. 4.4.2. Indirect Effects 2, Represent 50\textsuperscript{th} percentile of negative lightning flashes measured at ground

<table>
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<th>Cumulative Charge Transfer (Coulombs)</th>
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<tr>
<td>LC1024 &amp; ANSI LC 1</td>
</tr>
<tr>
<td>LC1027</td>
</tr>
<tr>
<td>LC1027-Lubbock FGS (^1)</td>
</tr>
</tbody>
</table>

\(^1\) LC1027-Lubbock FGS - Lubbock, TX, Fuel Gas Subcommittee and city staff, minimum CSST arc resistance requirement, 8/26/15.
• Single Layer Conductive Jacketed CSST
  – Semi-conductive polymer layer
  – Spread and dissipate energy
  – 4.5 Coulomb test
  – Black jacket
LC1027-listed CSST

- Metallically Shielded CSST
  - Multi-layer
  - Metallic shield between polymer layers
  - Shield-to-fitting electrical continuity
  - Spread and dissipate energy
  - 36 Coulomb test
  - Black Jacket
Industry Reports and Articles

- **Whitepaper (Titeflex)**
  - *Comparison of Listing Criteria for Protective-Jacketed CSST*

- **APGA Source**
  - *Emerging CSST Products*
  - Feature article, July 2015
Recent National Press

- **Lawyers, Lightning and Building Codes**
  - Public safety
  - Role of litigation in product development

- **Buddy Holly’s Hometown Unlikely Pioneer with Lightning and CSST**
  - Lubbock, TX, minimum requirement for LC1027-rated CSST
Fuel Gas Piping System Using CSST

- Yellow CSST performance requirements
  - Since 1991
- Sec. 5.16 Arc resistant jacket (optional)
  - Since 2014
    - 4.5 Coulomb (C) electrical arcing test
    - Extreme temperature
    - Resistance to corrosion
    - Resistance to installation damage
• Recent proposals to ANSI LC 1 performance standard
  – Increase 4.5 C electrical arcing test to 36 C
  – Test in direct contact
  – Add low voltage withstand

• Proposals have moved to working groups
  – CSA process and maintenance
  – Working groups open to outside experts
22 Public CSST Comments

16 Restrictive
  - LC1027 minimum, protective jacket
  - Direct-bonding limits
    - 50-ft max. bond wire length
    - Clamp location
  - 6” separation req’t
  - Metal studs exclusion
  - Provide ground fault current path
    - Single layer conductive jacketed
    - Yellow jacket
Can the NFPA 54 Technical Committee rely on higher CSST performance levels into the ANSI LC 1?

Gas Associations support for improvements?

<table>
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<tr>
<th>ANSI LC 1 Test Area</th>
<th>2014 LC 1</th>
<th>Proposals @ Working Group</th>
</tr>
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<tbody>
<tr>
<td>Electrical Arcing Withstand</td>
<td>4.5 C</td>
<td>36 C</td>
</tr>
<tr>
<td>Electrode to Test Sample</td>
<td>1/8” air gap</td>
<td>Contact with sample</td>
</tr>
<tr>
<td>Low Voltage Withstand</td>
<td>No Test</td>
<td>Add test for residential current fault</td>
</tr>
</tbody>
</table>
A CSST Future

• More robust performance standard
  – Lightning resistance
  – Low voltage withstand

• Metallically Shielded or equivalent performing CSST
  – Installation productivity
  – Joint reduction
  – Seismic performance
  – Greater reliability
Thank you