



Flexible Gas Piping - Evolving Technology & Industry

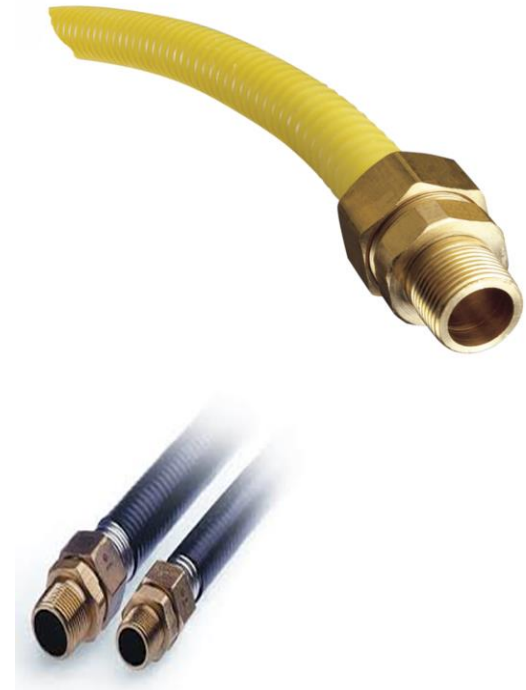
NARUC Annual Meeting

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



ANSI Performance Standard - *Fuel Gas Piping Systems Using CSST*

- 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

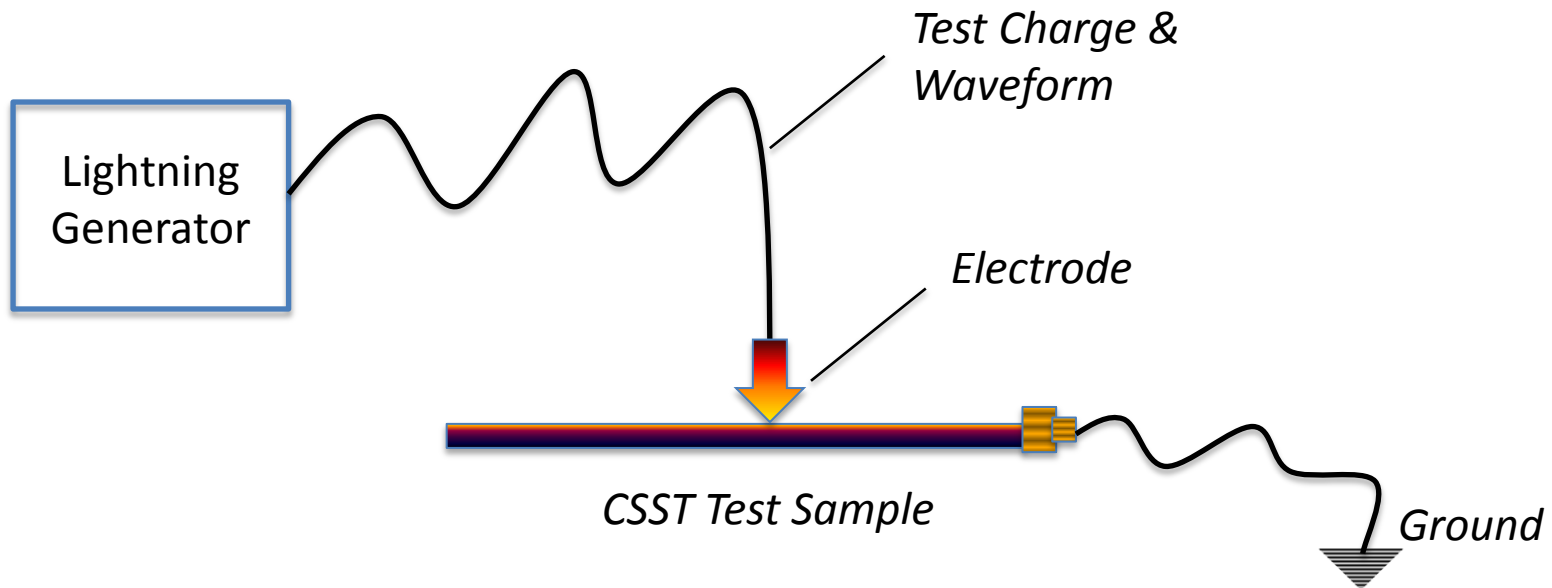
Industry Safeguards

- 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

	ICC-ES PMG Listing Criteria	
Parameter	LC1024	LC1027
Test Charge (Coulombs)	4.5 C	36 C
Min. Peak Current (Amps)	1,000 A	30,000 A
Test Charge Basis	Assumption of 2 coulomb maximum transient arcing energy w/in building	50 th percentile of negative lightning flashes measured @ ground *

* Informed from SAE ARP5412B Aerospace Recommended Practice, 'Aircraft Lightning Environment and Related Test Waveforms'

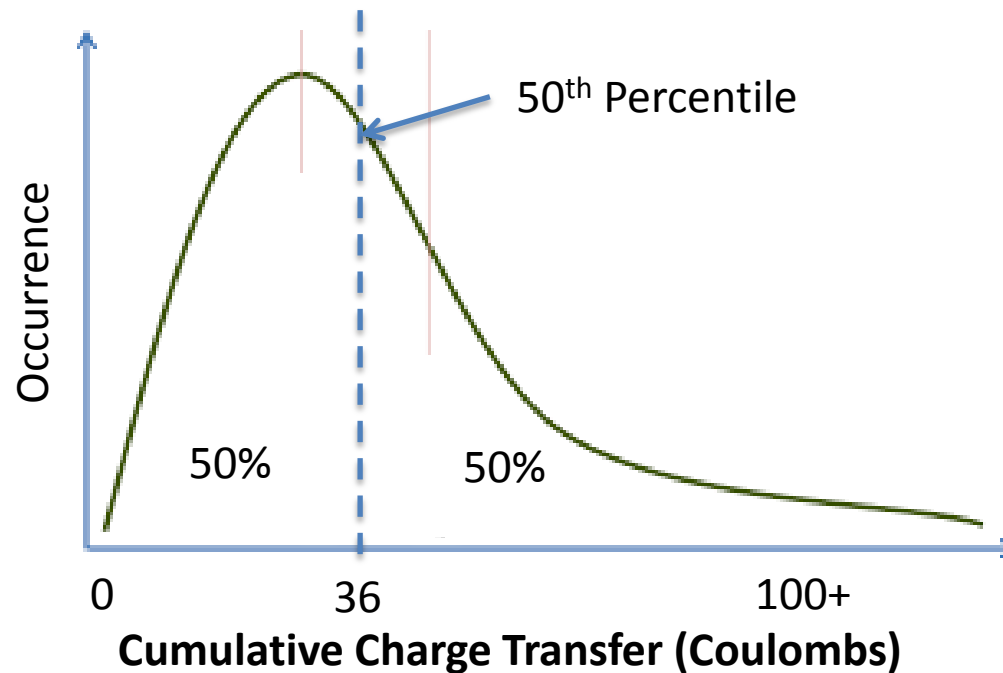
Lightning



Lightning Strikes Magnitude and Frequency

Negative Flash to Ground

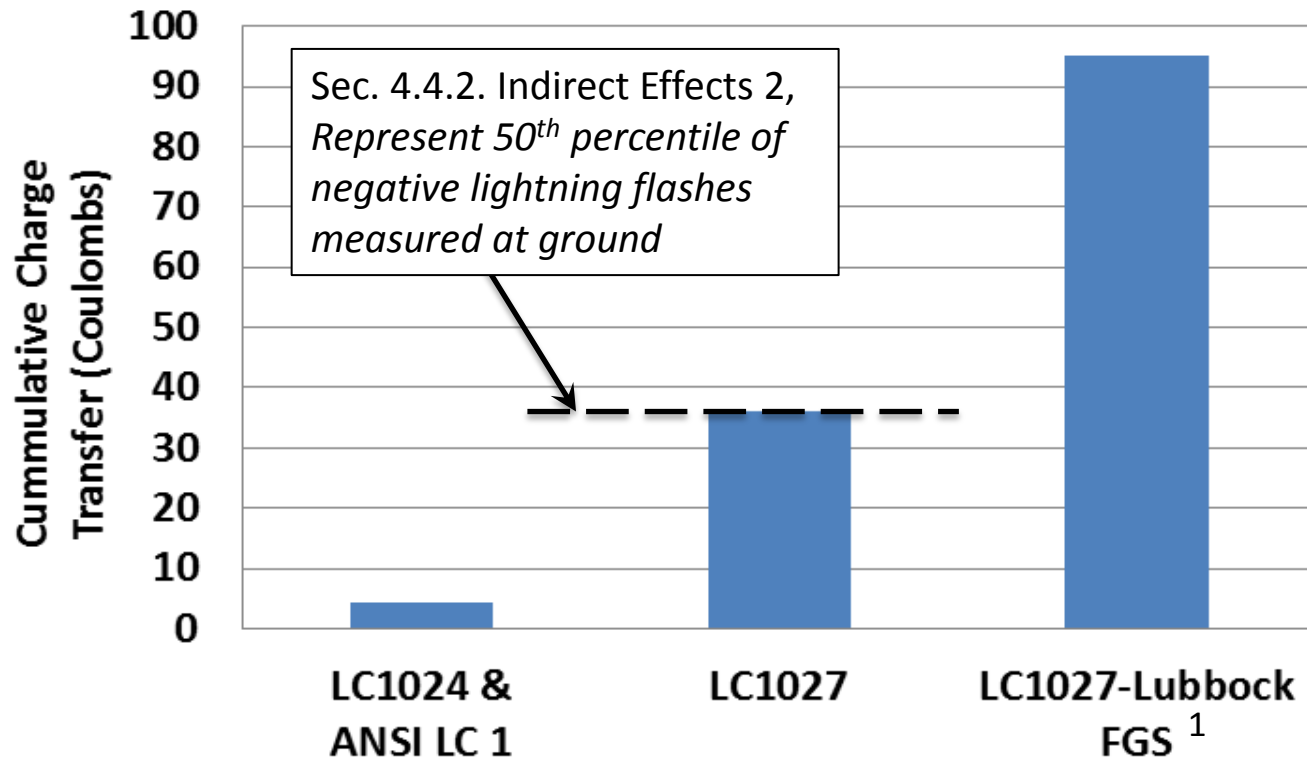
Parameter: Cumulative Charge Transfer



Informed from SEA ARP5412B Aerospace Recommended Practice,
Aircraft Lightning Environment and Related Test Waveforms

Distribution model

Industry Tests for Protective Jacketed CSST



¹ LC1027-Lubbock FGS - Lubbock, TX, Fuel Gas Subcommittee and city staff, minimum CSST arc resistance requirement, 8/26/15.

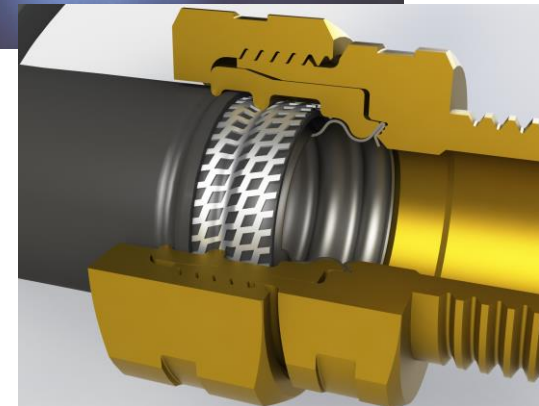
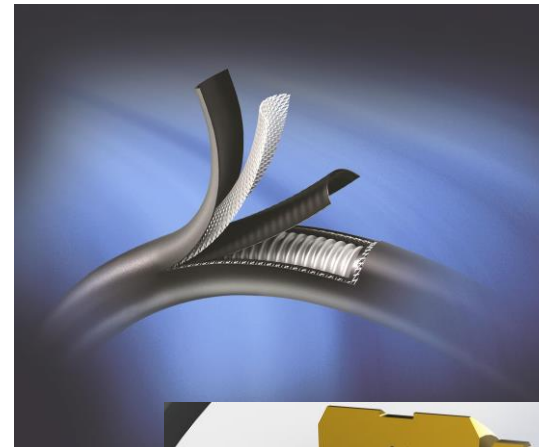
LC1024-listed CSST

- 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

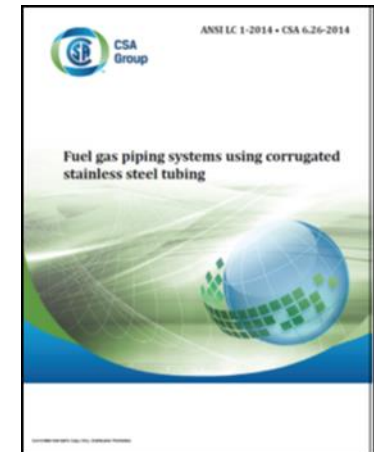
- *Lawyers, Lightning and Building Codes*
 - Public safety
 - Role of litigation in product development
- *Buddy Holly's Hometown Unlikely Pioneer with Lightning and CSST*
 - Lubbock, TX, minimum requirement for LC1027-rated CSST




ANSI LC 1 CSST Performance Standard

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

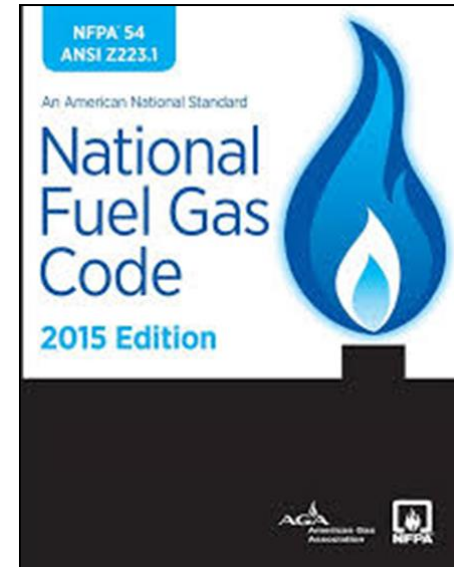


ANSI LC 1 CSST Performance Standard

- 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

Public Inputs to NFPA 54 -2018

- 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



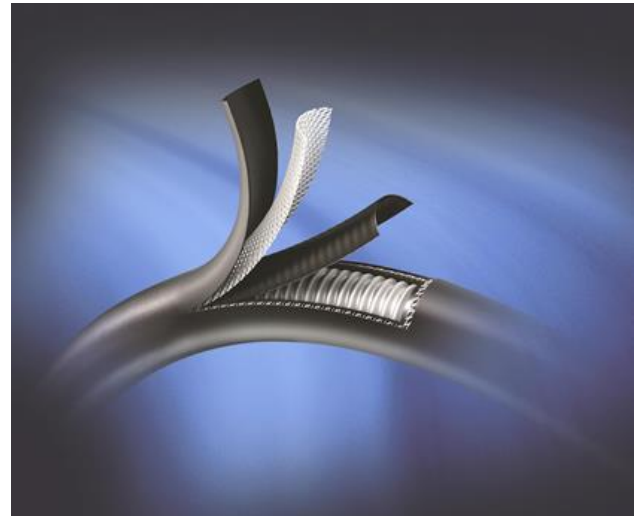
NFPA 54 -2018

- Can the NFPA 54 Technical Committee *rely* on higher CSST performance levels into the ANSI LC 1 ?
- Gas Associations support for improvements?

ANSI LC 1 Test Area	2014 LC 1	Proposals @ Working Group
Electrical Arcing Withstand	4.5 C	36 C
Electrode to Test Sample	1/8" air gap	Contact with sample
Low Voltage Withstand	No Test	Add test for residential current fault

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