MacLean™
POWER SYSTEMS

MAXIMIZING & VALIDATING ULTIMATE CAPACITY IN HIGH STRENGTH APPLICATIONS

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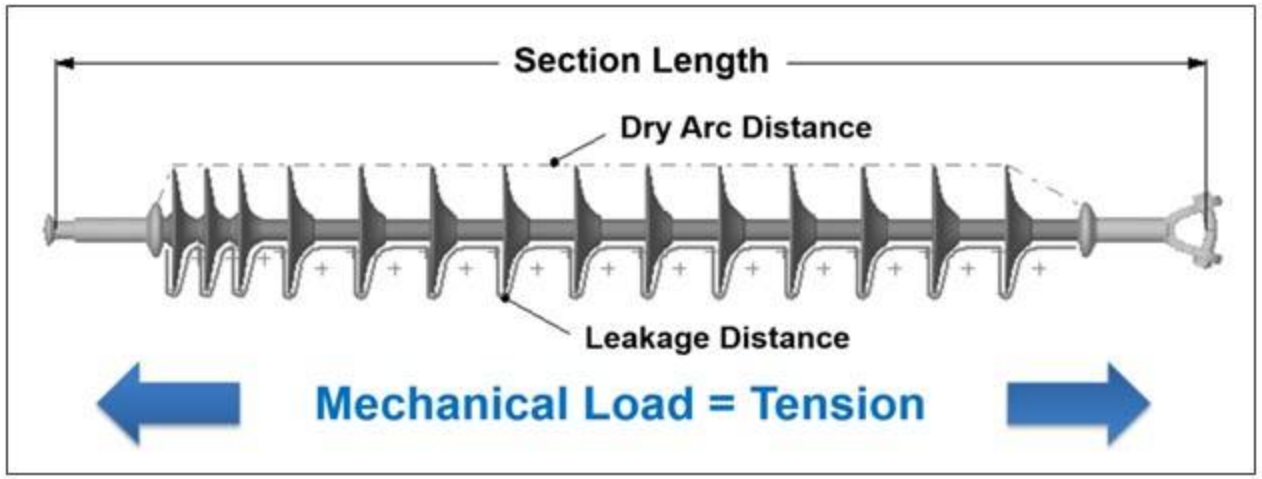
INMR 2019

SUSPENSION & TENSION INSULATORS



- Primary load = tensile
- Not limited by section length
- End fittings governed by Standards
- Easily Quantifiable
- Established 3rd Party Test Protocol

End Fitting Pull-off

End Fitting Break

Rod Shatter

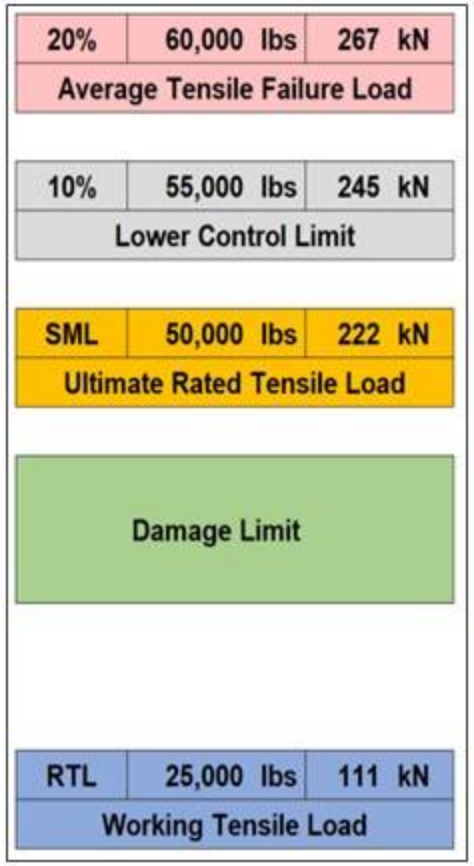
TENSILE RATINGS

Defined in Standards / Included on Product cut sheet

- SML = Specified Mechanical Load = Ultimate Rated Load
- RTL = Routine Test Load = Working Load
  - 50% of SML
  - Customer Defined

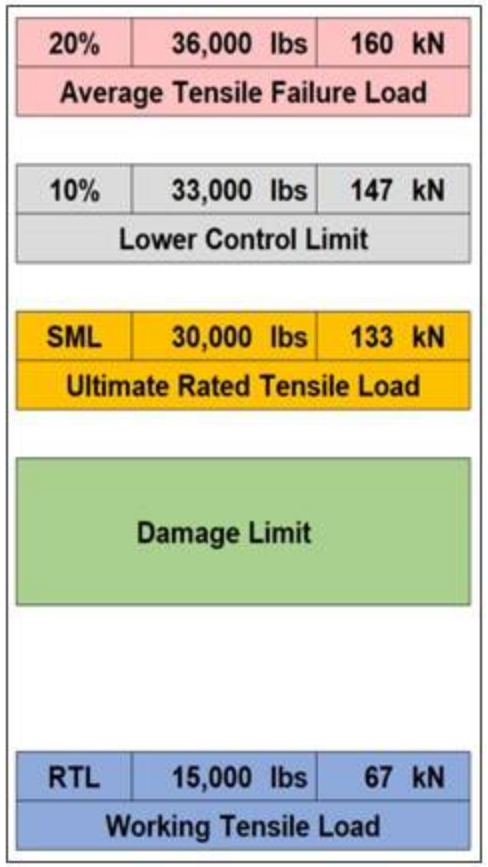
Not Defined in a Standard / Not on Product cut sheet

- TFL = Tensile Failure Load – actual failure load
- Lower Control Limit – Minimum performance criteria
  - *SPC – Statistical Process Control*
  - *Function x% of the SML Rating*
- Damage Limit – damage starts to occur
  - *End fitting elongation / deformation*
  - *Fiberglass strands breaking*
  - *Function x% of the TFL not SML*



The 10% Lower control limit and 20% Average tensile failure are selected at random, for reference only in this presentation

TENSILE RATINGS



Why do we need a Lower Control Limit?

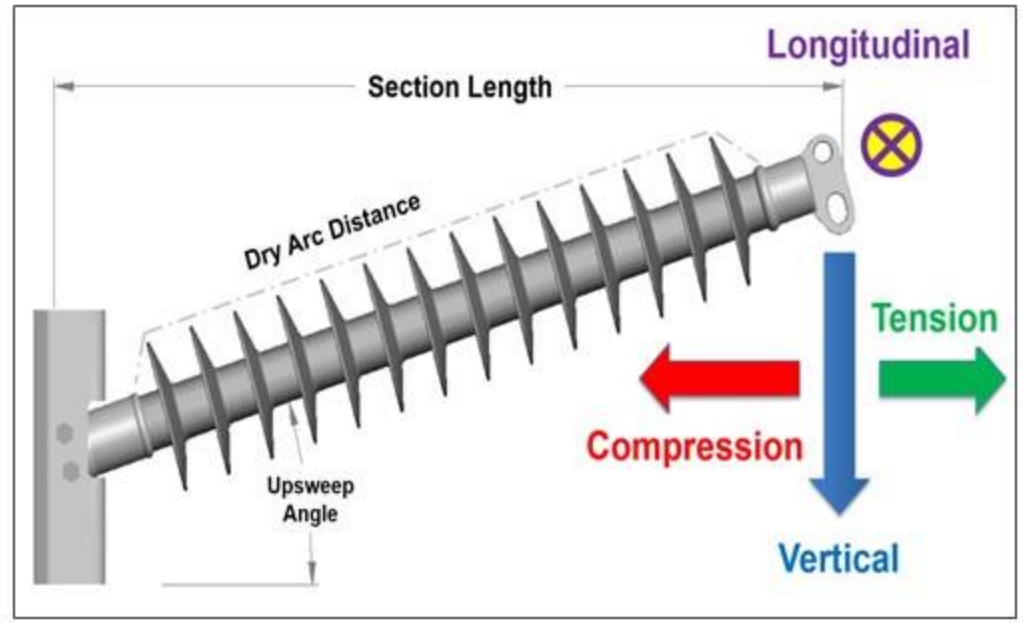
- Target minimum tensile load the MFG would use to develop a controlled & repeatable crimp process.
- Helps define SML
- Safety Factor / Extreme Load Event

- Which 30k SML is better?
  - Ultimate failure load = 30,001 lbs.
  - Ultimate failure load = 36,000 lbs.

- Damage Limit as a Function of TFL (Not SML)
  - Assume lowest TFL = 34,000 lbs.
  - 75% of lowest TFL = 25,500 lbs.
  - 10,500 > RTL
- TWL = Tensile Withstand Load = 24,000 lbs.
  - Maximum load this insulator can withstand without compromising original strength rating.
  - Consider as a new drawing rating to be defined by MFG.

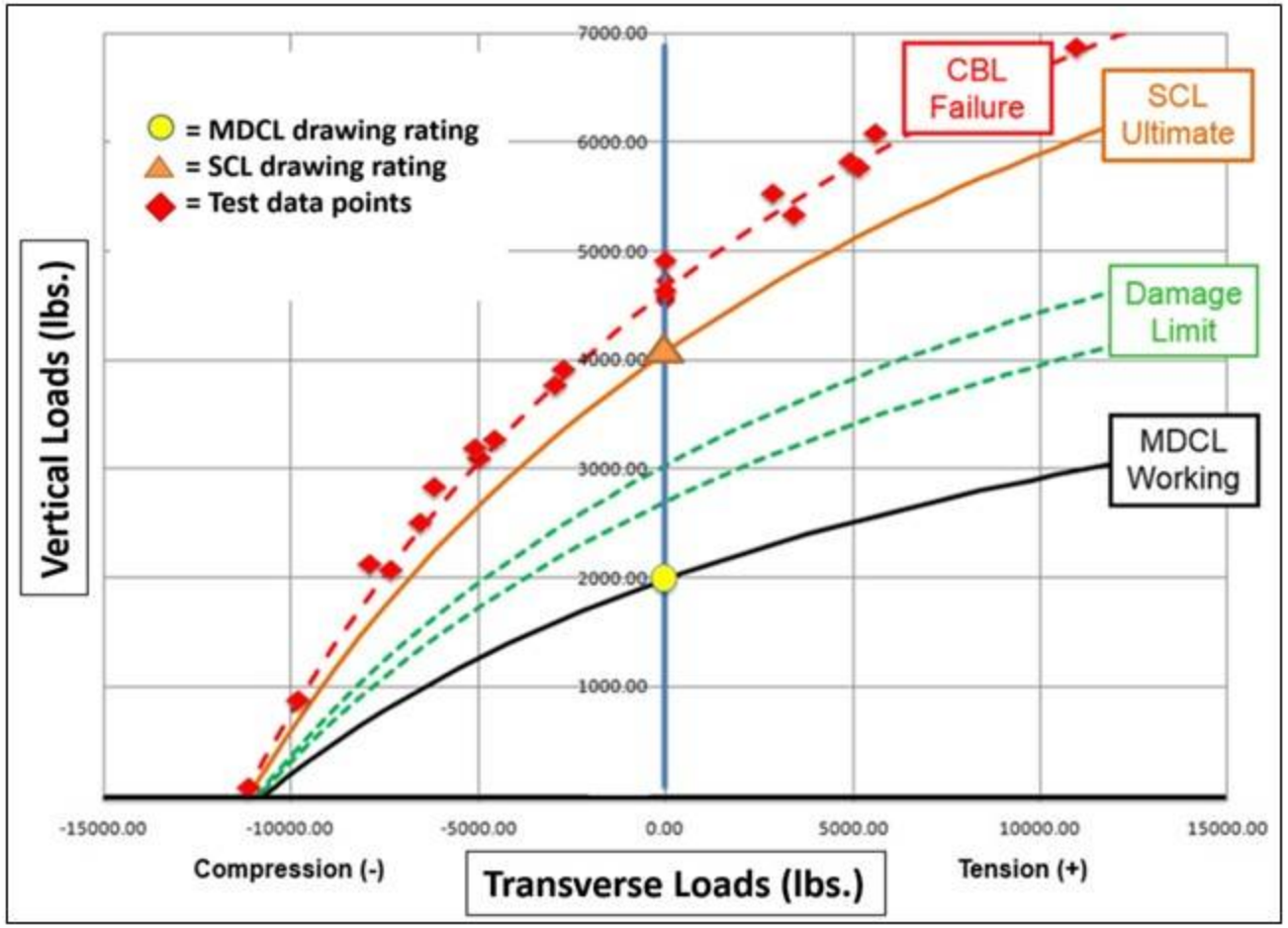
CANTILEVER LOADING OF POST INSULATORS

- Post insulators are not selected by a mechanical rating (SCL)
- Cantilever Strength is a determined by the core rod Diameter & Length of the post.
- Need a balance between Mechanical & Electrical performance.
- Transfer loads from the conductor through the post into the tower.
- The base connection is very critical to the strength of the post.
- Load Curves are required for line post and braced post.
- No Industry default for a load curve
- No Industry defined test / validation procedures
- Requires many “Combined Load” cases to validate the load curve. There is no single mechanical test.



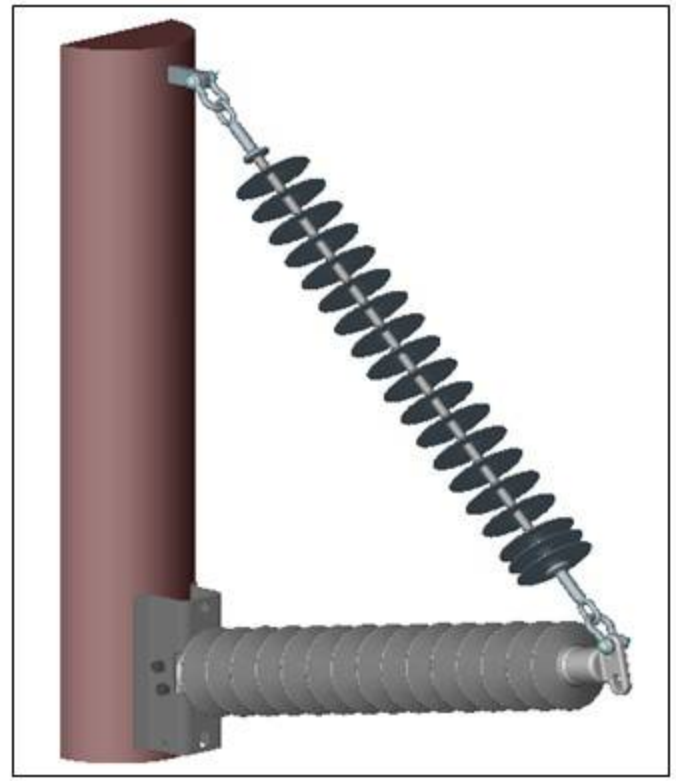
- Post Tip Deflection
- Buckling Limit of the Post
- Safety Factors

LOAD CURVES / RATINGS / VALIDATION



- SCL = Specified Cantilever Load
  - Ultimate Drawing Rating
  - SCL = 4,000 lbs.
- MDCL = Maximum Design Cantilever Load
  - 50% of SCL = 2,000 lbs. [2x Safety]
  - 40% of SCL = 1,600 lbs. [2.5x Safety]
- Transverse Loads – Compression & Tension
  - Compression = Negative side of curve
  - Tension = Positive side of curve
- Longitudinal Loads
- CBL = Cantilever Breaking Load
  - Actual load at which the post fails.
  - Failure Mode is not avails easy to ID
  - Should be some % above the SCL.
  - Safety Factor applied to Ultimate Load
  - MDCL can remain 50% of SCL
- Damage Limit
  - Function of the CBL

MAXIMIZING CANTILEVER APPLICATIONS



Line Post Insulators

- Increase core rod diameter
- Improve the base strength
- Add a brace insulator to make a braced post.

Braced Post Insulators

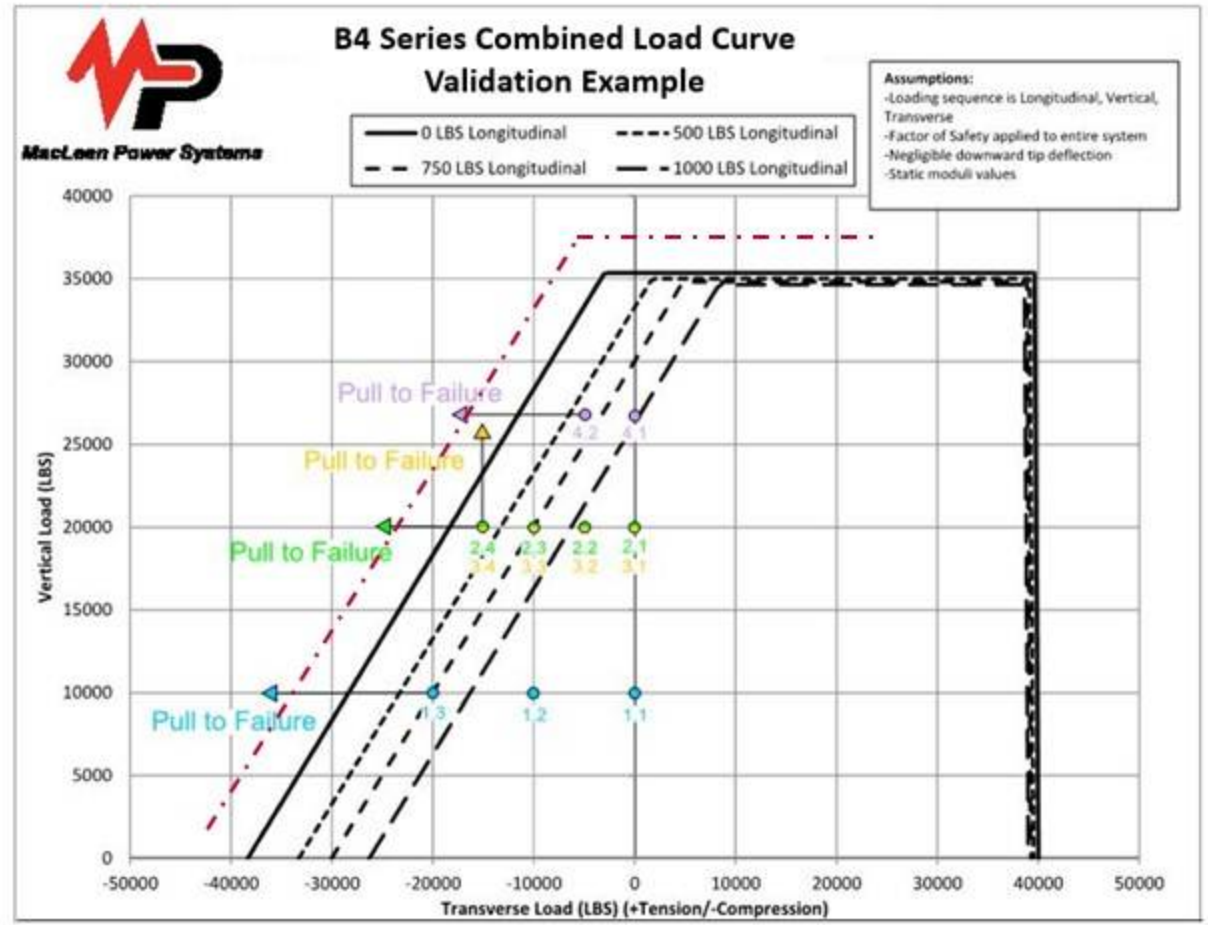
- Vertical Capacity – Increase Brace SML
- Transverse Capacity – Increase LP rod diameter
- Load Curve – Combined Loads
- Traditional Braced Post Limitations
  - Line End Fitting
  - Tower Connection / Base – Longitudinal Loading

High Strength Braced Post Insulators

- Traditional limits overcome
- Higher Strength = Longer Spans

TESTING AND VALIDATION OF THE LOAD CURVE

- Multi-Axis Test Procedures
  - Vertical, Transverse, Longitudinal Loads
  - Longitudinal Resistance
  - Field Conditions / Storm Loading
  - Final Load to Failure
  - Failure Mode – Easy to ID
- CBL Data Points to confirm SCL Rating
- SCL Rating = Buckling Limit of Rod
  - Load at which post transitions from “Rigid” to “Flexible”



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THANK YOU

FOR ADDITIONAL INFORMATION
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