

Improving Lightning Protection of Power Systems with Externally Gapped Line Arresters (EGLA)

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Today's Presentation

1. Real Value of Arresters
2. Improving Distribution Line Protection with EGLA
3. Improving Substation Protection with EGLA

The Real Value of Arresters

- Do we really need to spend our reliability budget on arresters?
- Do they really work?
- How do we justify all this effort?

Very valid questions and ones that every new surge protection engineer should ask.....



Montreal 1990's

In the early 1990's Hydro Quebec provided great data on the value of an arrester.

For many reasons, they had many distribution transformers without arrester protection.

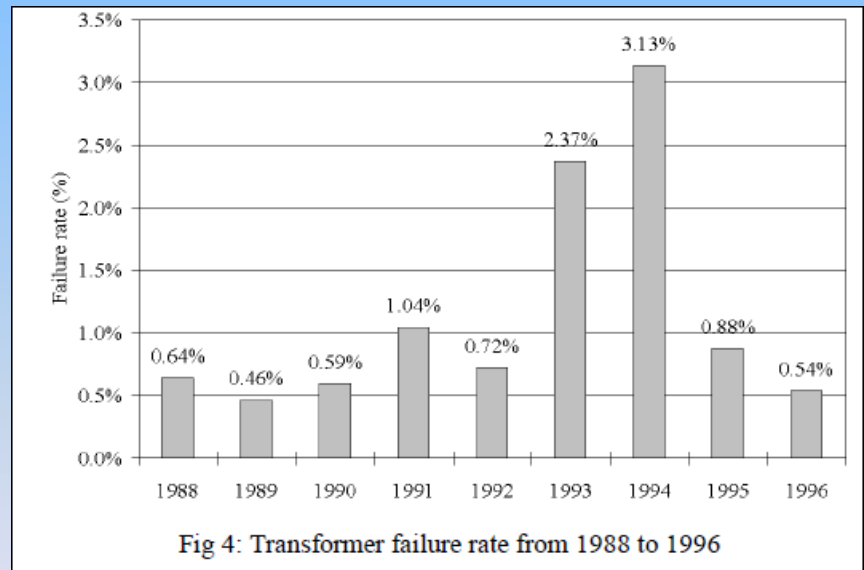
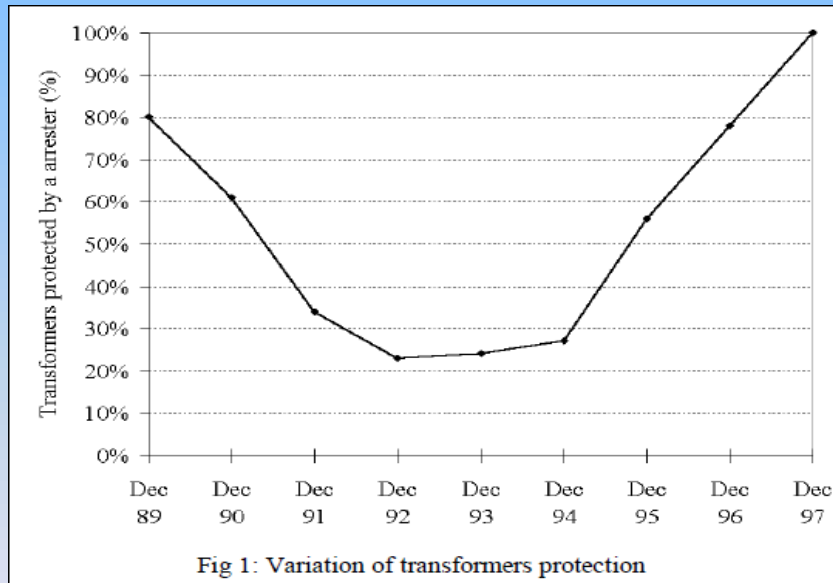
Then.....1993-1994 Fewest Arresters and More Lightning

Results..... Not good

Montreal 1990's

DISTRIBUTION TRANSFORMER FAILURE CAUSED BY LIGHTNING AND ASSESSMENT OF ARRESTER EFFICIENCY

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Institut de recherche d'Hydro-Québec
1800 boul. Lionel-Boulet, Varennes, Québec, Canada



Montreal 1990's

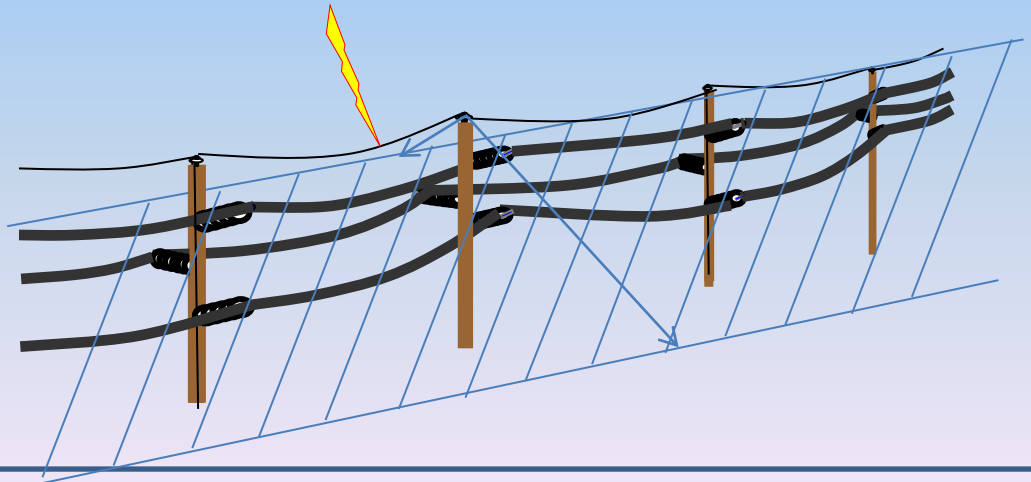
Study Conclusion

Lightning arresters reduce the rate of transformer failure by about a factor of 10



Example 2 is based on Ground Flash Density and the System Configuration

If the direct strike collection rate of a 4 span section is calculated, then the transformer failure avoidance rate can be determined.



The Real Value of a Distribution Arrestor

Assumptions

1. With a Direct Strike and No Arrestor will equal a Transformer Failure
2. Direct strike is a function of system and ground flash density

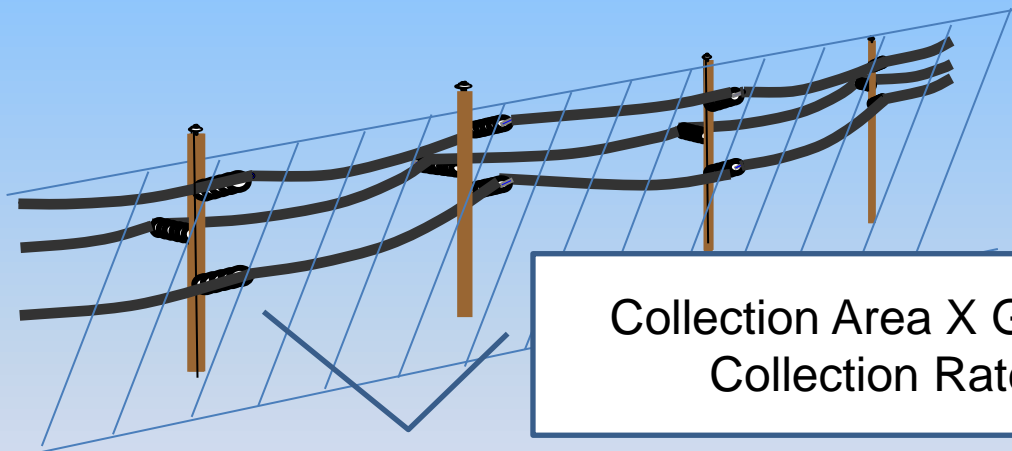
Calculating the Direct Strike Rate on a Distribution Line

$$N = N_g \left(\frac{28h^{0.6} + b}{10} \right)$$

N_g = ground flash density (flashes/km²)

b = width between outside conductors (m) (2m)

h = the height of the pole or tower (m) (10m)



Collection Area X GFD =
Collection Rate



Results

For 4 spans of a distribution system assuming a distribution transformer cost 1000 USD installed

N_g	Time between direct Strikes	Number of saves in 20 year life of arrester	Dollars saved over life of the arrester
1	37 years	.54	1851
4	9 years	2.22	2,200
8	4.5 years	4.44	4,400
12	3.1 years	6.45	6,450



The Real Value of a Distribution Arrester

If a 100 dollar investment on an arrester results in cost avoidance of 6000 USD over its life, then the arrester has a value 60 times it cost

Cant beat that as a return on your dollar.....

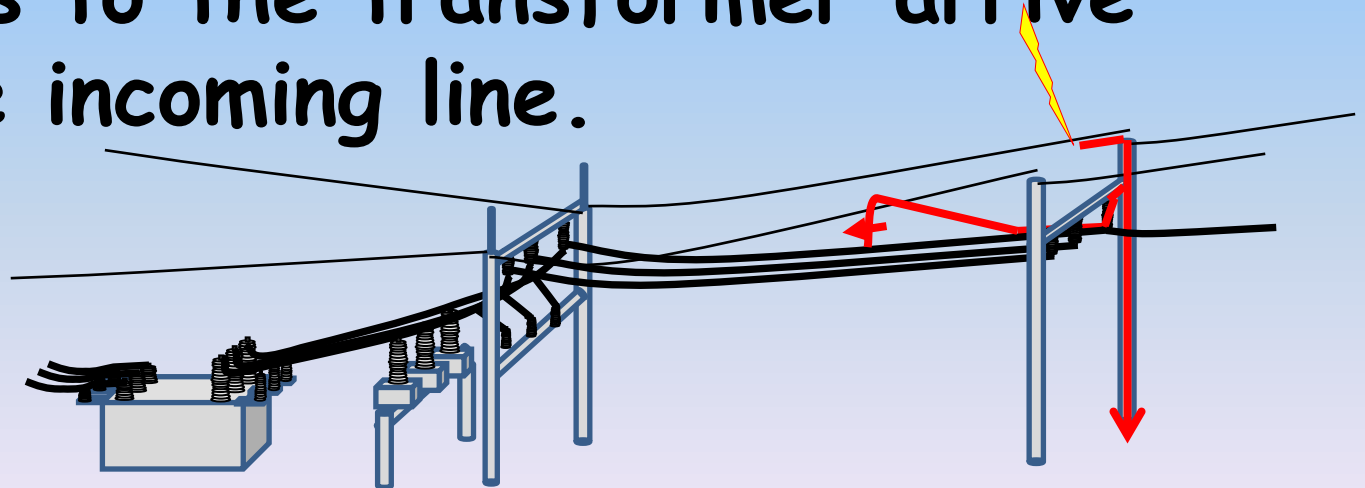
The Real Value of a Station Arrester



The Real Value of a Station Arrester

Assumptions

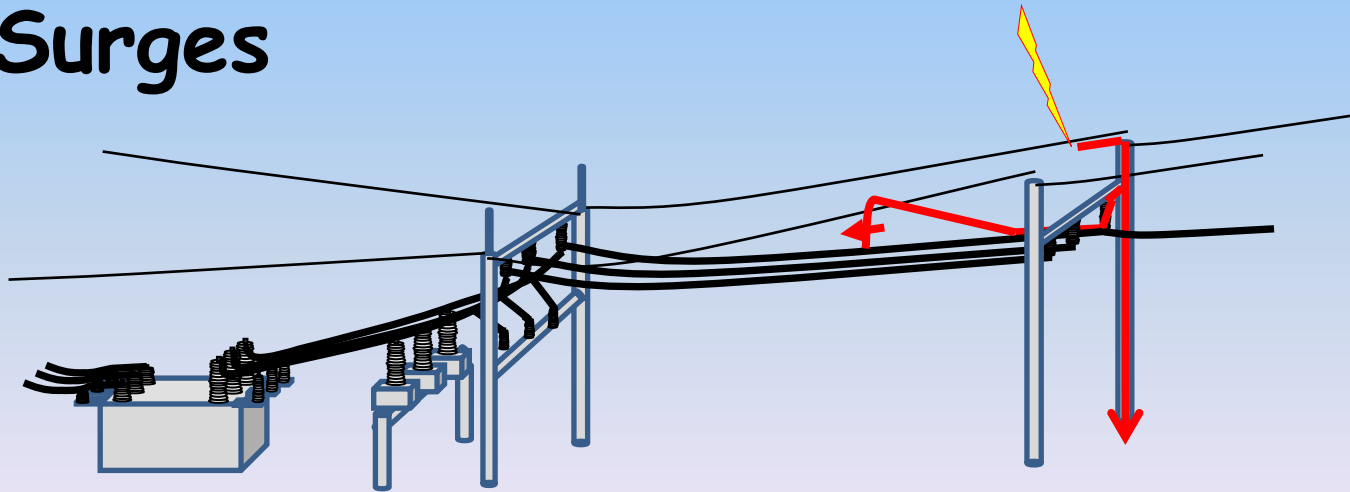
1. All stations are protected from direct strikes
2. Induced surges are low enough level not to damage equipment
3. Surges to the transformer arrive on the incoming line.



The Real Value of a Station Arrester

Example Parameters

1. 115kV system
2. 1000 meters collection
3. 1% backflash rate
4. Not accounting for Switching Surges

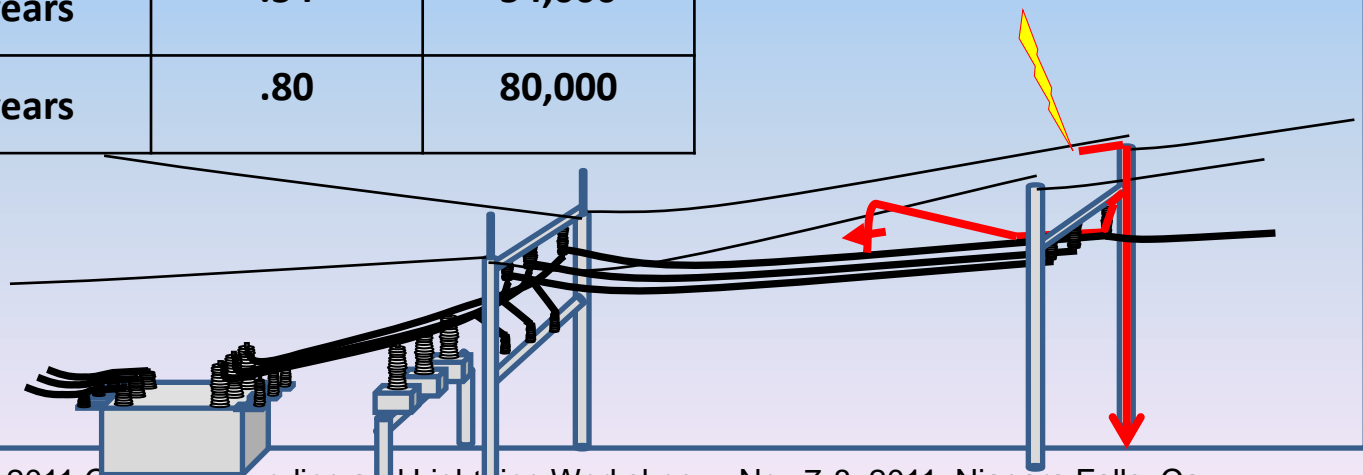


The Real Value of a Station Arrestor

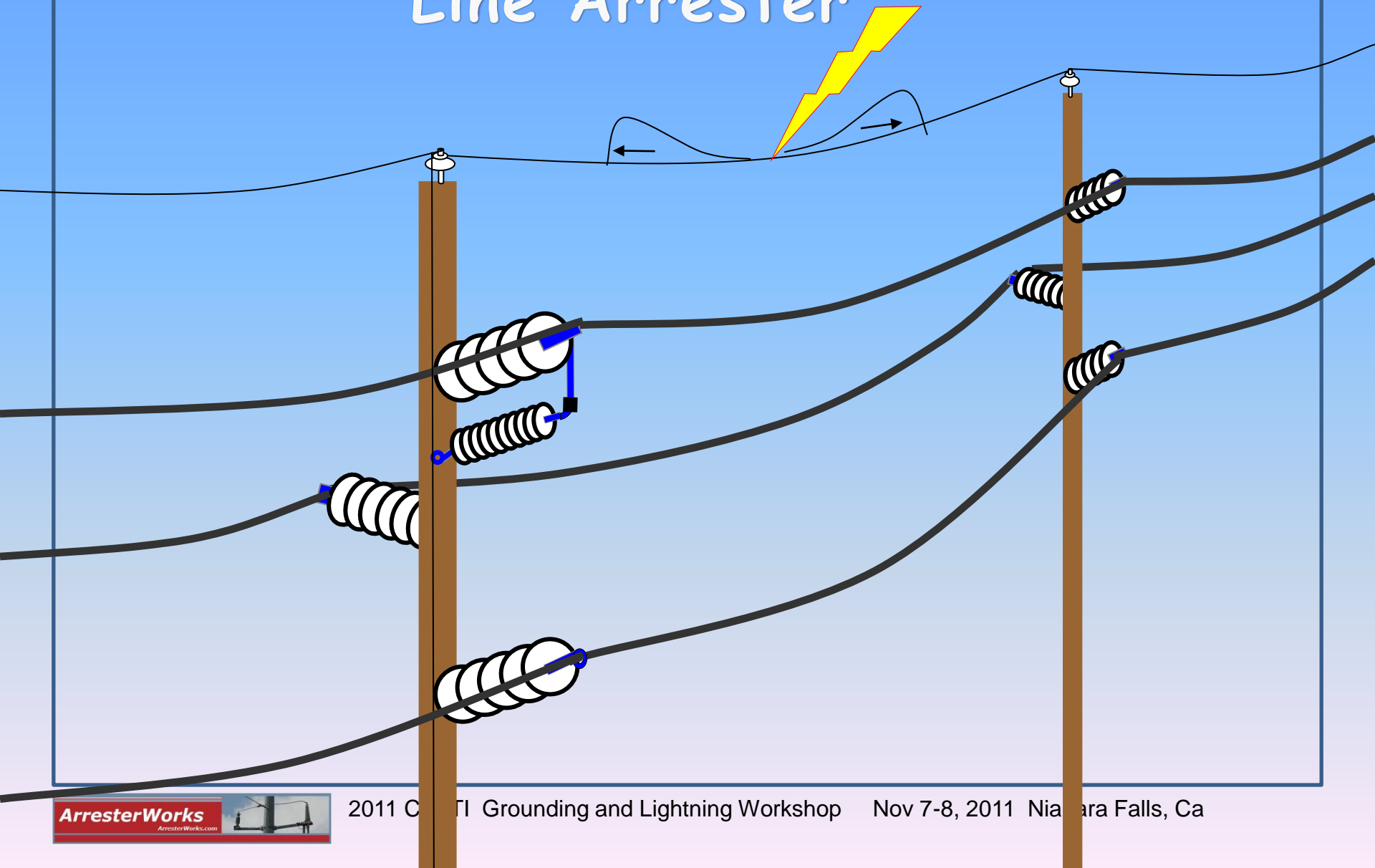
For 1000 meters of 110kV transmission line and a transformer worth 100,000 USD

N_g	Time between direct Strikes	Number of saves in 20 year life of arrester	Dollars saved over life of the arrester
1	27 years	.074	7,400
4	7.3 years	.27	27,000
8	3.7 years	.54	54,000
12	2.5 years	.80	80,000

Lightning Only!!!!



The Real Value of a Transmission Line Arrester



The Real Value of a Transmission Line Arrester

**Not Sure
But**

The Real Value of a Transmission Line Arrester

- It is related to
- Ground Flash density
 - Line Geometry

Most Importantly

Effect of Outages on the Users
of Power!!!!!!

Improving Protection of Power Systems



Opportunities to Improve the Lightning Performance of Distribution Systems

1. Transformers are already protected very well
2. Line Protection is only real option to improve lightning performance

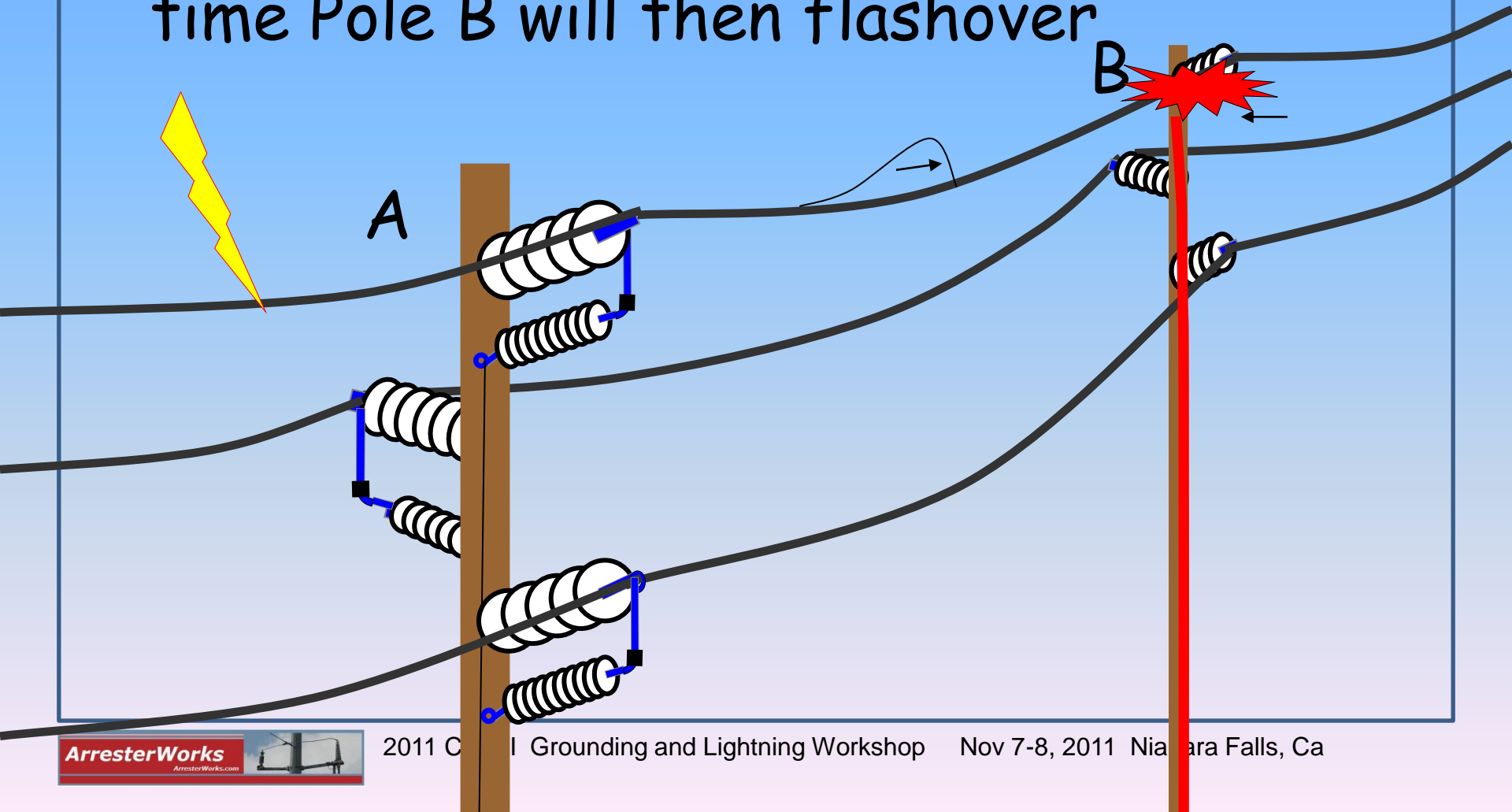


Opportunities to Improve the Lightning Performance of Distribution Systems

**Eliminate the
4/mile
practice**

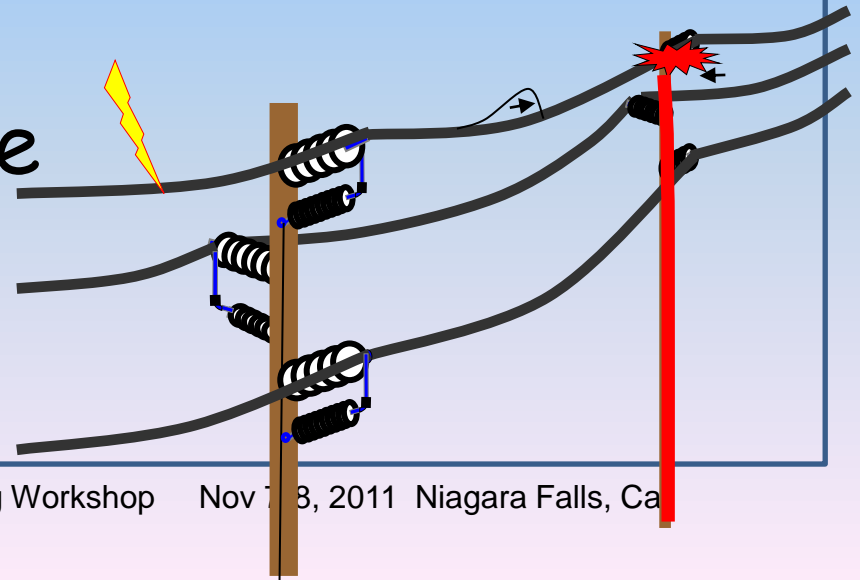


- When a surge hits near Pole A, Pole A is well protected..... However most of the time Pole B will then flashover

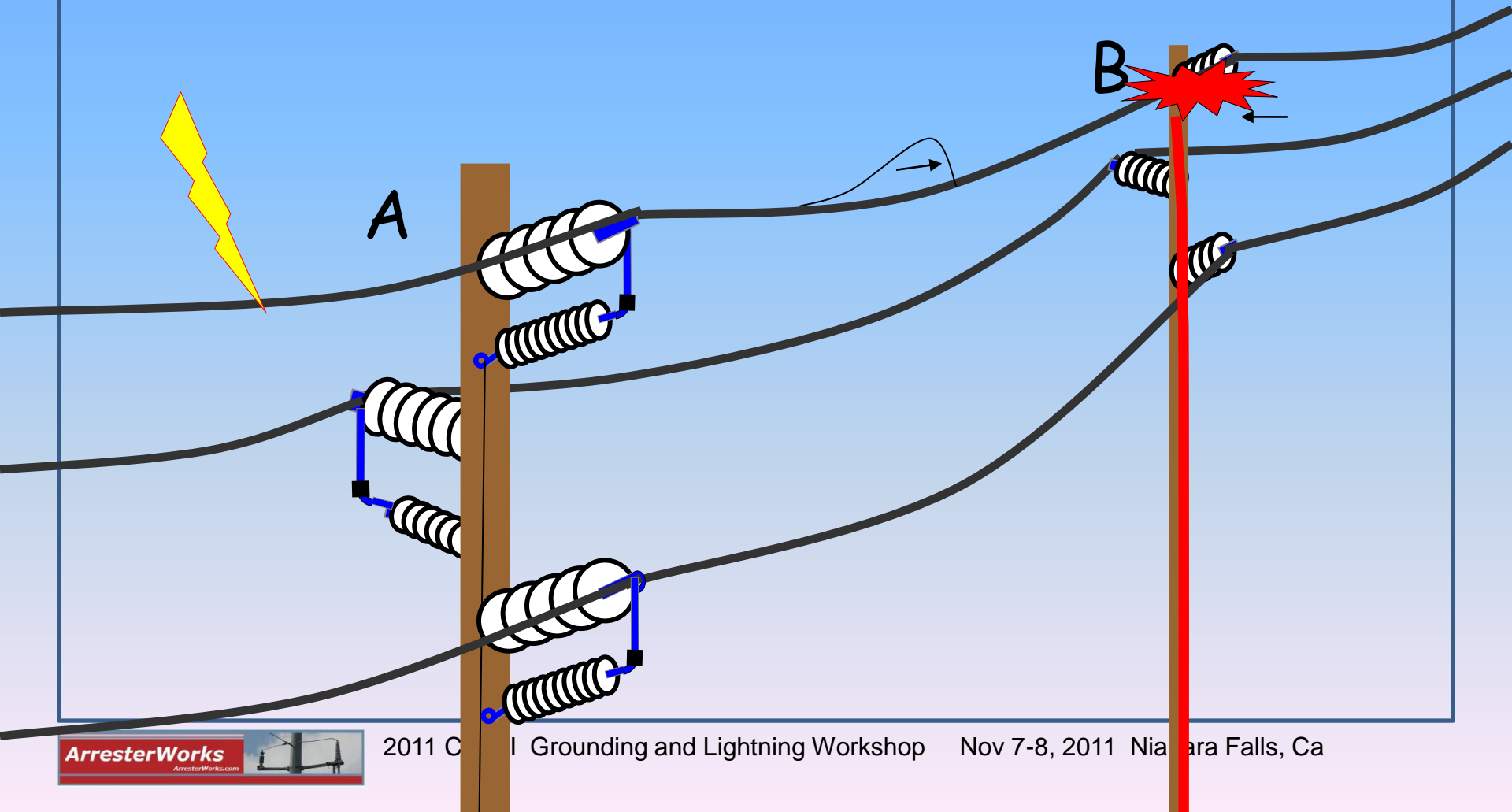


- The reason for the transfer of the FO is because even though the line arresters save the insulators on Pole A from FO, the pole top voltage rises to significant levels. Several megavolts.

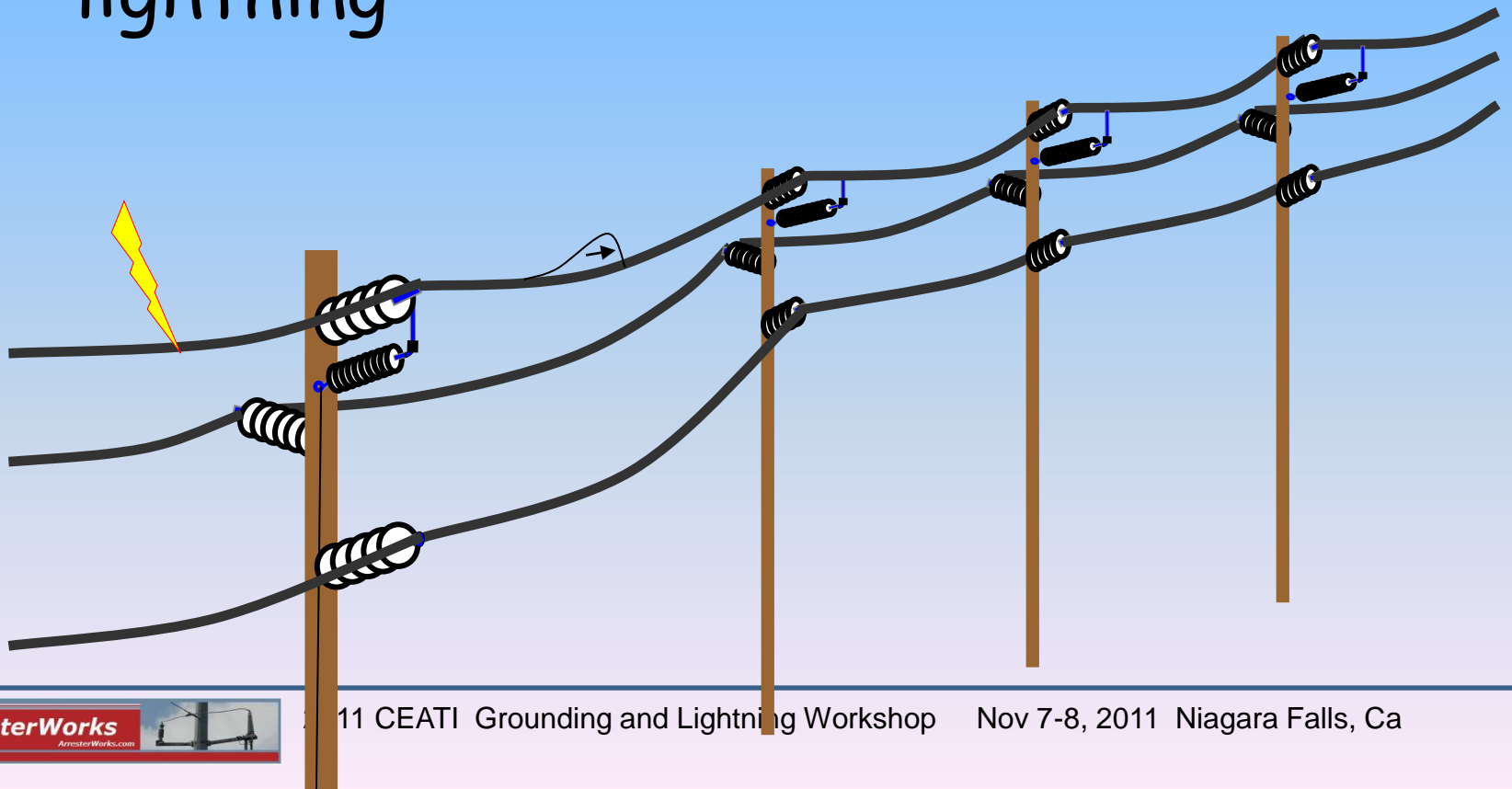
The voltage rise propagates down the line.



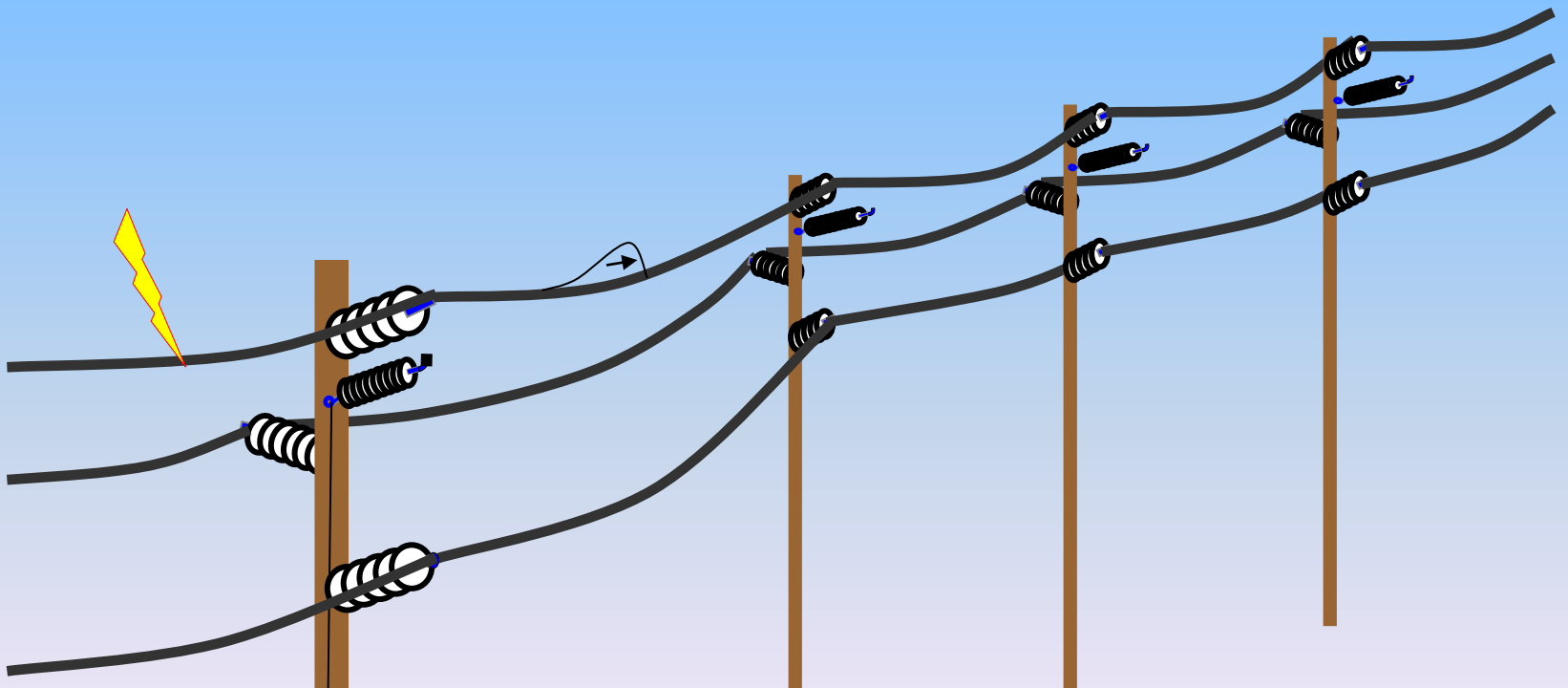
- With no protection on other poles, the arresters on Pole A are nearly worthless



A much better alternative to 4/mile
is one on top phase of each pole
This configuration can bring your
outage rate close to Zero from
lightning



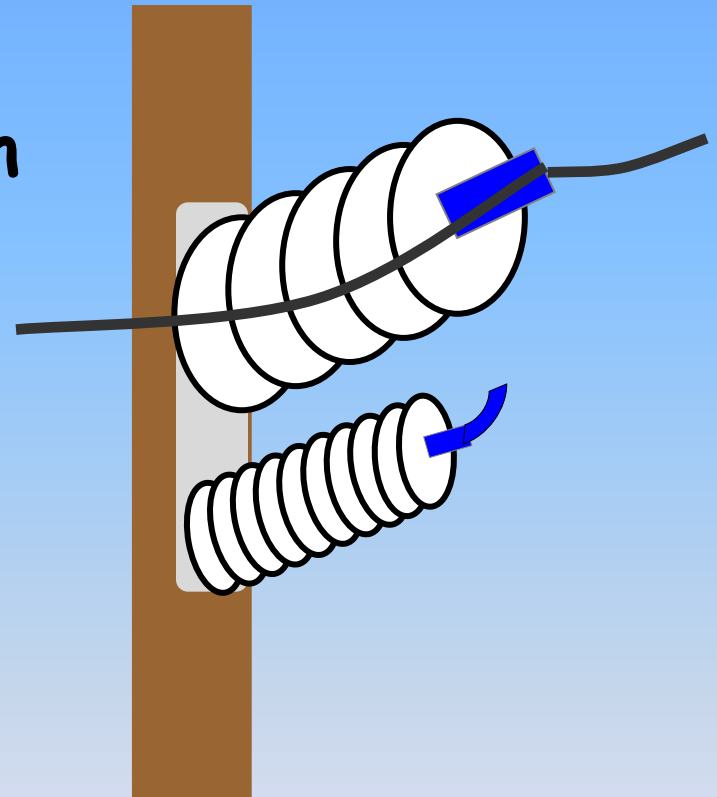
An even better option is to use
Externally Gapped Arresters in this
application



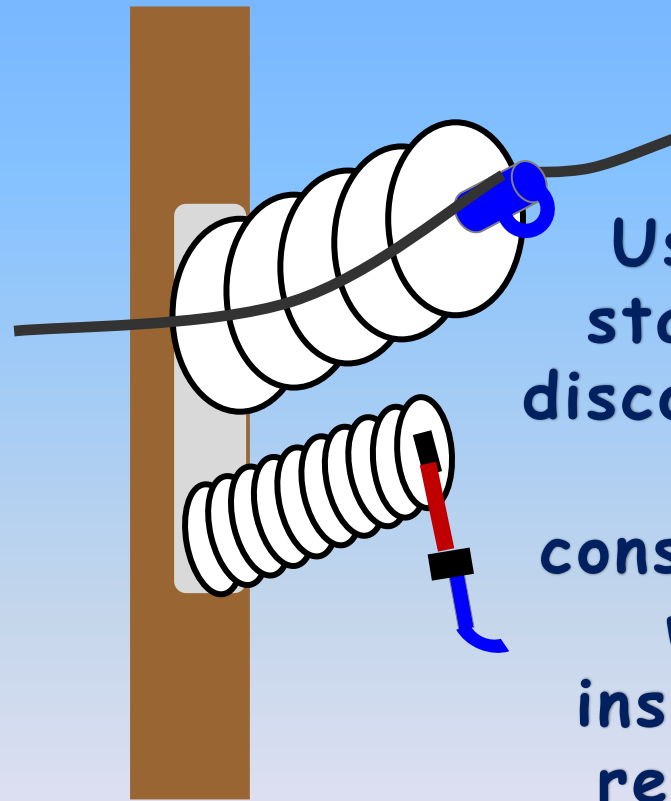
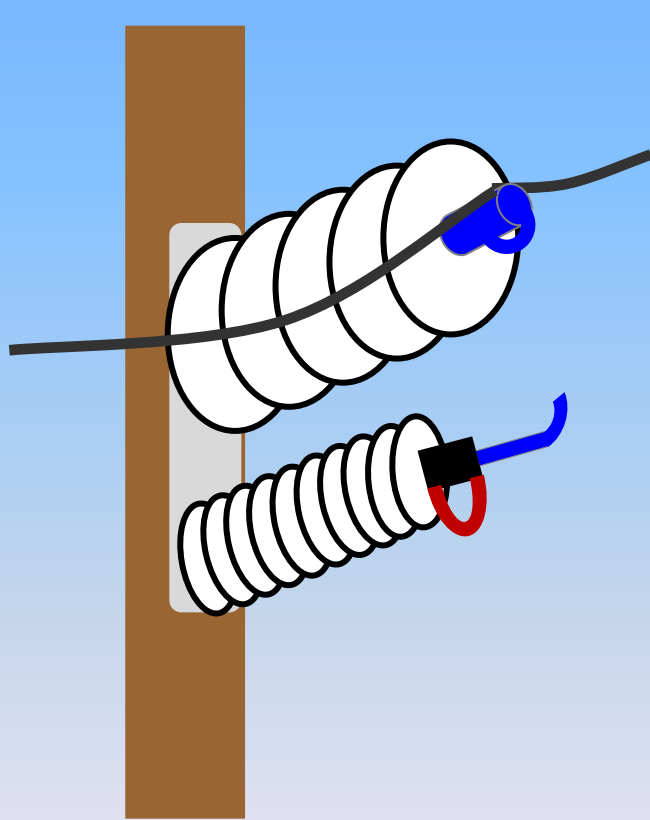
Why the EGLA is a Better Alternative for Line Protection

1. Guaranteed to Fail Open
2. No Losses
3. Environmentally more friendly
4. Longer Life
5. Less aging of parts
6. Retrofitable

AND



Soon to be available with
a Failure Indicator and with
100% BIL Restoration



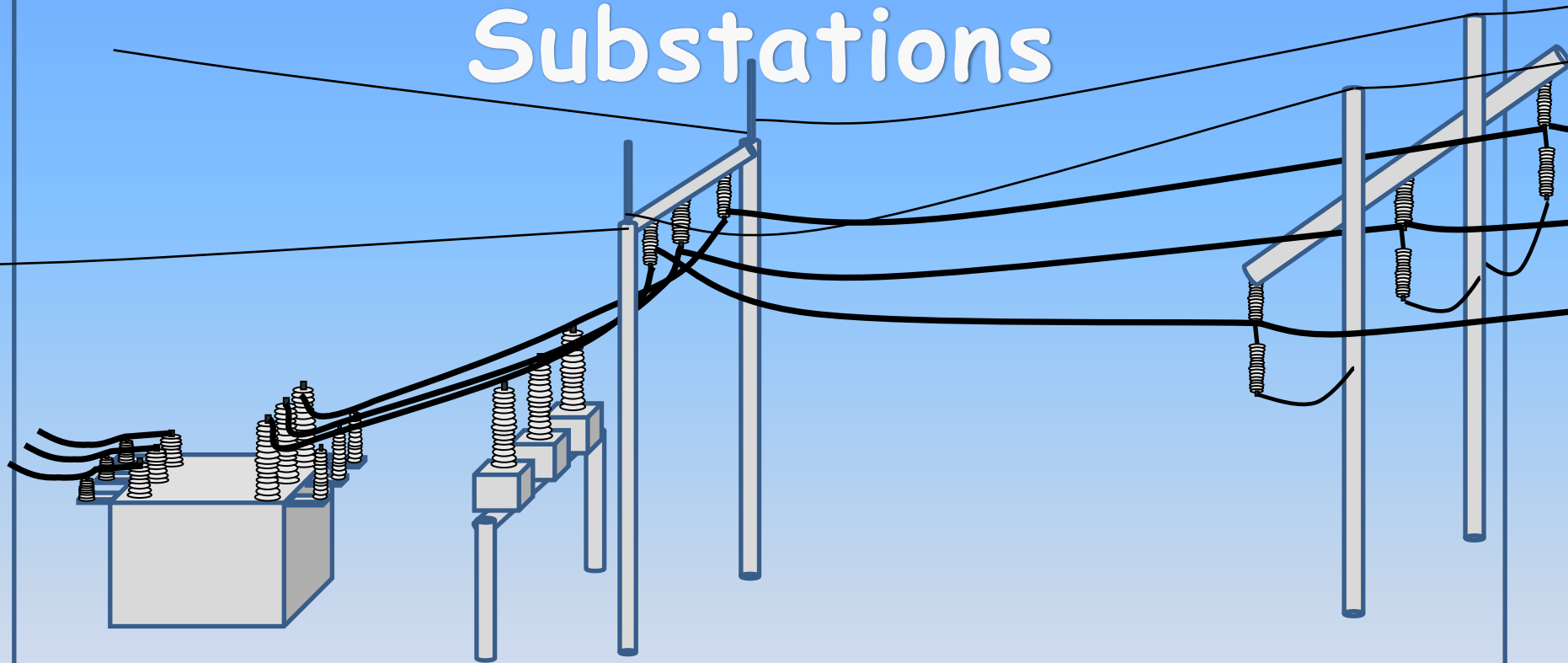
Using a
standard
disconnecter
but
constrained
with
insulating
retainer

Patent Pending

Opportunity to Improve the Lightning Performance of Substations



Opportunity to Improve the Lightning Performance of Substations



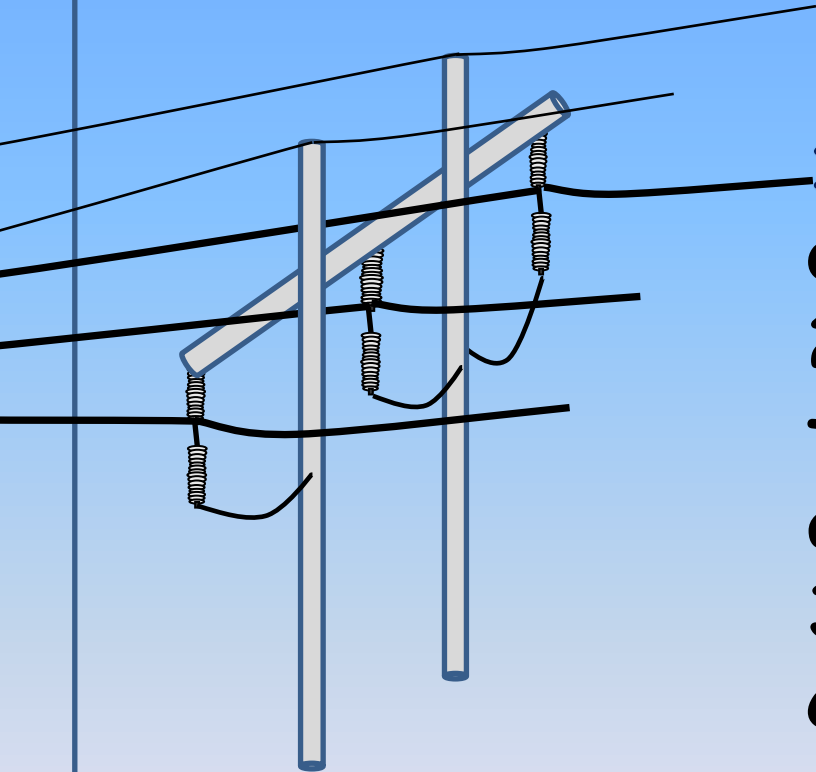
**Install Line Entrance Arresters at
line entrance or first tower**



Line Arrester at Sub Entrance



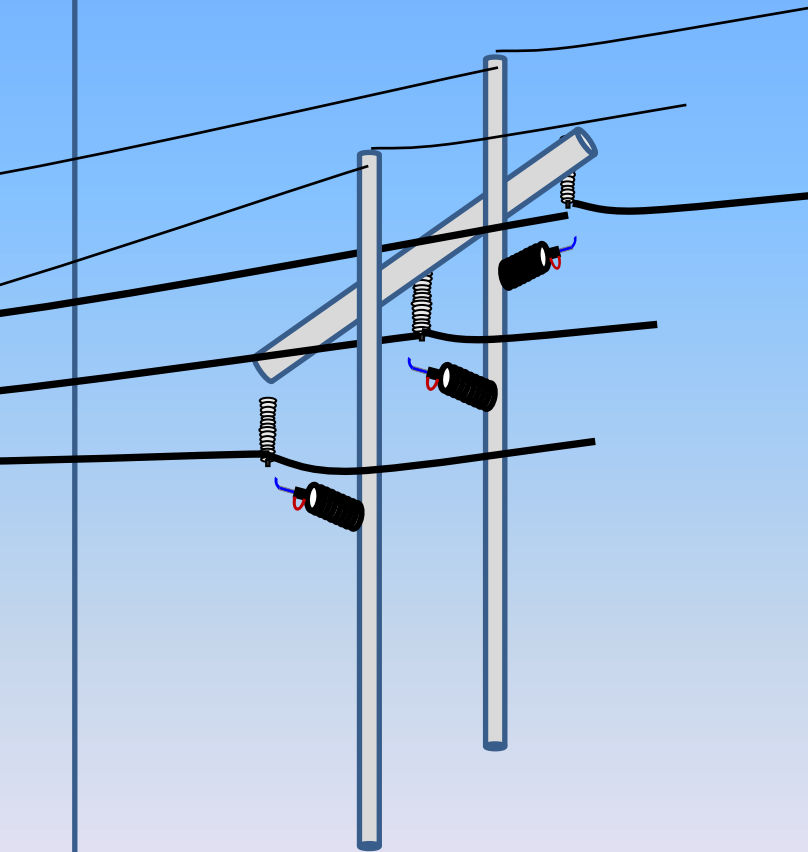
Benefits of Line Entrance Arresters on First tower



1. Eliminates potential of open breaker flashover
2. Reduces stress on transformer mounted arresters
3. Minimal mounting issues compared to mounting in station



Benefits of EGLA as Line Entrance Arresters



1. No Grading Ring
2. No Losses
3. Fail Open
4. Minimal Clearance Issues
5. Failure indicator and 100% BIL Recovery



Summary

- The real value of arrester is vastly underestimated
- There are real opportunities to improve lightning performance of power systems
 - Distribution
 - Substation
- The EGLA Arrester offers even more opportunity for line improvement.