Overhead Line Design Optimization.

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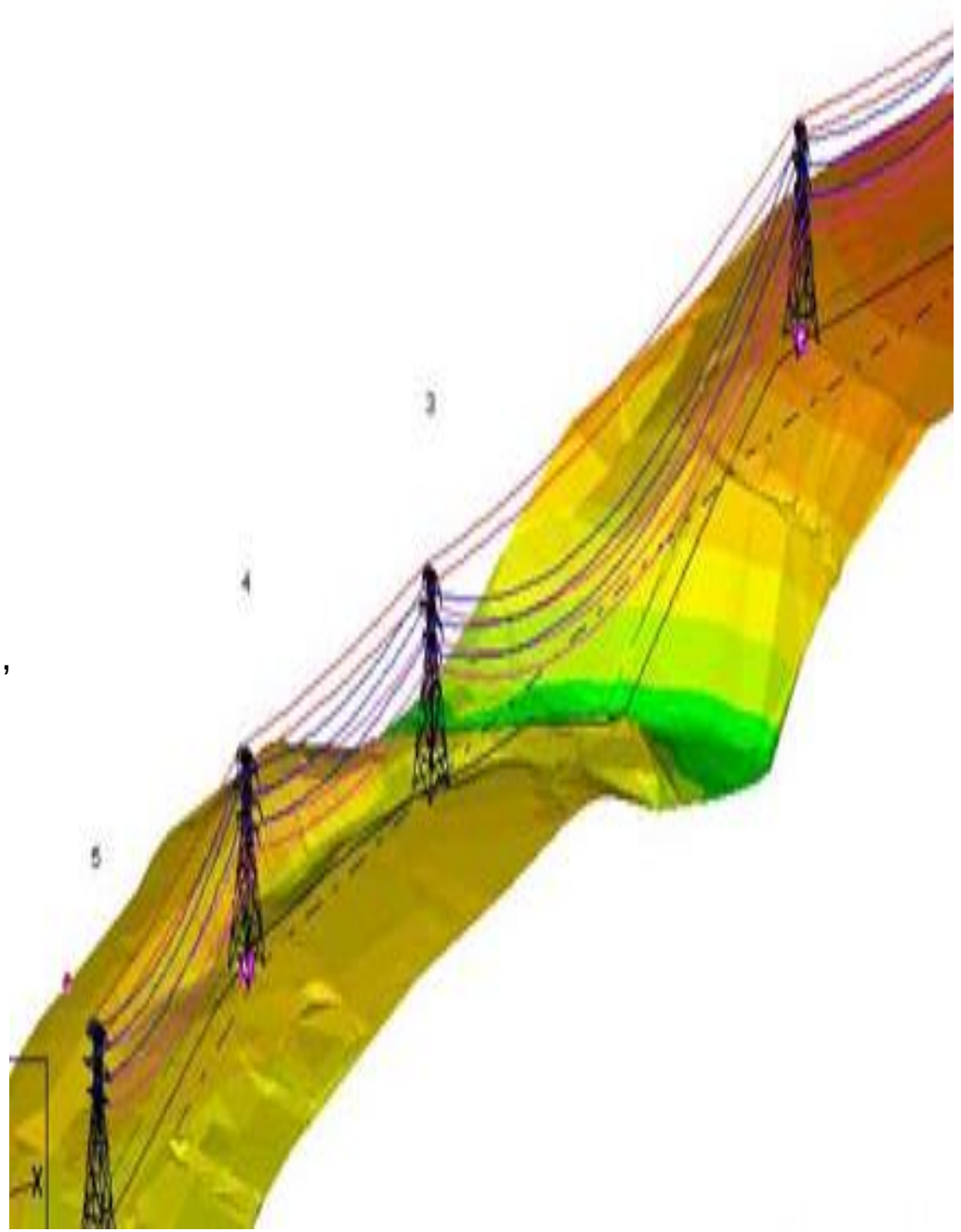
Agenda.

- Introduction.
- OHL Design Facts
- Design criteria
- Design weather cases.
- **Comply to OHL Design**
- Insulator Fitting Selection
- ROW
- Design optimization for Distribution system.
- Introduce HVIC technology.
- Recommendations.

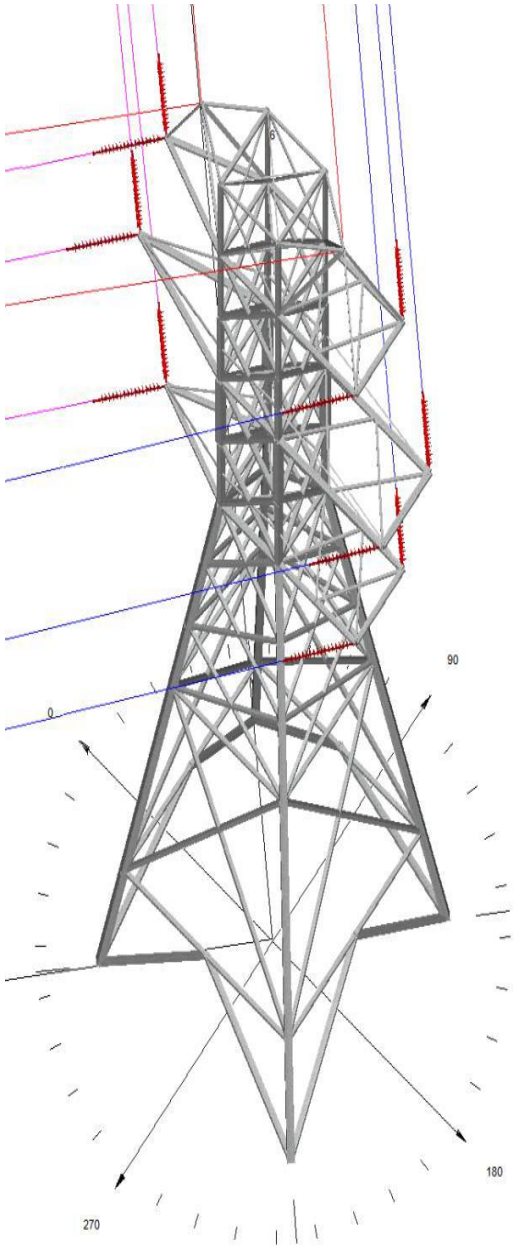
Introduction

- Although the world's continues grow and the demand for electricity increases, so too do the occurrences transmission and distribution system.
- The economic requirements call for minimizing the transmission project cost, design costs, material purchases, labor cost for assembly and installation, etc
- Many challenges faced by the OHL Engineers and designers and solutions for nor proper terrain or Non- plain area.
- OHL Engineers should investigate local weather information, soil conditions, etc
- Good line design should result in high continuity of service, long life of physical equipment, low maintenance costs, and safe operation.
- The lines route alignment design, accurate terrain and features measurement is necessary to select the most feasible OHL route.
- The horizontal & vertical clearances are critical factors while design the OHL Line.



OHL Design Facts

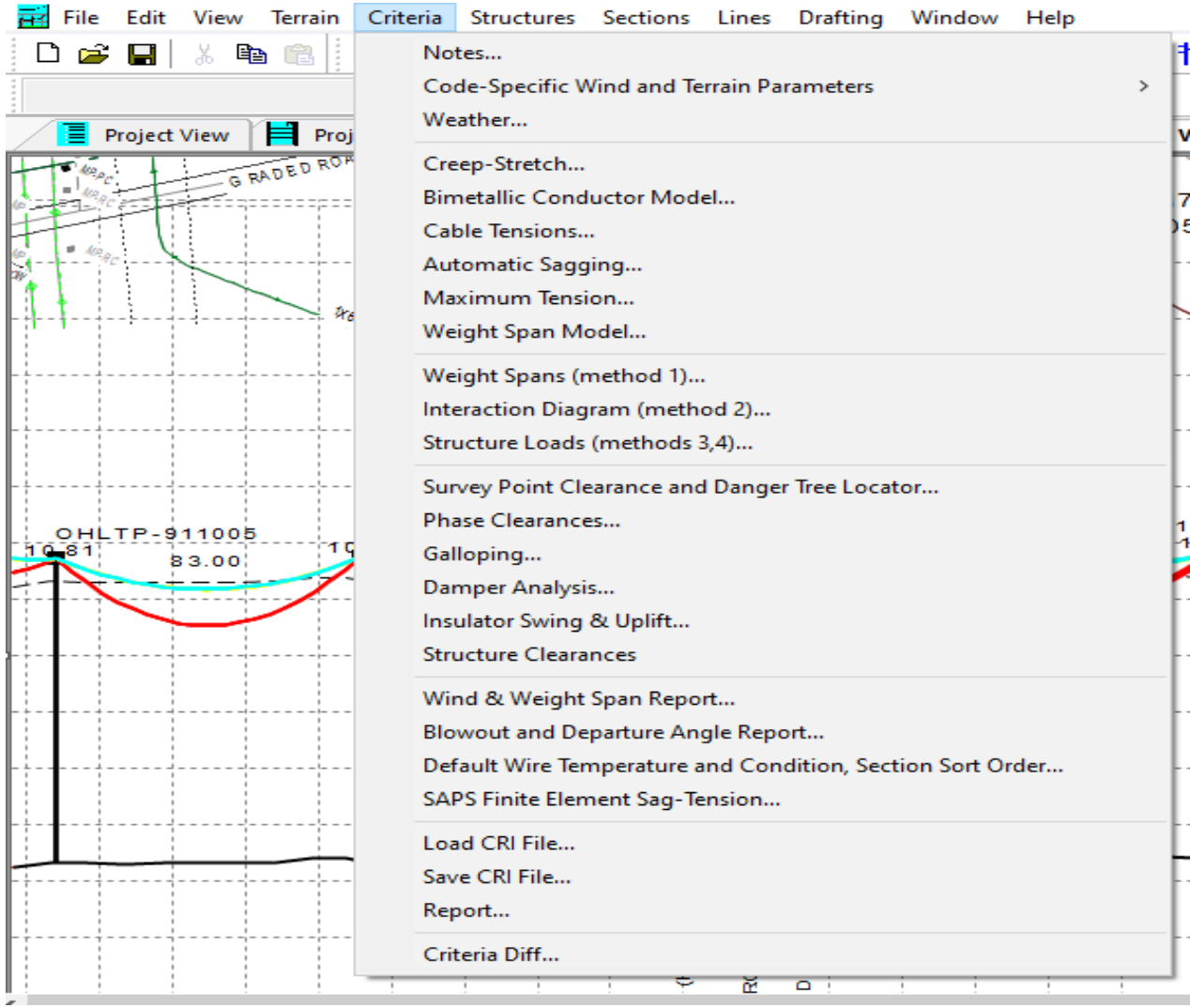
- Prior to design Wind records should be obtained.
- The line angle, terrain condition is the drive for structure type selection.
- The weather-related loads are associated with wind, ice or both.
- The SAG should be adjusted with respected to UTS of conductor, connector accessories, structures.
- The conductor tension should not exceed =<50% of its UTS.
- The SAG and Tension calculation are varied when structure at equal & unequal levels.
- Footprint of the structure one of main consideration on selection type of Structure such monopole or lattice structures.
- Between 15 times as much to install underground cable as to build an overhead line.
- Conductor cost is approximately +/- 10% of the overhead line cost.
- The structure loads should be applied on vertical, longitudinal and transversal direction.
- The structures at straight line support vertical load, transverse & longitudinal wind loads.
- Transverse load from the angular pull of conductors & longitudinal due to unequal spans, broken conductor.



Design criteria

Design criteria for power lines are vary from country to others or even different companies within the same country. They must be defined before proceeding with the design of any project.

- International standard reference.
- Wind & Terrain Parameters.
- Weight & wind span
- Weather cases.
- sagging limits & tension.
- Conductor Galloping.
- Structure & Structure clearance
- Insulator swing & uplift
- Conductor Tension % (Initial, creep)



Weather cases

All weather cases which will be used in a particular design must be described in the **Weather Cases Table.**

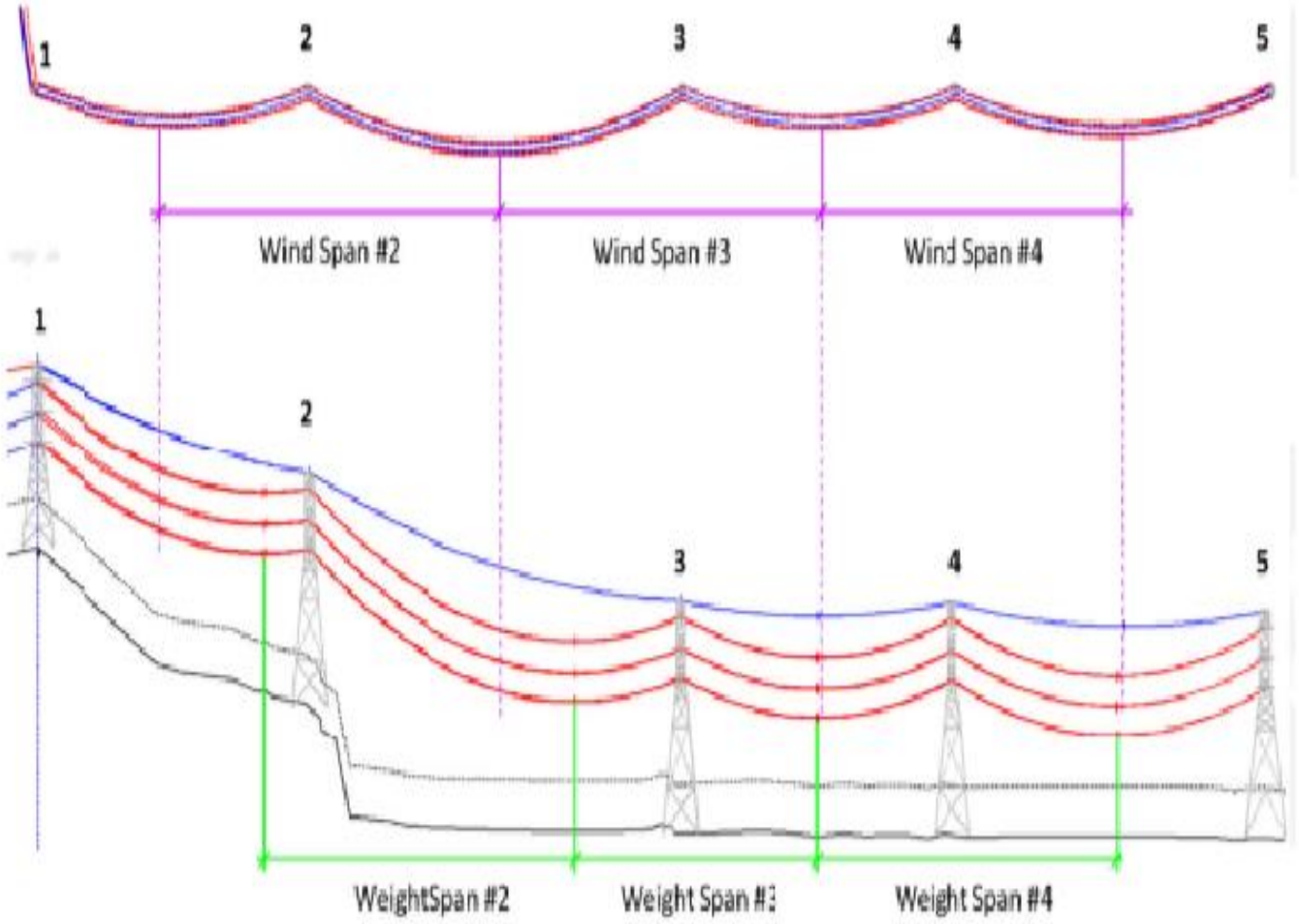
Weather Cases

See Criteria/Code Specific Wind and Terrain Parameters for more information on height adjustments and gust response factors.

	Description	Air Density Factor (Q) (kg/m^3) (Pa/(m/s)^2)	Wind Velocity (m/s)	Wind Pressure (Pa)	Wire Ice Thickness (cm)	Wire Ice Density (N/m^3)	Wire Ice Load (N/m)	Wire Temp. (deg C)	Ambient Temp. (deg C)	Weather Load Factor	NESC Constant (N/m)	Wire Wind Height Adjust Model	Wire Gust Response Factor
1	5DEG STILL WIND	0.613						5.0	5.0	1		None	1
2	5DEG MAX. WIND	0.613	38.3	899.204				5.0	5.0	1		None	1
3	10DEG STILL WIND	0.613						10.0	10.0	1		None	1
4	15DEG STILL WIND	0.613						15.0	15.0	1		None	1
5	20DEG STILL WIND	0.613						20.0	20.0	1		None	1
6	25DEG STILL WIND	0.613						25.0	25.0	1		None	1
7	30DEG STILL WIND	0.613						30.0	30.0	1		None	1
8	35DEG STILL WIND	0.613						35.0	35.0	1		None	1
9	35DEG RED. WIND	0.613						35.0	35.0	1		None	1
10	40DEG STILL WIND	0.613						40.0	40.0	1		None	1
11	45DEG STILL WIND	0.613						45.0	45.0	1		None	1
12	50DEG STILL WIND	0.613						50.0	50.0	1		None	1
13	55DEG STILL WIND	0.613						55.0	55.0	1		None	1
14	60DEG STILL WIND	0.613						60.0	60.0	1		None	1
15	80DEG STILL WIND	0.613						80.0	80.0	1		None	1
16	90DEG STILL WIND	0.613						90.0	90.0	1		None	1
17													

Wind span, weight span & OHL Clearances.

- Wind span is the half back span length plus the head span length **or** Wind Span =S1+S2/2
- Weight span is the distance between the low point in back span and the low point in ahead span.
- Design on hilly terrain required more attention (Weight span).
- Calculation wind span is relatively straightforward, But weight span is complexity due to sloping terrain with inclined span.
- Vertical clearance to ground surface, accounting for line sag.
- Horizontal clearances between the line and other electric lines.
- Horizontal clearances between the line and aboveground and underground pipelines.
- Horizontal clearances between the line and nearby residences.



Comply to OHL Design.

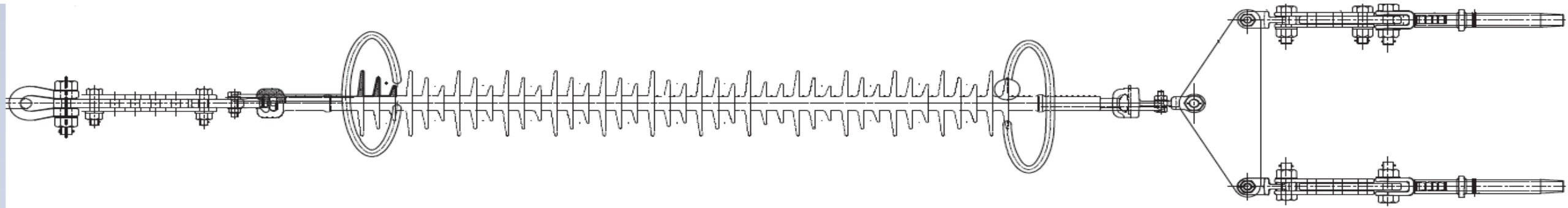
Example 1 : Transmission line, Length 250 Km, conductor AAAC ELM or YEW
Wind span = 350 m
Weight span = 880 m

Max. Span (M)	Total structures	Additional structure
350 m per span	714	-
340 m per span	735	+ 21
330 m per span	757	+ 43
320 m per span	781	+ 67
310 m per span	806	+ 92

Example 2 : Distribution line, Length 150 Km, conductor -ELM
Wind span = 100 m
Weight span = 120 m

Max. Span (M)	Total structures	Additional structures
100 m per span	1500	-
95 m per span	1579	+ 79
90 m per span	1666	+ 166
85 m per span	1764	+264
80 m per span	1875	+ 375

Insulator Fitting Selection

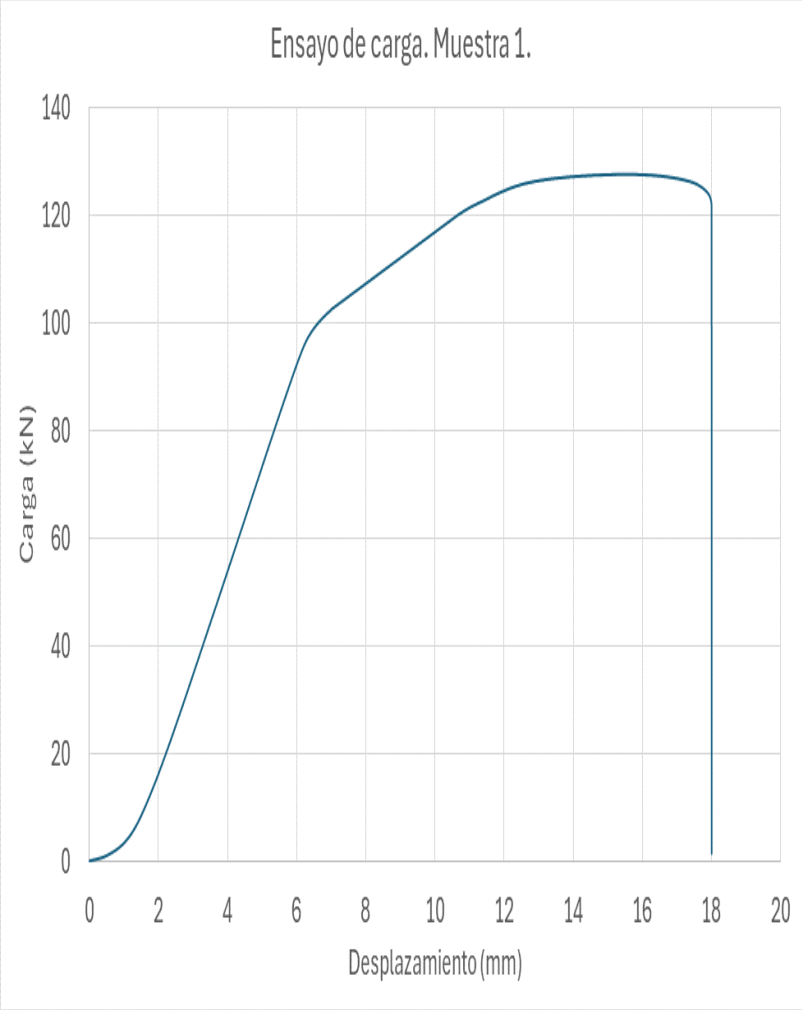


- Compression Dead-end
- Extension Links, Coupling fitting
- SAG adjusting plate
- Tension clamp
- Stud & Tees

Main Data :

- ✓**UTS of hardware & Fitting.**
- ✓**UTS for conductor.**
- ✓ **Conform as per IEC, BS, EN , etc**
- ✓ **Types and dimension of each item, split pins.**

RCA carried out for 132kV Dead-end clamp

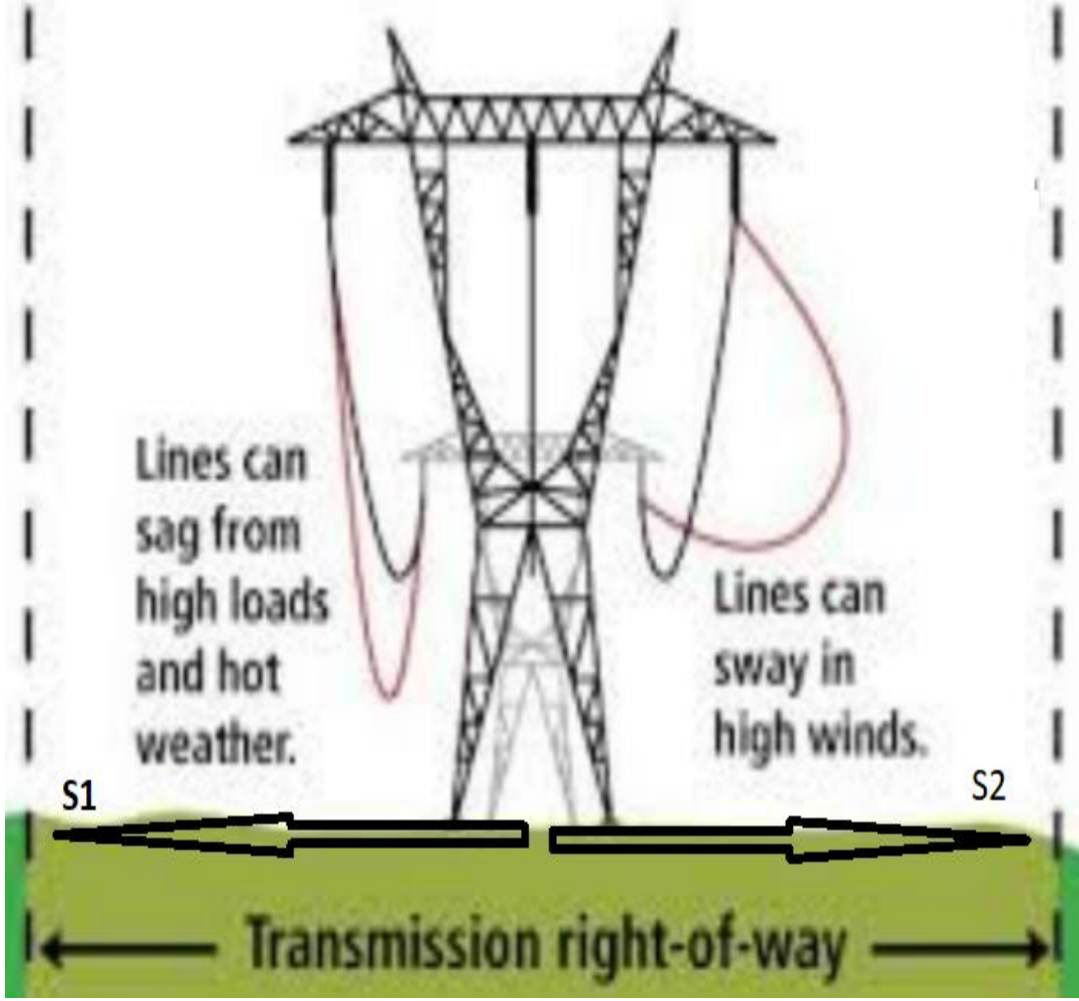


Conductor Type : AAAC YEW
UTS : 141 KN
Clamp Tech data : 95% of conductor UTS

Result:
Clamp breaking result : 125KN

Right of way (ROW)

- ROW's are Very critical path for OHL system. They provide a safety margin between Transmission /distribution lines and surrounding structures, building, vegetarian, etc.
- ROW mandatory for fault protection and used to reduce risk.
- ROW provide an access for ground-based for inspections, repair & Live line washing.
- ROW known as permanent and/or land width.

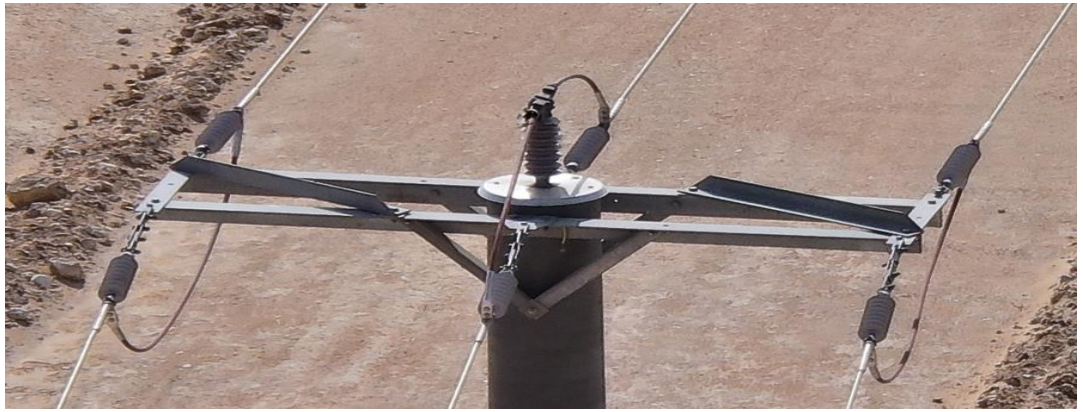


Introduce distribution steel poles.

- Available Distribution Monopoles of 36 kV.
- Design arrangements without cross arm
- They have a minimal installation cost.
- Positive environmental impact for its slim and aesthetic design.
- Greatest performance within totally acceptable weight limits, especially for hilly area.
- They are excellent for towns and areas where spaces & corridors are constraint.
- Excellent on average of basic span.
- Limited practical maintenance and able to withstand at exceptional weather conditions.

Improved OHL 11kV & 33kV design

Improved Design for OHL Distribution system by avoid crossarm arrangements.



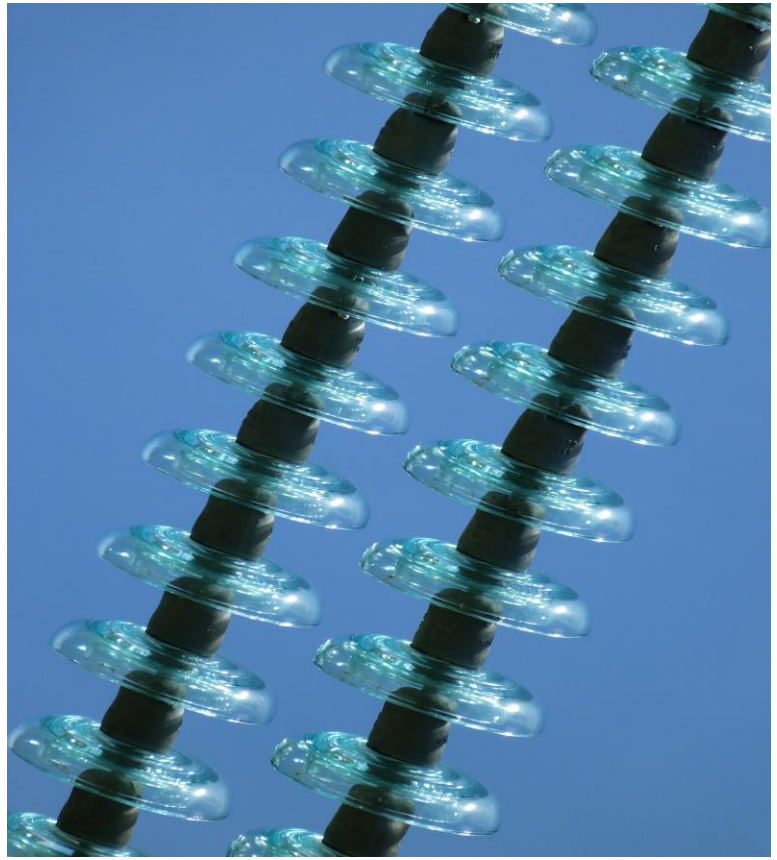
Introduce 33kv Covered Conductor

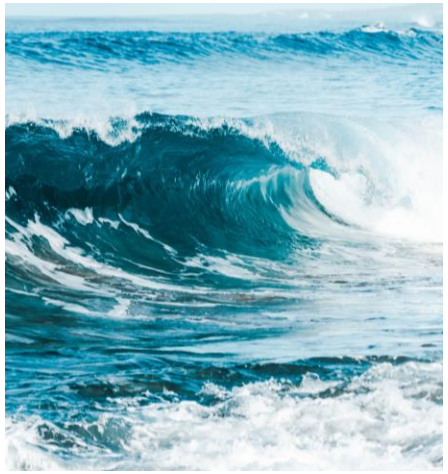
- Structure/ support (Steel or concrete) pole.
- 33kV cover conductor-AAC, UTS 29 KN, 0.512 kg/m
- The messenger wire.
- Cable spacer for covered conductor.
- Insulator (Pin, Tension)
- Different connectors & accessories.

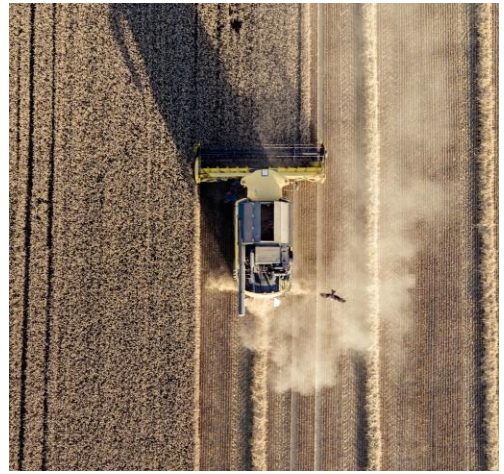
Features.

1. Improves reliability of power distribution lines
2. **Safe against short circuit.**
3. High tensile strength and light weight with longer spans
4. Reduce the operation and maintenance asset stresses.

HVIC - High Voltage Insulator Coating







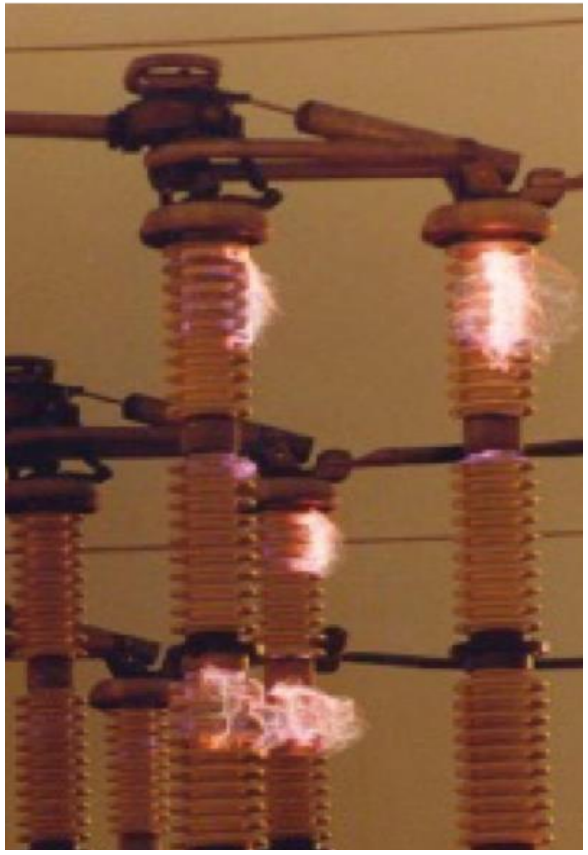
Problem

Contaminants like salt spray, cement dust, salt fog, industrial pollutants and even desert sand can affect the performance of high voltage insulators and lead to costly power interruptions.

When there is a contamination deposition on the insulators, it can cause everything between leakage currents, dry-band arcing and air ionization, and end up with flashovers.

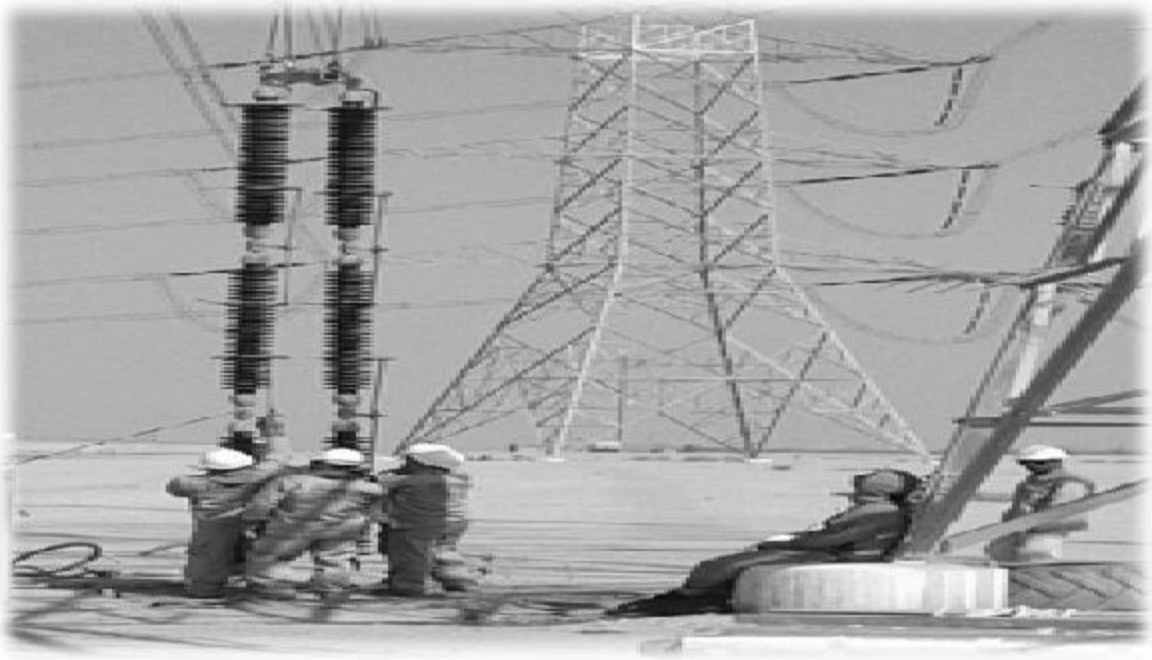
Consequences of a Flashover

- Power Outage
- Disturbance of Service & Business
- Equipment Damages
- Safety Effects



Solutions

Live line washing to remove the accumulation of dirt, dust, or other materials on periodic frequency.



Over insulation, that extends the cleaning cycle.

HVIC Solution

- line of silicone coatings, provide superior protection in highly contaminated areas and polluted regions by avoiding power interruptions due to excessive leakage current.
- RTV insulator coating is a one part hydrophobic, UV resistant coating. Its hydrophobic surface prevents water filming and encapsulates the pollution, avoiding the ability of the contaminant to combine with water to form an ionic solution.
- It can be done by paintbrush , Air assisted / airless spray equipment & Robot (Automated Application System)

The Features

- Hydrophobicity
- High resistance to arcing and corona
- Resistance to atmospheric and chemical degradation
- UV resistant
- Suppression of leakage current, discharges and pollution flashover
- Non-toxic and environmentally friendly material
- High resistance to air, airborne pollutants, rain, humidity, etc.

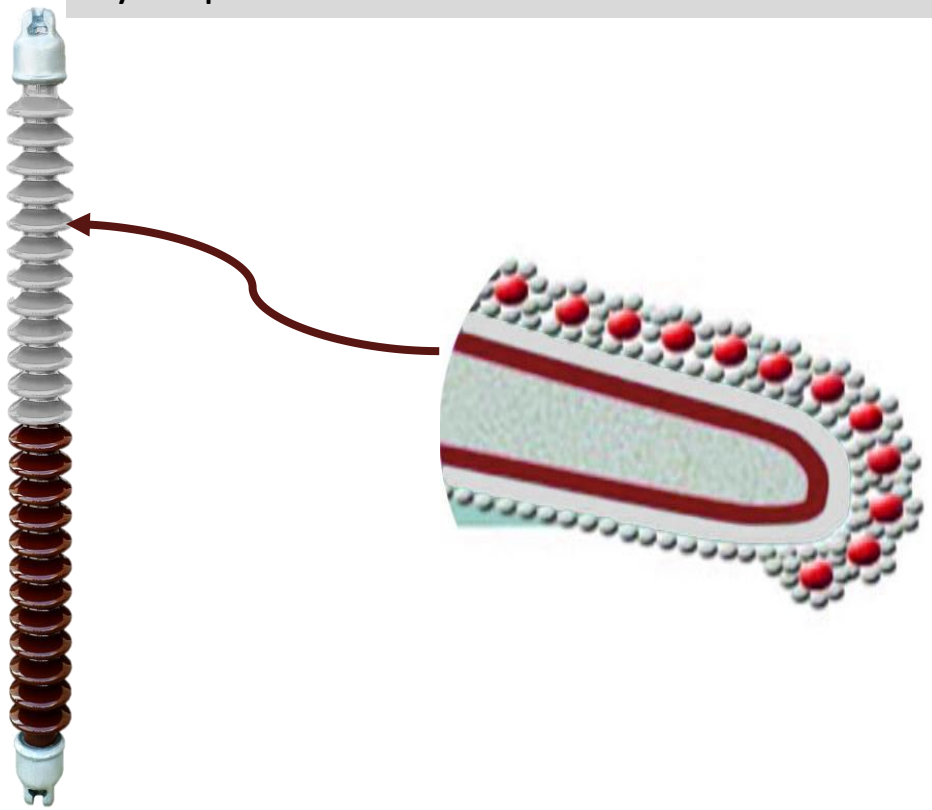
Coated Insulator

Un-coated Insulator

How does HVIC protect?

- Hydrophobic surface prevents water filming
- Surface oil (Cyclic) coats contaminant particles and renders them hydrophobic
- Reduces the contaminants' ability to combine with water to form an ionic solution
- Maintains these features over the long life of the installation

Low molecular weight (LMW) components are responsible for the hydrophobic surface of the coating. Water repellence and a low surface energy will be obtained on hydrophobic surfaces.



Two layers are typically required to fill the recommended layer thickness. The coating surface must become track-free before application of subsequent coat, otherwise flow will appear giving rise to drops and icicles

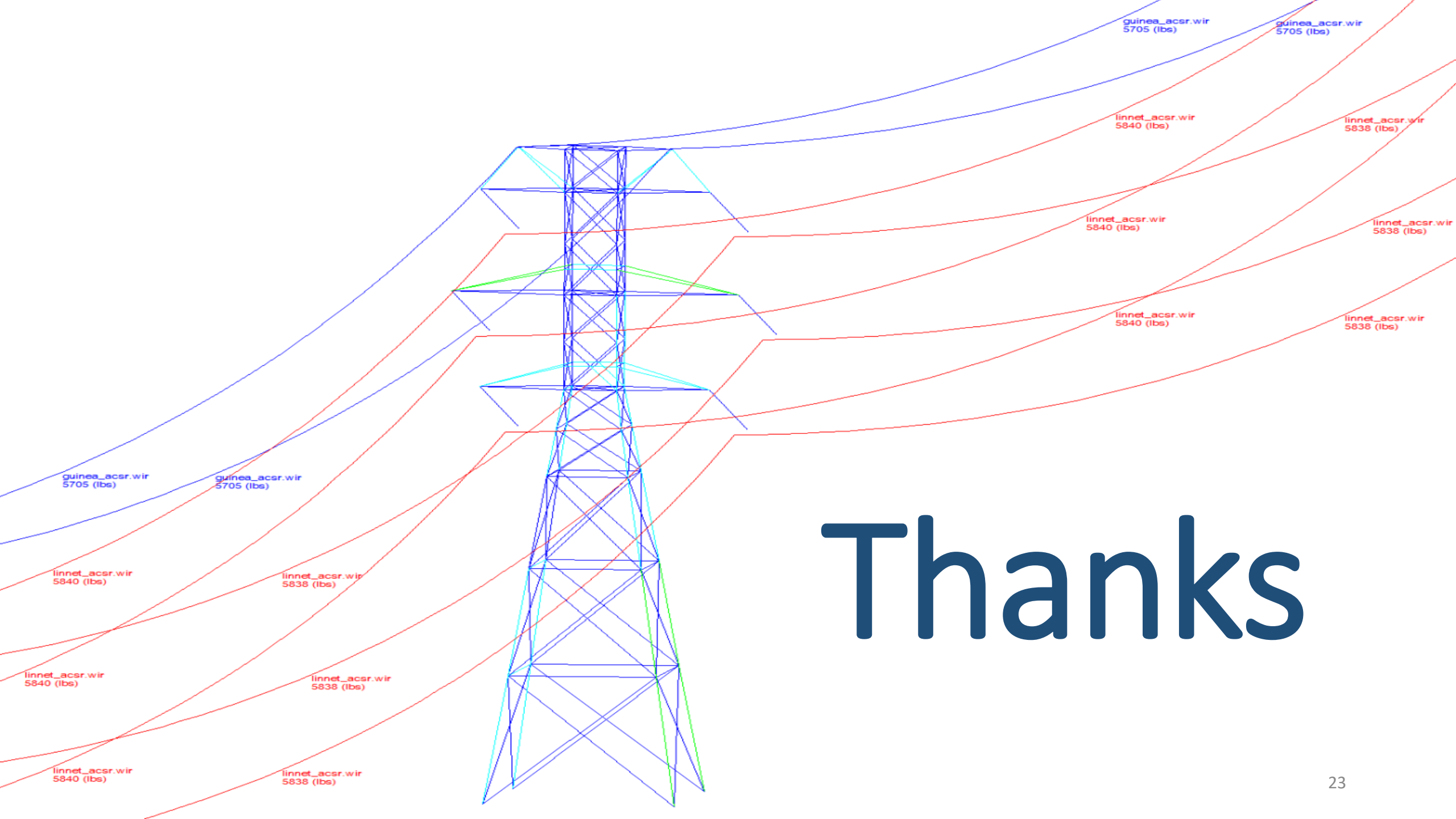
Type Tested

Test	Reference
Dry Arc resistance	IEC 61621
Inclined plan test	IEC 60587, Clause 5.2
Hydrophobicity	IEC TS 62073
Thickness	See above section 2
Adherence by scratch	EN ISO 2409
Adherence after 100h boiling water	IEEE 1523 / LV\/IWG-02(96), Clause 5.1, Water Penetration Test
Tracking & Erosion test	IEC 62217 (2012), Clause 9.3.3

Recommendation.

There are many recommendation not limited to below

1. The design simulation of broken wire and unbalanced loads in essentially.
2. Max weight span shall be utilized during design.
3. The simulation for wind form from both sides for all design is essentially.
4. SOF factors shall be reviewed due to history of some cyclones in last 20 years.
5. Selection OHL accessories shall be seriously reviewed due quite number of failures.
6. Contamination level should be taken in consideration while design OHL on selection insulator.
7. OPGW fiber & type no with short circuit to be standardized.
8. HVIC recommended for glass and porcelain insulator.
9. Drones should be used to improve powerlines inspection for better issued identification & proactive action.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