

Lecture NO. 03

Corona

IEEE Joint Technical Committee Meeting 2007

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Compiled By

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What Is Corona?

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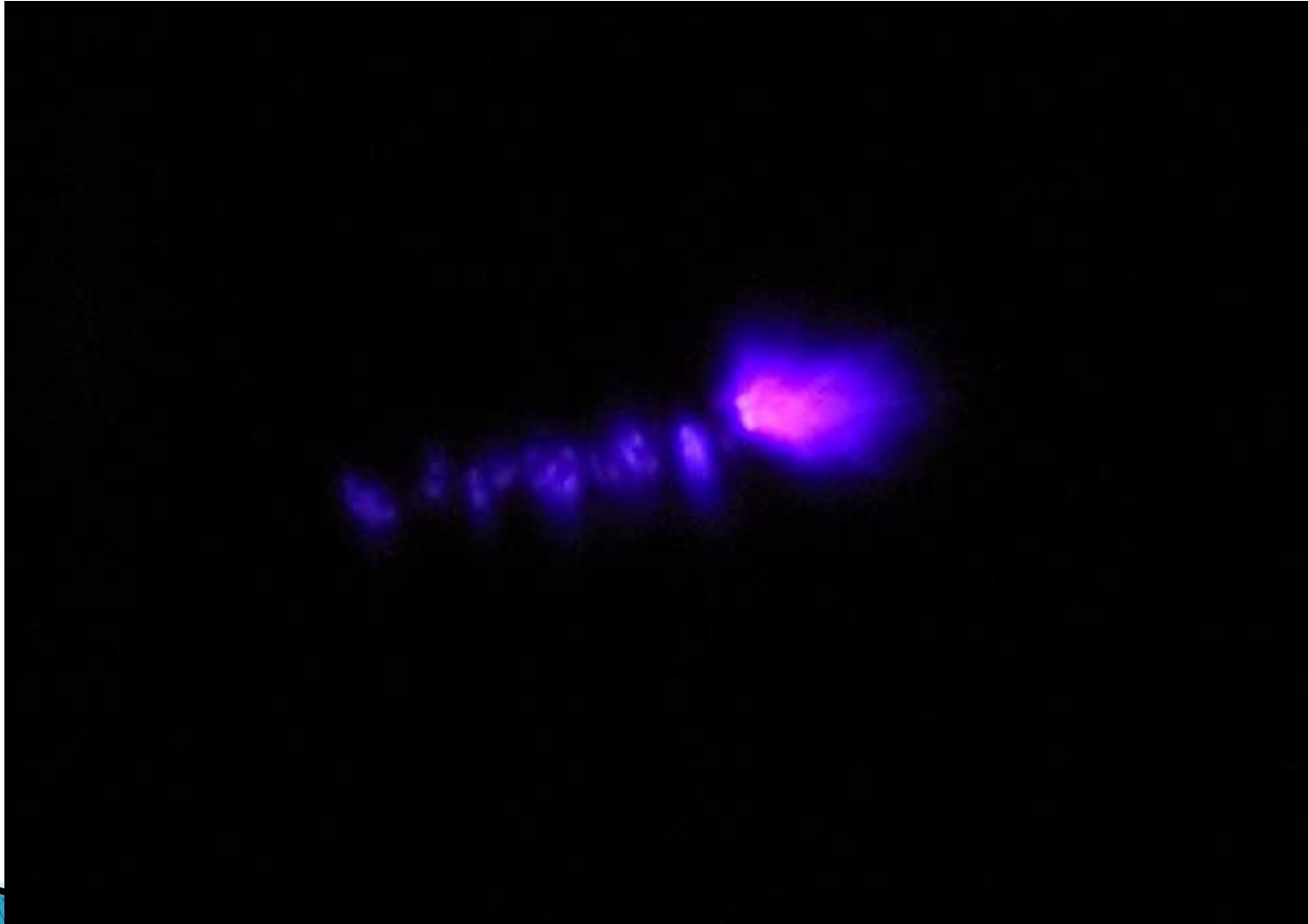
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What Is Corona?

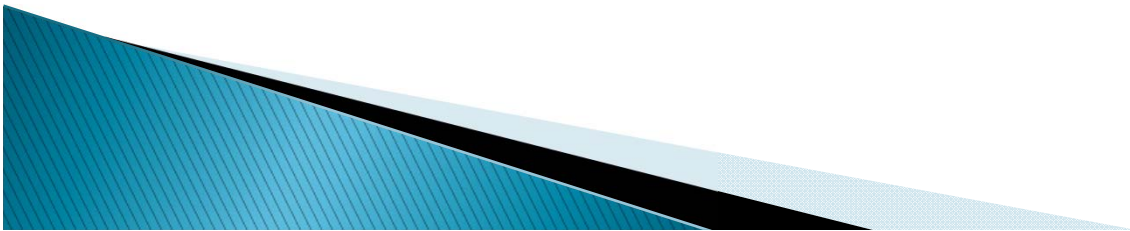
Corona is a luminous discharge due to ionization of the air surrounding an electrode, caused by a voltage gradient exceeding a certain critical value.



Example of Conductor Corona



What's The Fuss?



What's The Fuss?

Corona from conductors and hardware may cause audible noise and radio noise ▶



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**Audible noise from conductors ▶
may violate noise standards**



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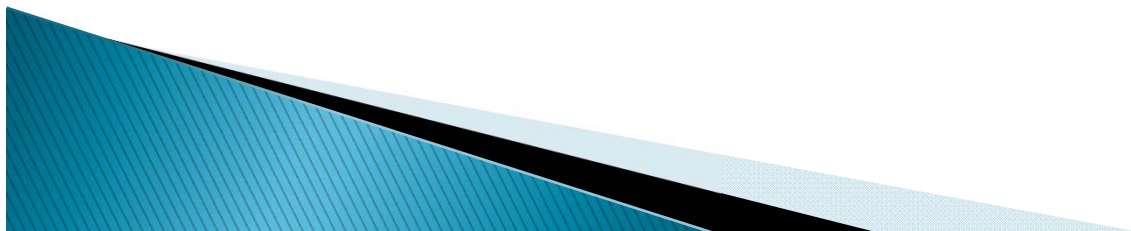
Audible noise from conductors may violate noise standards ▶

Radio noise from conductors may interfere with communications or navigation ▶



What's The Fuss?

- Corona from conductors and hardware ▶
may cause audible noise and radio noise
- Audible noise from conductors may violate ▶
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- Radio noise from conductors may interfere ▶
with communications or navigation
- Corona loss may be significant when ▶
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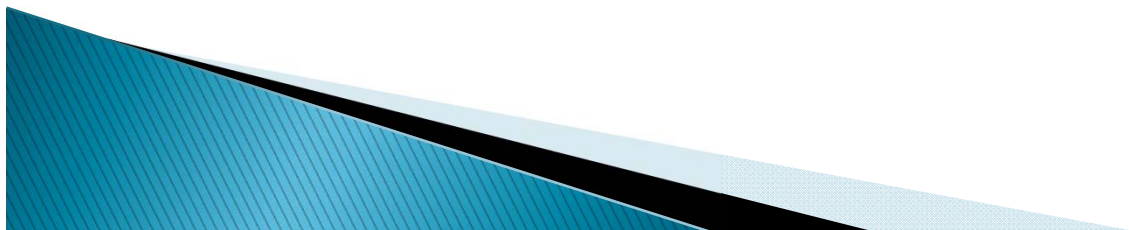
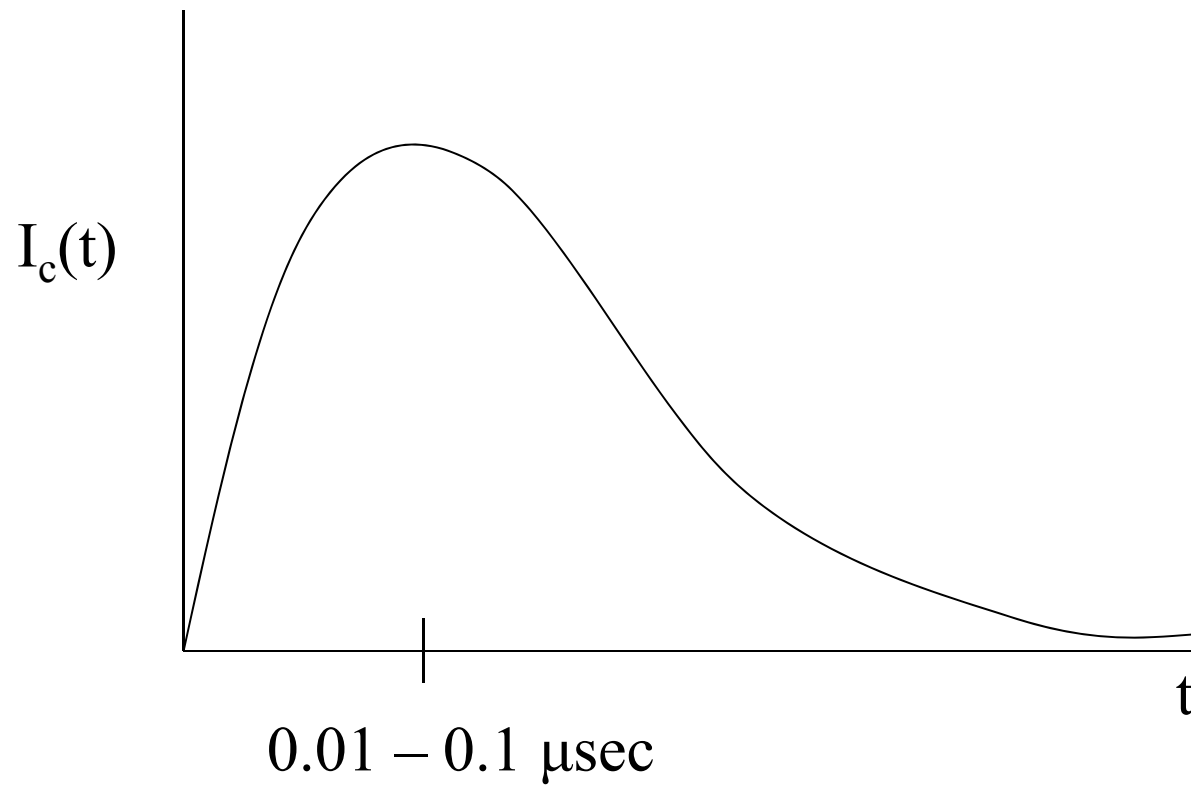
Radio noise from conductors may interfere with ▶
communications or navigation

Corona loss may be significant when compared ▶
with resistive loss of conductors

**Corona can cause possible damage to ▶
polymeric insulators**



Corona Discharge Currents are Impulsive



Physical Parameters of Corona

Corona is caused by the ionization of the media (air) surrounding the electrode (conductor) ▶



Physical Parameters of Corona

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- Corona onset is a function of voltage ▶



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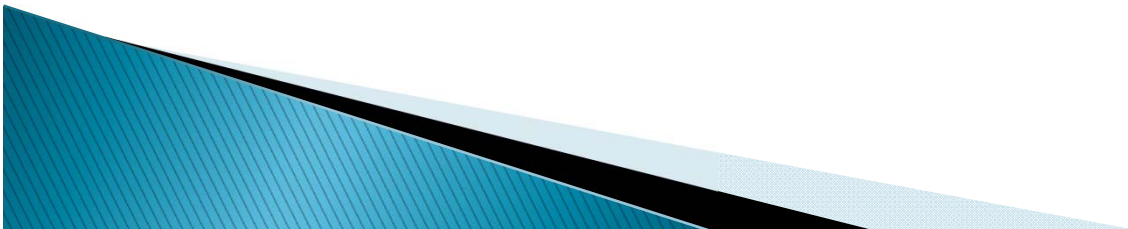
Corona onset is a function of relative air density ▶

Corona onset is a function of relative humidity ▶



Corona and the Electric Field

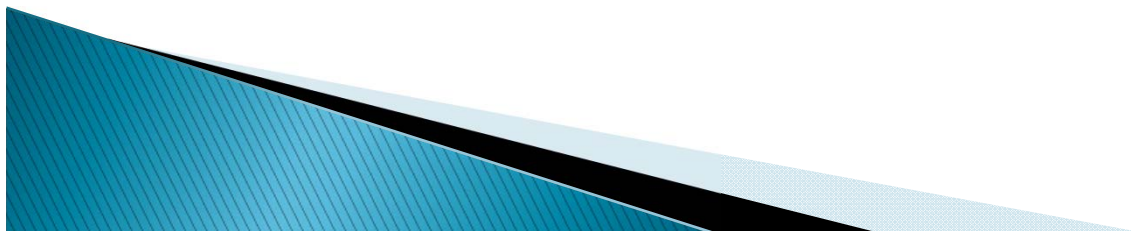
Corona is **NOT** solely a function of the Electric
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Corona and the Electric Field

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Corona is a function of the electric field on the surface of the electrode (conductor)

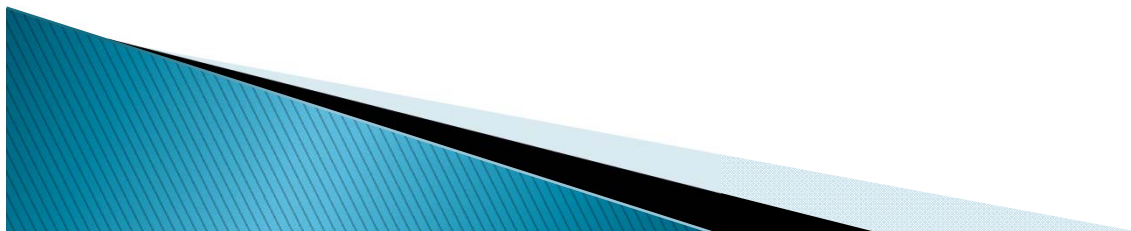


Corona and the Electric Field

Corona is NOT solely a function of the Electric Field

Corona is a function of the electric field on the surface of the electrode (conductor)

Corona is also a function of the radius of curvature of the electrode (conductor)



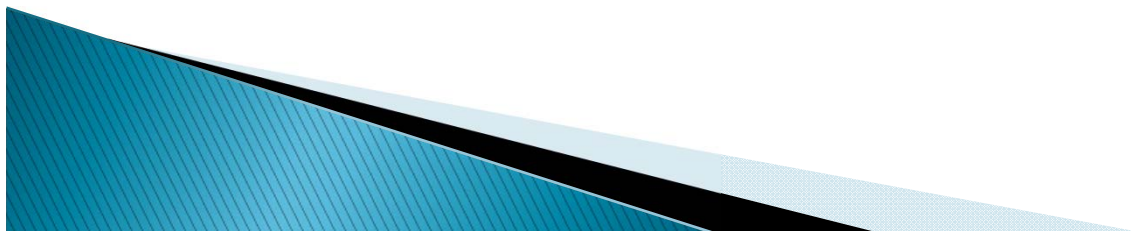
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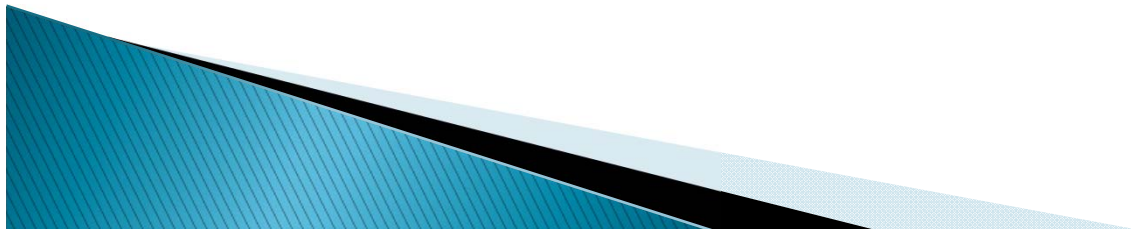
Corona is also a function of the rate of decay of the electric field away from the electrode (conductor)



Corona and the Electric Field

For the preceding reasons, selecting the conductor with the smallest electric field at its surface is not correct.

One utility found out (the hard way) that simply choosing large diameter conductors did not work well because the electric field decayed slowly away from the surface



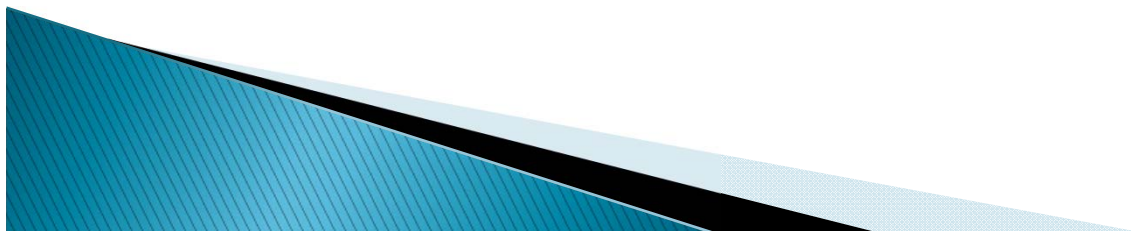
Corona and the Relative Air Density



Corona and the Relative Air Density

Corona has an inverse relationship with air density ▶

density



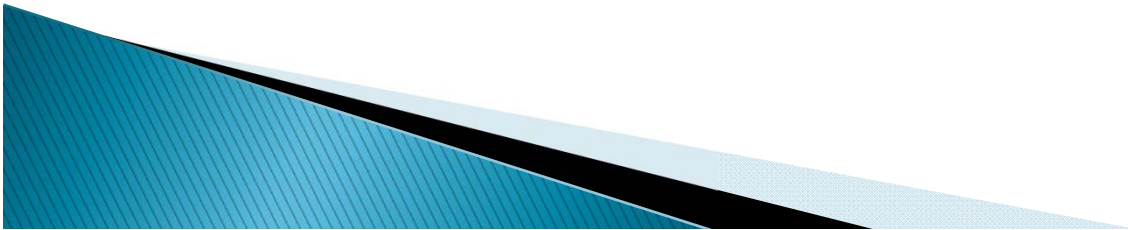
Corona and the Relative Air Density

Corona has an inverse relationship with air density ▶

Standard line designs that perform well at sea level, may have significant corona issues if used on lines that are installed over mountainous areas ▶



Corona and the Humidity



Corona and the Humidity

Corona has an inverse relationship with ▶
humidity at power frequencies



Corona and the Humidity

Corona has an inverse relationship with ▶
humidity at power frequencies

Fair weather corona is more prevalent in low ▶
humidity environments



Corona Is Dependent Surface Condition Of The Conductors



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Corona is enhanced by irregularities on the ▶
conductor surface



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Irregularities include: dust, insects, burrs and scratches and water drops present on new conductors ▶

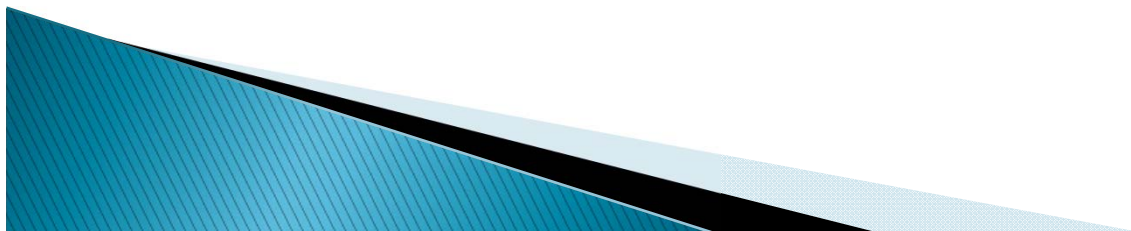


Corona Is Dependent Surface Condition Of The Conductors

Corona is enhanced by irregularities on the conductor surface ▶

Irregularities include: dust, insects, burrs and scratches and water drops present on new conductors ▶

Corona will generally be greater on new conductors and will decrease to a steady-state value over a period of approximately one year in-service ▶



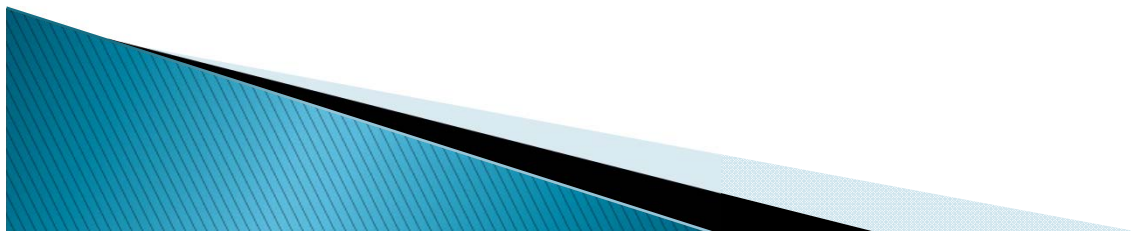
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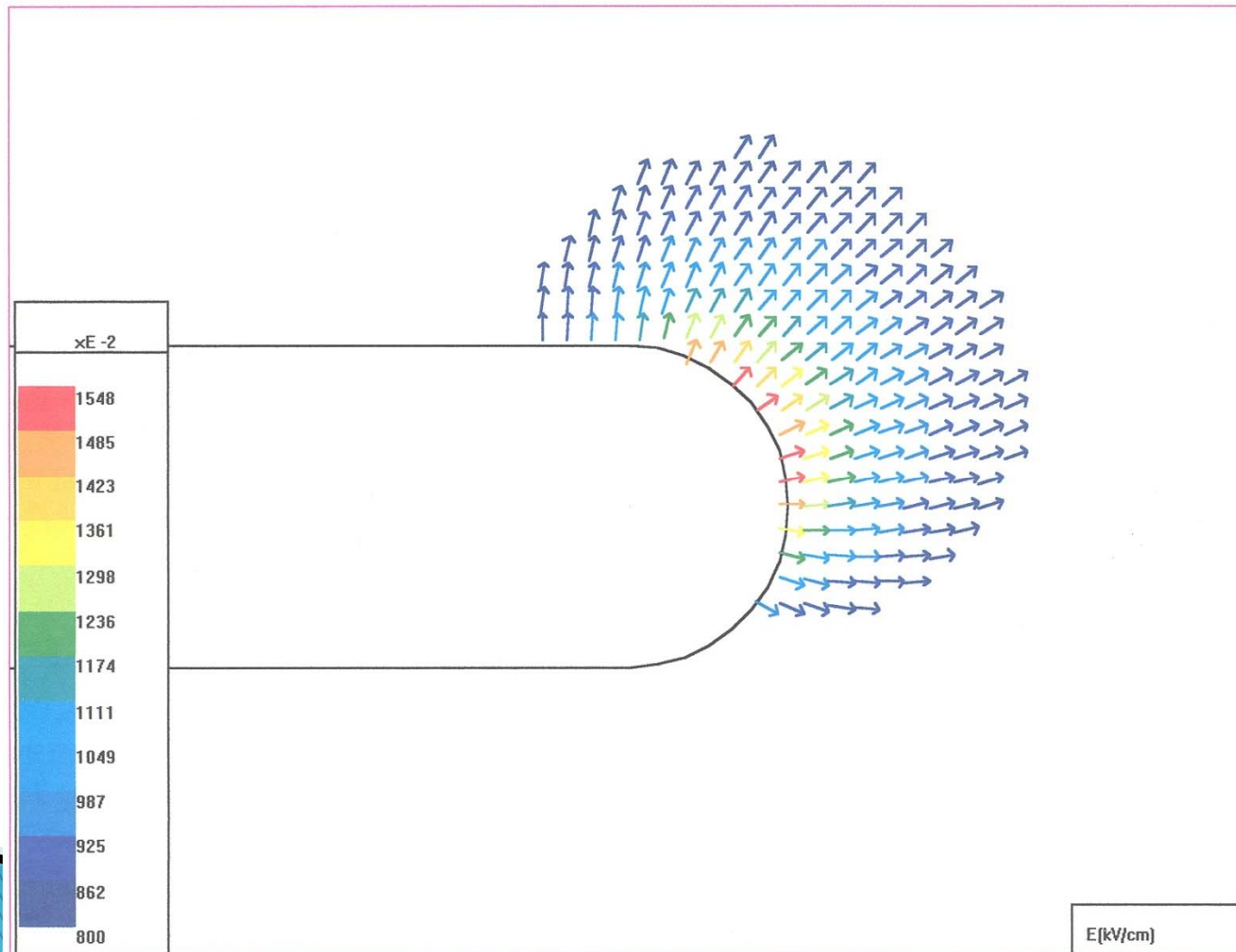
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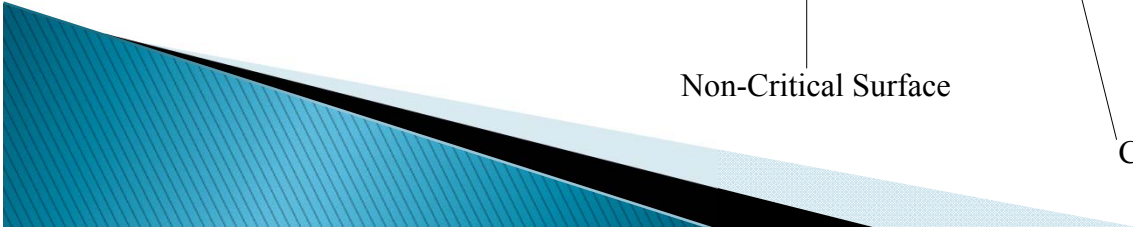
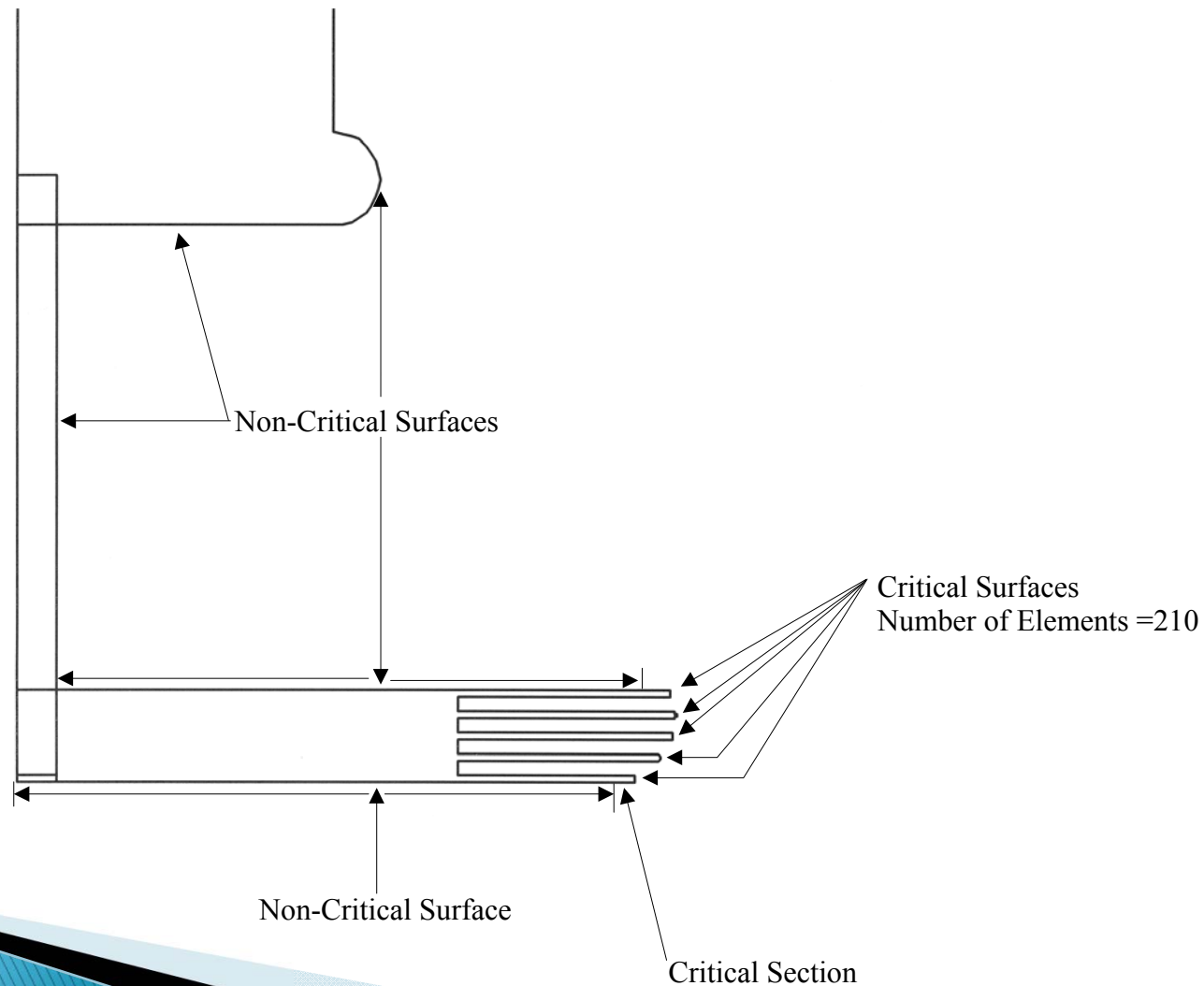
Corona is significantly increased in foul weather. ▶



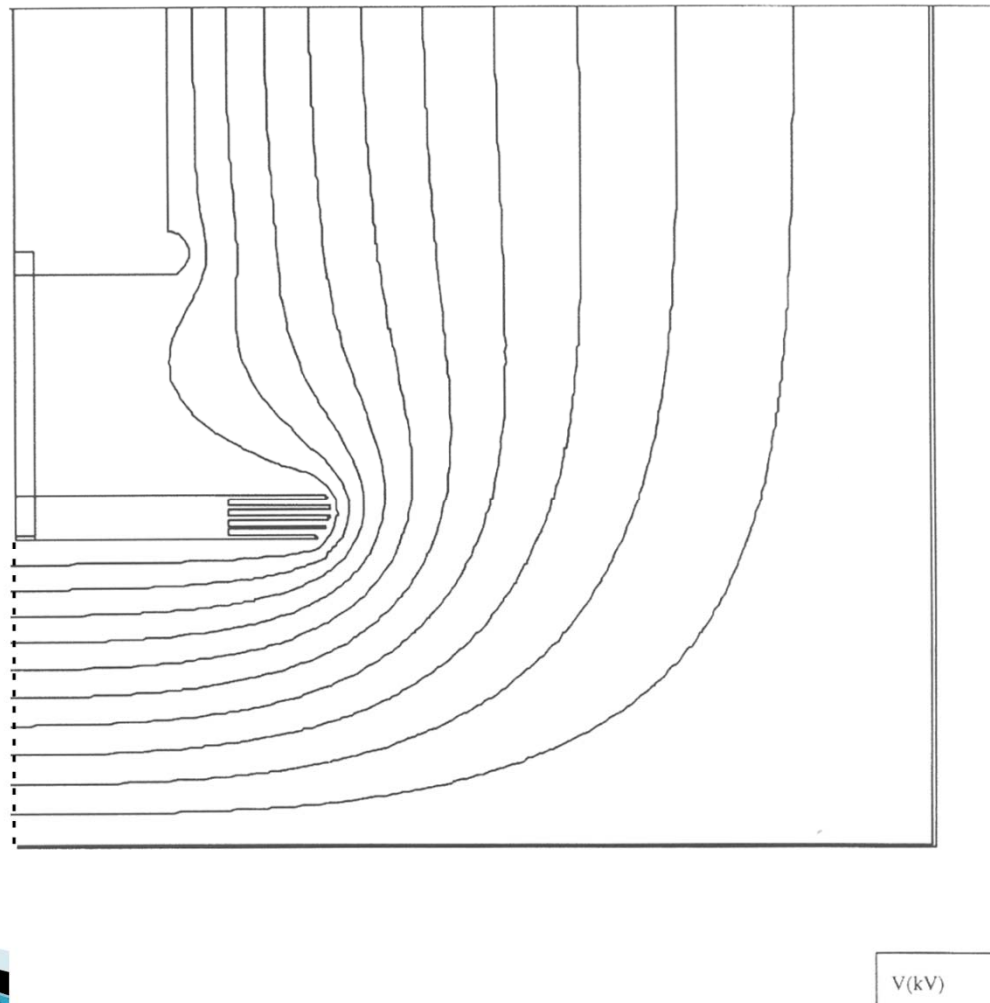
Corona Is Dependent On Local Electrode Geometry



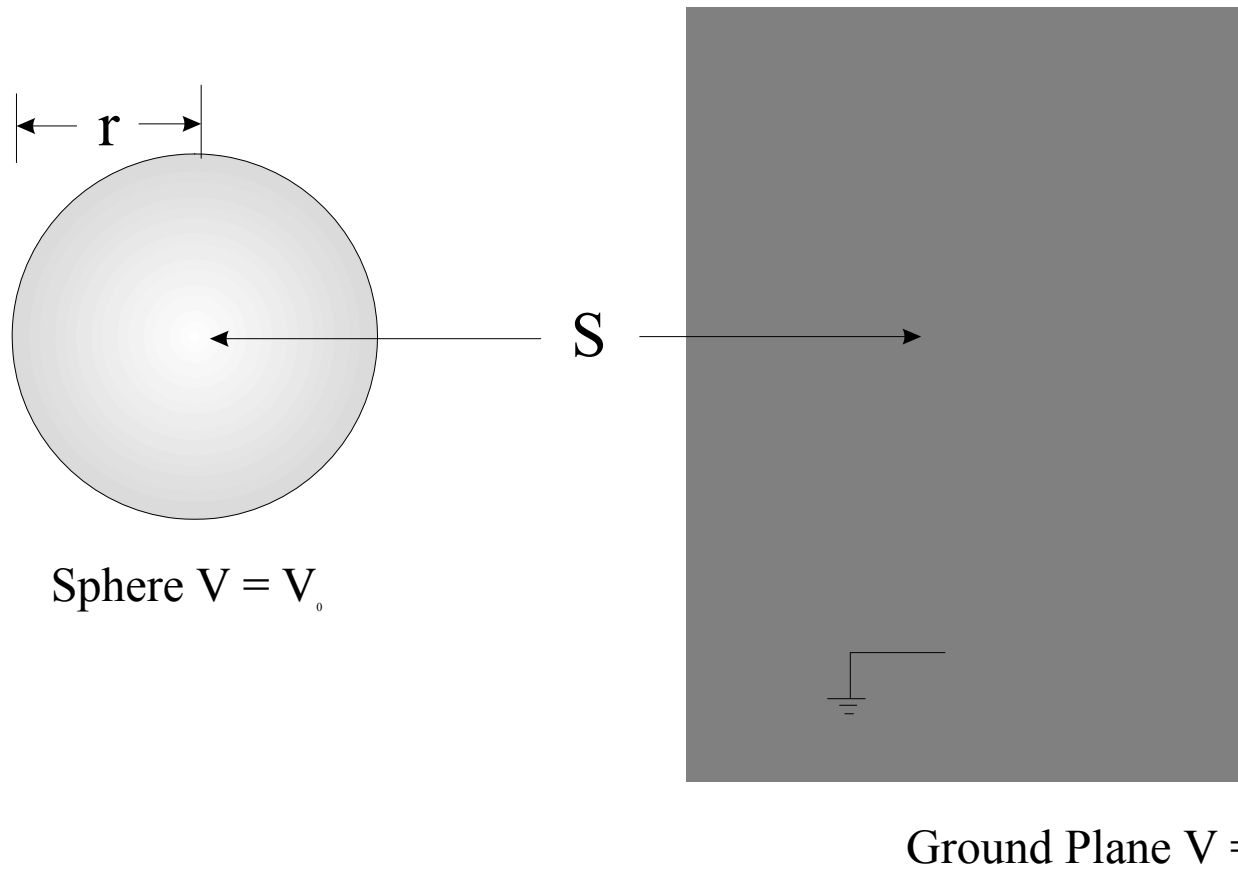
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Why is it a special problem for voltage upgrades?

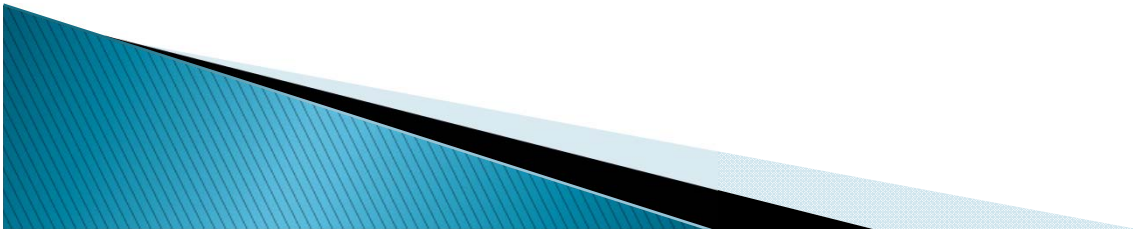
If the voltage of a transmission line is increased without changing the line design, the electric field at the surface of the line conductors (and hardware) will increase. This increase will cause additional Corona



Practical Consequences

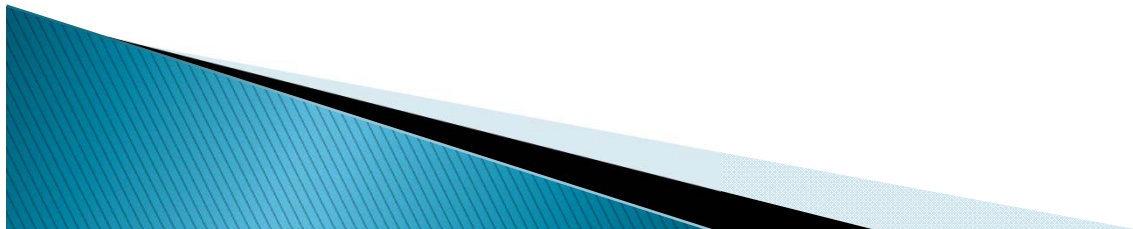
1. Larger conductors better – to a point
 2. Use conductor bundles to reduce corona
 3. Corona phenomena much worse in foul weather, high altitude
 4. Compact lines more susceptible
 5. New conductors can lead to poor corona performance for a while
- 

Cautions Regarding Radio Noise



Cautions Regarding Radio Noise

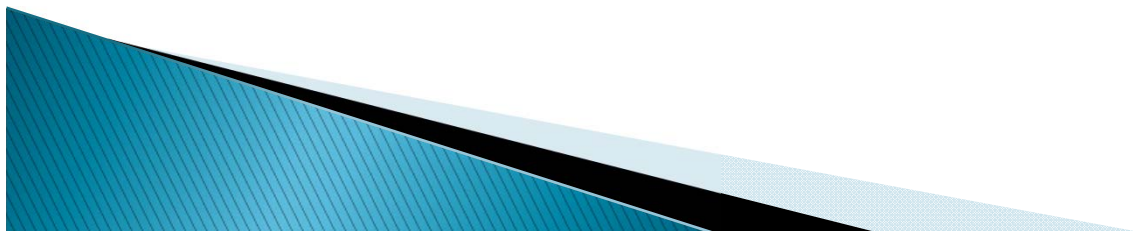
Radio noise from corona should not be confused with radio noise generated by spark discharge ▶



Cautions Regarding Radio Noise

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High frequency complaints are almost always due to sparks ▶

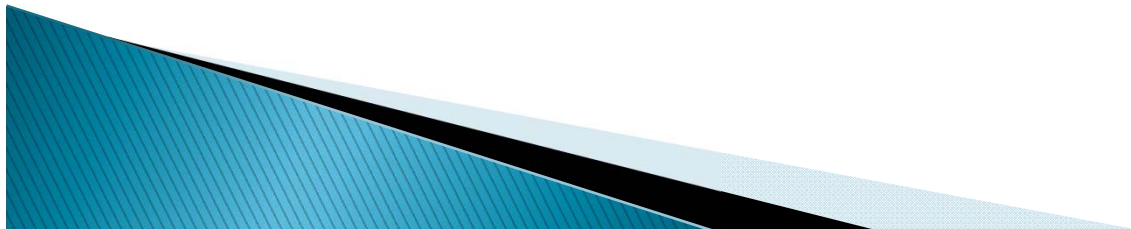


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Causes of spark discharges can be located and repaired ▶



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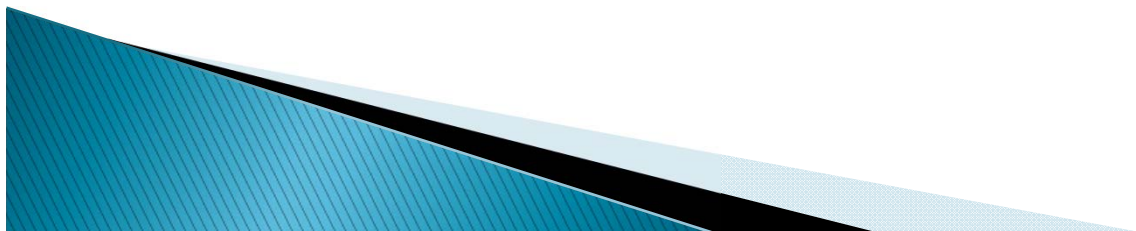
Causes of spark discharges can be located and repaired ▶

Corona is a DESIGN ISSUE ▶



Cautions Regarding Radio Noise

Radio noise caused by corona cannot be reduced by changing the line configuration near where the noise problem is occurring. The source of the problem can be several miles away



Audible Noise

Can get “broadband noise” and “hum”

Load can affect audible noise

For measurement see:

ANSI/IEEE Standard 656-1992 – “IEEE Standard
For Measurement of Audible Noise from Overhead
Transmission Lines

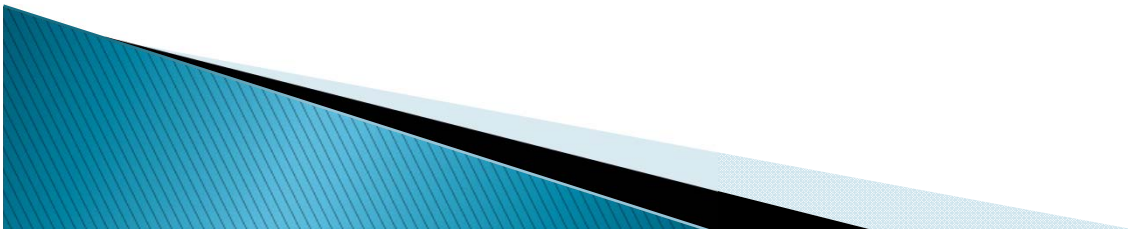


Audible Noise

- ▶ May be present as “120 Hz Hum” or broadband noise
- ▶ Can be affected by load



Audible Noise



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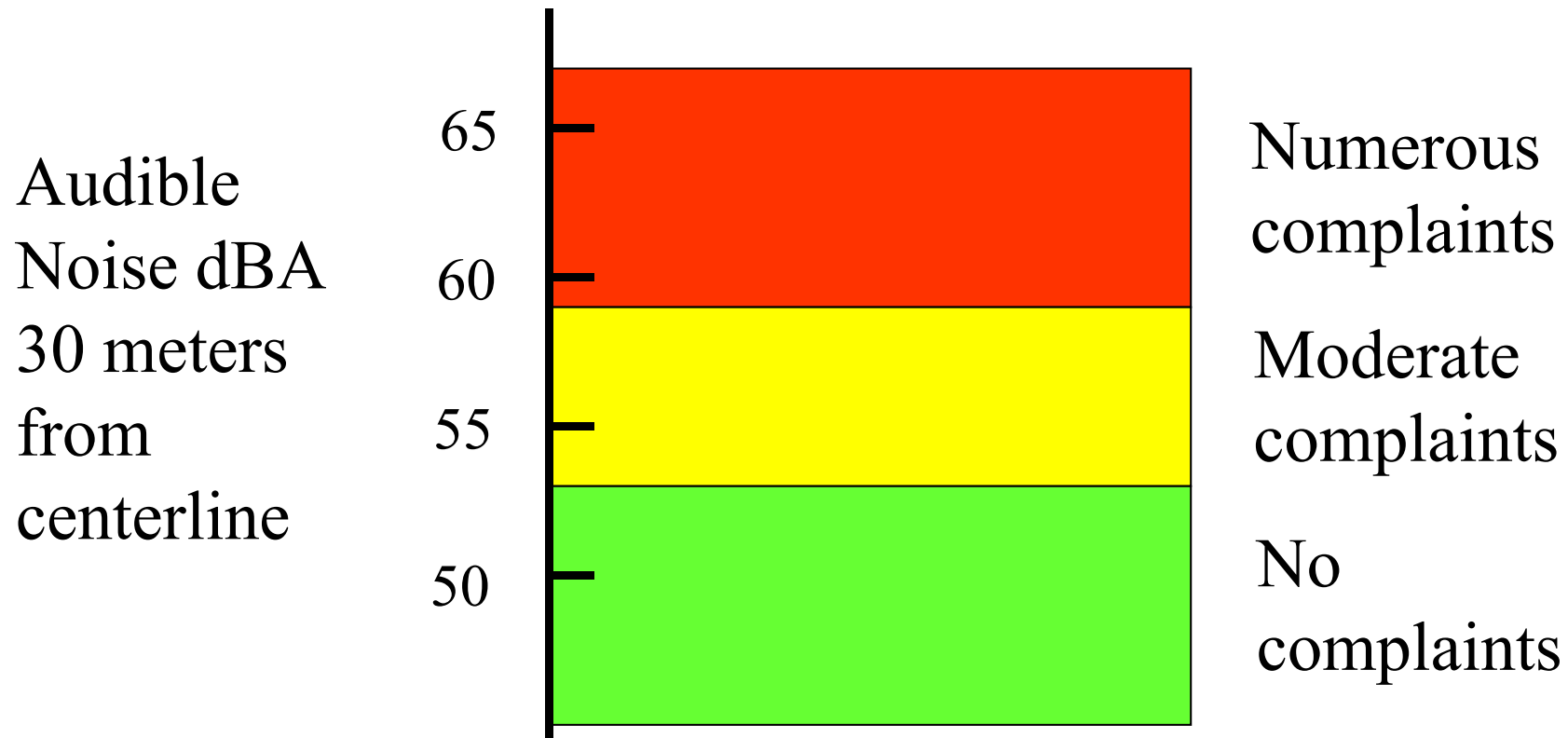
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broadband noise

Can be affected by load ▶



Audible Noise in Context



Source: BPA study


Corona Loss

What is it?

Whenever corona occurs on a transmission line, there is a corresponding loss of energy called “corona loss.” This loss is one of the reasons why the transmission of electric energy between two points is not perfect.

When can it be a problem?

Generally, corona loss is significantly less than resistive loss. However, at higher voltages, high altitudes and during foul weather, corona loss can actually exceed resistive loss.

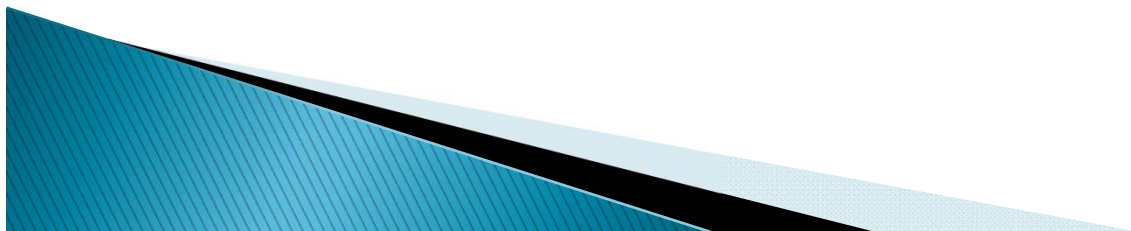


A Word On Corona Losses



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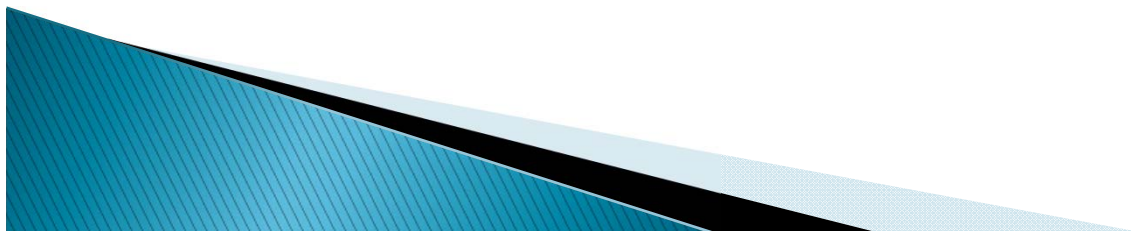
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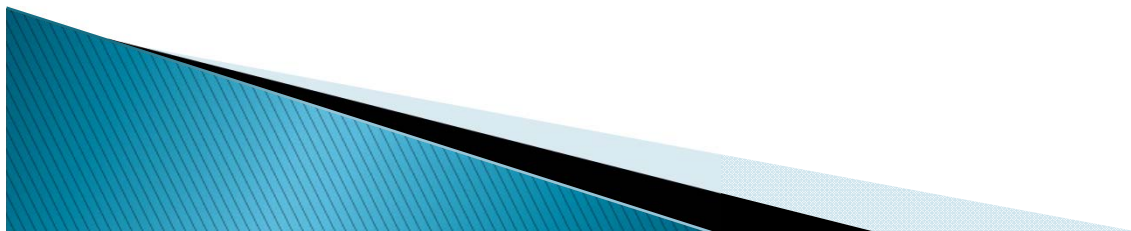
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Example Losses (sea level)


Line Voltage (kV)	Bundle n x 2a	Load MVA	I ² R Loss kW/km	Corona Loss (kW/km)	
				Average	Maximum
362	2 x 3.16	400	41	2	26
550	3 x 3.3	900	52	4	78
800	4 x 3.3	2000	93	8	208



Corona On Hardware

Transmission line hardware is usually tested in the laboratory prior to being selected to determine whether is corona free. This test is often done on a single phase system in order to conserve laboratory space.

It has been found that the traditional method of energizing the system to 110% of the rated line to ground voltage is not sufficient, especially for lines of more compact design. Apparently, the hardware is exposed to higher gradients in the field than those to which the hardware was tested.

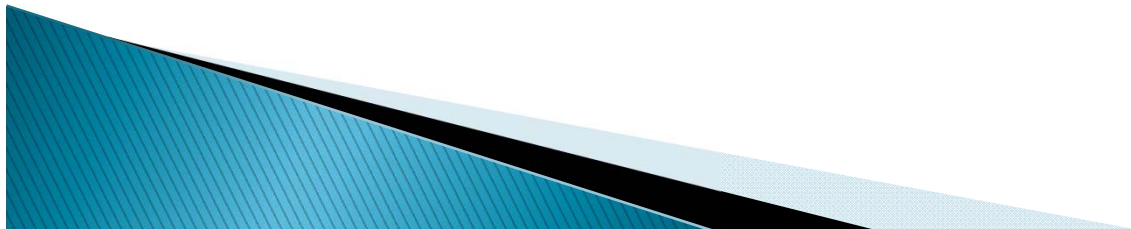


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