Advances in UHV Transmission and Distribution
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Lecture – 16
Corona nad interference on transmission lines

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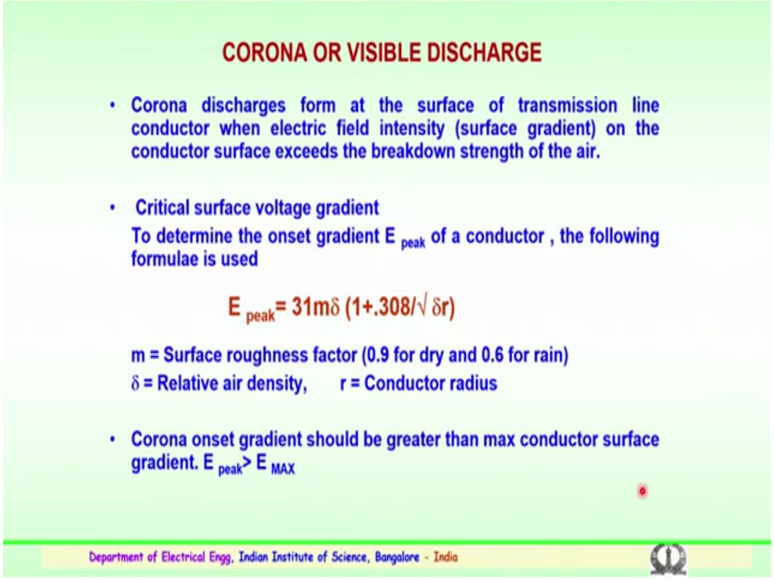

So, further conductor which is to be used for the EHV or UHV transmission is very important it has to be seen that the discharges like the corona or the visible discharges should not be generated on the surface. This again will create the problems for the communication or the loss power loss because of the conductor. So, corona discharges which form at the surface of a transmission line conductor when electric field intensity that is a surface gradient on the conductor surface exceeds the breakdown strength of air.

So, these discharges should be contained by the smoothening of the conductor. So, that the critical surface voltage gradient has to be should not exceed a particular value which is being specified. So, to determine the onset gradient that is the inception gradient E peak of a conductor the following the formula is employed.

So, E peak is onset or the inception gradient is equal to 31 m delta into 1 plus 0.308 divided by root of delta r; so where E peak being the inception gradient or onset gradient m is the surface roughness factor. So, the conductor surface roughness factor for calculation in case of dry conditions the factor is normally assumed to be 0.9 and in case of wet or rain or for conditions the factor of surface roughness employed is usually 0.6. So, delta is a relative air density and r, r being the conductor radius which is serving used for the transmission or the distribution this is the simple formulae to find out onset gradient of any size of the conductor which is 0 is 2.

So, the corona onset gradient should be greater than the maximum conductor surface gradient that is E peak should always be greater than E max that is the maximum surface gradient.

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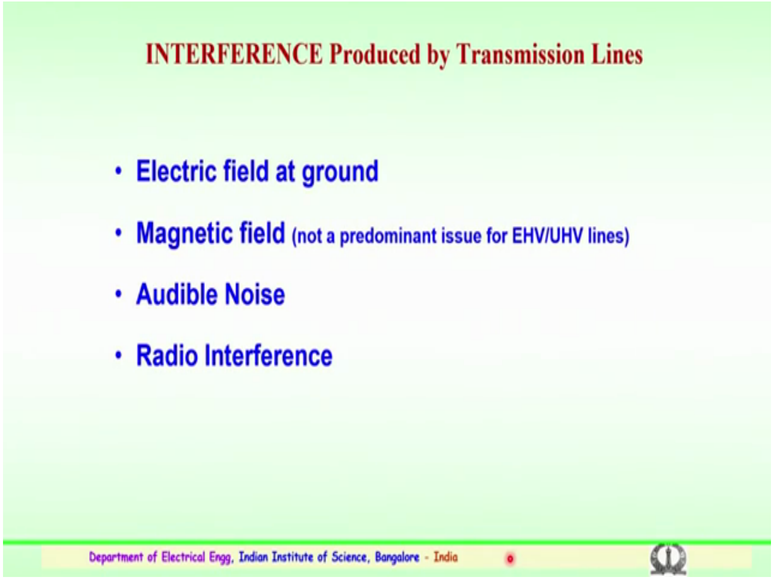

So, the important properties of a conductor have to be seen that, when it is used for the transmission or distribution system, for the 4 important parameters have to be verified during the energizing condition. The electric field at the ground level, the magnetic field may not be a predominant issue in case of extra high voltage an ultra high voltage transmission lines were the transmission conductor operated a very high voltage the current will be lesser. So, the effect of magnetic field may not be much of the issue the third being the audible noise the noise which is being generated by the conductor at the particular voltage which is being a used should not exceed a certain specified value, very it could cause in convenience to the humans animals or interferences with the neighboring circuit is communication circuit.

So, then the radio interference again the radio interference should not cause the interference with the communication radio communication or television interferences.

So, these have to be contained and this have to be seen that when the conductor which is used for the transmission has to adhere to the required norms that is the international specified values where the noise levels which it should not exceed before it is being used in the transmission. So, the details of the values particularly in the country for a 400 kilo volts and above EHV levels the audible noise from the conductor during energization should not exceed more than 60 decibel level.

And in case of radio interference the noise level should not be more than 60 decibel that is thousand micro volts radio interference voltage. So, these are the values typically followed in the country for the EHV and UHV transmission. So, any hardware conductors insulator strings the noise generated by the components or of the hardware or the insulator string should not exceed 60 decibels.

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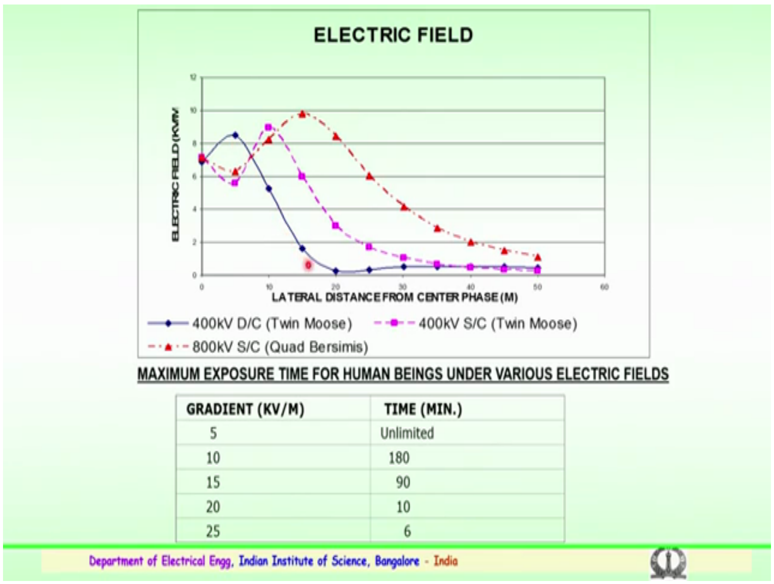

GRADIENT (KV/M)	TIME (MIN.)
5	Unlimited
10	180
15	90
20	10
25	6

The graph gives the electric field kilo volt per kilo volt versus. Here the lateral distances from the center kilo volt per meter for lateral distance from the center phase in case in meters very clearly shows 3 different curves here. So, one the black curve corresponds to the 400 kV double a circuit employing a twin moose conductors that is a 2 conductors of moose make that is a 2 moose conductors are used in a double circuit.

The noise generated over a period is shown as follows depending upon the distance from the tower. So, 0 corresponds the height where the conductor is being used then the field shows high very near to the conductor as a height towards the ground end towards the ground end the electric field decreases. That is how the line gets decreased over the ground level from the tower side.

So, similarly you have a red color with a triangular bullet us for a 800 kV single circuit similar type of seen initially the kV per meter of the electric field is slightly higher around 9 to 10 kV per meter. This comes drastically when you see over 50 meters from the tower towards the ground. So, this is how again this pink color shows the 400 kV single circuit twin moose a line where the electric field simulations have been carried out in measured values are given here.

So, the maximum exposure this table is very important the maximum exposure time for human beings under various electric fields are specified by the international committee where the gradients kV per meter versus the time in minutes. So, the humans could be exposed if at a fields of 5 kV per meter. For a long period of time the effect will not be dangerous to the humans. In case the gradients are 10 kV per meter the exposure should not be more than 180 minutes that is a 3 hours the exposure should not be more than that. In case of the gradients increased 15 kV per meter the exposure should not be more than ninety minutes or one hour 30 minutes.

Similarly, in case the gradients exceed 20 kilo volt per meter the exposure should not be more than 10 minutes, and if the gradients are 25 kV per minute the exposure should not be more than 6 minutes. In case the exposure is more than the specified limit the human could be uncomfortable or he could feel the effect of electrical field and he could have the effect because of this gradients where he will not able to tolerate.

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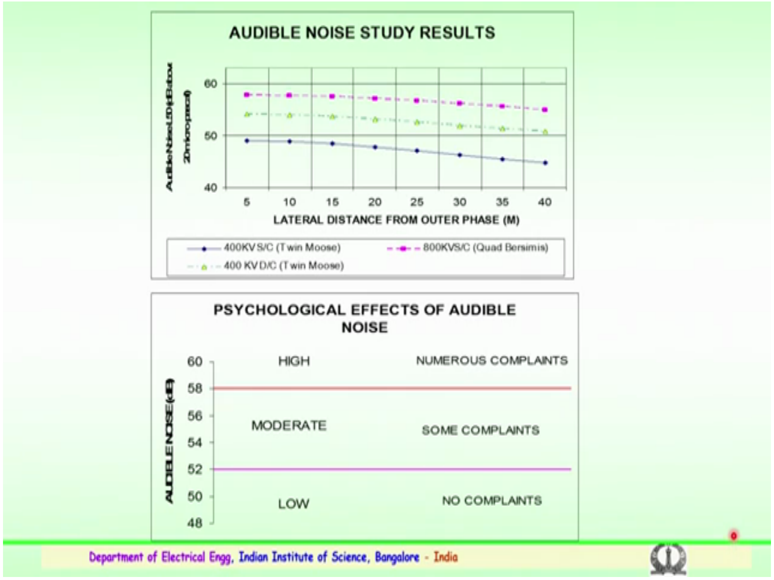

So, similarly audible noise a lot of studies have been carried out for 400 that is a EHV and ultra high voltage lines. And you can see the audible noise in decibels versus the lateral distance from the outer phase conductor phase towards the ground side. It is very clearly as that from the tower if you move away towards the distance in case of 400 kV single circuit twin moose you can see somewhere from 48 decibels it reduces to a lower level.

Similarly, for 400 kV double circuits from 54 to 55 decibels decreases to somewhere around 50 db. So, for UHV that is a 800 kV single circuit employing a quarter full bersimis conductor that is 4 conductor bersimis from the tower towards the distance of 40 meters you see a decrease from 56 or 58 decibels to somewhere around 54 or 55 decibels. So, as the distance increases the noise level is also for decreases.

The psychological effects similar to the earlier electric field here audible noise also has a psychological effect on the humans and the animals. So, above 60 decibels these are the decibels audible noise above 60 there are numerous complaints which could not be tolerated and they are very high and anywhere between 52 to 58, there are the moderate which have some complaints. So, the operation level when it is lesser than 52 decibels not many complaints have been seen. So, the study which was conducted for the transmission towers or transmission near the transmission lines where EHV and UHV conductors are being used.

So, typically the noise levels below 60 dB or below 52 dB are preferred by the humans or in the people who are working in the near the area. So, it is to see that utilities should adopt the conductors hardware insulator strings which do not generate more noise and create psychological effect on the humans or the animals.

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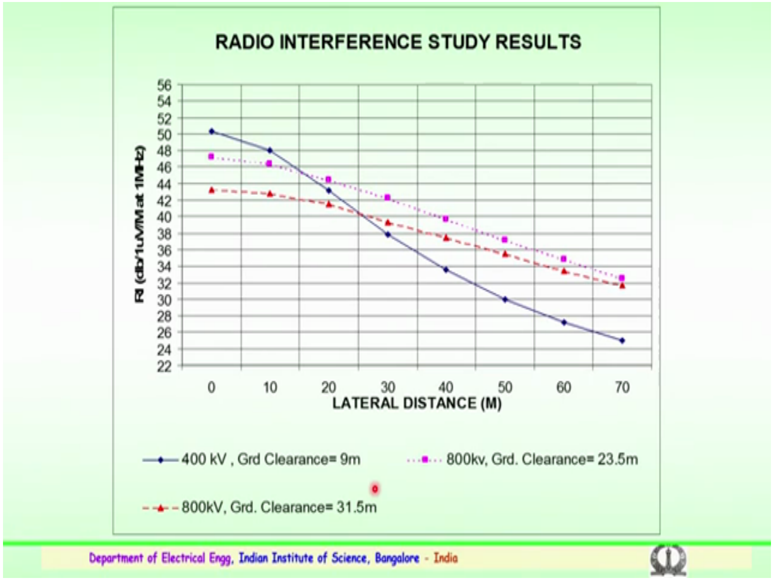

So, preferred radio interference again values are important radio interference values as mentioned earlier these are again radio interference in micro volts or decibels micro volts dB micro volts above one micro volt. So, here again db above micro volts versus the lateral distance as the distance increases you can see the radio interference dB level also come down for 400 as well as for UHV lines in case of EHV 400 kV a line you can see from 50 plus db comes down to 26 or 28 decibel as the distance comes around 70 meters laterally.

So, for 800 kV you can see as a distance increases more than 30 or 25 meters the reduction in the noise radio interference values also decrease. So, these are various study which have been conducted after the energization of for the UHV and EHV levels.

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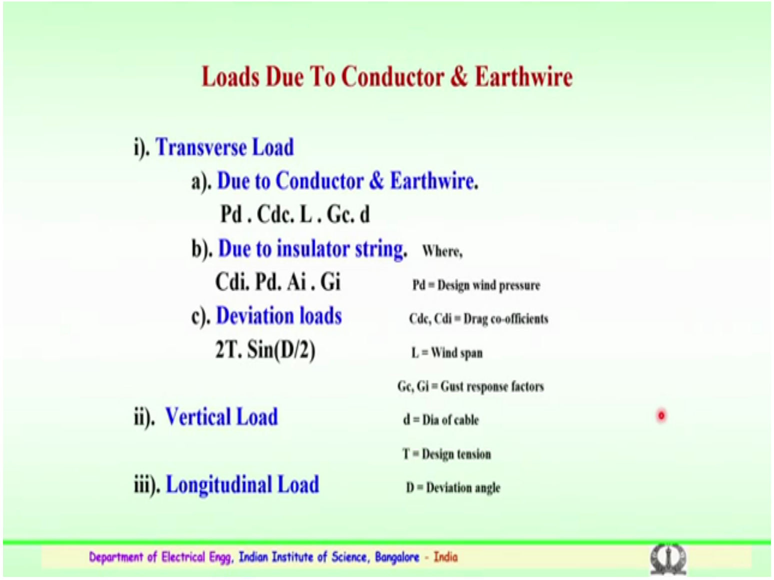

So, how the loads particularly due to the conductor and the earth wire which are connected to the tower are calculated. So, these are important considerations. The loads due to transverse load have to be bear in mind. This is because of the conductor and the earth wire. So, a simple formulae is being used for the calculations the details are for the transfer transverse load due to the conductor and earth wire it is Pd Cdc L Gc and d these are for 5 factors to be bear in mind.

So, due to insulator string Cdi Pd Ai and Gi are to be considered in case of deviation loads 2 t in the sin dby del dby 2 are considered and for vertical loads suitable considerations have to be made and for longitudinal loads. So, where p d being design wind pressure at that area where the transmission tower exist Cdc c d l are the drag coefficients of wind due to the conductors which see that and l is the wind span Cgc and Gi are the gust responsive factors Gc and Gi are the gust responsive factors d is the diameter of the conductor of the cable t is a design tension and d is a deviation angle.

So, these are the parameters which have to be born in mind while calculating the loads due to conductor and also the earth wire.

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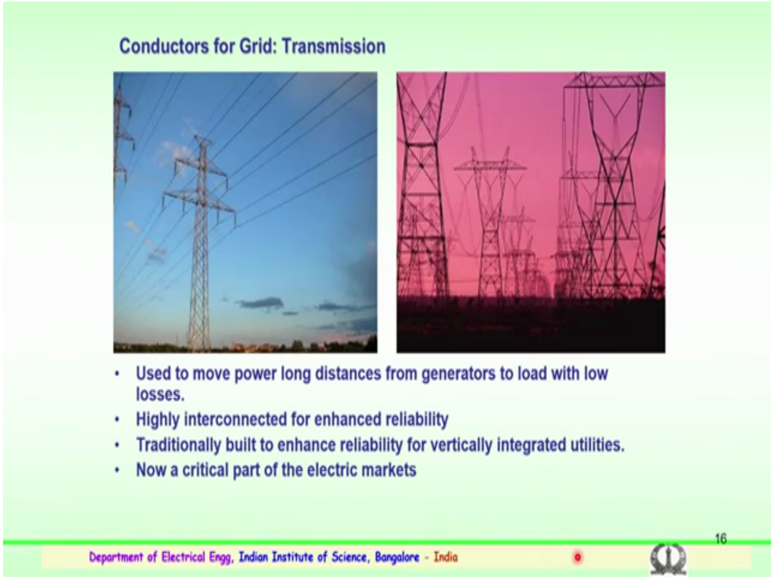

So, conductors a for the transmission that is the UHV and u h EHV transmission are of various types because we have use to move particularly this conductor self in transferring the power for long distances from the generating stations to the load centers load centers again cold be domestic industry agriculture or many of these things. So, we have to keep in mind the conductors have to be designed particularly for carrying more power with low losses. So, and these grid transmission is highly interconnected because mainly to enhance reliability of transmission or a distribution. And traditionally grid transmission is built to enhance reliability for vertically integrated utilities and now a critical part of which is a critical part of the electrical market.

So, very important proper planning of the conductors have to be chosen for the EHV and UHV transmission.

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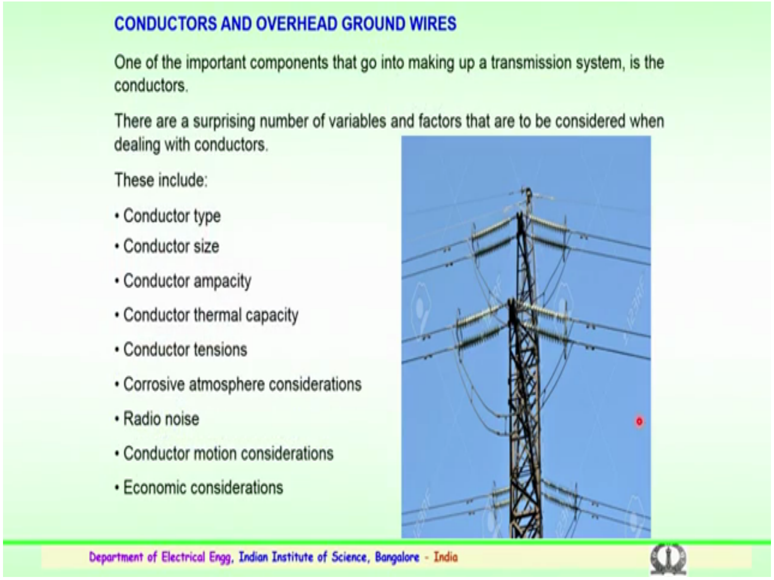

So, conductors and overhead ground wires you can see various conductors are from insulator string various types of conductors are used for transmission. This is the overhead earth wire or a ground wire which is connected to the top most point of the tower to tower. So, this in case of lightning protects the entire tower the conductors are the insulators. So, that the lightning strikes and it is grounded. So, this earth wire or ground wire helps in taking the search to the earth or a ground.

So, one of the important components that go in to making of the transmission system is the conductors. So, conductors are very important next to the insulators. So, you should know that there are surprising number of variables and factors that are to be considered particularly dealing with the conductors. So, what are these variables or a factors are to be considered this include the type of the conductor, the conductor size what is voltage level what is current carrying capability of the conductor. So, depending upon the sizes is chosen the conductor amp city the current caring capability of the conductor the thermal conductor thermal capability the temperature up to which during the transfer of power where the conductor could normally withstand.

So, this temperature or thermal capability is very important else the sag of the conductor increases, in case if it is not thermally capable of handling the power. So, conductor tensions the conductor should be able to operate in the tension or a compression mode. Then corrosive atmospheric consideration the conductors are for aide nature almost exposed to the environment. So, different climatic conditions create the conductors to become corrosive. So, these corrosive natures of the conductors have to be kept in mind. Then the conductor should not give interference or discharges particularly which creates wanted signals in the radio or television interferences that is a radio noise or radio interference values which increase because of the conductor discharges happening that is corona or radio interference noise. Then the conductor motion consideration mainly in the areas where the wind and such conditions the motion of the conductor has to be considered.

Then finally, the economic consideration going in for type of conductor for a particular voltage and type of the conductor span the line length. So, these again have to be looked in to the economic point of view these are some of the various types a factors and variables to be considered particularly when dealing with the overhead conductor as well as the overhead earth wire or a ground wires which are being used.