Recent Advances in Transmission Insulators

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Module No # 02
Lecture No # 07
Environment issues with of Transmission Insulators

Good morning we were discussing about the contamination or pollution issue which is very critical aspect for deign of line insulation in case of overhead transmission insulators. So their again we have discussed about the AC transmission and DC transmission we will focus on some important guidelines which have been framed by the standards and also the working groups in this particular insulation area.

So for the pollution testing we have also looked into the laboratory aspects of insulators are being tested for evaluation. Similarly for the DC as I mentioned earlier several long distance transmission HPDC lines are coming up in the country up to 800 KV lines several lines have already been in functioning and one of the line also which mentioned is the longest line in the world which is from Arunachal to Agra.

So very important aspect for EHP and UHP we have discussed about a contamination or pollution issue.

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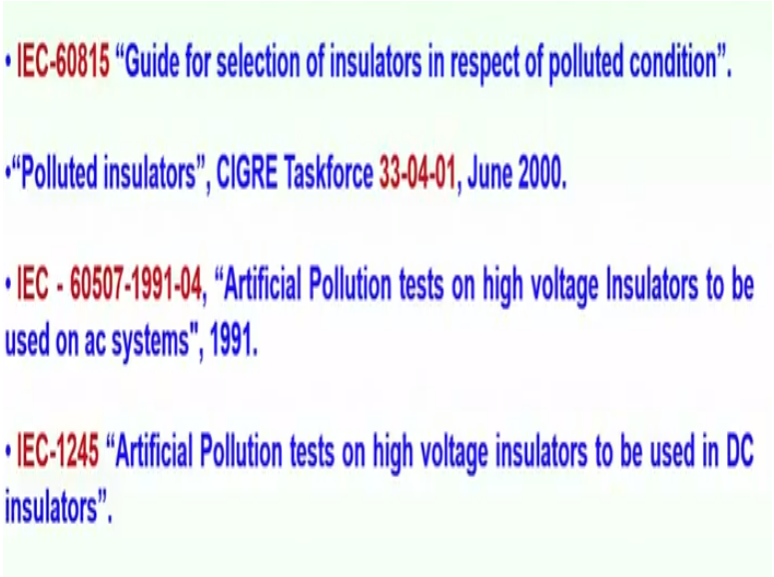

So there are few guidelines I would like to share some information which are in the standards. We have IEC standards 60815 this is a very important guidelines which gives the information of the selection of insulators particularly in respect of polluted conditions. This gives idea where exactly the insulators how the creep age length has to be chosen how the insulator dimension have to be chosen depending upon the area of the insulators which have been used.

So this is a again task force by CIGRE 3304 which has also come up with important document on polluted insulator where it gives the information of how to use to the insulator could be of ceramic glass or porcelain in various conditions. As per the testing aspects is concerned we have discussed the exact simulation of the contamination or a pollution problem in the laboratory is a difficult task.

So we also looked into the theoretical aspect or a modeling aspect which could be done is also equally difficult as involved several parameters which are to be considered and the dynamic nature of the changes which happen in the parametric direction of the wind the rain, the velocity several of this things do not give us the exact idea of to simulate or come up with the exact modeling.

So even the laboratory testing the experiments are been framed using the standards IEC 60507 this is a technical document which gives the methods of artificial pollution experiment or test to carried out on the various insulators which are to be used in the AC transmission systems. So there are again the methods which are specified how the insulators is to be contaminated the spray and how the experiments have to be conducted.

So for all the AC transmission system the standards are differ similarly for DC IEC specifies 1245 is the standard which gives guidelines of the simulate the condition in the laboratory and how the artificial pollution test to be carried out particularly for the DC insulator. We have already discussed there is a different between the AC and DC insulators.

So DC insulators require a different arrangements are experimentation where in the creep age is very high the material which is used for DC is slightly different in case of the AC insulators that we have discussed the alumina content even in the material should be higher and this

insulators are also to be done. So that methods which are adopted or similar in nature to the AC pollution but this modifications these are clearly mentioned in the standards 1245.

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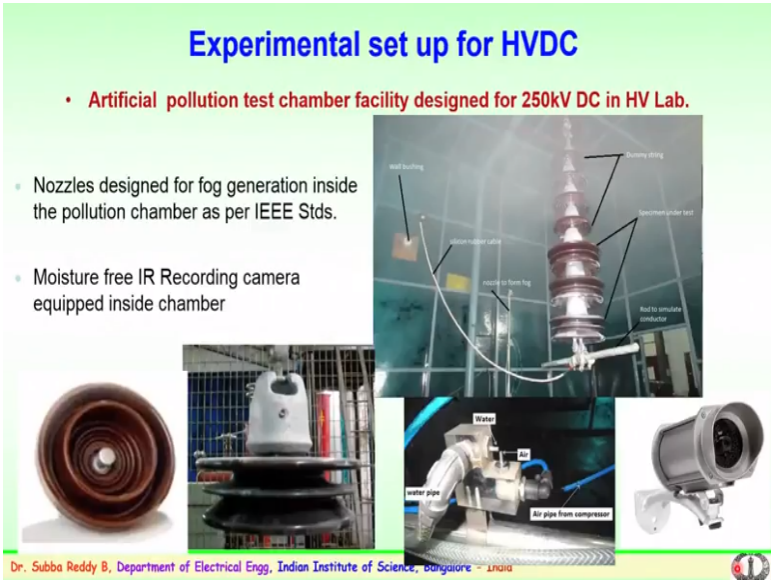

So here in laboratory we have conducted or developed the experimental set up for conducting the pollution flash over or pollution withstand or pollution performance experimental on various types of newly developed insulators for manufactures in the country. So these insulators use for various high voltage HVDC transmission lines in the country.

So several new type of insulators disk has been developed by well-known manufactures in the country or being experimented. Here the facility which have developed exclusively for the pollution performance for HVDC as capacity of 250 kilo volts with 100 milli amps source. So the AC setup which was existing as been modified and the same chamber which is a 5 meters cube 5 meters / 5 meters is being used so typical experimental arrangement is shown here where in you can see the specially manufactured DC insulators are being used this is high voltage and this is being grounded.

So we have used various nozzles as per the hydraulic standard to simulate the fog conditions or the rain conditions. So various insulators of various creep age lens particulars used for HPDC are being used in the laboratory the facilities also been made using an IR cameras to particularly find out the location of the discharge activity during the experimentation for a pollution when the experiments are conducting for long duration of time.

So here as mentioned the facility has been designed to 250 kilo volts and DC the nozzles design for fog generation inside the pollution chamber as per the standards as per the IEC standards. One of the example shown here where the water from the nozzle part from 1 side of the nozzle and other the air is pumped so the fog which is generated is applied to the insulation in the chamber. So the moisture free as mentioned I told you this is the IR camera which are used for recording the activity inside the chamber.

So various experimentation on single disk 3 disk in a string because of facility can cater up to 250 KV so the experiments have been conducted on the insulators single 3 strings and 6 insulators in a day.

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So this is the facility how we have adopted the same transformer which were used and 150 KV AC pollution test which is a 150 K 2 amps 100 KV 3 amps 50 KV 6 amps source. So is been suitably converted to a DC with using the rectifier and coupling capacitors (()) (08:08) capacitors. So under measuring unit so where this output of the DC is 250 KV with a very ripple content being very less and as per the standards.

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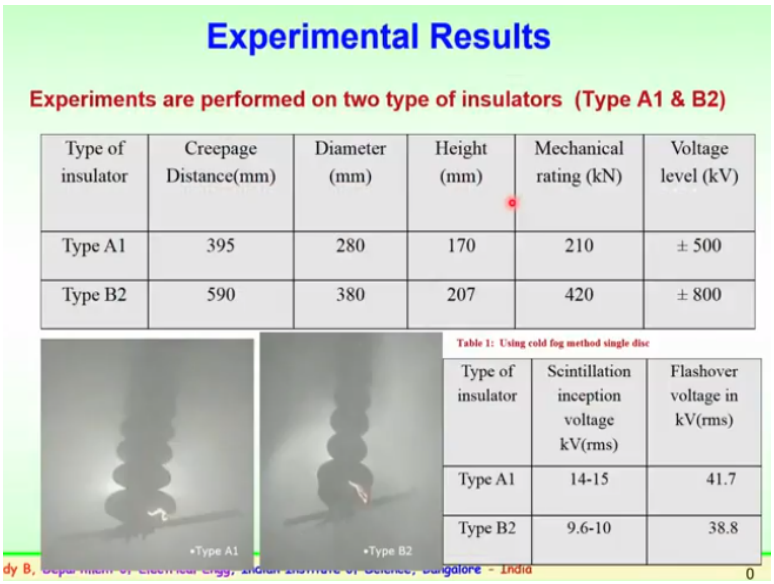

So some of the experiments information or experimentation insulators of various types as mentioned from different manufacturers with different creep age distances and dimensions have been employed. So several insulators have been tested typical or few values which are being shown here example like a creep age distance for a particular type A1 is somewhere around 395 and that disk diameters is 280 height of the disk being 170 and mechanical strength of the disk being 210 kilo newton.

This is used for + - 500 KV voltage levels so these insulators are pit and he single three insulators in a disk and 6 insulators disk are being experimented in the lab. Similarly the other type or different manufacturer where you can see the creep age strength is 590 and the disk diameter is 300 very big disk with a height of 207 mechanical strength of 420 kilo newton's and this insulators.

And this insulator disk used for + - 800 KV systems HVDC systems in the country. So various experimentation as per the standards using a coal, fog, steam or a spray methods being followed and the activity particularly the insulators are coated as the standards and experiments are conducted the intention is to see how this inception of the scintillation or a partial arcs which originate from the pin junction are known and how to arrest this.

This was one of the study which was conducted where in precaution or variant the method was develop to reduce the scintillation or the partial arcs for the insulator which are used for high

voltage DC systems. So this are some of the values which have been obtained say in case of 395 creep age distance and the inception of the scintillation inception of the arcs what we call this discharges whatever you see the inception the starting point of this discharges anywhere between 14 to 15 kilo volts and the flash over was the 41 or nearly for 42 kilo volts in case of this disc which are done using the clod fog method.

So cold fog and method is very clearly explained in the standards 1245 similarly for the B type insulator he inception of scintillating could was notice at 10 kilo volts itself and the flashover 80. You can now very clearly see that even though the creep age distance is very high the inception of ventilation takes early. So the design aspect is very important the inception of scintillation is to be limited or arrested so that the discharge activity will do not come across.

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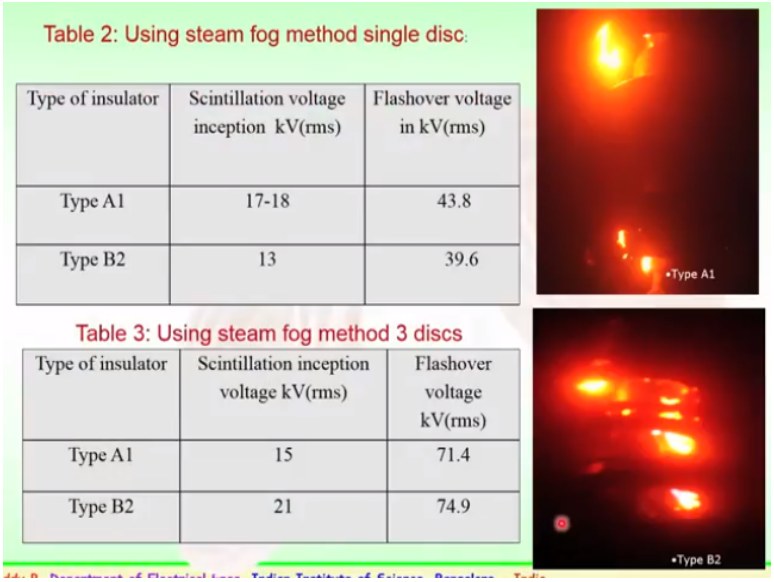

So similarly using a steam fog I told you the cold fog method and using the steam fog method the experiments were conducted for both single three and disc insulator. So this results issue conducted for the single disc using a steam fog method. So for the type A1 we have scintillation or inception of discharges happening at (()) (11:45) typically around the similar voltage level what we have seen.

In case of cold fog inception of 2 to 3 KV earlier here it is later because of steam fog takes us time for the surface to conduct and simulations to happen. Similarly for the B type the

values are 13 kilo volts and 40 KV 39.6 KZV flash over voltage which have been noticed and various number of disk different at least for each type three disk of same dimensions where used for the experiments.

Similarly using the steam fog as mentioned 3 disc in a string where also carried out so you can scintillation inception is early in comparison to the single disk and the flash over voltage being 71 KV's/. So the single disc you can see it is 43 KV when you put three disc it is not the linear phenomena where you can see the increase the flash over voltage. So this values similarly for the insulator B2 you can see the scintillation starts around 21 kilo volts in case of three disc in a string in a larger creep age diameter which I mentioned earlier.

And the flashover is around 74.9 KV for 3 disc in a string so it is to be noted here in case of a single disc for type A1 the flash over voltage was somewhere 44 kilo volts. But in case of three disc it should have been if it is a 3 it should have been 120. So it is not that phenomena the surface discharge the scintillation which are happening for that depending upon the stress the entire creep age bridges at 72 KV.

You can see that he phenomena of pollution or contamination is very dynamic phenomena which happens during that period of time how the scintillation spread of the activities happen for the formation of dry band the formation of surface conduction and the surface conduction several of this things play a role including in the field it happens the wind the direction of the wind.

The contaminants spread on the surface all this parameter do effect the scintillation activity and the flash over could happen again I am stressing at a normal or a working voltages. So these are some of the results very important thought of sharing this results and comparing the values always point to be noted that in case the insulator number goes on the flash over goes up it is not a linear phenomenon that is reason just have try to show the values which have been experimented various disc insulators.

That was about the DC or method for contamination or pollution which are being followed in any laboratory standard laboratory before the insulators are been used. So we have discussed about the pollution AC and DC aspect earlier I have mentioned about the important or the

pre maintenance or the maintenance before the monsoon with this pollution activity causes the flash over.

So there are standard for this one of the standard is the hydroponic standard 957 which describes or which guides the frames guidelines are given for cleaning of insulators for ceramic glass as well as polymer insulators. So this provides very useful information to the utilities and the people who are supplying the power to the consumer to take suitable necessary action.

Particularly in the winter conditions or the ice fog conditions and see that the cleaning of insulators is done and flash over or the values the flash over or the black coats which happen during contamination or raining conditions or due the fog should can be reduced. So with intention of this IEE guiding for insulators have been framed very important utilities as mentioned.

So we would like to high light few things about the contents of this standard or the guide which has been framed.

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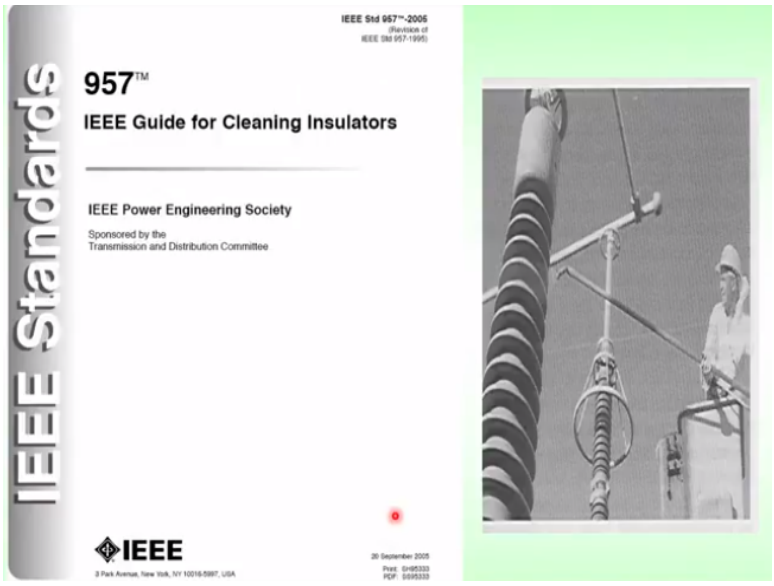

So most of the time in the transmission system or in the distribution system you cannot or the utilities cannot switch of the power and try to clean the insulators. So it has to be one be done by the lifeline washing methods so proper insulating and nozzle sets have to be used with the suitable solution with water content or particular resistivity which is given in the

standard as to be used during the conditions where without disturbing the normal condition that is what it is known as live line washing or not line maintenance of the insulator strings or he substation equipment's.

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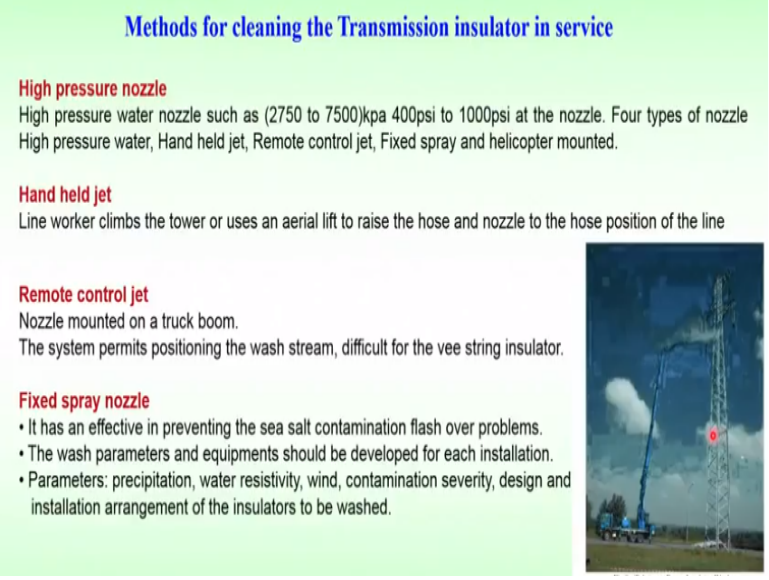

So some of the methods which are highlighted in the standards I would like to mention here few. So methods have cleaning of transmission insulators in particularly in service it is known as hot line or live line washing technics. So utilities or the power grid normally use various types of nozzle sets either of which are normally of high pressure. So this high pressure water nozzle sets should have a capacity 2750 to somewhere around 7500 kilopascals with 400 PIS to 1000 Psi to nozzles.

Sometimes this number could be slightly reduced in case of traction insulation which are operating at 25 kilo volts again this traction insulator could be of ceramic or polymer type there the some of the literature mentioned about 250 PSI to 350 PSI where it is used and here thousand kilopascals to 250 kilopascals. So these are for the transmission insulators these are four types of nozzles are normally employed which are of high pressure either it could be hand held jets or remote control jets are a field spray or the nozzles mounted on the helicopter or a helicopter mounted nozzles.

These are the four different types of nozzle sets which are being used by various utilities by the cleaning of the transmission insulators. So how the handled jet in the it is normally line or

maintenance personal or maintenance technique claims that tower of uses and areal left to rise the host and nozzle to the position of the insulator string or to be clean. So this is how with the help of hand jet the technician try to use the nozzle jet.

Similarly remote control jet again here the nozzles are mounted on a track bone which are similarly shown here which to this you can see the string of the insulators which are being cleaned using the truck mounted nozzle sets here the system permits a positioning of the wash streams. So the suitably the track is adjusted to clean the insulators either it could a tension or suspension type.

But this has a bit of difficulty for using in case of these type of strengths where suitable arrangements have to be done. So there are again fixed spray nozzles which are all being employed by the utilities these have an effective in preventing the particularly the sea salts the transmission lines which run here the sea cost were lost of salt contaminants that accumulated over a period.

So they normally fixed by the nozzles to clean this contaminants to prevent the flash over phenomena of problems so the utilities washed and the parameters and the equipment's should be suitably developed and used it is not that commonly the parameters are kept same similar to the other conditions same environment. So the parameters could be like the precipitation water resistivity.

So how much is the conductivity or the resistivity of the water and the wind the contaminants severity of location design and installation or arrangements to the insulators to be washed. So several of this parameters come in the way of designing the fixed brake systems for cleaning the insulators sometimes the insulators if the system or the parameters are not properly tuned there could be were damage to the insulator a petty coats or insulator shells.

So very important aspect to tune the parameter to the required location of the insulator with required pressure and the nozzle arrangements have to be done.

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Table 4—Minimum distance for energized washing[a]

Line voltage	Minimum nozzle-to-conductor distance	Minimum water resistivity	Minimum nozzle pressure	Maximum orifice diameter
(kV)	(m)	(Ω·cm)	(kPa)	(mm)
13 & below	1.82	1300	2758	4.76
13 & below	1.82	1300	2758	6.35
16	2.13	1300	2758	4.76
34.5	2.44	1300	2758	6.35
34.5	2.44	1300	2758	4.76
69	2.74	1300	2758	4.76
69	3.66	1300	2758	6.35
115	3.05	1300	2758	4.76
115	3.96	1300	2758	6.35
230	3.66	1300	2758	4.76
230	4.57	1300	2758	6.35
345	3.92	1300	2758	4.76

This gives some information about the minimum distances form the energized washing so this is again available in this standards which I mentioned for cleaning of insulators. So to show you how typical example in case considering some voltage levels in here say 33 or 35 KV that is 4.5 is the line voltage in such cases the minimum nozzle to conductors. So it mention is to 2.4 meters.

So person or whatever the arrangements the nozzle sets have to be at a distance of 2.4 meters and the conductivity or the minimum resistivity of water is mentioned to be 1300 ohm centimeter and the pressure minimum pressure is 2758 kilopascal and a maximum (()) (22:26) of the diameter is mentioned as 6.35 millimeters. So this is a typical example which have (()) (22:32) similarly for 66 KC and 230 KV and above 400, 800 KV the values could be slightly and the distances also could change.

So very minimum distances for energized portion because the proper precaution have to be taken as it is the live line washing. So suitable care as to be employed this have to be strictly followed about the conductivity the minimum pressure and all this are given in the standards.

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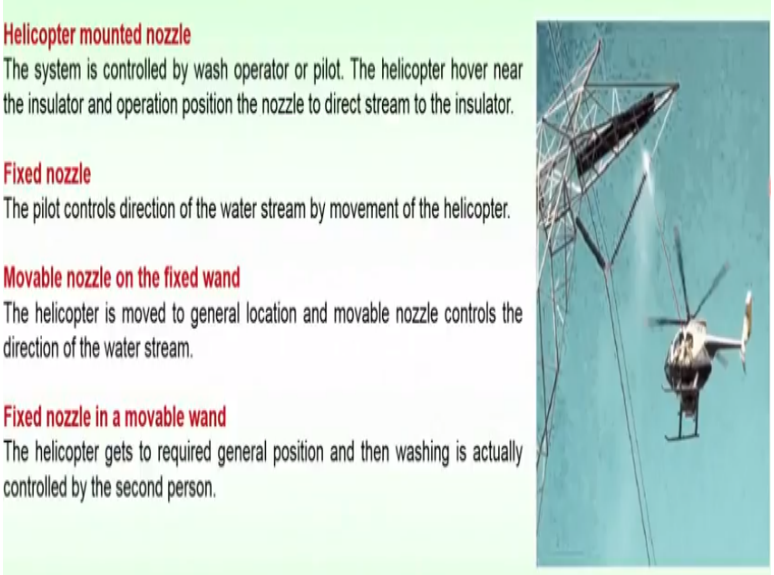

The helicopter mounted which I mentioned earlier again here the helicopter mounted nozzles system is normally being used in case here the other type of arrangements like that truck mounted nozzles or the hand held physically where the personal could be used or utility maintenance personnel could reach is difficult in such cases where the transmission lines are towers situated on the hill tops or in high altitude conditions or it is difficult to reach the tower.

In such cases helicopter mounted nozzles are generally used for cleaning the insulator systems here the systems is normally controlled by the has operator or the pilot. Generally the helicopter hose near the insulator string and operates position operation of the position near nozzle to direct industrial jet to the insulator. So this is carefully adjusted require a lot of skill to see that when you near t high voltage transmission lines and operating the train pilot ad operating personal over using his water jet have to be properly trained to use the system.

So fixed nozzle again here sometimes the pilot controls the direction of the water stream by a moment of the helicopter depending upon is arrangement and distance as mentioned, Again suitable distance minimum distance have to kept away from the transmission lines or depending upon the voltage levels. So movable nozzles on the fixed one the helicopter is generally move to the general location and nozzle controls the direction of the stream.

So several of this options are given to see the proper cleaning of the insulator are being done for eh towers which are suited on the high altitude or the places on the mountainous areas where a normal reaching to the spot is difficult in case of the truck mountain nozzle. So fixed nozzle in moveable van the helicopter gets to required general position and then washing is actually controlled by the other person who is also assisting the pilot.

So several option are being done to see the proper cleaning of insulation insulators in the transmission system is carried out.

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That was about the cleaning of insulators now we have discussed about the pollution contamination issue of the phenomena occurs how the remedial measures have been adopted several remedial measures apart from the other measures which we have also contributed to the improvement aspect in the contamination or pollution issues both for AC and DC conditions. Cleaning methods preventing maintenance aspects live line washing and so on.

So what happens in case of the faulty insulators in I also mentioned method in case of the insulators in particularly in transmission systems for a 220 KV systems you have anywhere between 14 to 15 insulators or 13 to 15 insulators in a string. For 400 KV it is 23 to 25 dick insulators for 765 it could be 35 to 40 insulators or depending upon the creep age larger creep age could be of 29 to 20 insulators for 765 KV AC systems.

So in this string what happen in case there are few easy which are faulty in nature so again how the modification of the field how the potential of the strings gets modified because of the faulty insulators this is a very important phenomena to be noted or to be considered by the utility engineers this will help in proper maintenance. So in case there are few disc which are faulty in the strength.

So there is not necessity if the effect of the redistribution of potential field takes place where in at the flash over could not may not happen in such cases immediate removal of faulty may not required. So lot of effort has been put into this study where in experimental and less theoretically it is studied that the faulty insulators sometime plays a major role and see that they have to be immediately replaced.

And in some cases it could done at the later so we will see into this aspects this faulty insulators could be due to several it could be because of the vandalism it could be because of the over voltages which could have a shattered the shed or it could be because of the cement the Portland cement near the pin junction where in the cement growth happened over a period of time and the cracking of insulator happens and it gives the insulator becomes faulty.

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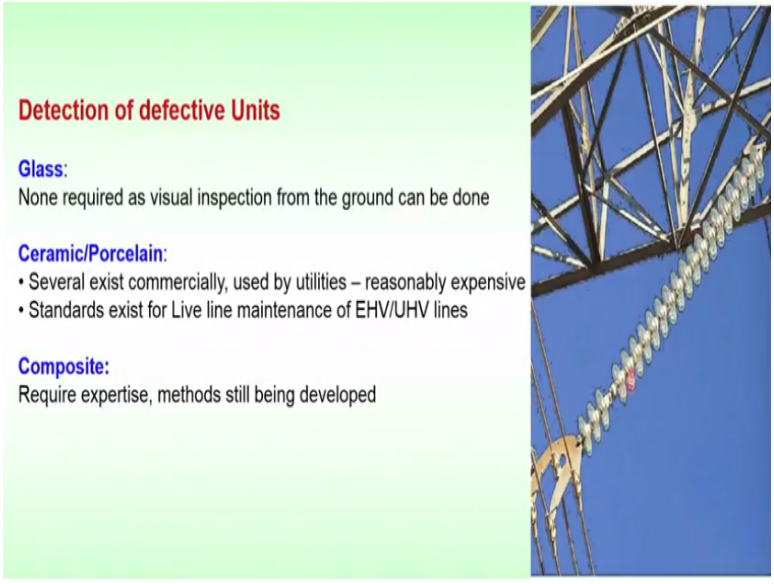

So what happens in case you see a sting of glass insulator a particular location it has been shattered this insulators has been shattered here. So where such things happens in case very near this is the line end of the sting this is tower end that is the ground end. This is the line

end where four conductors are this so what happens when this insulators are shattered damaged very near to the line end.

How the potential changes or how the field gets and whether the this could lead to the lieshore it is a very important phenomena many people have tried to under this so that which will be helpful for the utilities. So there are a part from physical or visual examinations there are method to find out the defective insulators in case of glass insulators as I mentioned none are required as you can see the shattered insulator bell could be visible from ground and suitable action could be taken whether to replace it immediately or depending on the fault or depending upon the bell which is disturbed in the string.

See for a ceramic or porcelain several methods or commercial methods are available which are normally being employed but the utilities and the power grid engineers. So this are reasonable expensive and also the standard exist of live line maintenance formation field and to find out the whether this are insulator or faulty of.

So for a composite insulators it requires lot of expertize as mentioned these are of recent origin there are methods still where to be developed for the maintenance live line washing cleaning of composite insulator and also the methods of deducting a faulty insulators strings.

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SR.NO	Method	Common technique
1	Electrical	• Field Measurement • Voltage Distribution • Insulation resistance measurement
2	Acoustic	• Ultra Sonic Detection • Corona Detection Gun
3	Visual	• Eye sight • Ultra Violet Enhancement • Infra Red Camera

So presently these are some of the methods like electrical methods the technics which are employed or the field measurements it could be using the sensors the voltage distribution method it is normally conducted in the laboratory where the voltage is measured across each disk in string and the percentage voltage distribution is formed out and it could be formed that insulator string which has fault could be rectified and it could be seen that this particular as to be adjusted,

Similarly there are methods which they used insulations or a resistance method for finding out the faulty insulators in the string. There are methods used like ultrasonic deduction or corona corrosion gun these gun come under the classification of costing of the where pulse or a ultrasonic methods are being done. Visually as mentioned it could be abnormal eye site where you can trace and find out whether the disk or whether in the field where previous which we have seen in the case of glass insulator the fault of insulator could be same in through the normal eye.

There are methods which are used ultra violet enhancement and infrared cameras or UV cameras which also given the information about the insulators being detected for the faulty conditions. So ultra violet enhancement infrared cameras I said in case of visual acoustic methods and electrical method or generally used for the detection of insulators. For what happens in filed so we have also tried to understand the phenomena how it happens our field gets modified in case of hardy disc in a string.

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So the modification of potential energy field particular in case of ceramic disc insulators with faulty units in a string or studied for various voltage levels both experimental theoretical and gives and important information to the utilities particularly in case whether the change is necessary immediately or how is the importance and where important the faulty disk insulator in case available in the string to be replaced.

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Several experimentation and theoretical simulation have been conducted by the develop method at the laboratory.

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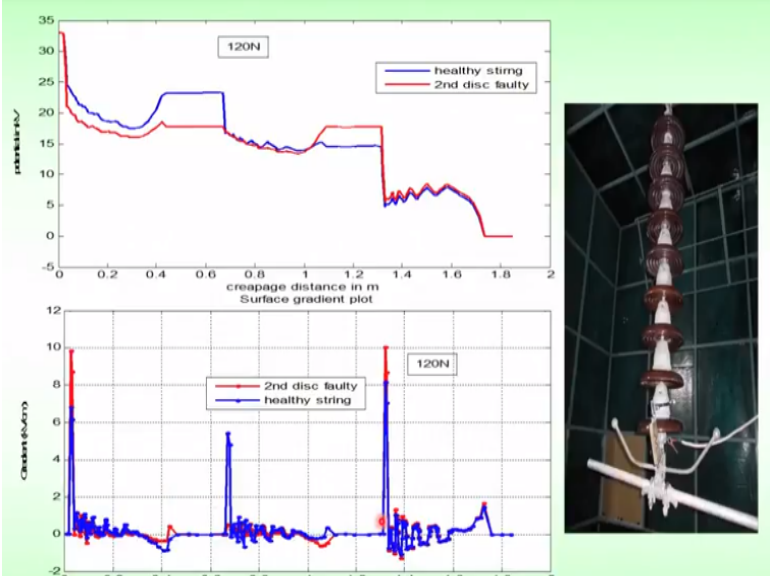

We have tried to see the using the surface chart simulation method this is one particular experimentation simulation which has carried out for three disc string. So three disc 33 KV is the potential at the line end the second will be at the potential somewhere around 22 and 23 KV and third will be around 11 or 13 KV this blue one is or he normal healthy what we call healthy is that without the disc in the string or faulty.

What happens in case there is a faulty disk in the second so you can see the red curve here 33 kilo volts is the first pin or line end. Once the second is disk faulty the potential comes down and you can see the raise in potential at the third disk. So this raise in potential will cause potential difference or a field effect on that which will be very series threat in case of the strings which are of containing number of disk insulators for 400 KV 165 KV which we will be observing.

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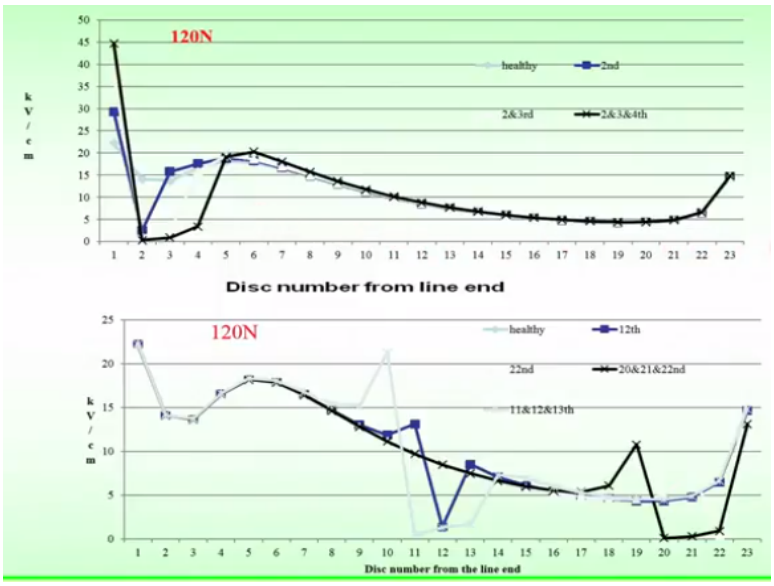

So this shows for 120 kilo newton disk for 400 KV system where the potential gets modified in case the comparison has been done for the healthy and strings which are faulty particularly considered second and third disk near the line end what happens you can see the green curve this is a green curve this shows for healthy conditions the green curve here.

So potential gets immediately modified for fault conditions if the fault is at second third fourth you can see this last second third fourth fault conditions and this is for the fault conditions of the second and third so in case what happens entirely the potential gets modified and you can see the rise potential first disk happens. So once the this rice in potential happens we can see somewhere here to here the stress at line end increase and there could be discharges across the first disc insulator initially the cascading effect could cause a series blow to the string.

So immediate replacement is required similarly what happens in case there are failures in the middle of string you can notice that incase of middle of the string the field gets modified but not much of disturbance to the initial conditions. So major threat happens so even the fault condition are somewhere here in the last 20, 25 near the ground end not much of series effects so similar steady was conducted for various insulators 160 kilo newton's or 765 KV line that tis the insulators in the industrial is various fault conditions were simulated for 400 newton's this is a again for 29 disc again in a 765 KV line.

So again you can see the how the fields gets modified depending upon the insulator location where the fault as they can see the second and third fault how the modify field gets modified here pollutant gets modified. So you can see the green and faulty conditions this creates a very important information this are some again the experiment.

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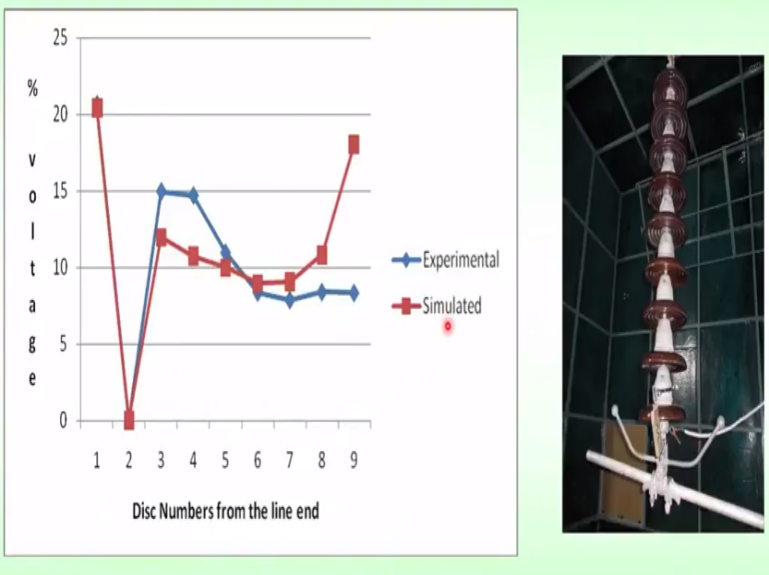

These are some again the experimental and simulated results in the laboratory for disc insulators string where we try to see the failures which intention faults have been created and the steady has been done.

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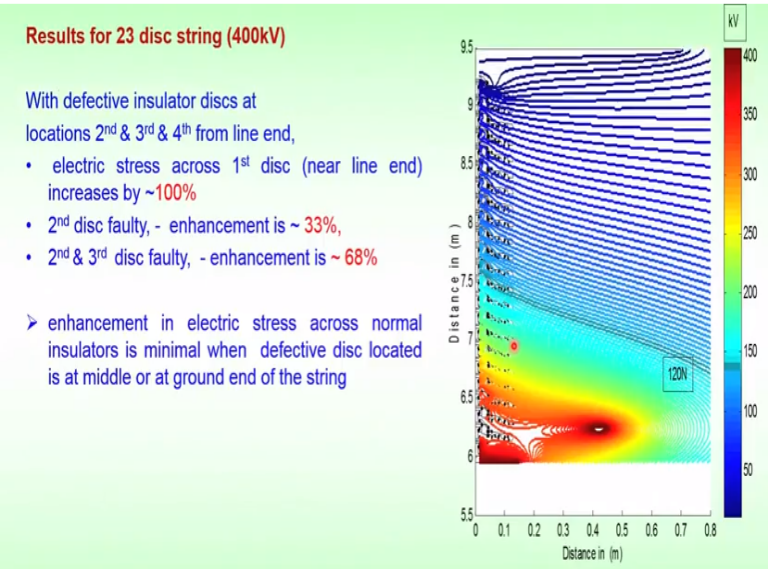

So overall when you look into that results of 400 KV transmission system when we need to take defective insulator in case if it happens to be the second and third or a fourth from the line end that is the high voltages to the electric stress across the first disk which is good insulator very near to the conductor so you can see the raise in potential or electric stress rise in electric stress is 100%.

So double the stress which it was facing all the insulator which in service similarly in case of second is forty for line end the enhancement will be 33% across the first disc for second and third enhancement will be 60 so as the number of disc from the line end leaving the first insulator if other insulator first second third or faulty the stress across first disc will be rising to a very high this could leave to early scintillation early flash over across first disc cascading effect cause the serious ness of the entire string flash over.

So the enhancement in electric stress across the normal insulator is minimal when defective insulators or located as mentioned earlier at the middle in case of 23 disc in shifting. So after 13, 14, 15 and at the ground end not much of impact or not much of electric stress which is seen.

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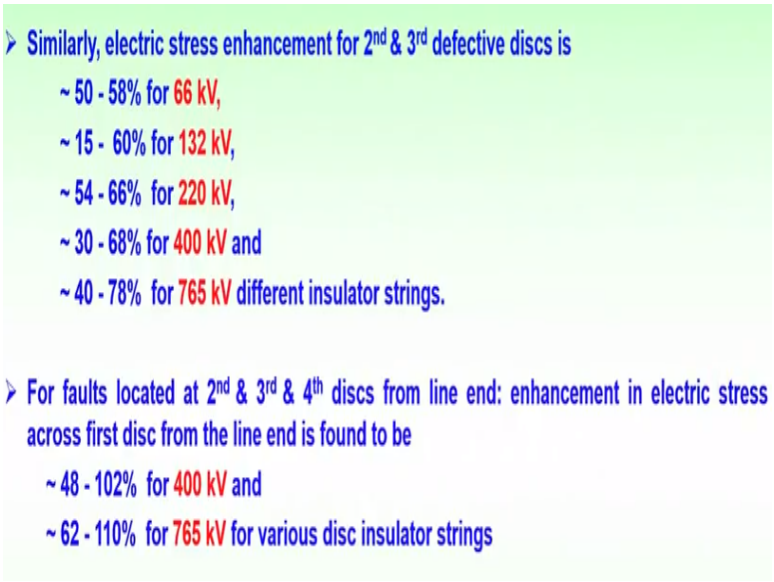

So this is one of the important point to be noted so several experimentation and also the implementation have been carried out for various strings considering the faults at virus locations in a string. So we did happens in case of 66 KV line the first disc see around 50 to

60 % for 132 KV systems the stress could be increase depending upon the second or third disc in a string that faults are prevent available the stress could increase up to 60 for 220 where could be of 13 to 15 days here there are faults in second and third the rise in electric stress could be 66% which is faced by the first insulator.

Similar stress for 400 and anywhere 40 to 78 % in years of 765 KV so you can see that the normal conditions so second or third disk faulty the stress increases this increase in stress again in the contamination or because of the fog this could see the effect much and finally the insulator string could be the failure of insulator could happen. So what happens if in case of thee faults where three insulators are shattered or faulty in the string from the line end.

So you can see the increase will be more than 100 % for 400 KV and 765 KV disc insulators.

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Table: percentage electric stress across the first disc from the line end in a string with defective insulator discs in different location

Ins type	2nd faulty (33kV)	2&3rd faulty string					2,3&4th faulty string	
		66kV	132kV	220kV	400kV	765kV	400kV	765kV
160N	43%	50%	60%	66%	59%	73%	87%	110%
120N	44%	55%	48%	60%	68%	-	102%	-
120AF	44%	52%	44%	60%	57%	-	88%	-
160AF	42%	52%	14%	54%	44%	-	67%	-
210N	-	-	-	-	30%	40%	48%	62%
400N	-	-	-	-	-	58%(29d)	-	91.5%(29d)
90N/120N	48%	58%	40%	-	-	-	-	-

So this table gives the entire information about the percentage of electric stress across the first disc here the first disc assumed is e good ne the second third and fourth are treated as faulty and the simulation been conducted and the stress calculations have been made for the various disk you can see from 160 newton's to 120 newton's 400 newton's. So these disc are normal used for which AC DC lines and where in case of second disc is faulty the voltage levels are also gives when here for the faulty of only second disk is faulty.

These are the stress values which increase across the first disc this second and third disk considering faulty for various voltage level are to 765 you can see how the percentage stress increases across the first disc for various voltage for a typical 765 KV you can see 73% increase in stress across the first disc is noticed. So similarly is for 29 disc for 400 KN newton insulator where 58% of the stress is increase across the first disc.

So for 3 insulated faulted conditions that is second third and fourth from the line end these are the stress values how the insulator sees the first disc insulators is. So very important study which has been done this gives the very important information in case the insulators units are faulted after the mid of insulator string not much of our whereas if the disc are faulted in the near the line end.

The first after the first insulator second third and fourth series is we considered it is very serious and the utilities have to immediately take necessary action in changing the insulator improving the bringing down the stress level across the first disc insulators. So here we have completed about the ceramic disc insulators the pollution phenomena about the methods which are employed for the laboratory conditions.

The cleaning of insulator the pre monsoon and present due maintenance the about insulator disc which are faulty in the system it could be glass of porcelain how proper care as to be taken by the utilities how series is the issue in case of fault disc are located at second third or fourth or in the middle of or at the end of insulator step. So we will stop here thank you.