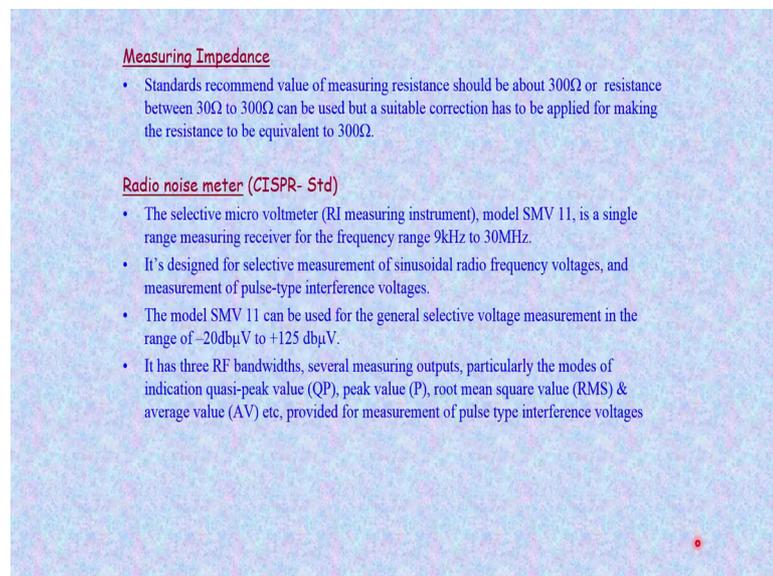


Advances in UHV Transmission and Distribution
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Lecture – 11
HV testing techniques for various apparatus

Good morning. We are looking into the radio noise measurements RIV measurements for the insulator strings, line hardware power connectors of the high voltage equipment which are to be used for the high voltage transmission.

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Measuring Impedance

- Standards recommend value of measuring resistance should be about 300Ω or resistance between 30Ω to 300Ω can be used but a suitable correction has to be applied for making the resistance to be equivalent to 300Ω .

Radio noise meter (CISPR- Std)

- The selective micro voltmeter (RI measuring instrument), model SMV 11, is a single range measuring receiver for the frequency range 9kHz to 30MHz.
- It's designed for selective measurement of sinusoidal radio frequency voltages, and measurement of pulse-type interference voltages.
- The model SMV 11 can be used for the general selective voltage measurement in the range of $-20\text{dB}\mu\text{V}$ to $+125\text{ dB}\mu\text{V}$.
- It has three RF bandwidths, several measuring outputs, particularly the modes of indication quasi-peak value (QP), peak value (P), root mean square value (RMS) & average value (AV) etc, provided for measurement of pulse type interference voltages

So, very important radio interference measurements which are to be carried out in the laboratory before the equipment are being installed in the field.

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6. Voltage distribution Tests

Test Procedure

The PF voltage appearing across each disc in the insulator string is measured using a 2 cm diameter sphere-gap with 4 mm gap spacing.

The sphere-gap is connected across first disc of insulator string - voltage across insulator string is gradually increased till it is just sufficient to cause a sustained spark-over of sphere-gap – values are recorded.

Procedure repeated for each disc in the insulator string.

The percentage ratio of mean voltage that appears across an individual insulator unit, say n , is given by

$$V = \frac{V_s}{E_n} \times 100$$

where, V_s = nominal spark-over voltage sphere-gap under laboratory conditions
 E_n = mean voltage across insulator string, with sphere-gap connected across insulator disc n .

So, next to radio interference measurement we have the important test which has to be carried out for the reliability of the insulator string, which has to see the proper potential distribution or the voltage distribution across each of the insulator units. So, the main purpose of this voltage distribution test which is to be done depends on the voltage level. If as mentioned earlier for a 220 KV and above, the voltage distribution tests are made mandatory in the country.

So, the voltage distribution you know that the ceramic disc insulators which are being connected in cascade, in the transmission lines, whether it is a I suspension or double tension or a v suspension string. We know that for 400 KV we have anywhere between 23 to 25 insulators cascaded. Similarly, for 765 KV is 35 to 40 insulators in cascade.

So, these insulators have a typically capacitance ranging from 40 to 60 p f each disc. So, connected in cascade the distribution in the voltage distribution from the line end up to the ground end has to be properly distributed. So, this is the main aim of the voltage distribution experimentation, and also it provides the corona control ring the (Refer Time: 02:21) and other accessories which are being used for the proper maintaining of the voltage distribution, so voltage distribution how it is being done in the laboratory.

So, usually the insulator string complete insulator strings with the accessories corona control ring and as per the field conditions have to be simulated. Then measurements could be carried by applying the voltage across each disc. So, usual practice in the

laboratory is to use a smallest sphere gap arrangement with appropriate gap spacing. So, presently we will be showing the 2 centimetre dia sphere gap, small sphere gap with a 4 mm gap spacing could be used for the measurement of voltages.

So, this has to be carried out on every disc from the line end up to the ground. So, the procedure is you have to physically connect the sphere gap arrangement across each disc. Apply the voltage see the breakdown of the small sphere gap. So, this sphere gap is to be connected first from the line end up to the ground end. And every insulator across every insulator a 5 breakdown or a spark over readings is normally taken. And this is again a further repeated for all the insulator units which are in the transmission line.

So, finally, the percentage is of the main voltage which appears across individual unit, say n suppose if the 400 KV there could be 23 to 25 insulators in case of 765 there could be 35 to 40 insulators. How it is measured it is simply measured by the V_n is equal to V_s by E_n in to 100, that is where v_s is the normal nominal spark over voltage of the sphere gap under laboratory conditions you have sphere gap breakdown voltage for that particular distance. So, E_n is the mean voltage across the insulator string with sphere gap connected say at insulator disc n .

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So, these are all the mounting arrangements for various configurations. This is the sphere gap arrangement a small sphere gap of 2 centimetre dia. And the spacing of the gap could be a 4 millimetre in this case, that is a standard breakdown voltage information which is

available in the standard. So, this again measured as per the breakdown of that then converted to the lab conditions, standard temperature and pressure. And it will be connected across each disc we can see here the suspension string is undergoing the voltage distribution the string is connected in a similar fashion as in the field, this is a laboratory simulation with the corona control ring, the insulator number of insulator saying 765 we have 35 insulators in place.

So, the arrangement is similar to the field this is for a I suspension. Similarly, we have for a double tension, and this is for the quarter pole tension. Quarter pole is the 4 insulators connected in a string. That is particularly used for very high voltages and ultra high voltages 765 KV and above. This string has to be simulated as per the field arrangements, you have all the necessary hardware like the uero plate the arcing horns the corona control arrangements, you can see here the corona control rings the end fittings metallic uero plates and other things; so all the accessories similar to the tower configuration where the insulators are strung. So, this is done in laboratory and using the sphere gap arrangement we connect across each insulator disc each insulator disc and the voltage is applied the 5 readings the breakdowns across sphere gap is taken.

So, the breakdown voltage across each sphere gap is made for the entire string, and the values are noted and finally, the distribution is found out. This helps in proper design whether the design of the corona control rings which have been done are properly grading the entire string or the arcing horns or other arrangements. So, which are being used for grading ring are properly designed.

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So, this is again different configuration we have seen here I suspension or a pilot string. We have a double tension arrangement, a similar to the field we have a quarter pole that is the 4 insulators string in the field. Here is a v configuration single v configuration and this is a double v configuration. So, these are some of or most of the configurations which you normally encounter at high and very high voltage levels.

So, you see the similar configuration have to be arranged, this a bar is like a tower where the tower to the tower insulator strings are connected with the necessary hardware this is again corona control arrangement rings for the double suspension v string. So, with the conductors which are phone numbers here, as in the field the simulation has been done then the voltage distribution will be measured across each disc from this is a line and which is connected to one million volt a transformer here. So, from here, we apply the voltage and see the breakdown up to the ground level and estimation is a done.

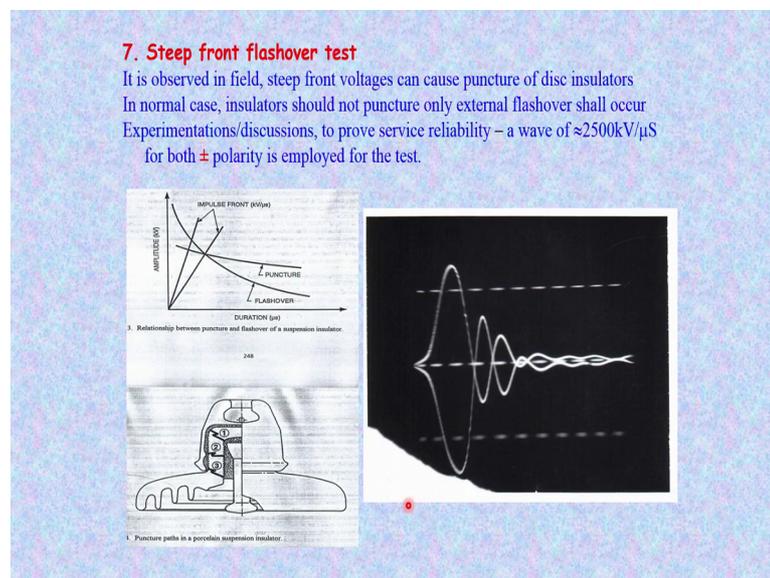
So, voltage distribution is very important, whether the entire string is properly potentially distributed across each insulator. In case if it is not properly done the line end that is the line end here insulators at both these side of the line end. The first one 3 insulators are being shielded by a corona control ring. And further in case if proper shielding or proper grading is not done now the insulators near the line end 1 2 3 or 4 insulators could see more stress comparative to the ground end or the insulators at the middle, where for in the longer run in the field this could shatter and there could be voltage distribution could

be disturbed. So, that is a reason to make the entire string a uniform, practically to make the entire string is highly difficult because it depends on the stray capacitances from the ground to the insulator string from the tower to the insulators because again the coupling between each of the insulators you have a capacitance here.

So, ideally making equally it is very difficult highly impossible. So, proper grading is being done with the help of corona control rings, arcing horns which are near the ground end. So, this will help to reduce the stress near the insulators particularly which are connected to the high voltage or near the high voltage n.

So, what happens in case if there are failures which are observed and how much will the stress be increased in the additional adjacent insulators so that we will be looking also after this the test which are being shown here. So, we will see how the performance of the string behaves in case there are faulty insulators in the string. A faulty could be anywhere in the string. So, how the performance or how the grading or how the potential distribution gets modified.

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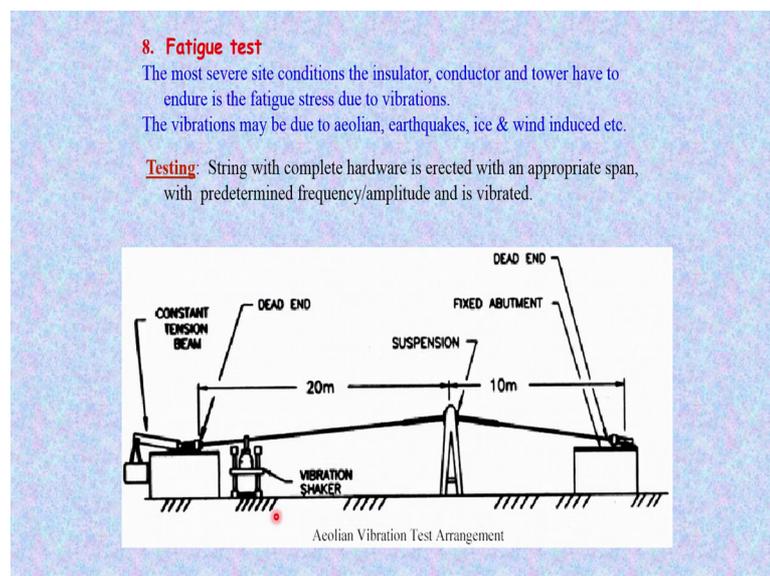


So, this is the steep front flashover again very important reliability test which is carried out for the extra high voltage or ultra high voltage transmission insulators. So, it is observed in the field particularly the steep fronted voltages very steep fronted voltages. Could cause puncture on the disc this puncture on the disc, particularly on the ceramic here it could cause a puncture. So, in normal case insulators should not puncture. Only

external flashover could happen that is external flashover from this metal to the pin on the surface flashover. So, surface flashover could at happen and the insulator again it is properties.

Whereas in case of puncture the insulator completely degrades, it is insulating properties where it has to be changed in the field. So, the external flashover could occur and to prove the service reliability, particularly for very steep fronted impulses a wave of 2500 KV per microsecond is normally recommended by the standards, that is for both the polarities were in the positive polarity as well as the negative polarity a wave of 2500 KV per microsecond is prescribed, where all the insulators have to be applied with this steep fronted pulses and that has to be verified whether this could be stand this stress.

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Next is the mechanical fatigue test for the insulator string particularly for the area very important mechanically the tower between the tower the insulator string are connected with help of a conductors. So, the most severe site conditions the insulator or the conductor and tower have to ensure a renewed in the fatigue stress, normally this is because of the vibrations. So, there are again vibrations because of a breaking used vibrations or a galloping or other type of a aeolian vibrations which could be seen by the insulator string in the field. So, these vibrations could be as mentioned like aeolian or due to earthquake or due to ice and wind at that area where the transmission towers are being put up.

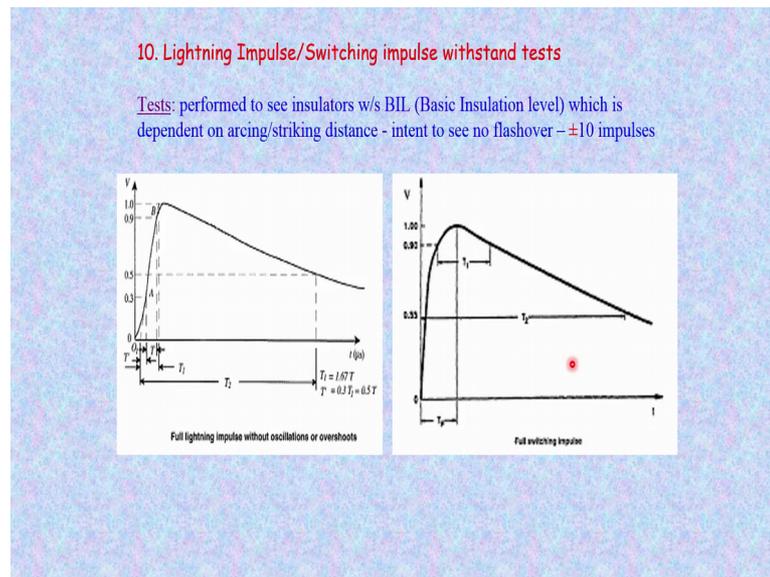
which is known as power follow current which flows succeeds the flashover this could reach a dangerous limits, very high limits.

So, especially particularly in the event of malfunctioning of the delayed tripping of breakers in case the breaker trips, the power follow currents could be limited because of the breaker in case the breakers do not trip, then there could be a dangerous thing for the insulators, where the current levels will be could shoot up to very high magnitudes. So, these high currents during such power arcs, that is during such flashovers and the currents which are shooting up. So, the power arcs can cause heating and also consequent damage to the tower, a line hardware conductor insulator insulators and insulator accessories which are connected.

So, this could be damage and this could heater and that could lead to failure of the insulator string in the transmission tower. So, for this special arrangement has to be made in the laboratory to test this event where this is a shows a circuit for the power arc. The short circuit generator could be of a prescribed value depending upon the equipment to be tested. You have a presently shown here is a 30,000 KV a short circuit generator is very important here. It has to deliver that amount of current during flashover which is being prescribed. So, you have a proper arrangement of a potential transformer to the required level to be set, you have a circuit breaker which is to be tested or for the power arc.

Then again you have 22 KV potential transformers you have a test specimen which has been connected and again you have current transformer for measurement and recording devices and so on. So, intentionally the short circuit current of non short circuit current to the equipment is applied for a period of time and it is observed that whether the currents which could go up very high will be able to withstand with equipment under test. So, this equipment under test could be insulator string or could be any other high voltage equipment which is to be tested for the power arc.

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So, earlier we have discussed. So, I would not go deep in to these lightning surges and switching surges. This is one of the mandatory tests which have to be carried out for EHV and UHV transmission components, insulator strings line hardware transformers and other equipment, switch gear equipment.

So, these tests are performed to see in case the insulator string example will withstand the basic insulation level which is provided. So, again the basic insulation level depends what is a voltage level which is being operated, depends on arcing or a striking distance. Main is to intend is to see that no flashover, particularly when you are applying either impulse lightning impulse or a switching impulse lightning impulse, again I will be repeating here lightning impulse is for a duration of 1.2 by 50 microseconds, that is front time is one point 2 microsecond till time is 50 microseconds till this. And for switching the front time is 250 microseconds and the till time is 2500 microsecond, which sim this lightning impulses or lightning surges, similar the natural lightning and the switching impulses or a switching surges simulate the conditions like closing or opening of the circuit breaker or because of the switching actions which normally happen in the power system network.

So, these pulses as per standard the impulses to be applied to the equipment under test, both for polarity there is a positive and negative polarity, of a specified 10 impulses or 10 surges are applied. And during this period the insulator string should not flashover that is

the criteria which have been set by the standards, so very important test for the reliability of any high voltage or UHV equipment.

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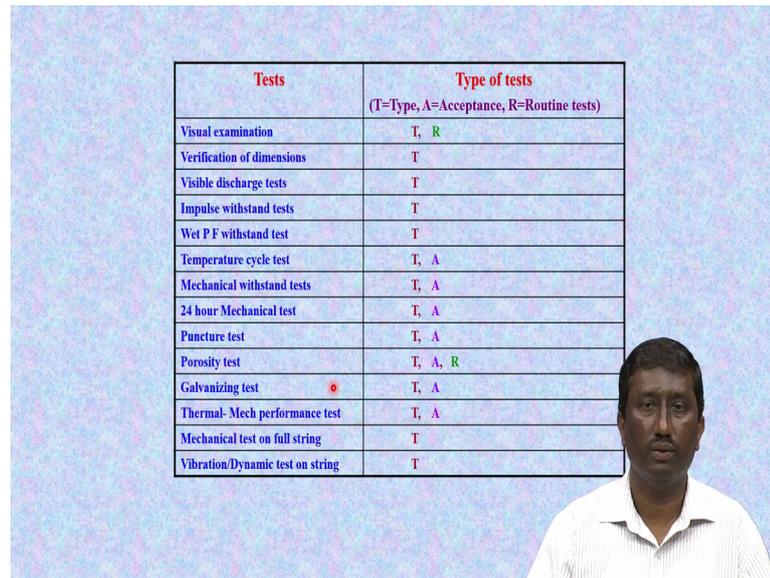


So, after withstand of the earlier test impulse, this is for the power frequency. That is a normal operating 50 hertz frequency. Where the insulator strings will be subjected to the flashover. Say for a 200 or a 400 KV as mentioned, the volt number of insulators remain in case of 213 to 15 and for 400 it is 23 to 25

So, similar arrangement again with the help of the conductor connected to the tower and all the corona control rings arcing horns will be placed similar to the field condition, and the voltage the power frequency voltage the high voltage at 50 hertz will be applied to the conductor and will be raised as a in steps up till the flashover or the entire surface flashover happens between the metal that is a ground end to the high voltage end.

So, this again flashover withstand value. So, what is the flashover before power frequency, flashover how long it could be stand in the field, the design string is checked then the flashover is applied and it will be also verified where the insulator string flashes and what is a maximum insulation limit which it can offer. So, these withstand and flashover tests are usually conducted for both that is a dry conditions as well as for the wet that is a rain conditions. So, dry and wet power frequencies withstand and dry and wet power frequency flashover test are normally conducted for the insulator in strings in the EHV and UHV levels.

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Tests	Type of tests (T=Type, A=Acceptance, R=Routine tests)
Visual examination	T, R
Verification of dimensions	T
Visible discharge tests	T
Impulse withstand tests	T
Wet PF withstand test	T
Temperature cycle test	T, A
Mechanical withstand tests	T, A
24 hour Mechanical test	T, A
Puncture test	T, A
Porosity test	T, A, R
Galvanizing test	T, A
Thermal- Mech performance test	T, A
Mechanical test on full string	T
Vibration/Dynamic test on string	T

So, this chart gives a idea of various reliability tests which have been carried out for various test prescribed by the standards. So, you can see the 2 columns here. The requirements I was a mentioning about the different type of test which are carried out for the reliability of any equipment. So, we have 3 types that is a type test the second bring acceptance or the sample test, which we called, and third bring the routine test. So, we also clearly know that type test is being conducted on a selected particular design samples at recognized laboratory in the presence of the utility as well as the manufacturer.

Acceptance test again it is between the manufacturer and the utility could be carried out in the industry or a factory premises. Routine test are normally conducted on each and every component in the industry, where it is manufacturing of that product. Say if it is an insulator each and every component has to undergo some routine test.

So, what are the routine test, what are the acceptance, what are the type test have been classified here you can see that. The visual examination in case has been clubbed or base or been put in 2 categories, that is it is a type test as well as a routine test. Similarly, the verification of dimensions very important the manufacture has adhered to the proper dimensions manufacturing as per the specified drawings. So, this comes under the type test.

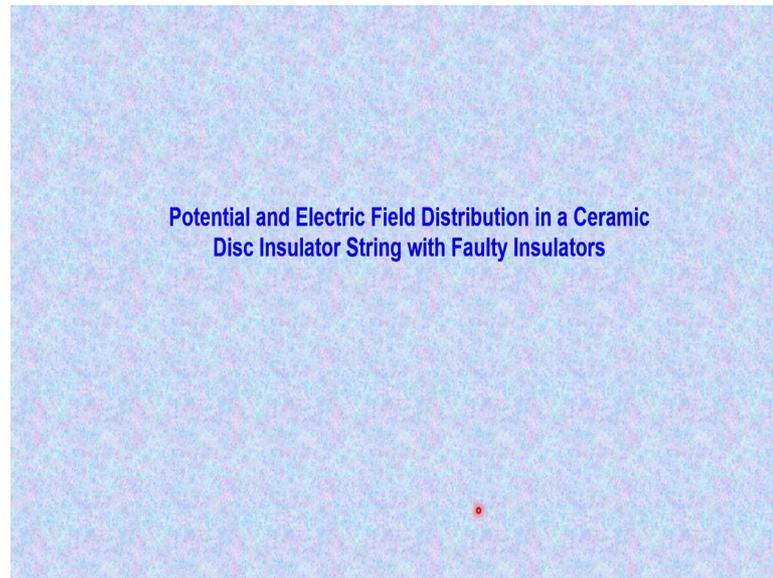
Similarly, visible discharge test. Visible discharge is again corona test this corona test is normally conducted in the high voltage laboratories. It is a certification test which is being conducted. So, this falls under the type test category. Similarly, impulse withstand it may be lightning impulse or a switching impulse this comes under the type test category. Then wet flashover power frequencies withstand or dry power frequencies withstand this again comes under the category of type test which are to be conducted in the recognized laboratories presence of the manufactures and the utility (Refer Time: 24:39)

Then temperature cycle test this temperature cycle test again it falls in both the categories. It is in the type test as well as the acceptance or the sample test which is to be carried out. Mechanical withstand this falls in 2 categories type and acceptance. Then 24 hour mechanical test similar to the both it is type and acceptance. We have puncture test for the insulators which is being done this falls in both acceptance and the type test.

Similarly, porosity which it verify the insulator contains any holes or porous made up of porous doing manufacturing. So, this is very important it falls under 3 categories. So, each of the insulator is tested for this test. It is type test it comes under acceptance and also the routine test which has to be carried for each and every component.

Galvanizing this is again categorized in both type and acceptance. Similarly, thermal mechanical performance we have to make it both the type and acceptance. So, mechanical test particularly on the full string arrangement, that full string consisting of the entire line hardware conductors' corona control arrangement, arcing horns similar to the field conditions are normally conducted in the test laboratories or recognized laboratories or certification laboratories. And vibration dynamic test this also falls under the type test. These are some of the classification for the insulator strings, which gives an idea where which come under the category of type testing acceptance or the routine testing arrangement.

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So, I we were discussing with the type test, what happens to the field and electric potential and the electric field, how it gets modified, how it gets distributed. Particularly in a ceramic disc insulator string, if the string contains a faulty insulator. Again the faulty insulators could be in the string any position on the string. So, this could be happened because of the failure of insulators due to attention loads or because of inherent property of the insulator which could I have failed over a period of time losing it is insulating properties.

So, in case the insulator position where the failure as happened is very important, so studies we have try to analyze and conduct some experimental studies on this how the potential gets modified with the particular location of fault insulators being in the string. So, we will be seeing in that with the fault location also along with the potential, the electrical field distribution the electrical stress distribution across the insulators which are adjacent to the fault it is how it gets modified.

So, this is a very important particularly for the utilities where the decision has to be taken if there are 24 insulators in a 400 KV system, you happen to see physically failures at particular locations. So, whether the entire power supply has to be switched off to replace the insulators, immediately or it could be left for sometime. So, taking this decision by the utility engineers is a very important. So, we have try to see that analysed in the

failures or discs which are of faulty in nature. Try to analyse from a very low voltage to the ultra high voltage strings. So, we will be looking into this.

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So, here this shows detection and replacement of how a faulty insulator in a string is normally carried out. This will ensure for the reliable power supply. You can see there are faulty disc which are physically observed. So, in that case it is easy to replace the insulators, by there are some instances, where physically the insulator failure could not be seen. There could be cracks or the puncture which could have happened it is difficult to observe through the naked eye. In such case the modification of the field and potential could drastically change.

So, there are some methods to recognize this failures and which help in the replacement of the insulators in the line.

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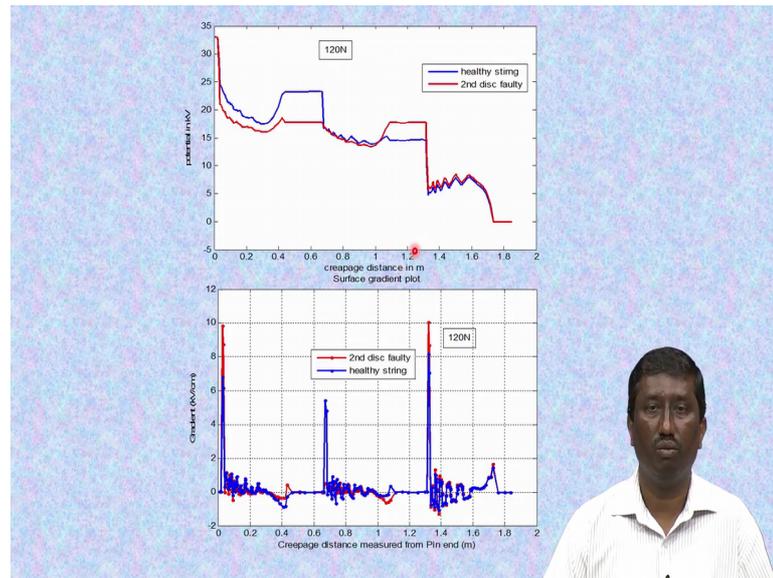
SR.NO	Method	Common technique
1	Electrical	<ul style="list-style-type: none">• Field Measurement• Voltage Distribution• Insulation resistance measurement
2	Acoustic	<ul style="list-style-type: none">• Ultra Sonic Detection• Corona Detection Gun
3	Visual	<ul style="list-style-type: none">• Eye sight• Ultra Violet Enhancement• Infra Red Camera

So, like electrical you have the techniques like field measurement, voltage distribution as which we have shown in the laboratory voltage distribution. Then there is an insulation resistance measurement. So, electrically these common techniques are being employed to check cases of a failure of any faulty discs are in a string of the insulator which are connected.

Second is the acoustic method, acoustic method employees' ultra sonic detection, where ultra sonic gun is used to check verify or scan the entire insulator string and find out the defect. This is also corona detection gun which is again works on the similar principle of it is acoustic and is being used visually the third through the normal eye sight.

You could see in case of the sheds damaging or if there are failure if insulator is physically able to see with a naked eye, then ultra violet enhancement and infra red cameras. These are also being used to with the help of the naked eye to check and verify the faulty insulators in a in a string containing a faulty insulators.

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So, we have a try to see how the potential behaviour or a performance in case of a simple we start with a example of a simple 3 disc insulator string. So, 3 disc this each you can see is one disc is connected at 33 KV intentionally 33 KV potentially is applied. You see the 33 KV potential and second is at 20 KV or 22 KV is not uniformly distributed and third insulator is here and which is connected to the ground and the cap of the third is connected to the ground end.

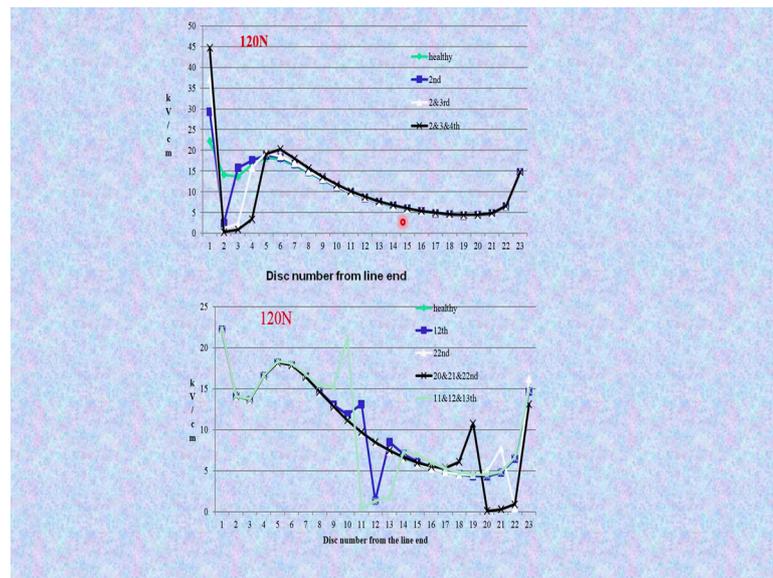
This is how a typically insulator string when we there are several methods to numerically analyse this. There are finite element boundary based elements which has methods. So, we have tried to use a surface charge simulation method for the work and we have try to plot the potential field and also to see the faulty disc in case if there are present in the string, how this faulty a discs could lead to the change in voltage distribution.

So, you can very clearly see here. The intentionally what we have done the blue colour of the graph each shown for the healthy 3 disc insulator string. So, healthy in the sense the third the ground the high voltage end is connected to the 33 KV and the third units connected to the ground. So, the blue colour will trace will give you the voltage distribution of the healthy string. Similarly, you see the blue colour here, this use the electric field across the 3 insulator strings which are connected.

So, now in case the second disc is fault the second disc is fault, that is the second disc is faulty suddenly the voltage gets modified you can see the red colour here, the line shows

very clearly there is a drastic fall in the voltage here, because this and the third one are at the similar potential. So, the entire potential distribution gets modified and the potential across the first insulator and sometimes across the third insulator depending upon the tower to ground capacitance and capacitance to ground depending on number of insulators gets completely modified, which is shown here. You can see suddenly there is a rise in electric stress across the first insulator and the third insulator.

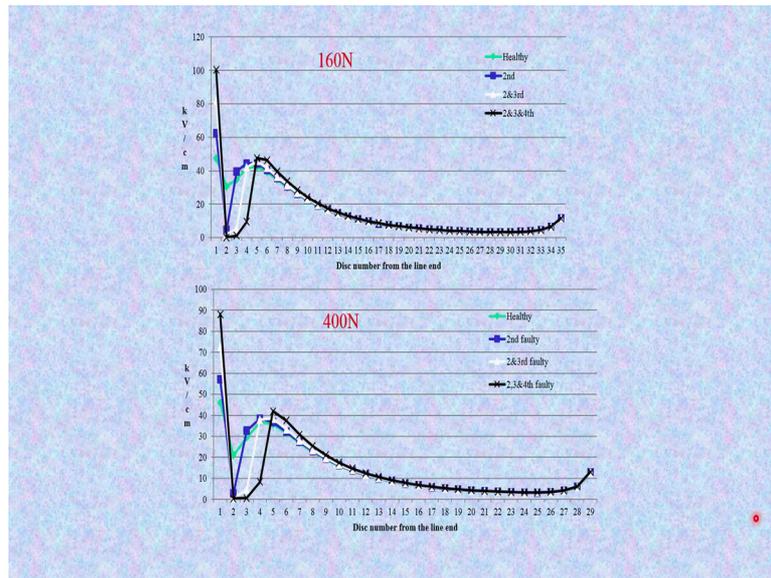
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Similarly, if there are discs which are faulted at various locations, the study has been conducted. This is for a 400 KV transmission insulators string where actual consideration as per the field condition is taking into the corona control ring and necessary hardware the simulations have been carried out and the graphs show here, the green colour graph indicates for the healthy conditions. And you see the second insulator in case second disc from the line end is faulty how it gets modified. Similarly, if there are faulty in locations of other insulator disc, which are different locations the potential gets modified at that particular location and the adjacent disc see higher stress or higher voltage distribution which is observed.

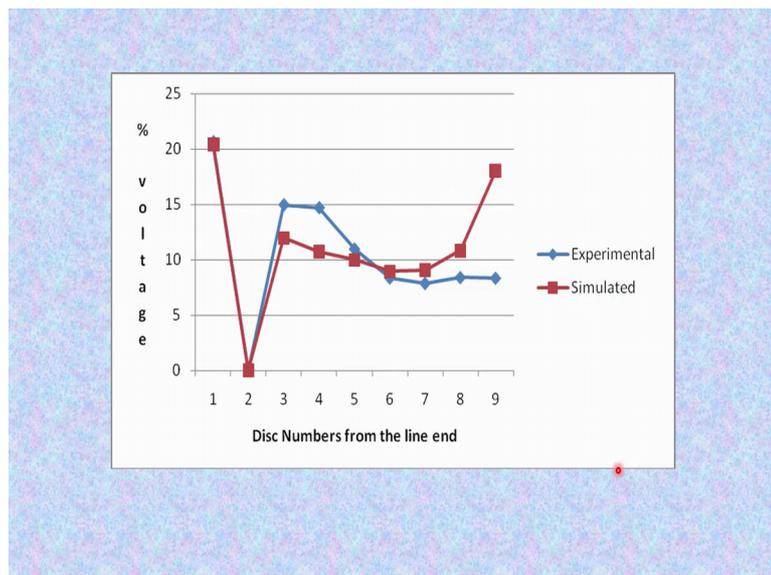
So, various locations the faults have been intentionally created, and the distribution change in distribution pattern has been presented here, for different disc. This is for 765 or ultra high voltage transmission towers.

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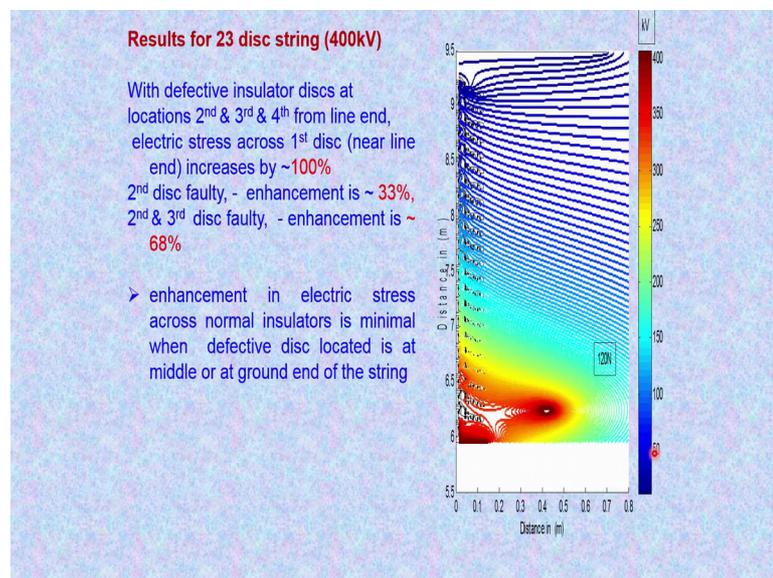
So, what happens in case the faults are at different junctions considering the faults at second insulator, considering the fault at different location arbitrary, we have try to see that how much potential or how much field modification happens, this gives an idea in case there is a fault at that location the adjacent insulator sees a higher potential or a higher field, which could be estimated whether it is at it is a dangerous limit. So, that immediate change is required or it could be allowed for some more time.

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So, this is an experimental and a simulated graph, which has been carried out in the laboratory for 132 KV systems. So, 132 KV you have 9 disc in a string. So, both the simulated values are indicated in the red curve here. You can see the experimental curve here. So, experimental we have shorted the actual insulator when we are considering the failure of that insulator, we have try to see that that particular disc has been completely shorted. So, that it is acts like a fault in the string. Then the experiments are repeated for a various possibilities various fault locations and it has been compared with simulation results.

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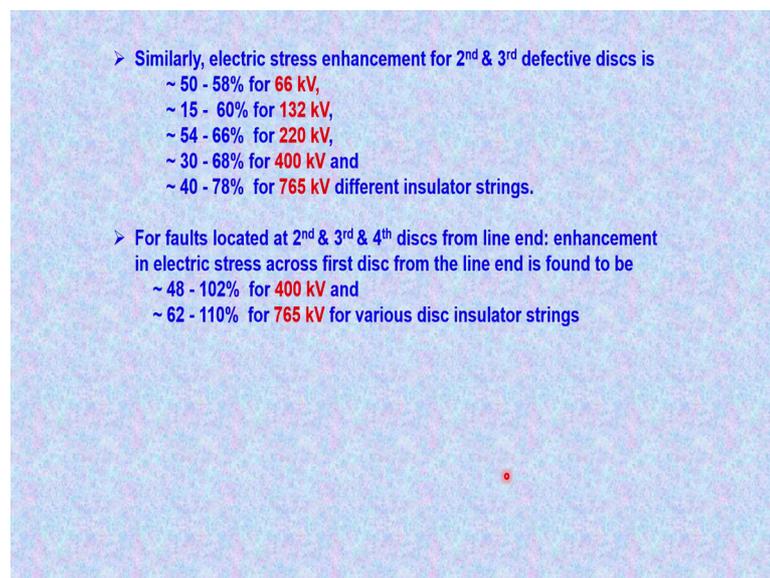
So, this gives idea for 400 KV in case the earlier results. In case there are defective insulators at the location say this is the high voltage end these are all the insulators this gives an equi potential plot arrangement here. So, these red indications are the corona control rings and other accessories which are connected near the line end. This is the line end which shows the insulator string is at a particular height of 6 to 7 meters which has been considered for simulation.

So, you see the defective insulators which are located intentionally, we have try to simulate the faults at second third fourth, from the line end line end is here the disc from the second third fourth are intentionally created a faults. If that happens, so what will be the stress which is going to be near the first insulator that is immediately after the line end? So, you can see here the electric stress across the first disc increases more or equal

to 100 percent. So, whatever the stress which it use to earlier see if there are faults or the insulator second third fourth are a faulty in nature, the stress will be doubled across the first this will hamper the performance of the insulator where the insulator is likely to shutter or there could be a failure or the entire string flashover could happened.

So, this gives an idea if there are faulty disc. So, that has to be immediately rectified. So, similarly fault locations at arbitrary have been chosen, and we have try to estimate the faults of the insulators for various string configuration. So, here you can see other example. In case if not second third fourth only the second insulator disc is faulty. Then the field enhancement is around 33 percent or in case if the second and the third are faulty enhancement is 68 percent. So, you can see that in case 3 are faulty it is 100 as the number of discs are reduced the percentage of stress also decreases. So, the fault plays a role how many insulator disc are faulted play a role and the location play a role. So, location how far from the line end that is very important or factor to be noted.

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So, similarly electric stress enhancements for different voltage levels have been calculated from 66 kilovolts to the ultra high voltage range. You can see in case there are faulty disc at second and third from the line end. The percentage increase of the stress for a 66 will be 50 to 58 percent this goes on up to 78 percent in case of ultra high voltage. So, very important point; so physically if there are failures or fault locations which are to be observed. The next or the adjacent insulator sees an increase of 78 percent which is

not advisable for a longer period the utility engineers have to be immediately questioned and see that or the changes have to be made. Similar fault locations at second third fourth show this values for 400 or 765 KV how the stress increases with a adjacent insulator discs.

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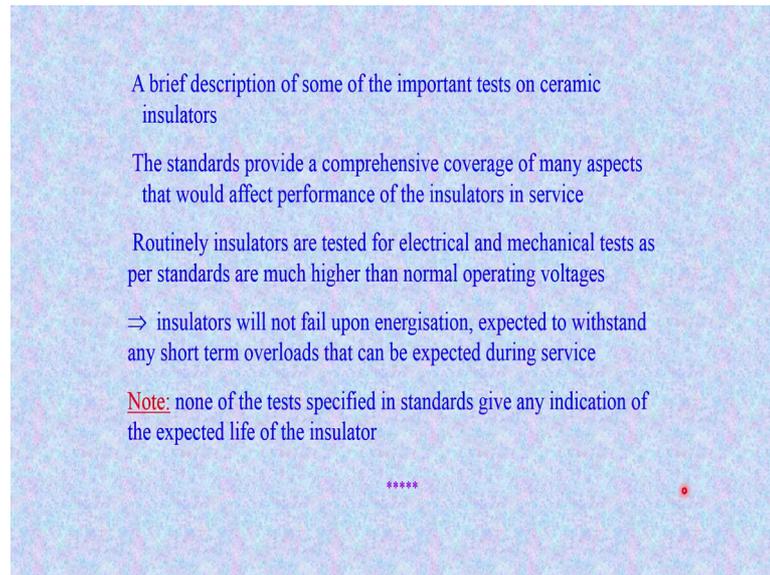
Table: percentage electric stress across the first disc from the line end in a string with defective insulator discs in different location

Ins type	2 nd faulty (33kV)	2&3 rd faulty string					2,3&4 th 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 gives a complete percentage of the electric stress across the first disc. Particularly we have taken the first disc is functional, the first is disc is functional there is no failure. The consideration was second could be a faulty which is a very serious thing. In case second and third faulty or in case of second third and fourth faulty these are the values of percentage stress which the first disc sees that is very important.

So, for various insulator discs which are manufactured in the country, we have try to see that and estimate the flashover or estimate the electric stress which could shoot up. Very important criteria where it gives an idea how the changes and how fast the changes have to be done in case the failure or the fault locations of that insulator string that happens.

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So, this was brief about the some of the important tests particularly on ceramic insulators. We know that standards provide a comprehensive coverage of many aspects which would affect the performance of the insulator strings in service very important point. Routinely these insulators are ceramic or a glass is tested for both electrical and mechanical tests, as per the international specified standards. Usually for slightly higher than the normal operating voltages this is to ensure in the contingency of the over voltages which could happen in the field, or the electrical or the mechanical over load or higher voltages. The insulator string should function without disturbing the normal activity. So, that is a very important.

So, here insulator should not fail upon energization, which is expected to withstand. Or short term loads that could be expected normally during the service conditions because of several contingencies. So, it is very important the tests for reliability have to be carried out before the insulation in the field, but of an a note is to see that none of the test whatever the test which have been discussed reliability test specified in the standards or in the technical reports which are being internationally followed give any indication the expected life of an insulator after performing this test.

So, the utility is the manufacturers have to way the options which technology or which type of the insulator technology to be used. Then it has to be decided just performing the entire test there is no guaranteed that the insulator string could be of our a expectation a

life as the estimation of life expectancy of the string in the field, after performing in the lab is there is a no indication from this a test it should be noted.

So, the tests which have been described till now concerns about the various porcelain or a glass type of insulators, which are used from lower voltage to very high or ultra high voltages. So, we will focus for the polymer insulators. This polymer insulator has mentioned earlier are of a recent origin and are of organic in nature. So, this requires apart from the test which have been mentioned some of the tests, not all the tests some of the test have been standardized. And some of the tests have not at been standardized even though the insulators are in service for a decayed or so because of organic in nature they are prone for environmental degradation.

So, we will look in to this aspect apart from the normal test what are the reliability experimentation or the reliability special testing arrangements have to be made in case of a composite or a polymer insulators, which are being in service quite decade also, but there are some issues a related to the polymeric insulators. So, the details of this will be discussed.