Recent Advances in Transmission Insulators
Prof.B. Subba Reddy
Department of Electrical Engineering
Indian Institute of Science – Bangalore

Module No # 02
Lecture No # 08
Cleaning methods adopted for insulators

We have discussed about the contaminant which are affecting the insulator performance in the field either in substations or transmission system this contaminants over a period time cud create a flash over and the tripping of the line so proper cleaning mechanisms is to be adopted in the transmission system or in the substation. So various methods are being employed by the utility personal in the field there are prescribed methods which are being followed IEE standard 957 is one of the method which gives the guidelines for the cleaning of insulators in substations or in transmission system.

Here this standard or the methods guidelines which are given in this standard mentioned about the importance of for the methods to be followed and various procedures to be adopted by the utility personal.

(Refer Slide Time: 01:22)

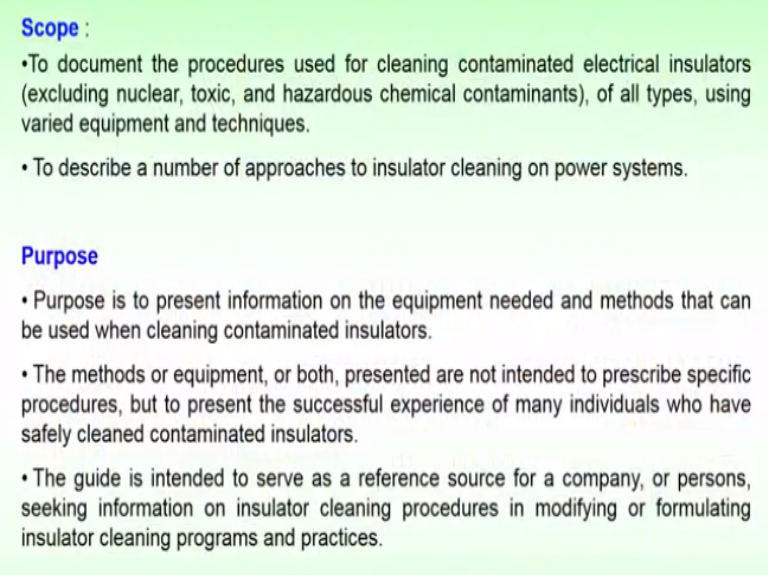
So we know that various types of insulators in the substation are being to be maintained it could be a post insulators it could be the insulator housing which are employing arrestor elements the surge arrestors. Here again the porcelain or ceramic arrestors recently polymer based arrestors so the methods which are being used have to be properly planned.

There are bushings or the insulating hollow insulating which are being used for the current transformers it is potential transformers the PT's and various substation equipment's where the bushing are used to mount the high voltage equipment's. These bushing should be regularly maintained for cleaned so that the dust or the accumulation contaminants never accumulate on that and the performance of this insulation comes down.

So various methods are being suggested in this standard we will focus on the importance of the methods the procedures which are to be employed both during live line or hot line washing at that is during the energized conditions and during the de-energized condition when the power supply is switched off for the maintenance aspects. So the method differ to an extent for energize and de-energize so proper care has to be taken in particular when the maintenance is being carried out during the energized condition that is a hot line or a live line maintenance period.

So the potential levels have to be looked into the nozzle jets which are being used properly installation of the personal and safety aspects have to be considered when the maintenance of or the cleaning of the insulators is being done.

(Refer Slide Time: 03:45)



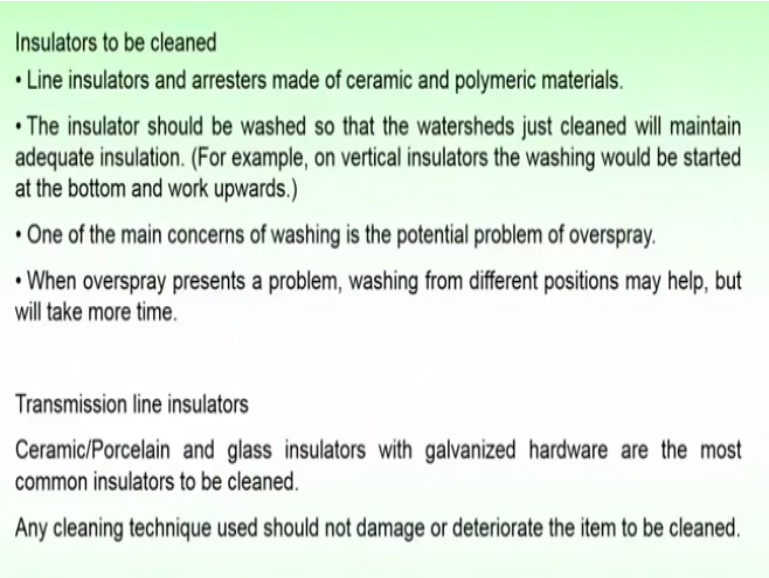
So we will look into the important scope or purpose of this guidelines have been made. So this standard 957 clearly prescribes the procedures basically used for the cleaning of contaminated electrical insulators for all types ceramic porcelain glass and also the recent polymer or insulators and for equipment which are being used that is the bushings the hollow post insulators and so on.

So various equipment's and technique to be followed are mainly under the scope of this standard it also describes the number of approaches to be adopted for cleaning of insulator and power system network. The main purpose of this guide is to present information on the equipment which is needed and the methods this can be used while cleaning the contaminated insulators this is a prime importance.

The methods or equipment or both are presented or mainly not intended to prescribe specific procedures but here it is seen that to present that successful experience of many individuals in the utilities or in the power working in the power network systems who have safely done the job of cleaning the contaminated or polluted insulators. So with the inputs this guidelines are being made and is mainly intended to serve as the reference source for an utility company or the personal who are working the substation or industry where the high voltage equipment's or the insulator system are being used.

And the cleaning procedures which are to be followed are been prescribed and modifying or formulated for cleaning could also be carried out appropriately.

(Refer Slide Time: 06:09)



Insulators to be cleaned are mainly of transmission distribution substation again post insulators hallow type of both ceramic polymer materials. The insulators should be washed so that the water sheds which are clean will maintain adequate insulation this is of importance. So once the pollutants or contaminants are clear the insulation level of equipment or the insulation part will be improved.

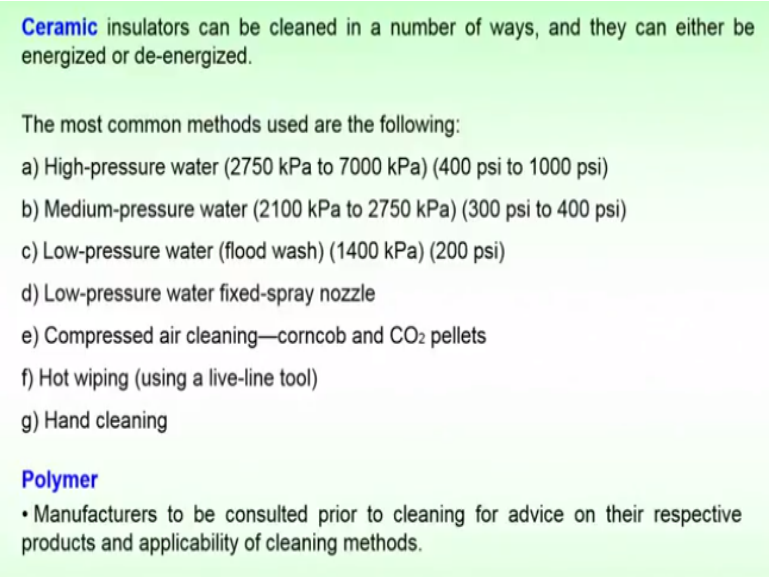
So one of the concerns of washing from different positions again in case of the string insulators in the field we discussed various types of configuration it could be of suspension it could be attention it could be V suspension combination in the field for EHP and UHP transmission system. So during the cleaning of particular leave V type of string the contaminants or pollutant could be carried to the other string other arm of the string.

So here proper mechanism has to be followed where the spray should be in such a way that cleaning of the insulators of one side should not contaminate the other insulation of the other side. So when incase also about the over spray one of the main concerns is because sometimes the washing could create the put off over spraying. So when over spraying present the problem washing from different positions could also help.

So two different positions have to be followed for cleaning in such cases so transmission line or distribution line insulators of ceramic porcelain glass which are connected with galvanizing hardware are most common practices are most common insulators which are to be cleaned regularly so any cleaning technic which is employed for the cleaning purpose. The main intention should not be to damage or decorate the surface of the insulation system during the cleaning process.

This has to be kept in mind by the utility personal who do the cleaning technic cleaning is the better thing to be carried out but again damaging the shed or petty coat could also cause an issue so proper mechanism or technique used to be employed.

(Refer Slide Time: 08:53)



So ceramic insulators can be cleaned in number of ways and they can either be as mentioned during the energized that is the hot line maintenance or during the switched off conditions that is de-energized condition the most method common method which are being used or the following for the ceramic or glass type insulator in the transmission system. So various methods are being suggested or being practiced by the utility personal.

High pressure of water here the water pressure could be 2750 kilopascals to 7000 kilopascals or the pressure could be of 400 Psi to 1000 PSI. The medium pressure water jets which are being used could be 2100 kilopascals to 2750 this is 300 PSI to 400 PSI the PSI is pressure

per square inch that is kilopascals KPA. The low pressure water again here flood washing type of arrangement is made with 1400 kilopascals that is somewhere around 200 PSI.

So low pressure water fixed spray nozzle this are done for a particular location where insulators are fixed. So in such cases for cleaning a spray type of nozzles are fixed and it will be used regularly for cleaning the jets which are connected in the nozzle jet are fixed to that regular cleaning could be done. So compressed air cleaning here again depending upon the surface conditions we will be discussion about this in further.

The corn cob or carbon dioxide pellets also are being used to clean the surface were the surface contaminants which are harden at on the surface have to be cleaned. In such cases a corn cob or carbon dioxide pellets are used for with the help of compressed air cleaning. Some cases hot wiping that is used for live line tool insulators are with a sudden temperate the wiping is done and some of the cases it is hand cleaning with the cloth of the smoother cloth.

So these are some of the common methods which are being used for the ceramic or glass insulator but the utility personal in case of polymer which are of recent origin. No methods are being presently available so there are method which are being followed by the utilities in cleaning but there the manufactures to be consulted priory as this polymer insulators are of organic where using a higher pressure with could damage the sheds are the surface condition rubber shed of insulator surface.

So manufacture have to be consulted prior taking up the cleaning on the respective products and applicability of cleaning methods have to be discussed. So there are some methods which are being followed we will be discussing both for ceramic and for polymer insulators which are in substation which are in transmission and distribution systems.

(Refer Slide Time: 12:42)

Table 1—Water pressure washing for polymer insulators

1. Direct molded units	
Silicone	Low- to high-pressure water washing (1400 kPa to 7000 kPa)
EPDM/EPR	High-pressure water washing (2750 kPa to7000 kPa)
Alloy EPDMs	High-pressure water washing (2750 kPa to 7000 kPa)
Epoxy	High-pressure water washing (2750 kPa to 7000 kPa)
Polymer ceramic	Medium- to high-pressure water washing (2100 kPa to 7000 kPa)
2. Individual weathershed bonded to a polymer sheath or to each other	
Silicone	Low- to high-pressure water washing (1400 kPa to 7000 kPa)
EPDM/EPR	High-pressure water washing (2750 kPa to 7000 kPa)
Alloy EPDMs	High-pressure water washing (2750 kPa to 7000 kPa)
3. Individual weathershed with an unbonded interface	
All compounds	1400 kPa at the pump with a 6 mm nozzle and no closer than 4.6 m
NOTE—For types 1 and 2, the water stream may be directed at any angle to the insulator axis. Type 3 requires the water stream to be directed on the upper (tapered) surface of the weathersheds at an angle no greater than 90° (perpendicular) to the insulator axis.	

So this table shows the water pressure washing particular for polymer insulators you can see for polymer insulators there are materials which are direct already units of composition of silicon EPDM or alloy PDM or proxy type of polymer ceramic these are various molded units which are being used for the bushing which are used for the high voltage equipment's this example for silicon which are used to low to high pressure here for cleaning purpose of the silicon they use a low to high pressure water washing which could be somewhere 1400 kilopascal to 7000 kilopascals depending upon the contaminants.

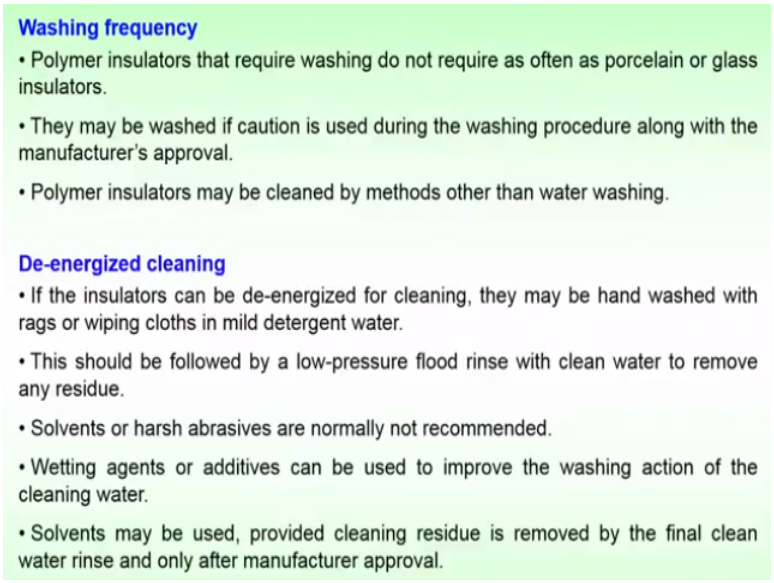
The second for the EPDM could be high pressure in the range 2750 to 7000 kilopascals the alloys and the EPDM materials where ever it is being used they use the high pressure water washing an in the range of 2750 to 7000 kilopascal. Similarly for e-proxy the similar pressure of water washing being done for proxy molded insulators where ever there being used. In case of polymer ceramic type medium to high pressure water washing is normally employed somewhere around 2100 kilopascal to 7000 kilopascal.

For individual water shed bonded to a polymer sheet or to each other here again different methods are being followed like silicon rubber to high pressure water washing with 1400 kilopascals to 7000 is being employed. For EPDM or here pressure water washing with again the like previous methods 7050 kilopascals to 2750 to 7000 kilopascals being used. Similarly for alloy EPDM high pressure water wash being normally followed.

So what happened in case of individual water weather sheds with unbounded (()) (15:02) and he bonded to a polymer sheet this with an unbounded inter phase here for all the compounds here the silicon EPDM and alloys normally the utilities are used 1400 kilopascals at the pump with 6MM nozzle and no closure then 6.5 meters. So this measure is being employed so for type 1 and 2 you can see for direct molded units and for individual weather shed bonded to a polymer sheet the water shrimp may be directed to any angle access.

So in case of third that is individual weather shed with an unbounded interphase it required the water shapes to be directed on the upper or a angler surface of the weather shade which is at an angle greater than 90 to the insulator access. So this are being in the given as the guide lines for washing the polymer insulators in the substation or in the transmission systems.

(Refer Slide Time: 16:11)



So what is the washing frequency or cleaning frequency to be adopted here again the polymer insulator that require washing or do not require as often as a porcelain or a glass insulators because most of the time glass or porcelain insulators have been seen to accumulate more pollutant and comparison to the polymer type. So they may washed in case caution is used during washing procedure along the manufactures approval.

So polymeric insulators are stings may be clean by methods other than then water washing also so there are two methods of cleaning as mentioned earlier one is de-energized cleaning this is the supply will be switched off for maintenance and other is he energized cleaning during

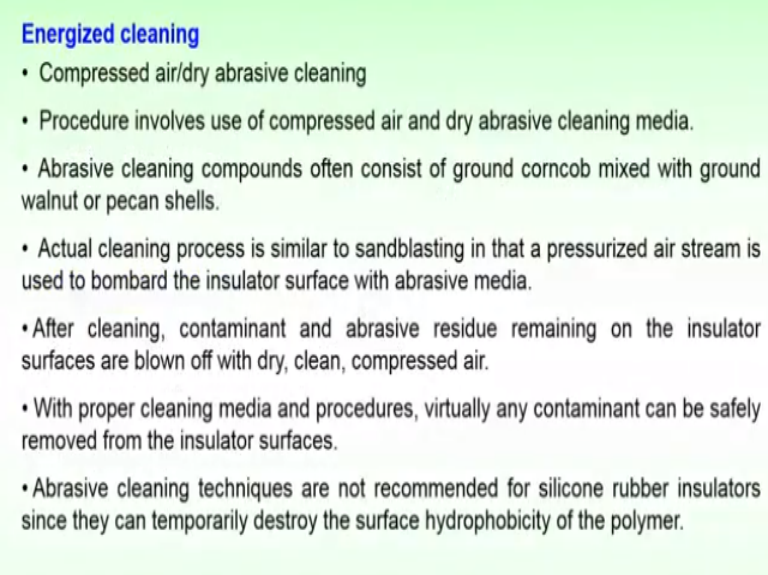
the energized condition during the live line or hotline tools the maintenance will be done or the cleaning of the insulators is done.

So in case of de-energized cleaning so the insulators can be the supplied into the insulators is normally switched off for cleaning. Here again there may be hand washed with cloth or wiping with the cloth or the mild detergent water again depends what type of contaminants on the insulator or spread we will further discuss about how the methods are to be used what type of arrangements or what type of techniques are to be followed for various type of contaminants here this should be followed by a low pressure cleaning or wiping of the clothes.

Low flood or rinse with clean to remove any residue which is present on the surface so various solvent are harsh brassies or normally not recommended. So these solvent some of the solvent are harsh or may damage the surface conditions. So that is one of the reason where this or not recommended for the cleaning. Wetting agents or additives can be used for improving the washing action of the cleaning.

So here choosing of this wetting is of also high equal importance the solvents may be used provided cleaning residue is removed by the final water in that is once the cleaning is done by racks of the wiping of the cloths followed by a mild detergent water this have to be cleaned out. So these things are normally undertaken with the approval of manufactured in particular to the polymer insulators.

(Refer Slide Time: 19:12)



So that was about the de-energized condition now we discussed about the energized cleaning that is during the power supply which is on conditions. So where hotline tool are being employed or hot line end maintenance what we call is being used for cleaning ah insulators. Here again compressed that is compressed air under dry abrasive cleaning is used this procedure involves of compresses air and dry abrasive cleaning medium.

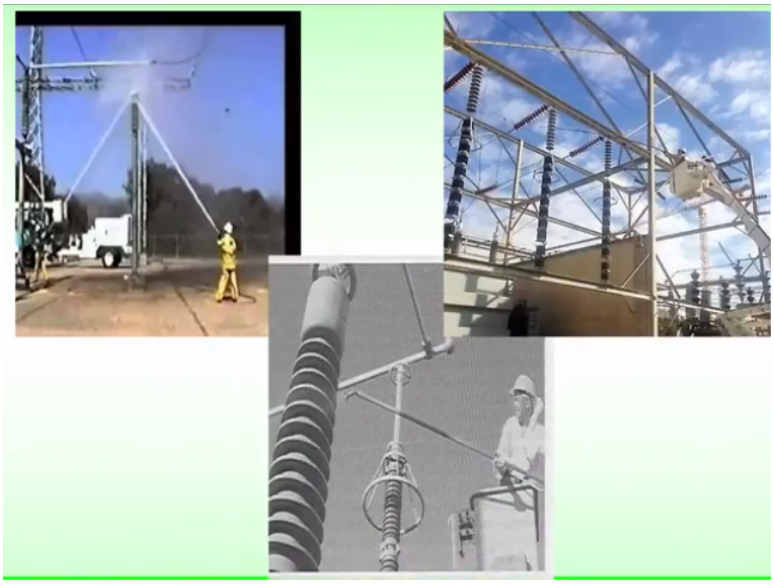
So again abrasive cleaning compounds of an consist of the ground corncob mixed with ground wall nut or pick an shells. So these are generally used for cleaning or removing the dirt on the insulator surface. So actually cleaning process is similar to sand blasting in that pressurized air spring is used to bombard the insulator surface with abrasive media so that the collected pollutants on the surface move away from the insulator surface.

So this is the pressure which is being used after cleaning the contaminants and the abrasive residue which are remains on the surface are to be blown of with driving cleaning or a compressed air arrangement. So these are all done during the energized condition with the supply on so with proper cleaning media and procedures virtually an contaminant can be safely removed from the insulator surface.

So the abrasive cleaning techniques are generally not recommended for silicon rubber as earlier mentioned as this abbres are hard harsh method could damage the surface or the rubber sheds of a polymer or a silicon rubber insulators they are temporarily or permanently destroy

the surface hydrophobicity conditions. So hence method which are very harsh or high pressure techniques are not to be followed for he ceramic ah sorry for the porcelain polymer insulator.

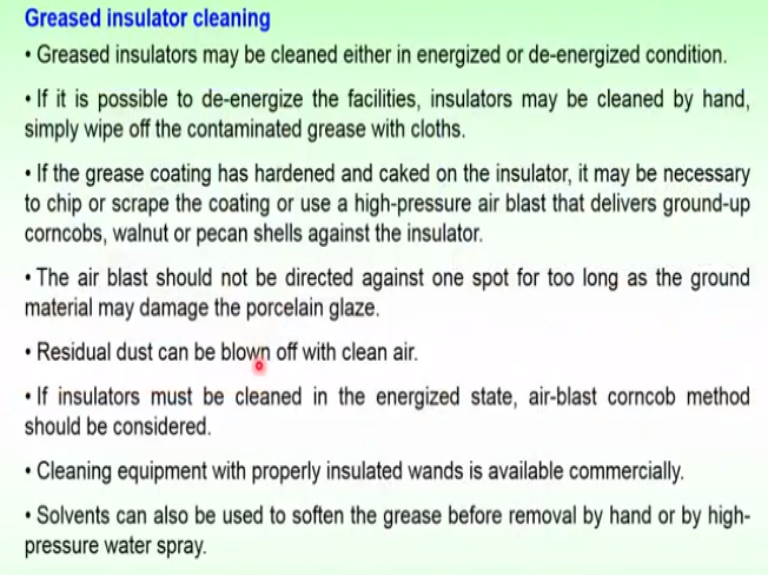
(Refer Slide Time: 21:36)



Some of the energized or polymeric conditions so these give some methods which are being followed by the hand pressure jets which are being cleaned during the live line conditions if the distance of the personal equipment which is being used is also very important and how cleaning procedure have to be done with the help of insulating the trolley ah where a personal user are insulating mechanism for cleaning the insulators.

This is again one of the similar method for cleaning he substation insulators with insulated equipment's. these are all some of the methods which are used or live line maintenance that is during the power supply energized conditions to clean the insulators at substation or transmission or distribution networks. So these are give you an idea of proper methods to be followed with necessary safety measures and using the safety equipment's for the cleaning.

(Refer Slide Time: 22:49)



So what happens in case about the grease insulators so sum the insulators over the period of time the contaminates could be oily in capture could be grease which could be hard on the insulators surface so the water jets may not be may not be able to clean the insulators or normal cleaning with cloth may not be sufficient so in such cases the methods to be followed either it could be energized or in de-energized conditions it is possible to de-energize in some cases and also to follow the energize conditions.

Here insulators may be cleaned either by hand simply by wiping on the contaminated grease using the cloth or the grease coating which is very hard and caked on the insulated surface must be a necessary to chip or scrap the coating or sometime use a high pressure air blast that delivers ground up corncob, walnut or pecan shells. Again is the insulated surface so it has to be in case of porcelain insulators these are the things which we have to be employed for cleaning of insulators.

The air blast should not be directed again is 1 spot for too long as a ground material may damage the porcelain glaze. So the material dust can be blown off with clean air if insulators must be cleaned in energized state air blast, corncob method could be considered. The cleaning equipment's with properly insulated vans is available commercially where it is being is used for cleaning grease insulators.

There can be used for some solvents which can also be used to stuff in the grease before removal hand or by high pressure water. So several techniques are methods are being used to clean the grease insulators in the energized or de-energized condition. So proper care as to be taken while removing the ahh coating grease coating damage surface damage to the insulators should not be done.

(Refer Slide Time: 25:36)

And well applying the fresh silicon grease over the contaminated silicon grease is also not recommended as the contaminated grease ah which is earlier must be removed prior to coating a new layer this is a important point to be considered in particular to the coating which are of grease in nature so simple hand wiping with disposable paper towels or a porous hand pads is all that is required for cleaning silicon grease insulators on energy energized lines.

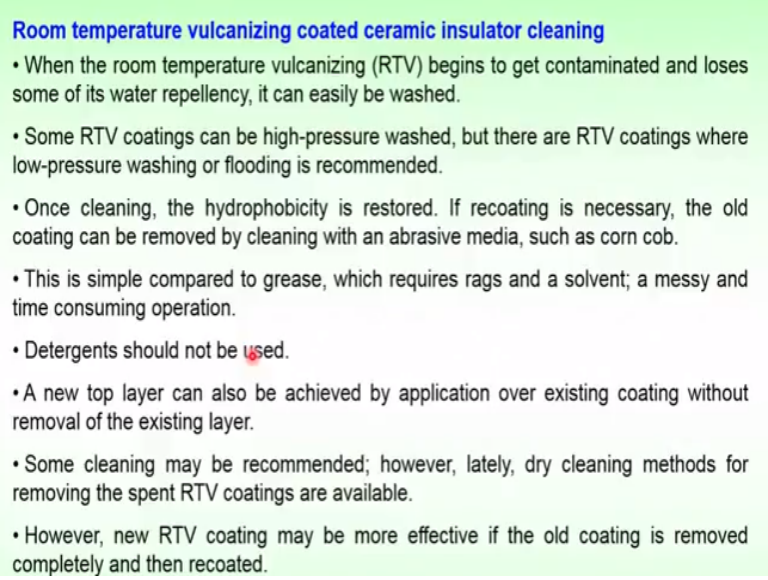
Use of demineralized water which is relatively low pressure 850 kilopascals that is 125 PSI and high capacity of 3.2 liters per second per 50 gallons per minute is normally recommended. Removal of silicon grease is relatively simple removal of petrol jelly from insulators so this as to be followed.

(Refer Slide Time: 26:42)

Resistive glazed insulator cleaning so resistive glaze or semi conducting glaze insulators can be treated the same as ordinary glaze like the porcelain insulators in concerning cleaning techniques as cleaning will not damage the resistive cleaning surface. However it is unlikely that properly functioning resistive glaze insulators will require cleaning due to their super contamination performance.

So resistive glazed insulators under pressure washing overwhelm resistive glaze properties so that resistive glaze insulators become as susceptible to accidental flash over at ordinary glaze in glaze insulators due to poor washing techniques so care has to be taken by the personal or utilities while cleaning the resistive list in insulators.

(Refer Slide Time: 27:47)



So room temperature vulcanized coating we have heard about RTV coatings on the insulated surface was better performance. So the cleaning of this RTV or room temperature vulcanized coatings are also important which beings to get contaminated and loss some of its water repellency. So this RTC coatings are basically coated on the insulators to see that hydrophobicity is restored over a period of time this could lose it properties and a proper cleaning mechanism as to be made.

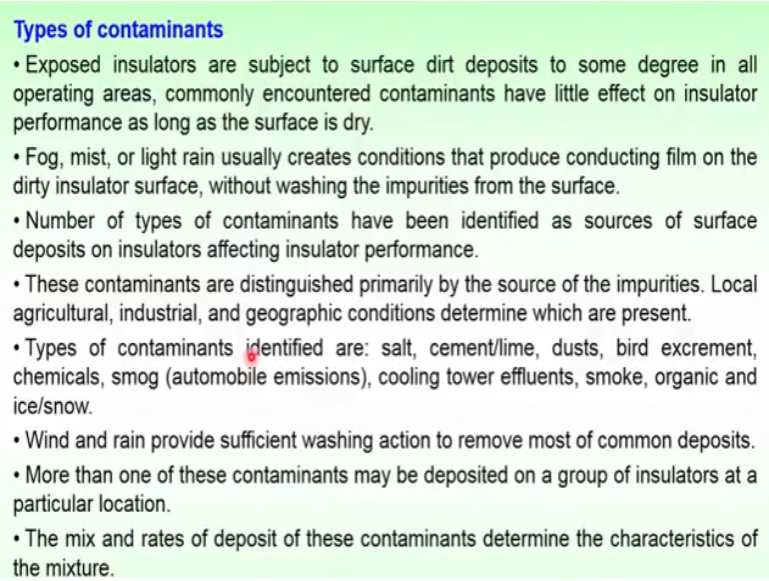
So some room temperature vulcanize coatings can be done be by using a high pressure washing but there are RTV coatings where there are low pressure coatings are flooding is also recommended once cleaning the hydrophobicity is also restored that is the water repellent action on the insulator surface is restored. If recoating is necessary old coating can be removed by cleaning with abrasive media such as corncob.

So this is simple compared to grease removal on contaminator or insulator which requires rags and solvent. So messy and time consuming operation which to be done in case of grease insulators. So detergents are not recommended to be used for the cleaning of RTV coating insulators as a new top layer could also be achieved by application of over existing coating without removal of the existing layer.

So some cleaning may be recommended however lately dry cleaning methods for removing the spent RTV coating also available in the commercially which are normally practiced.

However new RTV coats may be more effective if the old coating is removed completely and recoat it.

(Refer Slide Time: 29:57)



So this decision as to be properly taken on the by the utilities so types of contaminants this is an important point how the contaminants of pollutants get settled so what are the various types of contaminants which the utilities phase or the insulators get contaminated. So as insulated are exposed in the field or outdoor these are subjected to surface direct deposits to some degree in all operating which are commonly encountered contaminant little effect on the insulator performance as long as surface is dry.

So during surface conditions are dry condition or no much threat of this contaminants once the fog mist lightning this usually creates a conditions that produces a conducting films of direct surface which is without washing the impurities from the surface. So this number of types of contaminants which have been identified as source of surface deposits on insulators will effect the insulator performance during the fog mist or lighting conditions.

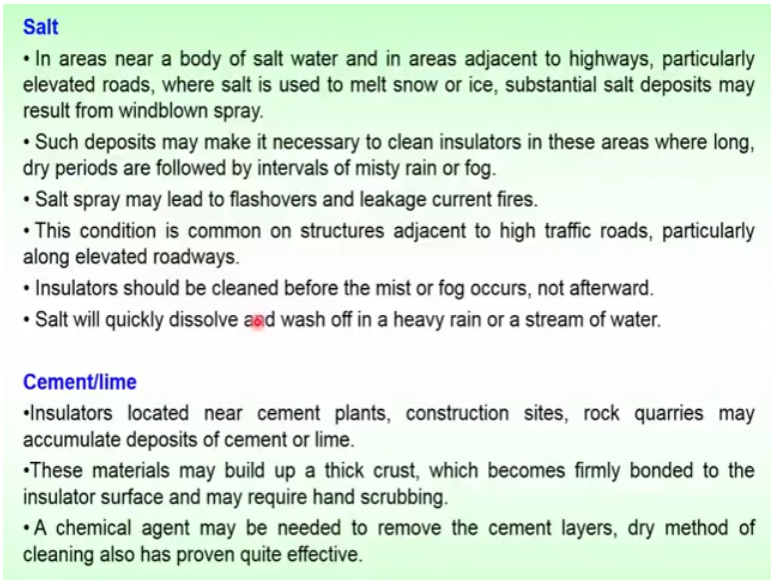
So these contaminants are generally distinguished primarily by source of impurities local agricultural industrial and geographical conditions which are determined about the presents. So the type of contaminants generally identified or the salt or cement or lime does bird experiments chemical small is again emission from the automobiles cooling tower effluent smoke, organic and ice snow.

This are various contaminants which are identified which could accumulate on the surface of the insulator over a period of time. So we will discuss each and every every contaminant how this contaminants effect the surface of insulators how the cleaning as to be carried out how the techniques to be washing as to be employed we will further look into this type of contaminants and cleaning mechanism.

In case of wind and rain this provides sufficient washing action to remove most of the deposits which have been mentioned that is the contaminants on the surface. More than one of this contaminants may be deposited on the group of insulators at a particular location. So the rain wind to some extent remove the contaminants which are spread on the insulator surface. The mist and rates of deposits of this contaminates determine the characteristic of the mixtures.

So various pollutants or contaminates are identified are to be removed or cleaned at regular intervals on the surface of the insulators.

(Refer Slide Time: 33:26)



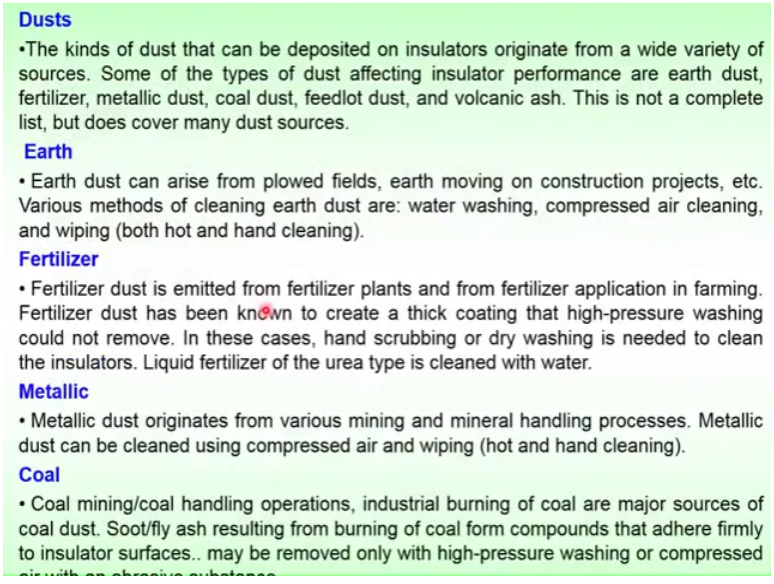
So we will look into the importance of the cleaning and how it is to be done so here in case of salts these transmitting lines or substations which are nearby areas it could be the sea coast or a body of salt water in that area adjacent to high ways particular elevated roads where the salt is used to melt snow are ice substantial salt deposits may result from wind blowing and beach gets sprayed on the insulator surface.

So in desert area sea coast or near the high way junctions so such deposits which are being carried out through the wind make necessary to clean this areas where long dry period are followed by intervals of misty rain or fog. So slat spray could lead to flash over and leakage current fast so here again depending upon the humidity conditions the surface or because of the lightning mist or fog.

The surface become conductive and mainly flash over or leakage current initially where dry band wet band formation happens partial arcs or scintillations do have further depending upon the surface condition the flash over could happen. This condition is common on structures adjusted in long traffic road particularly along with elevated roadways here insulator should be cleaned before the mist or fog occurs not after wards.

So salt which will quickly dissolve and wash of (()) (35:16) stream of water so what happens in case contaminants in a cement or line the insulators which are located and materials at crust becomes only bonded to the insulated surface and which required hand scrubbing as cements or line settles on the surface and becomes hard. So chemical agent may be needed to remove the cement layers so usually dry method of cleaning also has proven to be quiet effective.

(Refer Side Time: 36:02)



So dust could be of various kind and can be deposited on insulators which originates from wide varieties of sources. Some of the types of dust affecting insulators performance are the earth,

fertilizers, metallic dust, coal dust, feed lot dust and volcanic ash. This is not a complete list but cover many of the dust sources so there could be dust from various sources which accumulates on the accumulated surface and could cause the contamination.

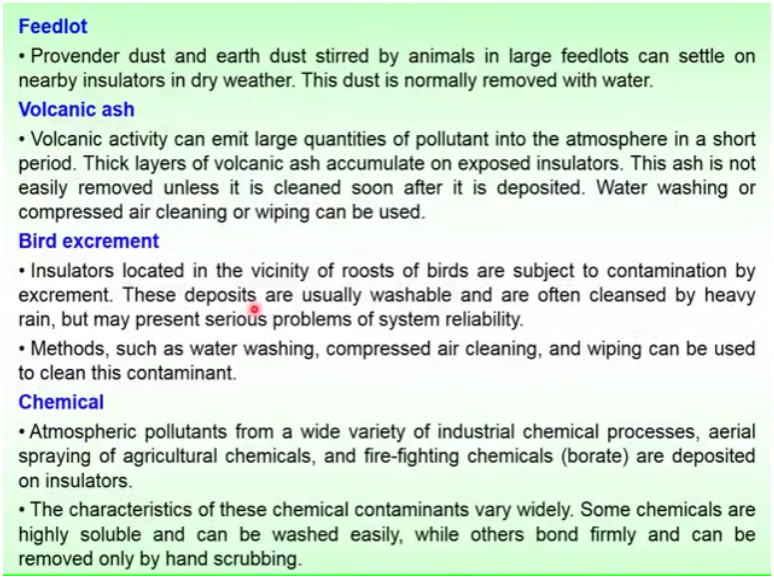
Earth dust can arise from fields when the agriculture activity like plowing of fields or because of the earth moving construction projects so on and hence so forth where this methods various methods have to be employed for cloning this type of dust due to the earth or due to the activity of the agriculture and the construction projects. So water washing or a compressed air cleaning and both hot and hand cleaning or generally employed.

The set the next is fertilizer dust this fertilizer dust is generally emitted from the fertilizer plants and for fertilizer application during the farming activities. So fertilizer dust has been known to create a thick coating that as can be done using a high pressure washing which could not remove. So in this cases hand scrubbing or dry washing is generally needed to clean the insulators.

Sometime liquid fertilizers of urea type is cleaned with water the next is the metallic dust this could originate from various mining and mineral handling process. So metallic dust can be cleaned using compressed air and wiping hot end and clean. The next is the coal mining or coal handling operations dust gets settle on this surface of the insulators here again industrial could be due to the industrial burning of coal source of coal dust also or fly ash resulting in the burning of the coal from the compounds that added to the insulator surface.

This coal dust may be removed only with high pressure washing or compressed air or abrasive substance.

(Refer Slide Time: 38:50)



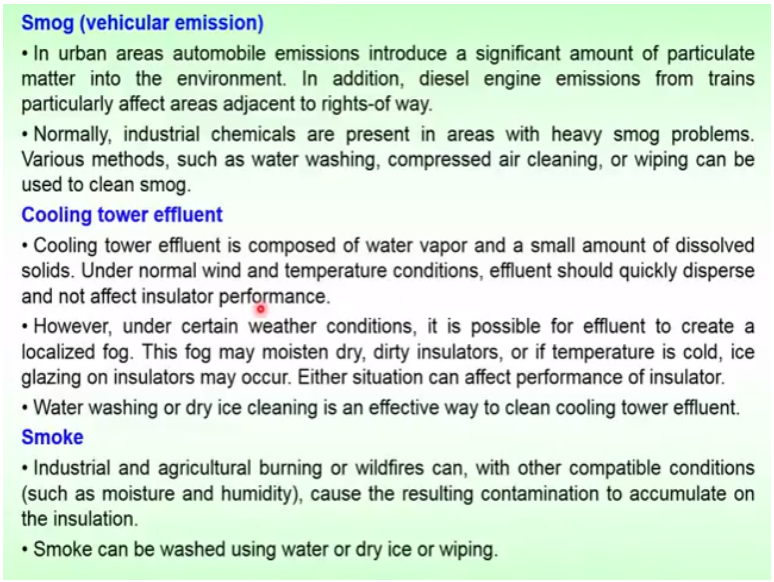
Feed lot provender dust and earth dust stayed by animals and large feed lots settle by insulators in dry weather conditions this dust is normally removed with water volcanic ash again the this is concerning only the few countries where activity happens so here volcanic activity can emit lot quantities of pollutants in the atmosphere in a very short period.

So thick layers of this are organic ash could accumulate on exposed insulators this ash is not easily removed it is clean soon after it is deposited water washing or compressed air cleaning or wiping can be used. The next is the bird excretion or experiment this is again insulator located at the vicinity of the rose of birds where large birds particular in countries like Australia and many places where birds do shape take shelter on the transmission systems or of a series concern and subject to contamination by the experiments.

These despots are usually washable and or often cleaned by heavy rain but may present series problems of system liability the method such as water washing compressed air cleaning and wiping an be used to clean this contaminant chemical or at here again the dust or because of chemical which could spread on the insulator surface which are ah of a series concern at atmospheric from the wide variety of industrial and chemical process aerial spring of agriculture chemicals and firefighting chemicals are deposited on insulators.

The characteristics of this chemical contaminants may vary widely some chemicals are highly soluble and can be washed in easily while other bond firmly and can be removed only by hand scrubbing.

(Refer Slide Time: 41:27)



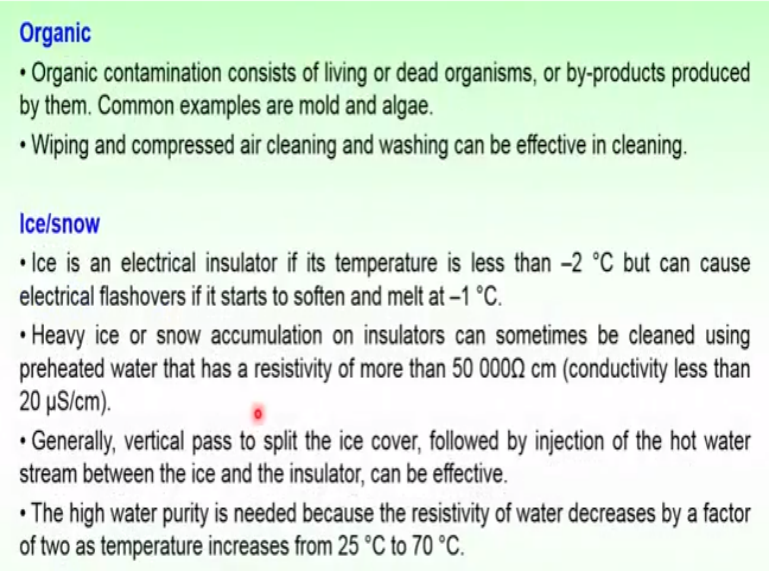
Next is the smog smog in urban areas automobile emissions introduce a significant of amount of particular matter into the environment in addition diesel engine emission from trains particularly affect areas at adjacent to write of wave normally industrial chemicals are present in areas with heavy smog problems various methods such as water washing compressed air cleaning or wiping can be used to clean this smog.

Cooling tower effluent cooling tower effluent in is generally composed of water vapor and a small amount of deserve solids and are normal wind and deserve conditions effluent could quickly disburse and not effect the insulators performance however and the certain weather conditions it is possible for effluent to create a localized fog this fog emission term dirt insulators or if temperate is cold ice glazing or insulators on insulators may occur.

So any situation where this can effect the performance of the insulator so the cooling tower effluent or also causes at contamination similar to a fog or any other contaminants. So smoke this is again due to the industry and agriculture burning activities or due to the wild fires this can result in the contaminants spread on the surface with other compatible

conditions such as moisture and humidity can cause the resulting contamination to accumulate on the insulation surface.

(Refer Slide Time: 43:35)



So smoke can generally wash using water or dry ice or by wiping the surface of the insulator of organic contamination generally consist of living or dead organisms or by products produced by them common example or mold and algea this are generally seen near the cement junction of the ceramic insulator or on the surface of the polymer insulators which on the alternative cold countries the mold and the algea for machine has been noticed.

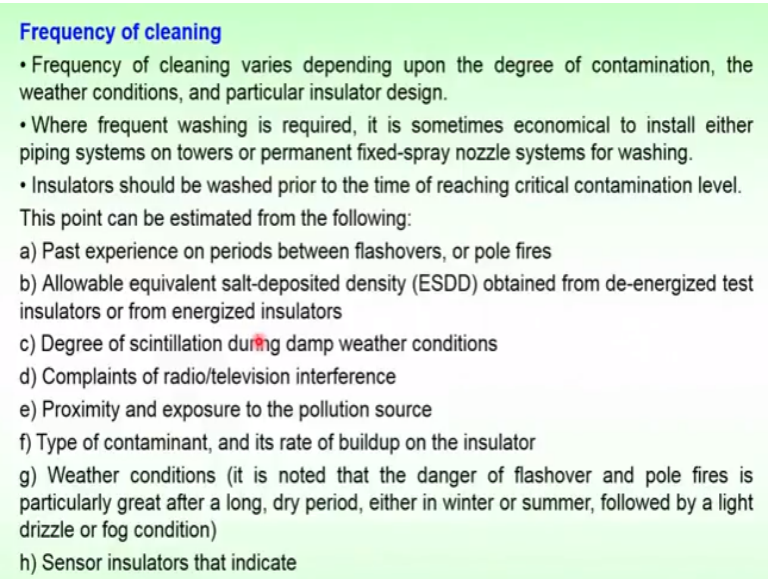
Here wiping and compressed air cleaning and washing can be effective in such places and the ice and snow conditions where the insulators string or insulators are subjected to ice and snow. Here ice is an electrical insulators if it is temperate is less than -2 degrees but can cause electrical flash over if it is start to stop from -10 degree centigrade. So heavy ice or snow accumulation can sometimes be clean using pre heated water that as resistivity of more than 50,000 ohm centimeter the conductivity less than 20 siemens per centimeter.

Generally vertical pass to split the ice cover followed by injection of hot water string between ice and the hot water be effective. The high water purity is required because the resistivity of water decreases by factor of 2 as temperature from 25 degree to higher that is up to 70

degrees. So several of this contaminates which are discussed are generally noticed in transmission or distribution or in substation system where these contaminants are pollutants accumulates over a period of time.

So proper cleaning mechanisms have to be done and necessary technique have to be employed for the roper maintenance and also proper efficiency and without causing the contaminants flash over to the insulator in the transmission system or a distribution or a substation system.

(Refer Slide Time: 46:08)



Now we look into the frequency of cleaning so what is the frequency of cleaning required? So this again is a important point where frequency of cleaning various depending upon the degree of contaminations. So where exactly the insulators which environment the insulators or which plays the insulation is so depends upon the contamination the levels the weather conditions and he insulator design the frequency of cleaning is essential or is to be done.

Here the frequency washing is required is sometimes economical to install either a piping system on towers or a permanent fixed spray nozzle system for washing. So insulators are to be washed prior to the time of reaching critical contamination level that is one of the important information would not be allowed for contamination thread and accumulate for a larger period.

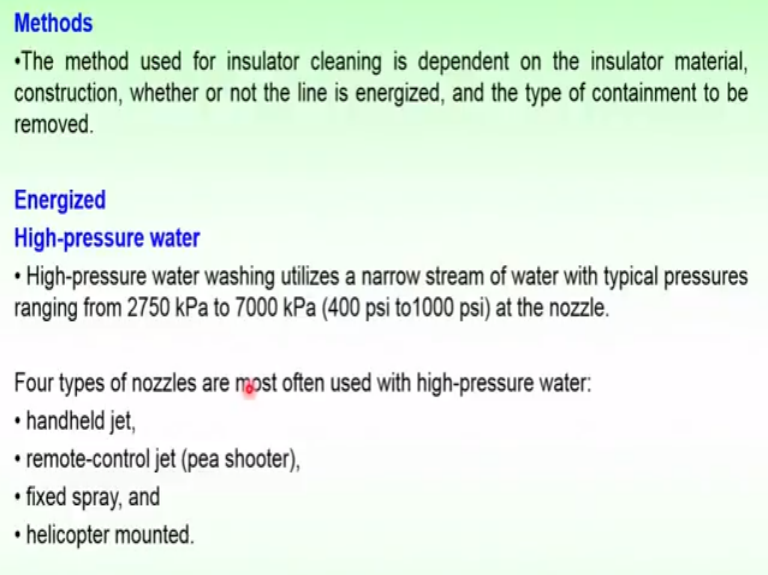
So these point can be estimated from the following by taking the past experience on pay rates between flash over not during the particular season or particular conditions of a pole fire allowable equivalent salt deposit density have to be obtained from de-energized testing of energized from the insulators or from energized insulators this gives back accumulation level that I equivalent salt deposited density.

Degree of scintillation partial arching and during fog wet or weather conditions complains about radio television or interphase RIV or television interference which cause during that period or during at that location. Proximity and exposure to the pollution source how far the transmission system is available to the pollution source could be as mentioned in industry or right could be sea coast where slat spread on the surface where could be that dust contamination ice loading or cement or any of the source how far is the proximity that is also an important information.

The type of contaminant and the rate of buildup of the insulators so type of again various contaminants which we have discussed and how the rate it is going to build up on the insulator surface is also an important aspect to be considered. Weather conditions so weather condition it should be noted that danger of flash over and pole fires is particular great after a long dry period either a winter or summer which is followed by light drizzle or fog conditions.

Then the sensor insulators that indicates so several of this information have to be considered for the frequency of cleaning insulation methods.

(Refer Slide Time: 49:39)



The method used for insulator cleaning in dependent material construction whether or not the line is energized and the type of contaminant to be removed. Energized condition again here high pressure water jets are generally employer for washing this utilize narrow stream of water with typical pressure ranging from 2750 kilopascals to 7000 kilopascals that is 400 PSI to 2000 PSI at the nozzle.

Four types of nozzle are most important which are often used with high pressure water and the energized condition that is the live line maintenance which is termed by utilities or the utility personal they normally employed held jets of nozzles. Remote control jets fixed spray type of arrangements and helicopter mounted nozzle jet arrangements. So these are all the types of nozzles and the various pressure which being adopted during the energized or condition that is the live line maintenance conditions.

(Refer Slide Time: 51:11)

Table 2—Fixed nozzle washing equipment and usage

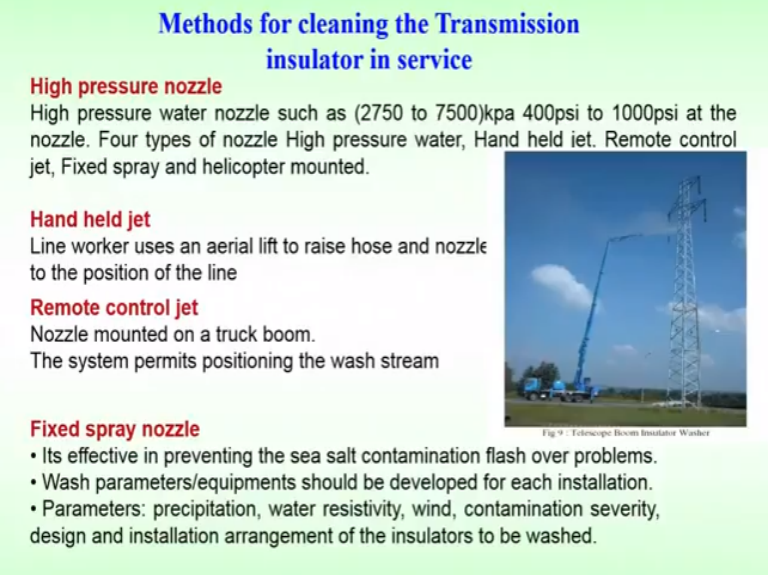
Type of nozzle	Spray
Number of nozzles	Multiple
Water pressure	350 kPa to 3000 kPa (50 psi to 430 psi)
Nozzle installation	Permanently installed on steel structure
Wash control	Fixed
Washing coverage	Water envelopes and swamps insulator in one surge
Operation	Eliminates both climbing and special skill requirements for washing
Application	Suitable in areas where washing is frequent (at least once a month) and where tower or station structures are very high
Other features	Piping to nozzle is required for each insulator assembly. Water usually controlled automatically.
Disadvantage	Affected by wind

So one of the fixed nozzle washing equipment and usage here you see the table which clearly mentioned about the type of nozzle and the spray method to be employed here you can see the number of nozzles it could be multiple water pressure prescribe for the live line washing could be 350 kilopascals to 3000 kilopascals that is 50 PSI to 430 PSI nozzle installation it could be permanently installed in structures as this washing is done at regular frequency wash control it is fixed washing coverage is envelopes and swamps insulators in one surge.

Operation this eliminates both climbing and special skill requirement for washing application it is suitably areas where washing is frequent to be done once a month and where tower or station structure are very high. So this comes in handy where regular maintenance to be made to be carried out. So other important features are piping to the nozzle is a required for each insulator assembly.

So water usually controlled automatically so main disadvantage is again effected by wind this method in case of wind conditions during the usage could be disturbed for regular washing. So wind could play a disadvantage for the washing conditions.

(Refer Slide Time: 52:56)



So methods for cleaning transmission insulators we did discuss about various type of arrangements and methods. So high pressure nozzle we discussed about the high pressure such as 2750 to 7000 pascals that 4000 PSI to 2000 PSI at the nozzle. These four types which mentioned earlier are hand held or remote control or fixed or helicopter mounted to handle held jets.

In general the line workers uses an Arial list to raise a hose and nozzle to the position to the line remote control again nozzles a mounted on truck similar to here the truck arrangement there is boomer here in the nozzle jet through the nozzle the spray is done to the insulator and insulators are cleaned. This is how the remote control of jet is generally done using a truck arrangement the system generally permits positioning the wash system.

So it could properly planned and insulators in either in tension or in suspension type of arrangements. Fixed spray nozzles here this is effective to mainly in preventing the sea salt contamination and flash over problems. Here wash parameter or equipment so should be developed for easy installation parameter like precipitation water resistivity wind contamination severity design and insulation arrangements of the insulators to be washed.

So all this are of important and several technique are being followed for the water pressure and the nozzle sets.

(Refer Slide Time: 54:51)

Table 4—Minimum distance for energized washing[3]

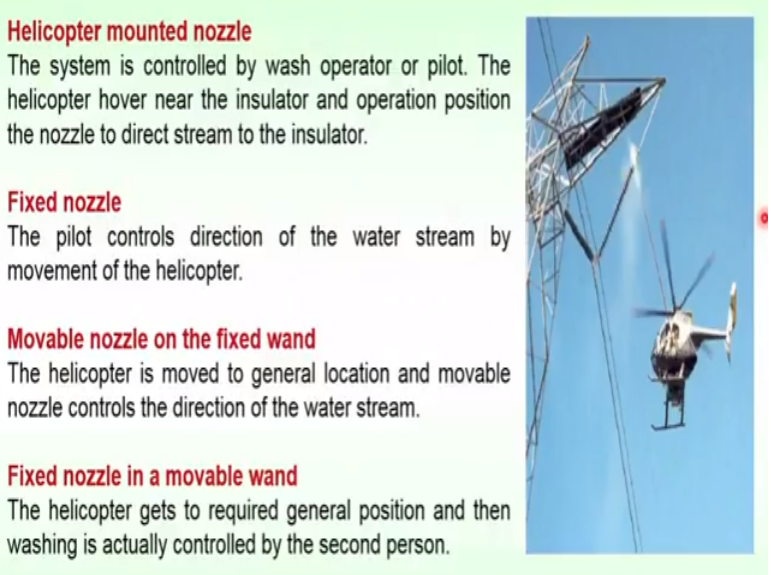
Line voltage	Minimum nozzle-to-conductor distance	Minimum water resistivity	Minimum nozzle pressure	Maximum orifice diameter
(kV)	(m)	(Ω·cm)	(kPa)	(mm)
13 & below	1.82	1300	2758	4.76
13 & below	1.82	1300	2758	6.35
16	2.13	1300	2758	4.76
34.5	2.44	1300	2758	6.35
34.5	2.44	1300	2758	4.76
69	2.74	1300	2758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

So what is minimum distance for live line washing important information to be safely precautions ah for the personal to be taken care and the minimum distance to be maintained while energized or a live line washing so this table gives you a line voltages the minimal nozzle to conduct distance minimum water activity minimum nozzle pressure and or the minimum or phase diameter.

So voltage levels are discussed here so 13 KV and below the minimum nozzle diameter is 1.82 meters minimum waster resistivity employed to be is 1300 ohm centimeter minimum nozzle pressure is 2758 kilopascals and maximum phase diameter of the nozzle to be 2.7 millimeter. So likewise voltage level increases ah the parameter of the nozzle to diameter distance the minimum water resistivity remains the minimum nozzle pressure remains same and the minimum (()) (56:12) diameter changes to extent depending upon the voltage level and the spray which is being done.

So this table is available in the methods for cleaning of insulators 957 further reading is can be made and the tables can handy for the utility personal now regularly maintaining and using this methods particular using energized or live line conditions.

(Refer Slide Time: 56:46)



The next s the helicopter mounted nozzle sets which we have discussed here the system is generally controlled by the wash operator or a pilot in the helicopter this helicopter porous near the insulator spray you can see the insulator string here the helicopter hose very near to that at a particular distance and the operation of the nozzles or the position of the nozzles is adjusted with insulator string so that the proper cleaning or nozzle is spray of the nozzles is directed to the insulator stream in directed stream to the insulator the cleaning.

Here again you have a fixed nozzle type of arrangement where the pilot controls the direction of the water stream to the insulator a moment by the helicopter hen movable nozzle on a fixed band here again the helicopter move to a general location and movable nozzle control the direction of the water strain. The whether is the fixed nozzle in a moveable van here the helicopter gets to the required control position and then washing is actually controlled by other second person apart from the pilot.

So various arrangements are also being done by the helicopter mounted nozzle sets for cleaning the insulators EHP and UHP transmission systems this is also being employed country for maintenance and cleaning of the insulators.

(Refer Slide Time: 58:29)

These are again some of the cleaning methods which are again being used by the helicopter jets you can see the insulator strings these are the horizontal or detention or insulator strings which are being washed by the helicopter jets this is one more arrangements where helicopter the personal from the helicopter that is apart from the pilot is using the wager jet for cleaning the insulators.

So several arrangement are being done for cleaning the insulators it could be fixed type or pilot controlled or the personal second or controls the spray and directs the spray to the insulator and proper cleaning. So several of this methods are being used presently for the live line maintenance some condition and also serve the de-energized conditions in case of the cleaning.

This are very important are mentioned proper maintenance at the monsoon and before the monsoon conditions is very necessary else or could be flash over or tripping of the system which can cause serious threat to the operation of the power system so maintenance cleaning aspects are being part. So thank you we stop here we discuss about the de-energized conditions further.