Session: HT Distribution Network

Learning Objective	Evaluation Criteria
Explain the HT distribution network breakdown maintenance - possible faults, identification and rectification	Interactive Questioning

	Duration	90 Minutes
	Resources	PowerPoint Presentation, Whiteboard, Markers, Screen and Projector
	Facilitator's Notes	In this session, you will take the participants through an interactive presentation with video snippets on the HT distribution network breakdown maintenance, the possible faults, identification and rectification.

End of Notes

		1.	**Tell:** Welcome to the video presentation on 'HT distribution network breakdown maintenance - possible faults, identification and rectification." Here, we will learn how the HT distribution network is maintained from sub-transmission, that is, from 66 kV lines to 11 kV.
			Facilitator's Notes: • Display the slide • Read out the objectives and ask learners to note them • Inform them that they will be asked questions during the session **End of Notes**
		2.	**Tell:** By the end of this session, you will be able to explain the HT distribution network breakdown maintenance - possible faults, identification and rectification.
		3.	**Tell:** Sub-transmission network comprises 66kV, 33 kV and 11kV networks in a distribution company. **Facilitator's Notes:**

			Click to play the video.
		4.	**Tell:** The main causes for faults in HT distribution network are over current, over voltage, external agency, accident, natural disasters like storm, cyclone, rain, dew, snow and so on. **Facilitator's Notes:** Continue to play the video.
		5.	**Tell:** The faults in HT system network can be classified in four components. They are transformer, switchgears, underground lines or overhead lines. **Facilitator's Notes:** Continue to play the video.
		6.	**Tell:** Let us first discuss transformer. This is power transformer, which converts 33 kV and 66 kV line into 11 kV. The 11 kV line is further distributed to feed the area with 11 kV distribution and connected with 11 kV distribution transformers or DT. **Facilitator's Notes:** Click to play the video.
		7.	**Tell:** Let us look at all the components and accessories of a transformer. This is 11 kV, 250 KVA Distribution Transformer installed outdoors in the substation yard. **Facilitator's Notes:** Continue to play the video.
		8.	**Tell:** Let us see the common breakdowns that occur in transformers. A tree has fallen on the plinth mount transformer and physically damaged the HT bushings, jumpers and so on. A cat is trapped on live wires and is electrocuted. **Facilitator's Notes:** Click to play the video.
		9.	**Tell:** HT bushings are made of porcelain. They are brittle and are commonly damaged due to exposure and variations in temperature as shown. **Facilitator's Notes:** Continue to play the video.

		10.	**Tell:** Here you can notice that the damaged HT bushings are replaced with the new ones. **Facilitator's Notes:** Continue to play the video.
		11.	**Tell:** Let us now discuss cases of oil leakage from various points of transformer. **Facilitator's Notes:** Continue to play the video.
		12.	**Tell:** Here, you can see cases of oil leakage from valve before and after. **Facilitator's Notes:** Click to play the video.
		13.	**Tell:** Here, you can see leakage from tap changer before and after. **Facilitator's Notes:** Continue to play the video.
		14.	**Tell:** Oil leakage cannot be stopped by M-Seal on sockets due to variation of oil temperature. Always replace the socket plugs as shown. **Facilitator's Notes:** Continue to play the video.
		15.	**Tell:** On similar lines, the gaskets used to plug oil leakage deteriorate with time due to UV effect. They require periodical replacement. The images of before and after replacement are shown. **Facilitator's Notes:** Continue to play the video.
		16.	**Tell:** Here, you can see that the gasket has been replaced at LT bushing. **Facilitator's Notes:** Continue to play the video.
		17.	**Tell:** Here, you can see that the gasket has been replaced at oil level indicator. **Facilitator's Note:** Click to play the video.

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	18.	**Tell:** The replaced gasket at oil level indicator is seen here. **Facilitator's Notes:** Continue to play the video.
	19.	**Tell:** Here you can see that the gasket has been replaced at HT bushing collar. These are the cases of oil leakage from various points of transformer. **Facilitator's Notes:** Continue to play the video.
	20.	**Tell:** Let us now learn about identification of defects in transformers and their remedies. **Facilitator's Notes:** Click to play the video.
	21.	**Tell:** Check bushings for cracks, chippings, over heating marks, flashover marks and replace the affected bushing. For oil leakage, use tight oil seal caps and gaskets. Don't apply M-Seal on HV/LV bushing to stop oil leakage as this may cause flashover. **Facilitator's Notes:** Continue to play the video.
	22.	**Tell:** Oil leakage from top plate can be addressed by tightening nuts and bolts diagonally. Replace gasket, if required. Pink silica gel should be replaced by blue silica gel. After filling silica gel, the breather should be tightened properly. **Facilitator's Notes:** Continue to play the video.
	23.	**Tell:** Due to improper coupling of breather bottle and flange, breathing points may be formed, thereby, creating a passage for moisture. This leads to condensation and rusting of the conservator tank from inside. **Facilitator's Notes:** Continue to play the video.
	24.	**Tell:** Check the diaphragm. If it is torn, replace it by a new one. Check the IR value of the DT HT to LT, HT to earth and LT to earth. Minimum value should be 50 MΩ. Let us see the faults that occur in HT switchgears. Switchgears occasionally flash or

			burst due to short circuit current. This carbonises its terminals or bus chamber causing delay in tripping mechanism. **Facilitator's Notes:** Continue to play the video.
		**25.**	**Tell:** Flash in RMU cable chamber. Complete chamber becomes carbonised. The OCB tripped and flash has occurred at its cable termination due to short circuit in outgoing cable. Faulty cable is disconnected from switchgear. Let us now learn about types of faults in yard, switchgear and their maintenance in detail. Switchgears commonly used are OCB, Vacuum and SF-6. **Facilitator's Notes:** Click to play the video.
		**26.**	**Tell:** Here, you can see the healthy state of outdoor RMU having two isolators on the sides of circuit breaker. **Facilitator's Notes:** Click to play the video.
		**27.**	**Tell:** You can notice the hotspot at palmtop conductor's bus bar. **Facilitator's Notes:** Continue to play the video.
		**28.**	**Tell:** You can notice the hotspot at circuit breaker connection. **Facilitator's Notes:** Continue to play the video.
		**29.**	**Tell:** You can notice the hotspot at joints. **Facilitator's Notes:** Continue to play the video.
		**30.**	**Tell:** This is the control and relay panel for 33kV switchyard. You can also notice the 11-kV switchgear panel. **Facilitator's Notes:** Continue to play the video.
		**31.**	**Tell:** Here you can see the 33 kV Circuit Breaker and 11-kV Vacuum Circuit Breaker. Let us now look at the factors that affect switchgear life. **Facilitator's Notes:**

			Click to play the video.
		32.	**Tell:** Factors that affect switchgear life are as follows: **Pollution:** It mainly affects the insulation properties of insulators along with deterioration of metallic parts (Corrosion of the equipment installed in industrial areas or near drains, which generate acidic fumes). **Climate:** It also affects the insulation of the equipment if the equipment is installed in humid conditions. (Major impact will be on insulators if space heaters are not ON.) **Loading of Equipment:** If equipment is loaded within safe loading conditions, it will have good life. If equipment is underloaded or overloaded, the life of equipment deteriorates. **Maintenance Practices:** Maintenance practices play a crucial role in determining the life of equipment. On one side, good maintenance practices enhance the lifespan of equipment. On the other side, improper maintenance practices deteriorate the equipment lifespan. **Facilitator's Notes:** Click to play the video.
		33.	**Tell:** Let us now discuss 'Thermal Imaging'. In this technique, a thermal imaging camera is used. Thermal cameras detect the changes in heat in the area to which they are pointed. The device can use these variations in heat to build a picture on a screen. These devices are fast becoming an essential tool for preventative maintenance work. This is because they show where heat is leaking from pipes or where electrical equipment is giving off more heat than it should. For example, in the case of using a thermal imaging camera for circuit breakers, the technician would point the device at all the circuit breakers. If the resulting image on the screen suggests that a high amount of heat is being generated from a specific breaker, then it may indicate that there is some damage. The cost for replacing the breaker at this point will be small. However, if the issue is left unaddressed for an extended period, it will lead to major damage of equipment; thereby costs will increase. **Facilitator's Notes:** Click to play the video.
		34.	**Tell:** RMU is Ring Main Unit, which has 2 LBS or load break switches and 2 circuit breakers. **Facilitator's Notes:** Click to play the video.
		35.	**Tell:** This is RMU or Ring Main Unit, which has 2 LBS or load break switches and 2 circuit breakers. Displayed here are the SF6 circuit breakers. The Voltage Presence Indicator System (VPIS) gives an indication if the bus bar is charged. **Facilitator's Notes:**

			Continue to play the video.
		36.	**Tell:** There will be many faults in HT network of any power distribution company as it is always big. Faults in underground cables are major challenge for a utility like TPPDL. Cable faults have become very common as many civic agencies work for development projects. **Facilitator's Notes:** Click to play the video.
		37.	**Tell:** Let us look at the underground cable faults and their rectification. Here, you can see the fault locating van, instrument indicator and the instrument that pin points the cable fault. **Facilitator's Notes:** Continue to play the video.
		38.	**Tell:** Compact System is one of the latest technologies of self-contained cable testing system. **Facilitator's Notes:** Click to play the video.
		39.	**Tell:** It is a small instrument, which is relatively light and is a computer aided system. **Facilitator's Notes:** Click to play the video.
		40.	**Tell:** For exact pre-location, a new method is introduced, that is, Arm plus. It makes it easy for testing, adjusting surge voltages and time. **Facilitator's Notes:** Click to play the video.
		41.	**Tell:** There is now considerable preference for U/G cables over O/H lines. In metropolitan cities, it is not feasible to have transmission and distribution with O/H lines due to non-availability of land for constructing O/H lines. O/H lines mar the aesthetic value of a city's skyline. On the other hand, U/G system is preferred as it is unaffected by abnormal weather conditions, storms, tree falling, trees touching, snowfall and other objects. **Facilitator's Notes:**

			Click to play the video.
		42.	**Tell:** Displayed here are the causes for cable faults. **Facilitator's Notes:** Continue to play the video.
		43-44.	**Tell:** Let us now learn about testing of IR measurement and HVDC testing. **Facilitator's Notes:** Click to play the video.
		45.	**Tell:** Let us see the instruments in the FLC van and their functions for pinpointing of faults. **Facilitator's Notes:** Continue to play the video.
		46.	**Tell:** A 75mm (3-inch) sand bed is prepared below and above the cable joint. **Facilitator's Notes:** Click to play the video.
		47.	**Tell:** The common instruments used to identify faults in HT system are MEGGER (to test insulation), high pot (to test voltage sustainability of cable), thermo vision camera (to test hidden weak joints or links) and FLC van. **Facilitator's Notes:** Continue to play the video.
		48.	**Tell:** Let us look at a fault in ABC (Aerial Bunch Conductor) cable. **Facilitator's Notes:** Continue to play the video.
		49.	**Tell:** Let us look at the replacement of a faulty HT AB cable. **Facilitator's Notes:** Click to play the video.

		50.	**Tell:** Now let us look at overhead system faults and their rectification. HT overhead system is vulnerable to storms, cyclones, floods and heavy rains, especially in rural areas. This is because uprooting of trees is common in these areas. Hence, overhead networks are susceptible to line leakage in case of improper protection. Here are glimpses of such occurrences. **Facilitator's Notes:** Click to play the video. **Tell:** Here, you can notice the damaged HT lines due to tree fall.
		51.	**Tell:** Here, a PCC pole carrying HT ABC line is uprooted from ground and is leaning towards trees. It needs immediate replacement. This is because electric supply will be affected to the whole area. **Facilitator's Notes:** Click to play the video.
		52.	**Tell:** Here, you can notice that the uprooted pole is being replaced. **Facilitator's Notes:** Click to play the video.
		53.	**Tell:** Here, the lineman is removing the HT disc insulators. **Facilitator's Notes:** Click to play the video.
		54.	**Tell:** This is an HT overhead line going across the road of an industrial area with movement of heavy-duty vehicles. You can see that the height of the lowest conductor (earth guard wire) from ground is more than 5.8 metres as per CEA regulations. Further, the guard wires are firmly tight at both ends so that line conductors may not touch the ground. **Facilitator's Notes:** Click to play the video.
			Tell: In this video presentation, we have learnt how HT distribution network breakdowns occur, how the faults are identified, how they are rectified and details of instruments used for testing.

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		55.	**Tell:** Let us quickly recollect the key points of this session. • Sub-transmission network comprises 66kV, 33 kV and 11kV networks in a distribution company. • The faults in HT system network can be classified into transformer, switchgears, underground lines or overhead lines • Factors affecting switchgear life are pollution, climate, loading of equipment and maintenance practices • In thermal imaging, thermal cameras detect the changes in heat in the area to which they are pointed • RMU or Ring Main Unit has 2 LBS or load break switches and 2 circuit breakers • Fault Locating Vans (FLC) pinpoint the exact location of fault in underground cable • Compact System is one of the latest technologies of self-contained cable testing system • IR measurement is done by using MEGGER