Power System Protection and Switchgear
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Lecture 40
Testing, Commissioning and Maintenance of Relays-II

Okay, so let us continue our discussion on the Testing, Commissioning and Maintenance of Relays.

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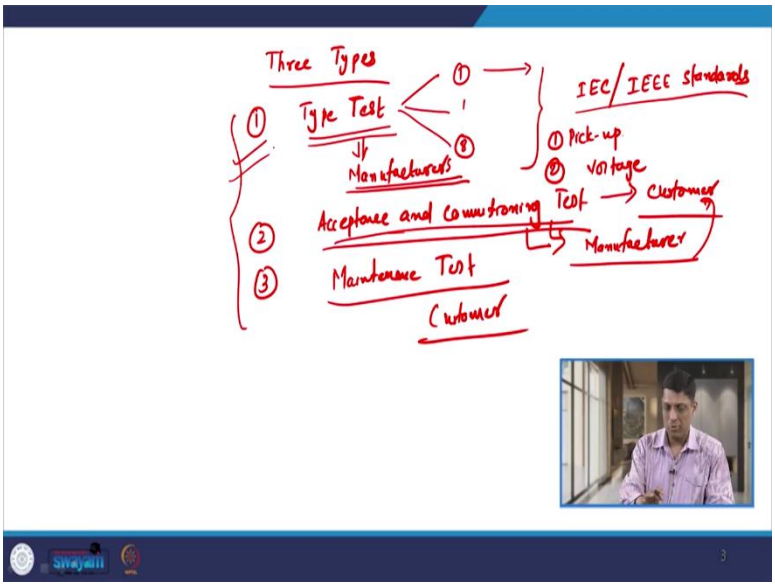

So, as we have discussed that there are basically three types of test that is to be carried out on the relay. So, the test are of three types, we have already discussed. The first type that is known as the type test. So, there are different types of type test to be carried out, that is from 1 to 8 and this, all this type test that is to be performed by the manufacturer itself. So, manufacturer has to perform all types of type test listing from 1 to 8 as we have already discussed at their own premises. So, all manufacturers they will carry out the testing of protective device or relay and this test are based on certain IEC or IEEE standards.

So, if some limits are given off current or voltage pickup variation in current, or maybe the voltage variation, so all this that is performed based on this. The second type of the test that is known as the second and third. The second type of test that is known as the acceptance and commissioning test.

Acceptance and commissioning test, this test that is performed at the customer premises. So, whenever the protective device or relay is available and that is installed at the customer premises, then before installing this test that is to be performed, and this test that is to be

performed again by the manufacturer only but at the customer premises that is very important.

And the third type that is the routine maintenance test, that is the maintenance test that is to be performed by the customer. So, that is the periodic test just to check whether the device which is installed that is working properly or not. So, these are the main three types of tests. We have already discussed the different types of type tests that is to be performed by manufacturer.

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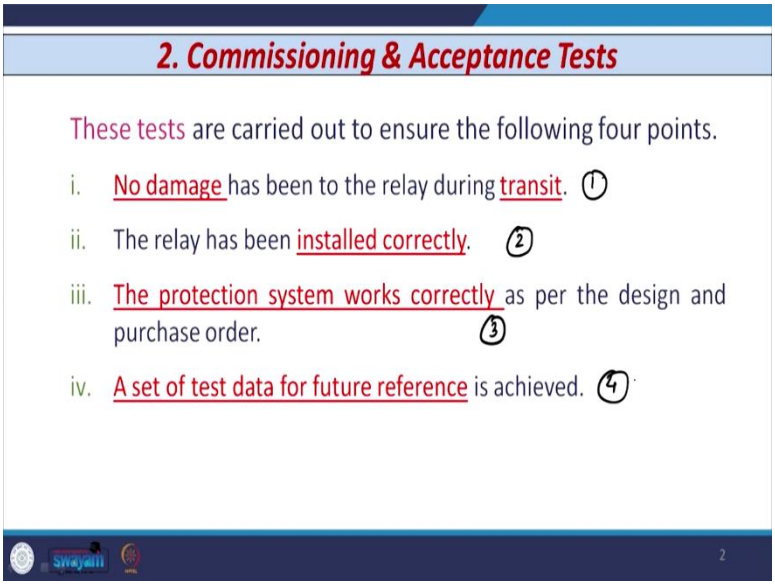

So, let us start with the second type that is the commissioning and acceptance test. Now, as I told you, this test that is to be performed at the time of installation of protective device. So, the main reason to perform the commissioning and acceptance test that is the first reason is, whenever we procure the protective device and that device wherever that is sent by the manufacturer at the customer location, then we need to ensure that no damage that should occur for the, on the protective device during the transit.

So, this is very important as far as the protective device is concerned. So, this is very important that whenever we send the protective device through any means, then the device should not be damaged. The second reason why we need to carry out the commissioning and acceptance test, that is we need to install the protective device correctly without any problem without any damage. Whatever functionality of the protective device that is mentioned in the catalog or the purchase order by the manufacturer, those all functionalities we need to test when we install at the customer location.

The third point which is very important, that is the protection system should work perfectly as per design specification and the purchase order. So, as I told you, all the functions available or mentioned in the protective device that need to be tested and performed and then the satisfactory testing of the device, that type of certificate that is also taken from the manufacturer.

And the last one, that is if we need to generate some data for future work, say for when we test the protective device on certain functions and we also get some data, so those data we can use for further work in the future.

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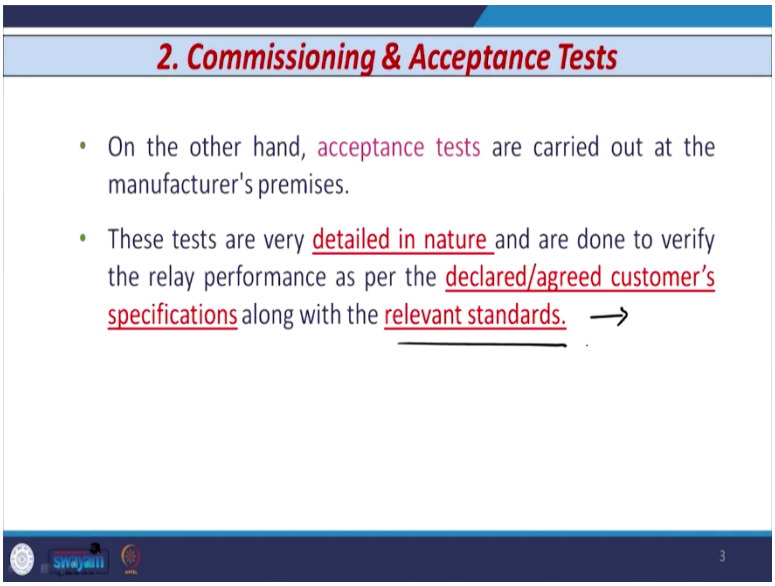

So, the acceptance tests are carried out at the manufacturer premises, whereas the commissioning test that is to be performed at the customer premises. So, this test are detailed in nature and that has to be done at the customer's premises and whenever you carry out this test, you will need to carry out this test as per the agreed or declared specification that is mentioned in the purchase order by the customer. And as I told you, this is to be carried out based on these certain IEEE or IEC standard.

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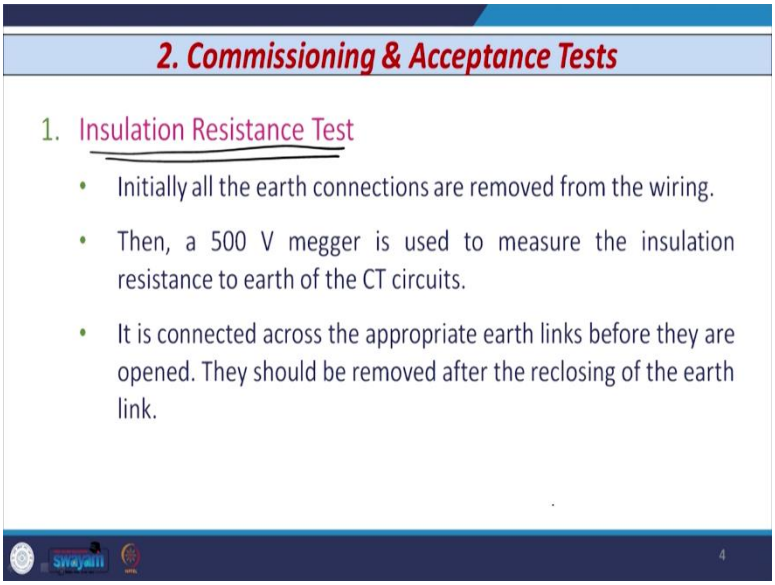

So, let us see what are the different tests that is to be performed. The first test that is known as the insulation resistance test. So, initially when we carry out this test on the protective devices, all the earth connections are removed from the wiring, then using megger 500 volt or 1,000-volt megger that is used to measure the insulation resistance to the earth of the current transformer circuit. So, this is connected across the appropriate earth link before they are opened and they should be removed after reclosing the earth link. So, this is how you can perform and you can measure the insulation resistance in this case.

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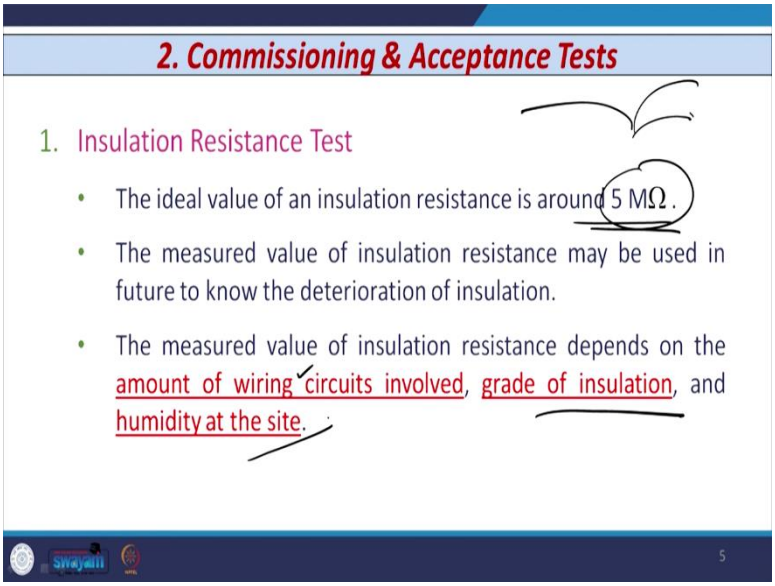

Now, when you measure the insulation resistance using the insulation resistance test, the ideal value of the insulation resistance that is around five mega ohm. So, the measured value

of insulation resistance that can be used in future to do the, what is the deterioration because the same test when you perform on the same device maybe after two years, then you are not going to get the same value of insulation resistance.

So, it maybe possible that after 2 years or after 4 years or after 6 years, this value changes. So, you need to find out what is the deterioration or reduction of the performance of the device as far as the insulation resistance value is concerned, so that you can note down. One more thing is that, the measured value of insulation resistance depends on many parameters.

For example, it depends on the wiring circuit, what type of wiring circuit you have used, what type of insulation class or grade of insulation you have used and what is the humidity where you need to install the protective device. If you installed in dry condition, then the insulation resistance is different and if you install in some hilly areas or in some other plain areas, then the insulation resistance that is different. So, that depends on the humidity at particular location.

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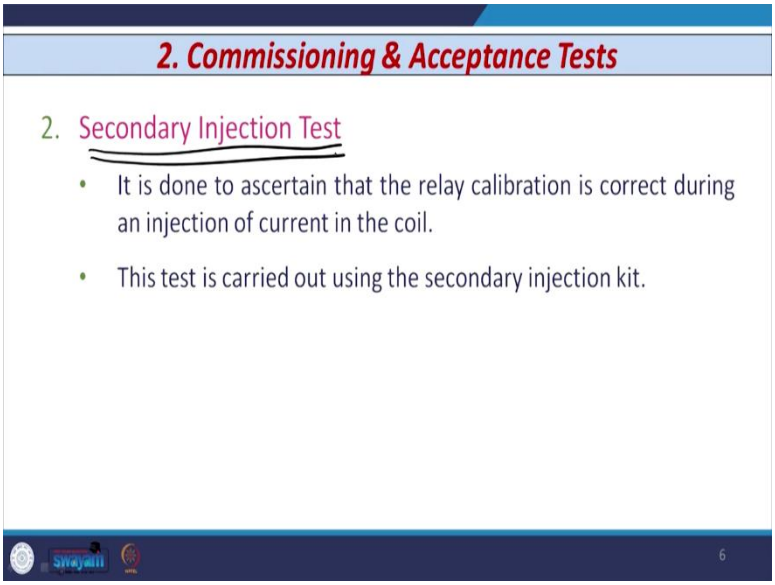

The second type of test that is to be performed that is known as the secondary injection test. So, this type of test that is carried out to ensure that the relay calibration is connect during the injection of current into the current coil. So, when you inject some current into the current coil of the relay, then you need to ensure that whatever injection is carried out that is correct. So, this test that is carried out using some device to the secondary injection test kit.

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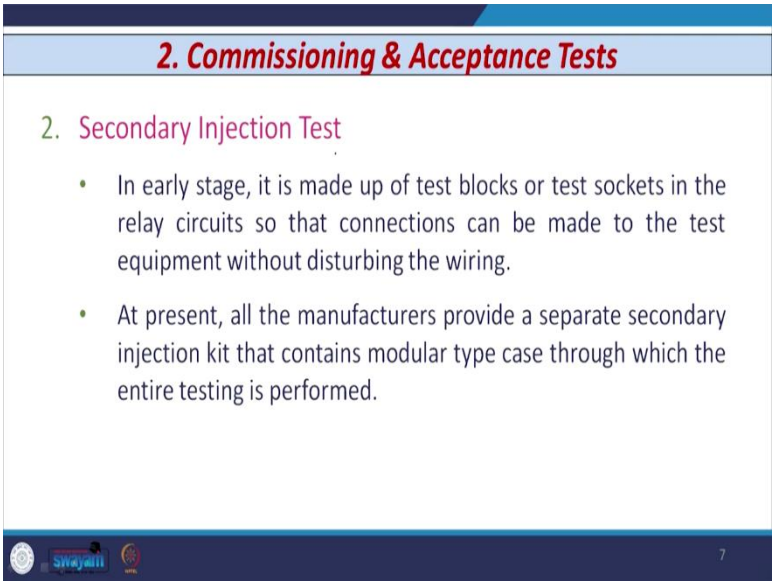

So, in early stage, several manufacturers, those manufacturers provide some tests block or test socket to carry out the secondary injection test of the protective device. So now a days, the separate secondary injection test kit that is available or that is given or provided by different manufacturers, so one can purchase it and you can just carry out the secondary injection test at the protective device.

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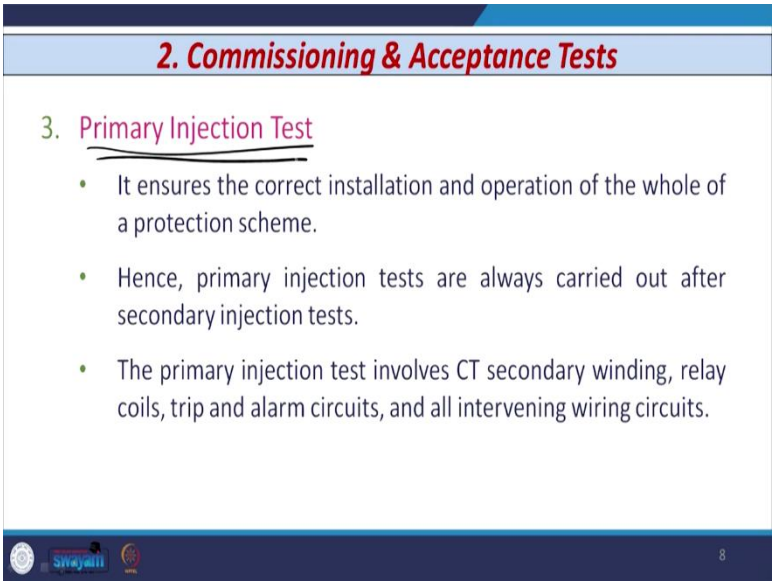

The third test that is known as the primary injection test. So, this type of test that is performed or carried out to ensure the connect installation and operation of the whole protective system or scheme. So, the primary injection test are always carried out after the secondary injection test. So, primary ejection test involves the secondary of CT, the coil of the relay, the trip and

alarm circuit and all the intertwining wiring circuit that is involved in the primary injection test.

So, this type of test is usually carried out with portable injection transformer. So, some transformer is there in order to inject the current in the coil of the relay or secondary side of the CT. So, you need some transformer, and it uses the local main supply that possesses several low voltage high current winding.

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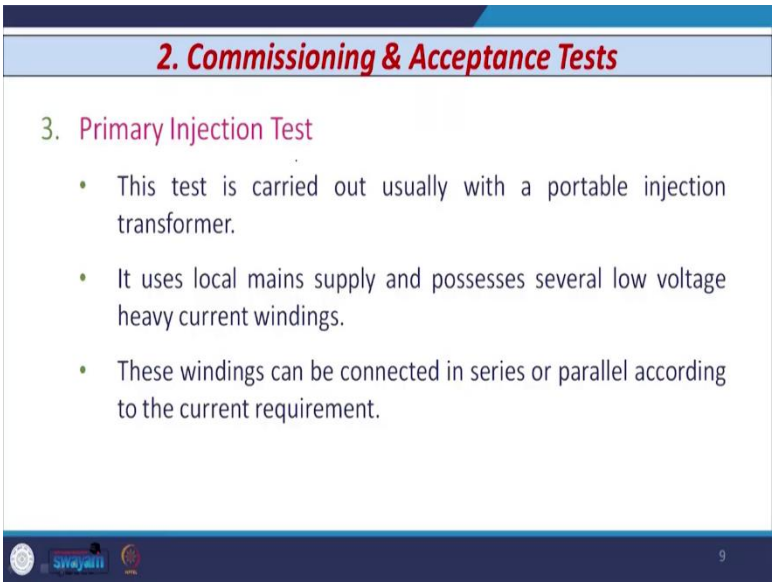

Now, when you carry out such type of test, one very important point is that how to perform this primary injection test kit.

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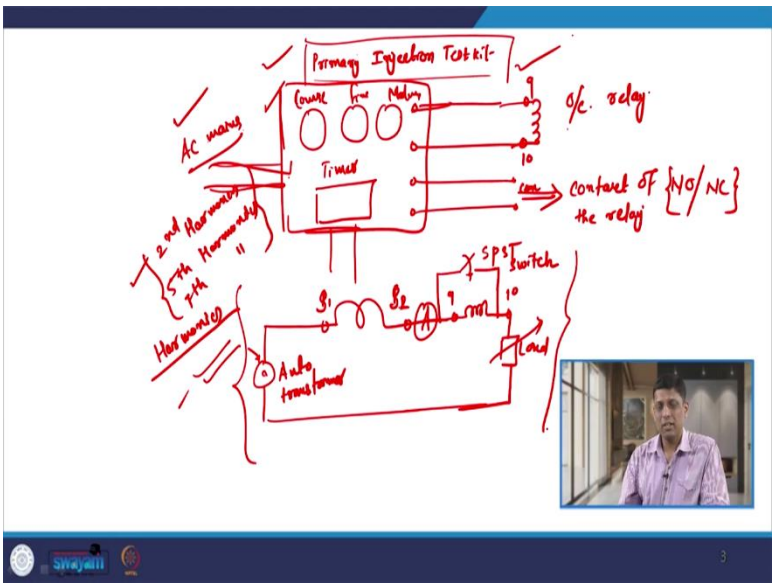

So, what they do is, you connect the primary injection test kit so it is available like this. Let us say this is your primary injection test kit. So, from that you need to give the supply to the coil of the relay, so relay coil, that is connected here, let us say the number is 9 and 10 for over current relay, so we need to connect it to the relay coil.

From here you need to also connect the two wires to the contact of the relay. So, contact of the relay. So, you can use either normally open contact or you can use the normally closed contact of the relay so that you have to give to the contact of the relay. So, that is given here. Inside this, you have three dials that is available, one is course, fine and medium dial, that is just to adjust the current and you do have the of course, the supply is there, AC mains.

And you do have along with this, you do have some device timer. So, this timer contact also you need to give. So, this is how the primary injection test kit look. Now, how to test it? So, what is done is that you have a say primary of CT, this is your CT primary terminal and you have the secondary, so I am just writing directly the secondary terminal. You have the primary as well as you have the secondary also so I am just writing secondary only.

So, the relay is connected across CT secondary. And this you need to connect it to the supply and then you have the coil of the relay, let us say this is the coil of the relay 9 and 10, and that is to be connected with some load, will be variable load. And you need to adjust, so across this let us connect one switch, simple single pole single throw switch. So, whenever you need to adjust it, you close the switch, so you can adjust the current, you can use some ammeter also here in series, so you can adjust the current.

Once you have adjusted the current, this is your autotransformer. So, you can adjust the current by closing this switch and then, wherever you have adjusted the current, you have to open it and at that time, you need to just note down the time till the relay contact closes. Same thing that is done or carried out by the primary injection test kit, that as soon as using course, fine and medium dial you can adjust the current and the timer will measure the time. So, different inputs you need to give.

Now, what is the difference between this and this type of? If I his is just, we use some devices like autotransformer and the ammeter and all that in the lab and you can just test the relay, you can note down the time and you can verify with the time given on the nameplate of the relay. Now, if you do this, there are fair chances of harmonics, here because the supply, you have taken from the autotransformer so input of the auto you are taking from the mains.

Whereas if you use the device like primary injection test kit which is given by some manufacturers, standard manufacturer, then though this receives the supply from the mains, the inside circuit is such that they are capable to filter out the harmonics. So, the second harmonic and the fifth harmonic and up to say seventh harmonic, it is this key it is capable to filter out this harmonic, so this harmonic that would not be injected and there is no effect on the performance of the relay when you check the current.

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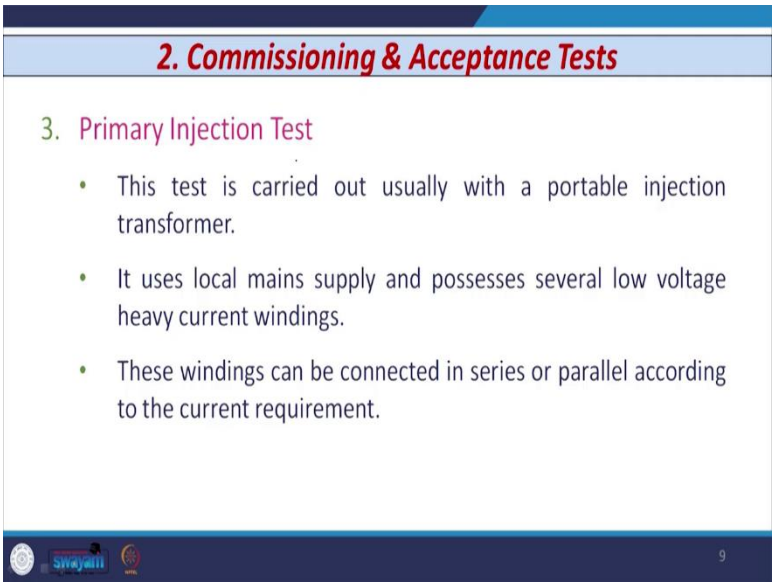

So, this is the main difference between this two, that is why normally in actual field, utility prefers this type of primary injection test kit just to ensure that whenever the testing is carried out, no harmonics that should be included that is one thing. So, when you carry out the test, using portable injection test kit, so you need to give some supply, and the windings of the transformers that is there inside the kit.

So, these windings that can be connected either in series or in parallel if you connect in series, the current magnitude is some x value, if you connect in parallel, then magnitude affects that increases. So just to, if you want to inject more current, because as I told you earlier in type test, you need to test the coil of the relay by injecting 20 times current on the primary and equivalently on the secondary side. So, same thing you can carry out using the primary injection test kit.

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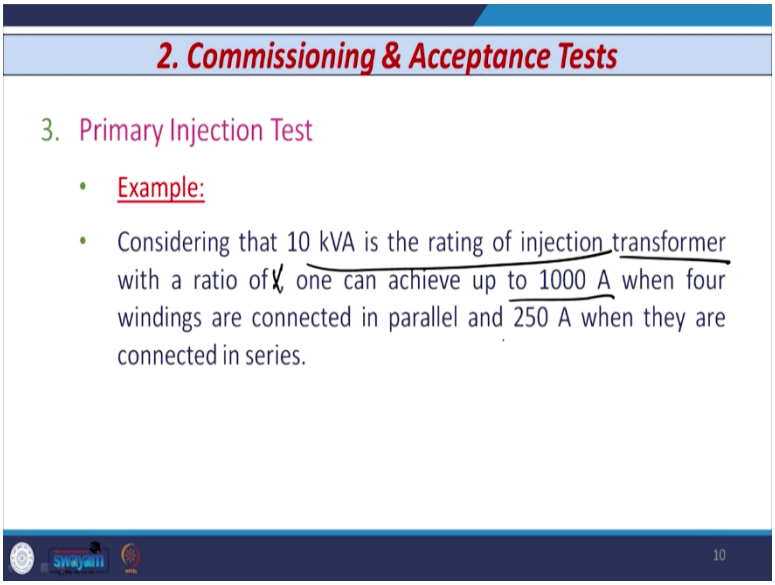

So, for example, if I consider the 10 kVA injection transformer with some ratio let us say x, then if you connect the winding that is available inside the transformer, this transformer, all the windings are in series then the current that would be maybe some value and if you connect in parallel, then the same, the other value of current you can inject it. So, it depends on what value of current you need to inject in the coil of the relay depending upon that, you can adjust this value at this type of settings that is already given in the primary injection test kit.

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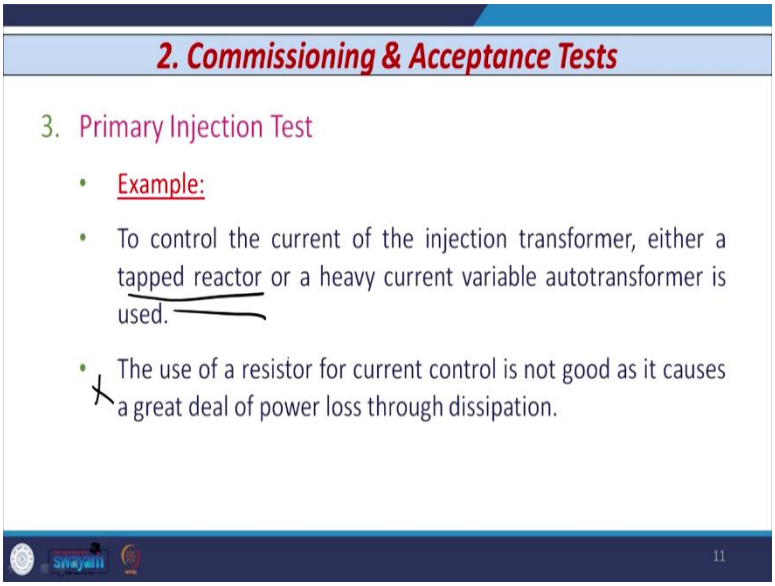

Now, to control the injection transformer, you normally boost up the primary injection test kit, they use the tap reactor, maybe sometimes heavy current variable autotransformer is also

used, but most of the time they use the tap reactor. Resistor that is not used, because if you use it then there can be a power loss through dissipation. So, to avoid that, the register that is not used instead of that tap reactor that is used in the injection transformer to inject the current into the coil of the relay.

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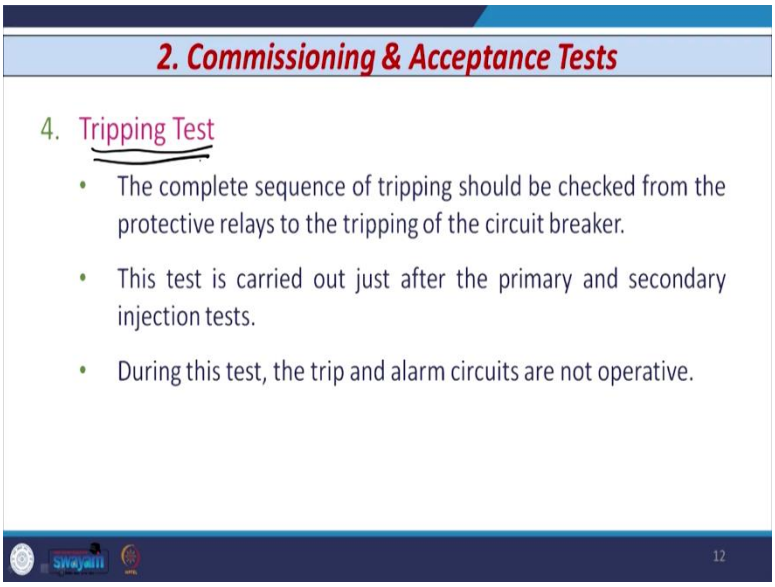

The fourth type of test that is known as the tripping test. So, the complete sequence tripping that should be checked from the protective relay to the tripping on the circuit breaker. And so, this test is just to carry out and to confirm that the primary and secondary injection test that is working properly and during this test, any trip or alarm circuit that need to be checked.

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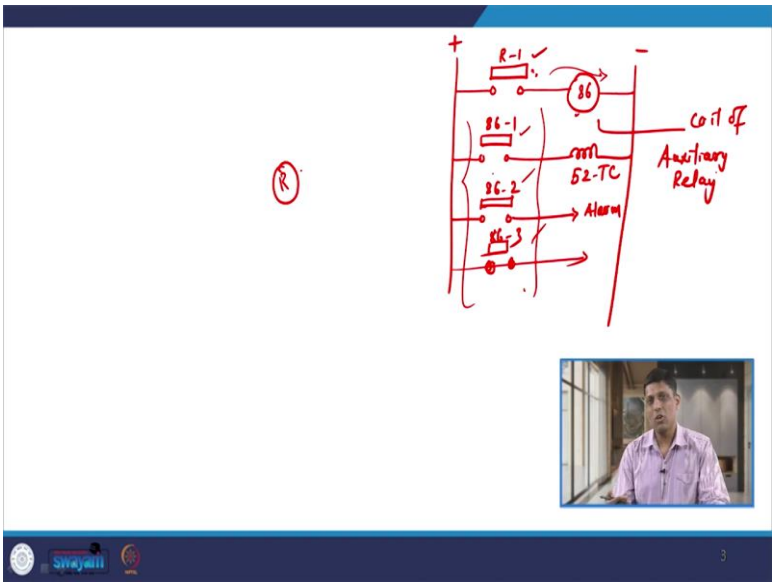

So, if I just tell you in this tripping test, what you do is whenever you have the control circuit like this. So, the contact of the relay that is your protective device, that is available here that is connected. So, this is the contact of the relay and the contact of the relay that is connected to the coil of the auxiliary relay that is 86.

So, this is your coil of auxiliary relay. And the contact of this 86 that is connected to the, this is 86-1 let us say, that is connected to the trip coil of circuit breaker, that is 52-TC. Along with this other contact of 86, that is also available or you can use it, maybe for say alarm purpose or maybe for some other purpose if you wish, you can use some other contact also of 86-3 like this, so that can be used.

So, when you use just carry out the tripping test, you need to ensure that the relay has to give tripping command to the contact. The contact of the relay must trip, it has to give the, energize the coil of the auxiliary relay and contact of the auxiliary relay all the contacts whatever you have used in the control circuit, they have to change their state if they are normally open then they become close, if they are normally closed they become open. So, that type of complete checking of tripping circuit that is required when you go for the tripping test.

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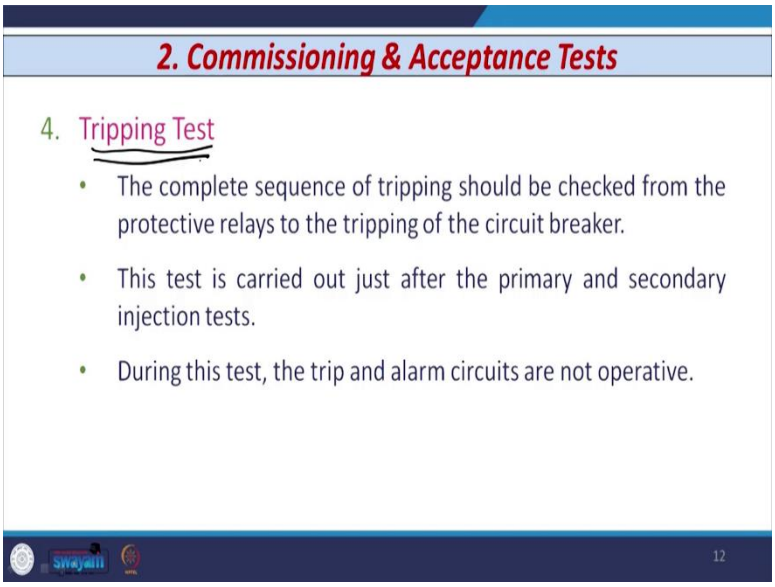

Now, during this state, as I told you the trip and alarm circuit that is also you need to check.

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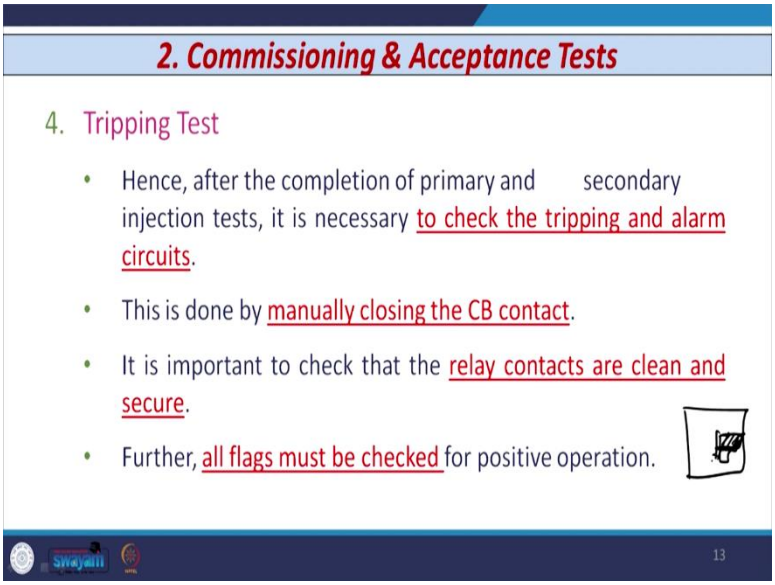

Hence after the completion of the primary and secondary injection test, the checking of alarm and the other enunciation circuit or VB have had alarm in form of voice that is also to be carried out or checked. So, this is normally carried out by manual closing of the contact of circuit breaker. So, it is important to check that the relay contacts are very clean and secure, so that is why the relay has to operate.

And at the same time, you need to check all the flags of the relay because you know that what is flag. Flag means along with any relay, if you just look you say on the relay, there is a contact with red color flag like this and one nob is given. So, wherever relay operates, this nob that comes on lower side, the red indication is available so you have to change this flag, so, this type of flag is provided in substation by the utility just to do that, something that has happened and operator can take the proper action by looking the position of the flat. So, that is very important.

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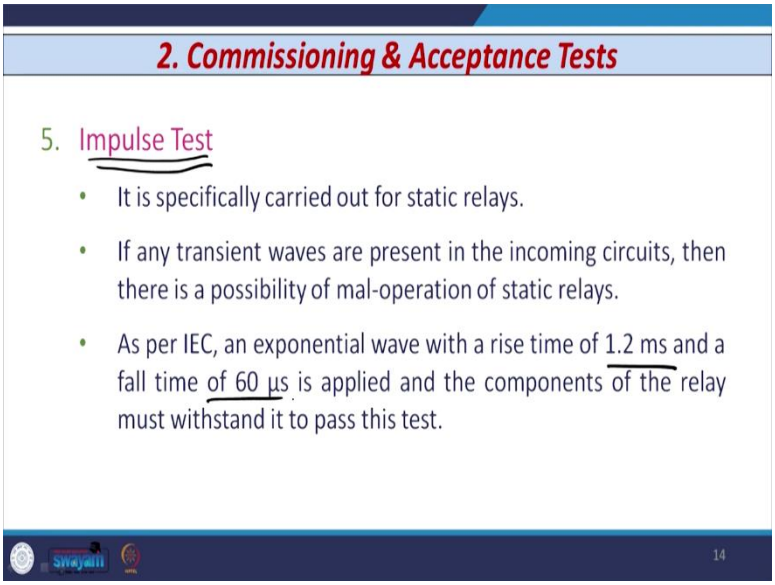

The fifth type of test that is to be performed that is known as impulse test. So, this is a special type of test to be carried out on static relays that is not performed on electromechanical relays. So, if any transient waves are present in the incoming circuit, then there is a possibility of mal-operation of relay. So, to avoid that, such type of test is carried out.

So, in this case, the exponential wave with a time for 1.2 milliseconds and fall time of 60 microseconds that is applied. So, for that you need to you need some impulse generator to generate such type of wave and then the components of the relay has to withstand this type of way. Once it is withstand by all the components of relay that means the relay is correct and it has passed the impulse test. So, this is very important.

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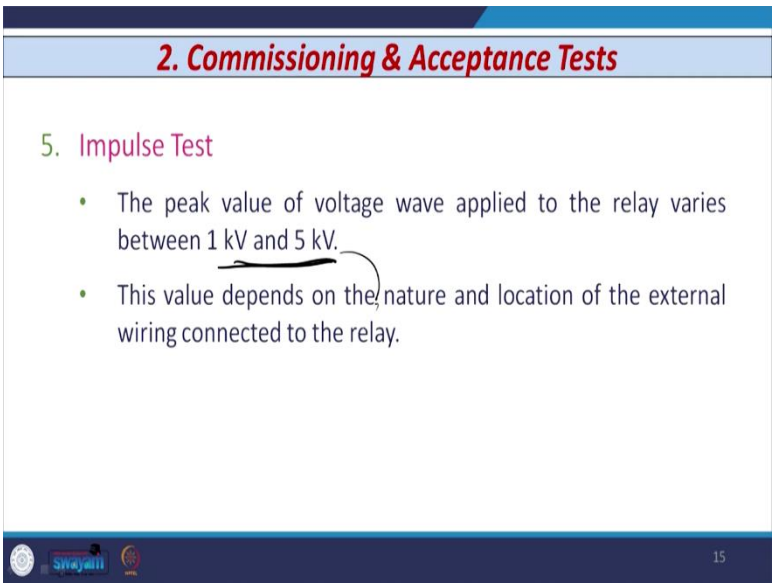

The peak value of voltage were applied that is, can vary from 1 kV to 5 kV and the value depends on nature and location of external wiring connected to the relay. So, this is also depend how this value varies that depends on this conditions.

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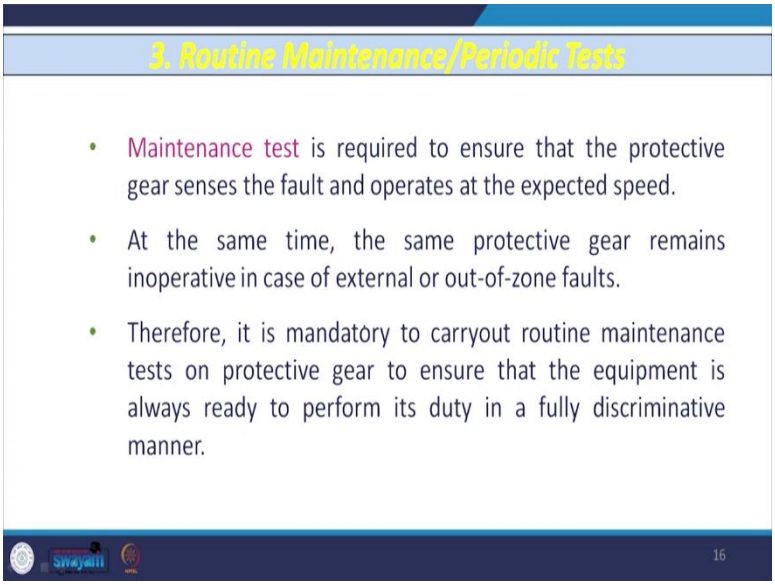

Now, the next type of test that is known as the periodic test or routine maintenance test. So, this type of test is required to ensure that the protective device senses the fault and operate wherever the protective device has to operate.

As I told you earlier, that the protective device will operate only in case of fault and they do not operate in case of normal condition or no fault or external fault condition. So, this type of discrimination that is required and hence routine maintenance or periodic test that is to be performed by the operator that is there in the substation.

So, it is mandatory to carry out the routine maintenance test on the protective device. And this is to be performed at certain intervals. So, what is the frequency of the periodic test or main routine maintenance test, that is also fixed.

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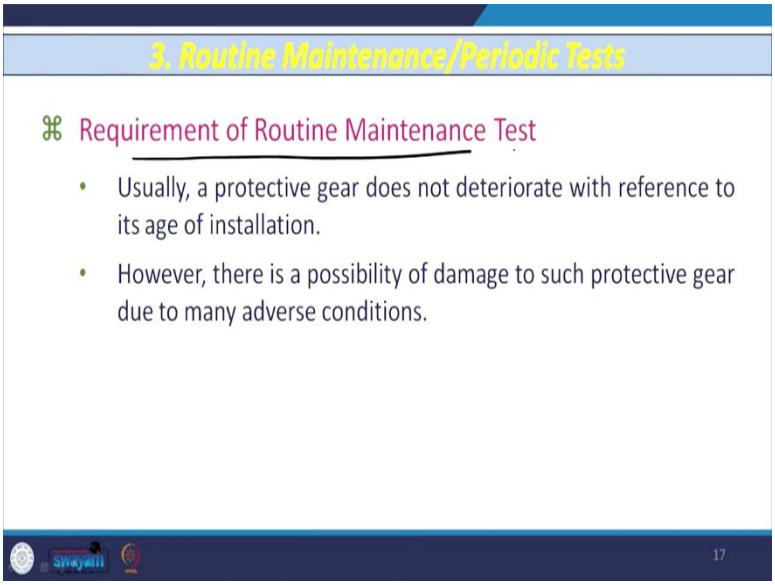

Now, what are the requirements of routine maintenance test. So, as I told you, that the protective gear does not deteriorate with reference to the age of installation. So, if you installed any protective device today, then after 5 years also it has to perform correctly adequately and to ensure that, such type of tests that is to be carried out.

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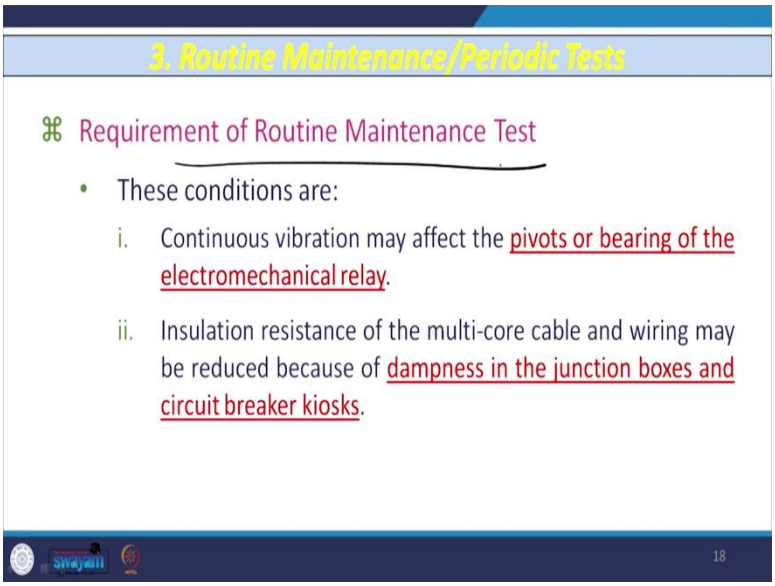

The different conditions on which the relay has to perform adequately. These conditions are the continuous vibration that may affect the pivots or bearing of the electromechanical relay. Insulation resistance of multi-core cable and wiring that may be reduced because of the dampness of the junction box or maybe circuit breaker kiosk. There is a possibility of deterioration of ligaments of the relay, the context of the relay (())(23.25) switches used in

the control circuit, maybe it has some effect on of the atmosphere also, insulation may deteriorate because of the environment condition or energization of coil, or maybe because of the production of heat, and there is a possibility of open circuiting of coils or contacts due to electrolysis which causes a green spot. So, to avoid all this situations, routine maintenance test that is required.

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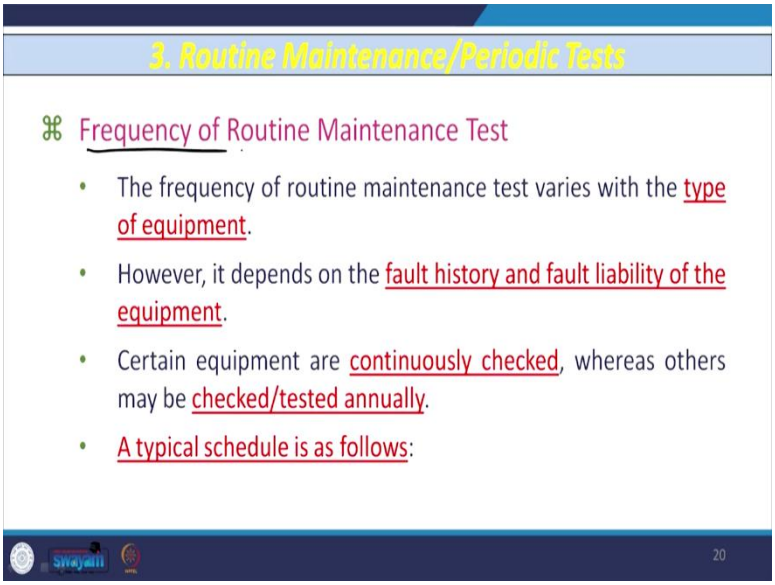

Now, let us see what is the frequency of routine maintenance test. So, the frequent of routine maintenance test that depends on what type of equipment that is you are using and what is the fault history and what is the liability of the equipment. So, certain equipment are continuously checked whereas, some of the equipment that is checked maybe monthly or bimonthly or maybe every year.

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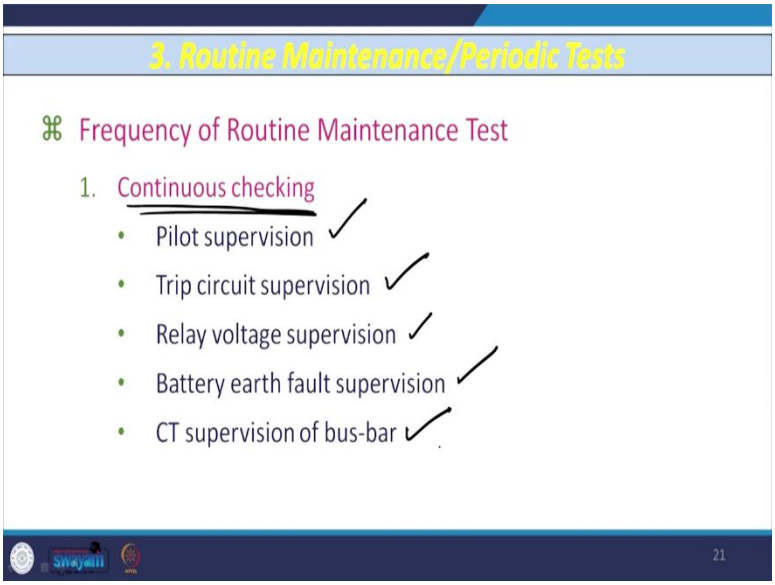

So, the typical schedule that is, the device which need continuous checking, that is let us say the pilot supervision, if you use pilot protection scheme, the trip circuit supervision that is also must, the relay voltage supervisor that is also must because relay should get sufficient auxiliary voltage, battery earth fault supervision and CT supervision of the bus-bar, because bus-bar is a very important protection.

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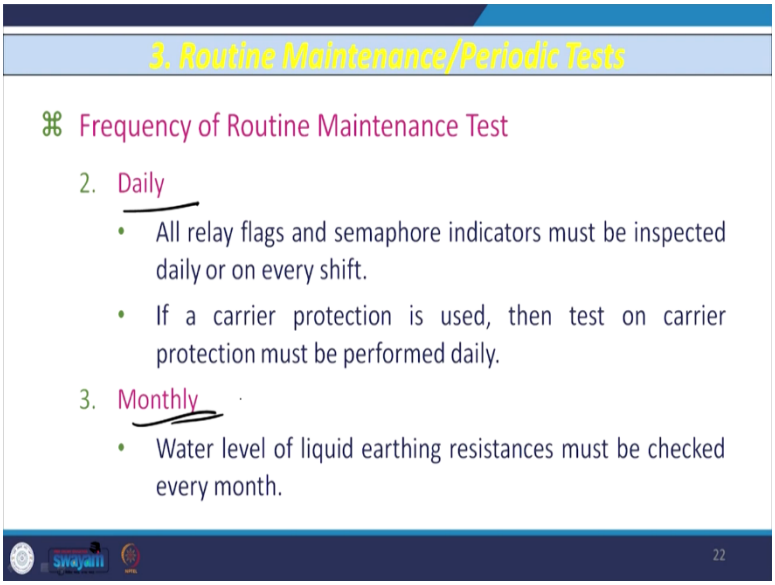

The daily check checking is required for all the flags, seven of our indicators. If you use carrier current protection scheme then you need to check the carrier signal, that means whether the carrier signal is adequate or not. The monthly checking required maybe for a water level of the liquid earth resistances that need to check every month.

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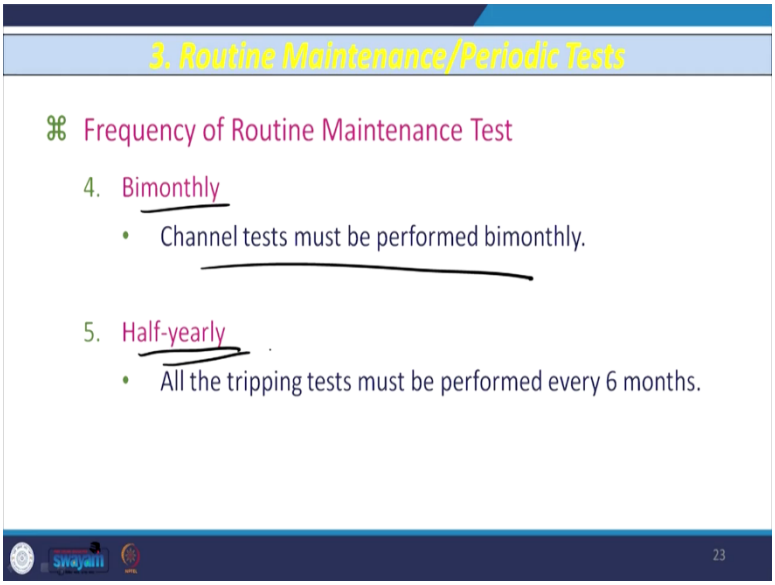

Bimonthly checking is required for the channel test that is to be performed on the like carrier lights and half yearly checking is required for all the tripping test that is to be performed every 6 month.

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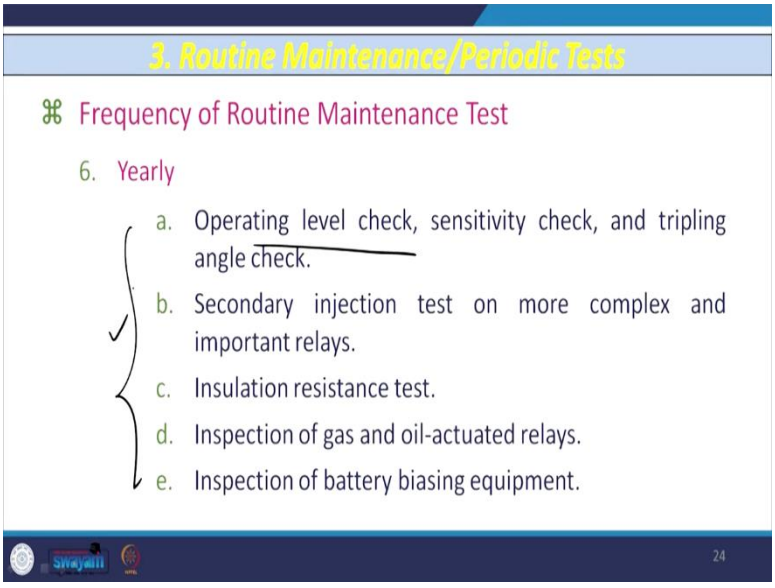

And yearly checking is required maybe for the operating level check, sensitivity check, tripping angle check, maybe secondary injection test, insulation resistance test. Test that is to be carried out on the gas operated relays like buckles relay and all that, and the inspection of battery biasing equipment. So, all this that is to be carried out every year. So, this is the frequency of the maintenance test that you need to perform or the protective device.

So, in this class, we have discussed, we started our discussion with the acceptance and commissioning test and then we have discussed, the routine maintenance and periodic test and what is the frequency of the routine maintenance test, that also we have discussed. So, I stop here and in the next class, we will continue for the next chapter. Thank you.