Enclosure Design of Electronics Equipment
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Lecture - 31
Index of protection, Safety

I would like to start with what is this IP classification regarding enclosures. So, if you see here I have a few enclosures that are kept on my table there. Just have a look at them.

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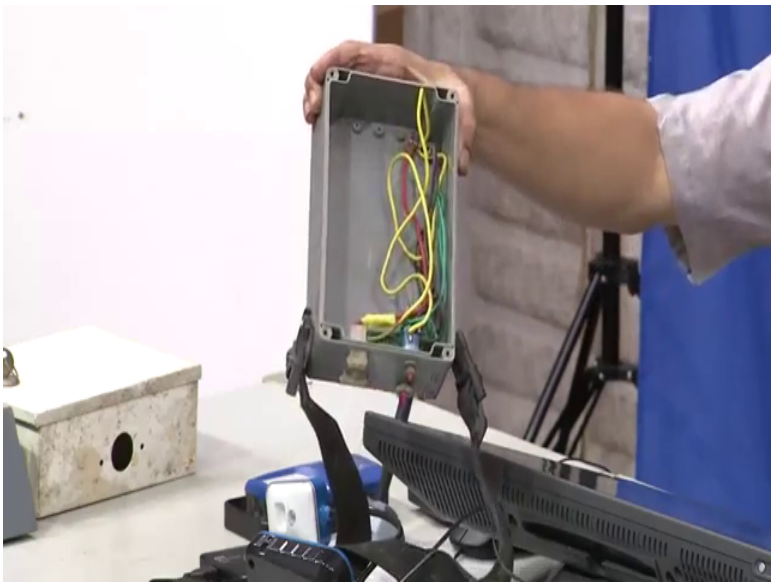

These are all meant for both indoor as well as outdoor uses. You notice here is, it is a polycarbonate or PVC enclosure. One of the things you see is elaborate arrangements have been made such that gasketing practice has been used. And then something related to this is also is that when you want to mount it, we have through and 3 holes here.

These holes you may just be able to see can you see it is through and through you can see that small white spot. Thing being the mounting holes are not what you call mixed up with the other features which are inside the equipment. Typically we have something which covers here, then we have a gap here and then you see we have several types of buses everything. And further now if you come down.

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In spite of my whatever I have been telling you will notice that, simple of the shell 2 and 3 pole connectors have been used here. So, whatever we have started with we have compromised it.

It does not really board well for it, but luckily since it is a indoor equipment plus the way we mount it, plus the way we carry it and the fact that it goes into another place makes it a an interesting case study, I will now take you to Typically other enclosures here.

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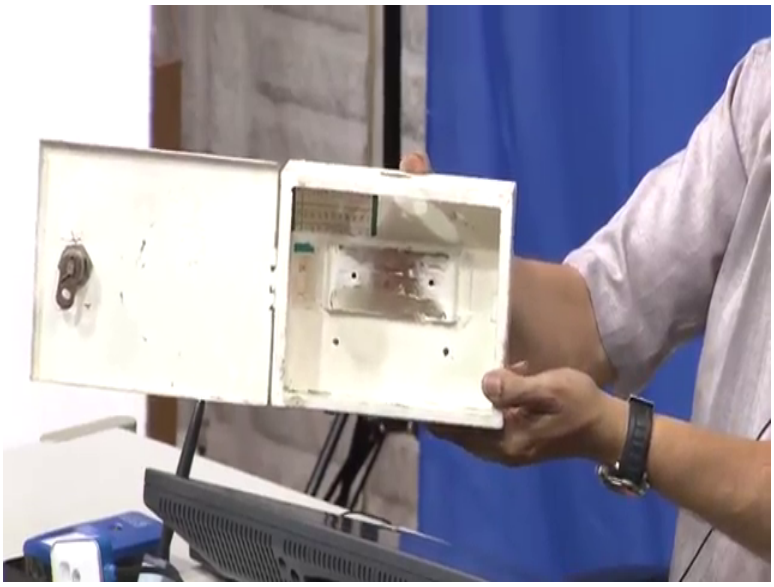

Can you see here? Something you will notice it is probably just a not proof indoor enclosure for mounting some hardware here. So, you have placed for something to a cable plant to come inside, then we have a place for a cable plant to go outside and there is a hinge here. Make sure that hinge is. One thing it is very, very prominently noticeable is, not too much of attention has been taken or paid to make it water or dustproof, because typically it is just an indoor equipment. It is an indoor enclosure for mounting safety devices.

This is a similar enclosure, but designed for outdoor application.

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One of the first thing you see it has a inclined top. That in the unlikely that you try ins or something like that happens, all the water will go out. And then we cannot see it here there is a nice gasket that is fitted inside. There is a leap here there is a gasket and once it is sealed once you lock, it basically it can serve outdoor applications without the slightest problem. And then one more thing also do you notice at the bottom we also have this grommets. So, if you select the proper type of a grommet, and outside if you provide reasonable strain relief this can be used, this is what is all about that index of protection.

To make it authentic, to make it authentic, I tried to go into the field and tried to take a few pictures. Later on I have also gone to the manufacturers catalogue who themselves have made available the specifications and the implications of design for the various types of specifications we would like to have. So, if we if you have a look at my PC.

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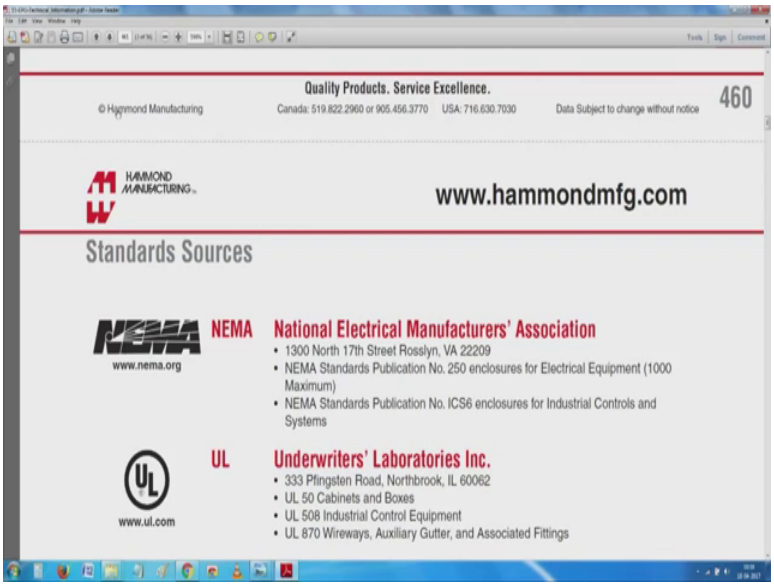

This is taken from Hammond. Again you have seen it is a copyright of Hammond. I am acknowledging the copyright and then since it is a student material and then expect you to check the original source, do not cut and paste it.

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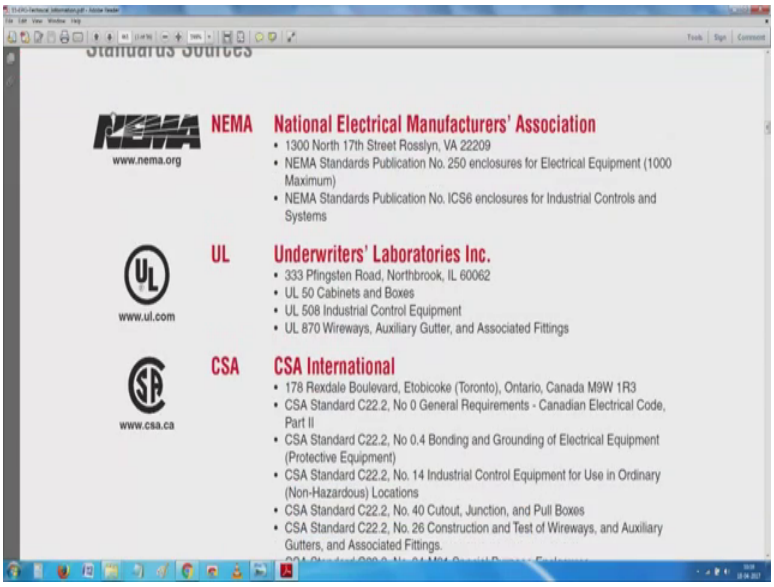

You see here very important thing is one of them is the national electrical manufacturers association. This talks about electrical equipment and enclosures for industrial controls and systems. So, 2 or 3 things are there one of them is saying what are the interface standard saying what are the center distances what are the dimensions, what are the

various things it takes care of for all mentioned here. Along with it also has a protection class, because in the previous lecture I showed you cabinets and all which need to cover all those things.

Next comes underwriters labs.

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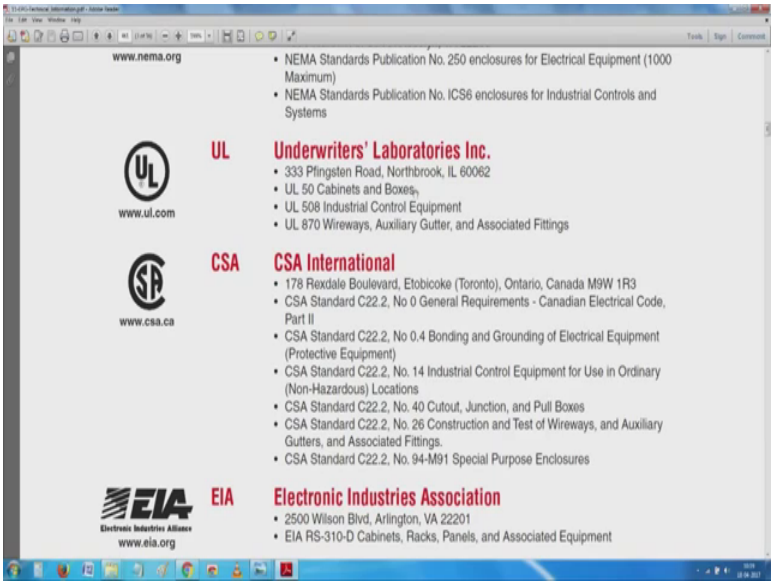

Underwriter lab are the people who give safety certifications.

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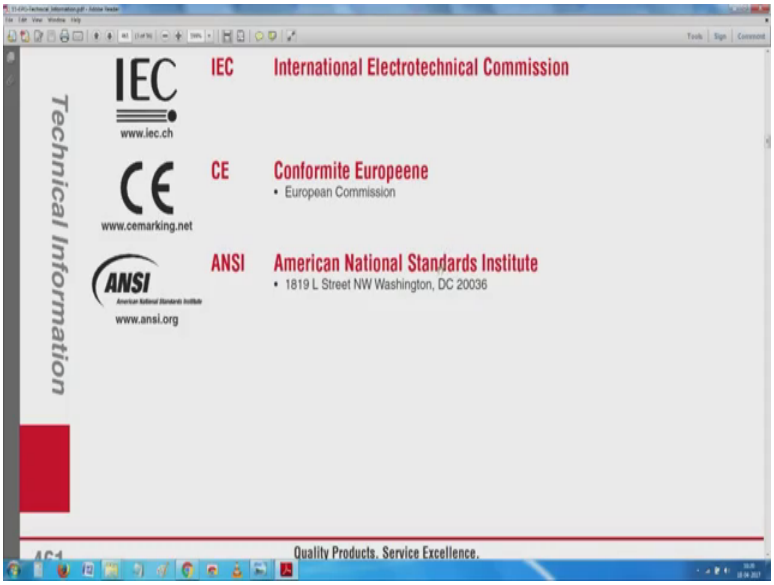

And then as we go down we have so many of these things, American national standards and so on, and then IEC.

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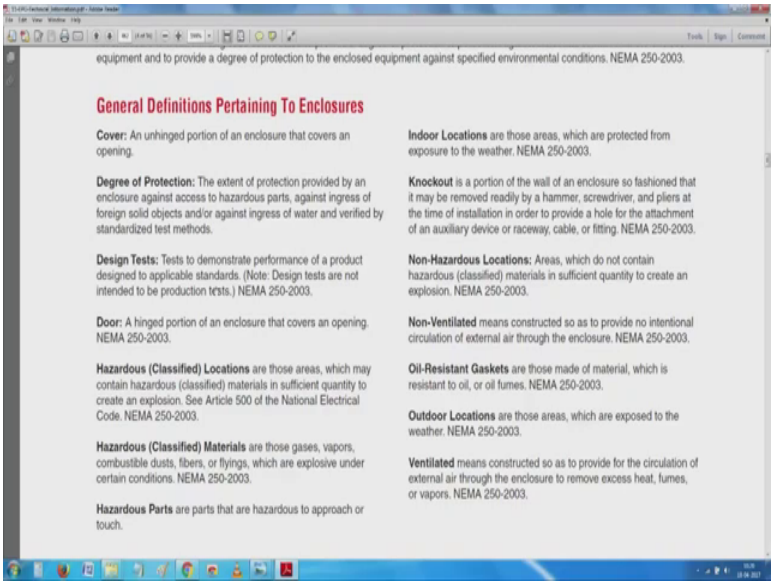

I would like to draw your attention here at the moment to talk about extent of protection provided by enclosure against access to hazardous parts, against ingress of foreign solids and or against ingress of water and verified by standardized test methods and design test.

Very important things are here saying, it is not just about protecting the equipment and the circuitry from the external world. It is protecting the operators in the external world from the vagarious of our circuits. I will show you some what look like you know potentially shocking pictures.

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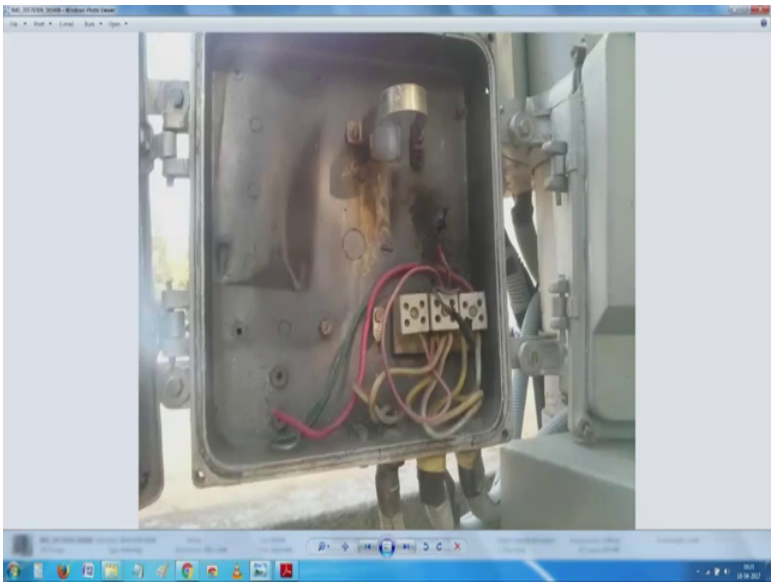

I just took a walk around outside world, I would not want to be judgmental, but you can judge for yourself.

In the right you see what is a iron clad cover and detailing and you see what has happened to it inside. And this thing this is the condition in which I founded attached to a light pole. Now you see 2 or 3 things can happen one is; obviously, going to defending our thing yes, yes, yes that is all whoever gave you access to this you have no business to take photographs, yes I have no business to take photographs. But still for the purposes of illustrations I would like to tell you that equipment inside it is also provide enough hazards for us, this beautiful iron clad switch.

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parts are fallen out and then you see a temporary arrangement has been made Such that you can use it.

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This is typically anywhere you can go around, I mean pardon me if our once again know passing comments which are not very appropriate that often we see this sort of what you call shap shroud and hap hazard way of, taking care of serious matters health matters and safety matters. This is inside our workshop. Fortunately we had So many people interact

with us and most of the things we follow very good practices as such. But then just outside this where I give my clothes for.

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Pressing I think it is obvious, what it is and then how dangerous it is. Even if you are to put a full isolation transformer and try to reduce or increase the voltage, we still risk everything. Imagine one small electrical shock and then the hard thing falls on somebody, and then it will make news, bad news.

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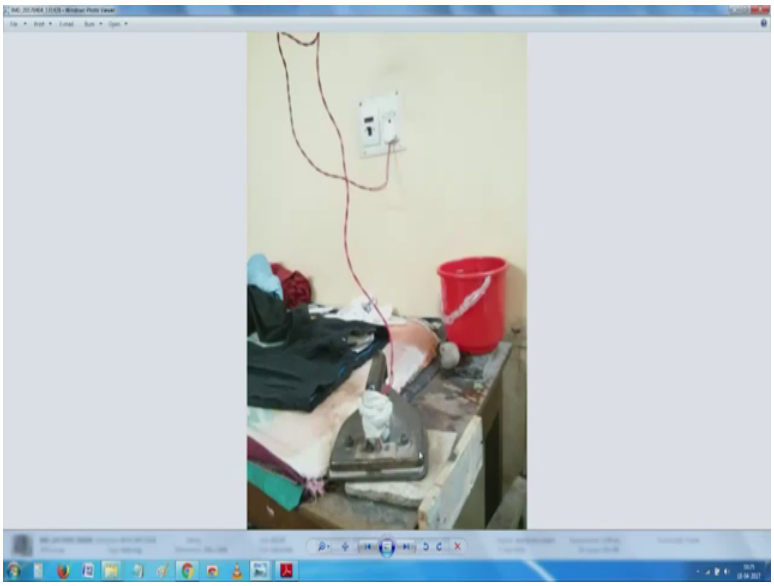

Just to make the effect complete, they have also provided us swab a cotton swab and also bit of a bucket of water there, you have seen that? I do not think it is a distilled water dnin star dematerialized (Refer Time: 11:26) it is a normal ordinary bucket water.

Also you see here we are risking our life. And then you also see one more very, very important thing is, when this was provided it had one more extra hole in the wall. So, I think you know what it is, whichever way you look at it know look carefully there are only 2 wires sticking out. And the 2 wires go and get attached to this place. So, equipment earthing does not exist here add it to that, it is a hot surface.

I do not think you will ever try it at home. First thing you will do is probably get a proper steam iron. Secondly, at the slightest risk of afraid cord or anything you are going to discard it.

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This is slightly better the original design started with this here. If you see carefully there is some insulator I will use the word as blisters, knowing very well probably it is not and then both these hot elements have been covered with sleeve. It could be a class cloth sleeve and then those 2 terminals which I showed you have been covered by another of those sleeves, fiberglass sleeve loosely called.

But then what is shocking is you see this bit of a cloth tied there, that is the only strain relief. So, that when you accidentally pull the cord it does not come off from here.

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They try to improve it marginally by adding accrued cover for it. I am not sure what it does what the purpose is. But then I am sure you will probably appreciate.

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This is the intended original when it came from the design house. You see here every element that you can think of has been taken care of.

Now, you may notice that small metallic plate that was attached there, maybe it was something to keep it on a stand or see that the neighbour does not touch it or anything. You will see all the elements first of all the bottom as before is probably made out of a

hot surface. But then, we have a bumper here which make sure. You can see the small gap at the bottom, it is not by photoshop. It is real. The actual element the heart in this case it is probably a copper or brass sole plate slightly projects out. And then you have a cover here and then you have seen here all these are doomed cabinets. A handle and then if you want to should you want to make it stand a beautiful stand to keep it in that.

And then here you see the ultimate safety precaution. One of them is wherever power is coming out should come out of a socket. So, power comes out of a wall socket similarly when you attach it here power should come out of a socket headed connector. So, instead of using the word male and female I will use the word socket and plug. And wherever power is drawn into that should form a plug. So, you see here all around you have a shroud here.

This shroud is earthed visibly if they want they could have hidden it intentionally all the parts including it is even attached here to make sure, that everything here is earthed.

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Next picture is going to show us more in detail. In the unlikely case something gets hot there is a small cooling pad here. Then you see these pins then you see the cup like thing which also forms part of the whole construction.

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So, if you see a little closer this is how it is expected to be used.

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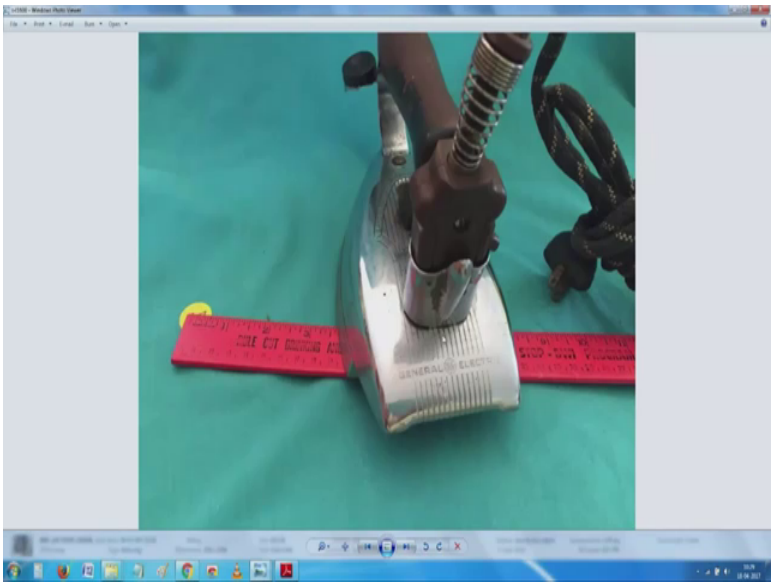

You see here a small projection is here, and this one is the socket, socket end of a wire on the other side it goes into the what you call into the wall socket. And I will talk about this later. And you say here this is strain relief both strain relief as well as it will let you flix it a little.

So, flexible strain relief, these are very old.

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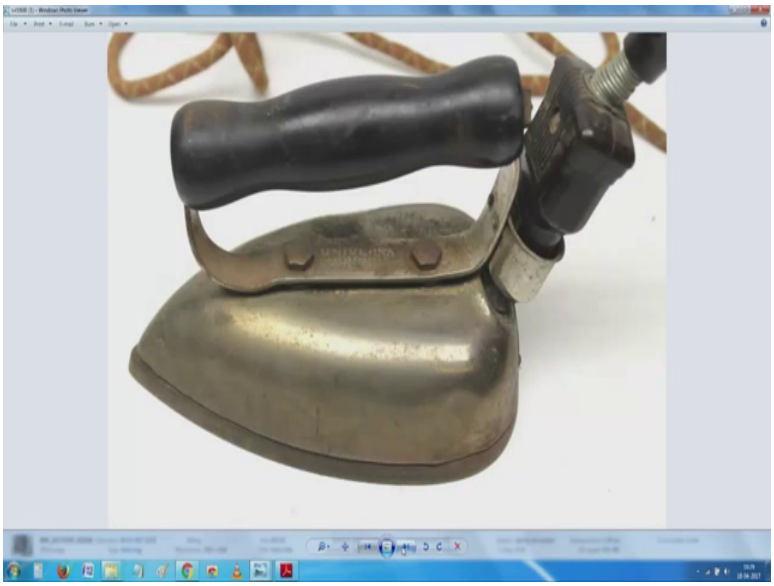

There Is nothing new about it, you have seen this? Old here and back here; usually on this socket there is also a metallic projection a clip which touches it.

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But then the bear thing when you open everything probably you have this as before. I think I will stop this at this point and get back to more serious, equipment design.

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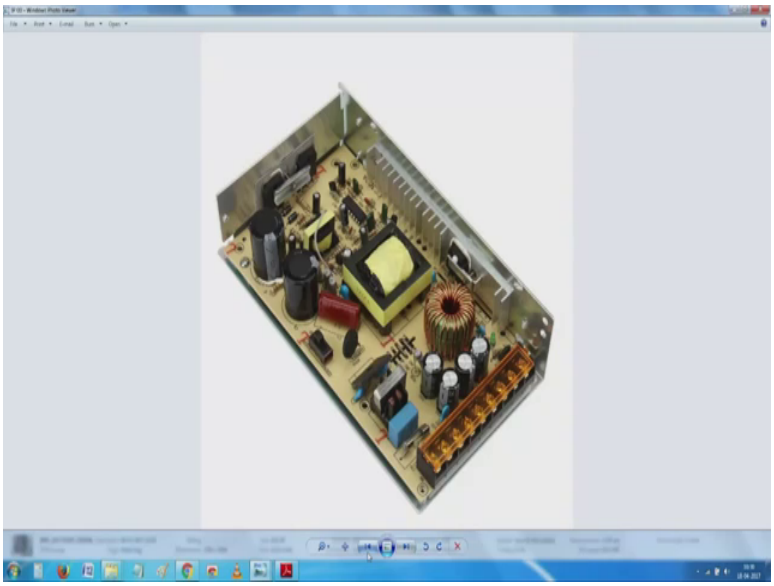

Whenever we start with an equipment; obviously, inside we have some electronic circuits. So, part of the electronic circuit can be active devices and passive devices I would not say, inactive passive devices are things like resistors capacitors and all.

Active are the ones which actually carry out some function. Like an amplification or filtering or something; and the issue being now if you go back to my slide here. You see carefully we have to 2 of these active devices. They are some series bus elements which give a relatively low dissipation hence that directly using a this particular thing is a silicon pad. It is clamped on the silicon pad, clamped down using another u shaped clamp. And then similarly on the side here one more time, probably down here either the whole thing has a lead compound attached to this here.

And then here you have seen that you have one more time some more devices which aid in the heat transfer. And then the other things I would like to talk to you about very, very nice thing here, can you see something here? That is the input output connector or terminal strip. Seen a very interesting thing about the terminal strip it is covered. So, that accidently you do not short circuit and damage the equipment alternatively, you do not get electrocuted by touching something.

As a small bit of access is given here and it is also numbered here. So, this is a starting point of any electronic or electrical circuit. 2 or 3 things we will notice is heat has to be dissipated. Secondly, there are certain requirements including how to isolate the operator

from the risks associated with it. Similarly in the reverse way how to make sure the external influence just do not come and affect this. So, you have a you have seen here a magnetic component. 2 things it can have one is it by itself, now can give electromagnetic radiation. Alternatively it may pick up things like them, because it works like a beautiful induction coil, also it can pickup depending on the ambient.

So, in this condition this is not expected to be used anywhere, I would call it an IP00 equipment, meaning there is no protection provided except during routine testing and assembly, in all other condition this is not expected to be used as it is without an enclosure. Next picture will show you slightly different thing.

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Can you see here, one of the first thing you see here is that it is been covered and then lot of cautionary and batch wise and you know guaranteed protection, these things have all been given out. So, you see here 2 important thing can you see here.

Caution high voltage do not remove this cover except by qualified persons only. Even if you were to be a home hacker, who enjoy working with these things; obviously, you know how to handle these things. And if you are in a professional work place 2 things can happen, one is it is an unsafe act; if the operator does something in violation of these that is an unsafe act. Other is the unsafe condition, meaning the whoever is responsible have not taken sufficient means of controlling or preventing these things.

Now, you see when I showed you inside it has something else now you see here. All these items have been identified here like there is a line and a neutral and then there is a earth there is a common points and then So many 3 different things. So, 2 things you will notice about it is in this condition, you can safely use it everywhere, anywhere you like for example, it can be fitted inside a cabinet which requires different types of power supplies. So, you see here at the at the top I will just switch it 12 volts 20 amps.

So, probably they are 3 parallel connections or it may be dummy connections and this labelling is very, very critical. Saying we better label it. And then something related to this is year of manufacture, and the batch wise how do you identify. In this case you can say the year is given here and the months are given here. And usually this is where we come into ISO2000 series of document record keeping, where we keep all these things.

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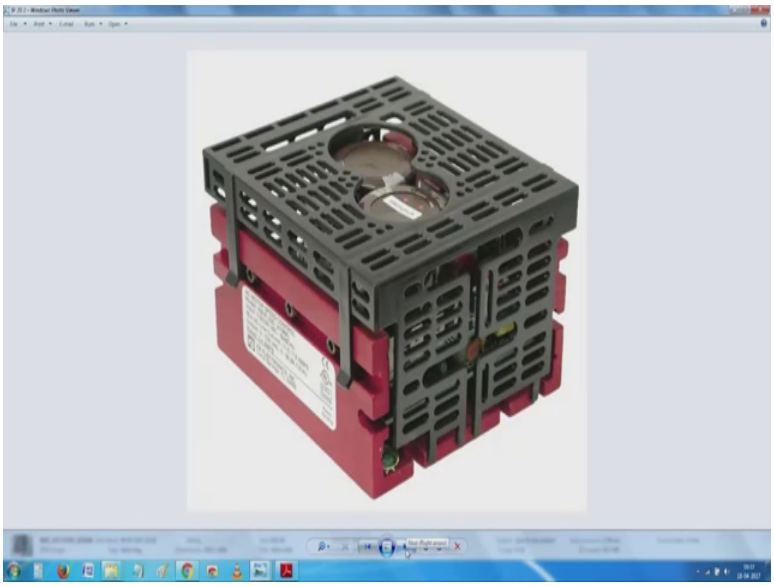

We are improving we are going a little deeper inside. So, you see here compared to the earlier unit, in principle it is about the same. Only difference is the external this thing is protected slightly. All the connectors are all kept inside is unlikely case or something being dropped. Or something being dropped on these chances of damage is less. Have you noticed here that absolutely no electrical parameters are all visible at all?

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I think you can see it is probably a driver I would not know what it is, because my interest is only in the packaging that is the making an enclosure design of it.

So, this is standard normal enclosure outside can you see there are lot of openings here. And then you see here a small projection also has been given here, a hat section and you can see probably what look like fins and a heat sink, rather a heat spreader. So, when it is sold it is sold with the condition that the bottom plate should face another cold plate where the cold plate temperature is maintained at something like you know 12 degrees or 15 degrees or 25 degrees.

25 is standard ambient, little over is in case you want to do something else and then the heat transfer coefficient for the particular equipment as a full entity is mentioned there, saying this much area is there and you need to maintain the succeeding operations typically at theta of 1 or 2 degrees centigrade per watt. So, if it is a 50 degree ambient now you know how much of voltage it can dissipate. So, now, you need to take action about how to play with these rather how to design the other things.

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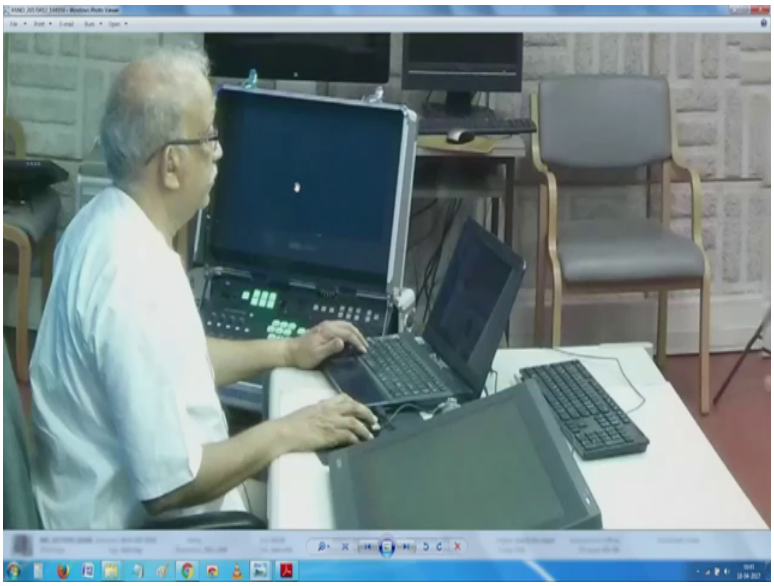

This is where I am sitting. In fact, it is me I ask somebody to take, lot of care has been taken even here can you see here on top. These are all flood lights. So, these flood lights and then there is a solid lighting rail, it is not the usual flexible or pantagraph type of a mount. They are semi permanent, except that we can orient them. But the characteristic is that whole thing has been sealed. So, normal course no dust can go inside we just need to clean the outside with a cloth. And then you see here same thing we have various things and this is one of the camera mounts. Everything here including each of these equipment why I actually wanted to show you is, this is standard PC on which I am working.

This is something which is provided for as a tablet PC, but very large size. You see this beautiful equipment there. This is a mixer cum monitor cum anything right now it is being used as a monitor. Interesting what you see is, it has a cover over it can you see here. It is a both the carrying case as well as a deployment case. In principle it is neither water or solids proof; however, it is impact resistant, which I will come back when we talk about the IP rating there are 2 types of rating.

One is called the IP another is the IK which very rarely they I mean it is not that often it is given their, advantage being inside it has a similar what you call studio equipment which would like to anything, but this carrying case is the one that makes it easy to carry. Let me skip all this and come here.

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This is a vertical milling machine. And these days even these have become fully electronic dependent you see here there is a air filter, and air is circulated in this. But then in a workshop environment I just showed you that is the reason why I showed you these other pictures in a environment like.

In a work shop environment there will be other equipments and all and chips are there being formed all alone.

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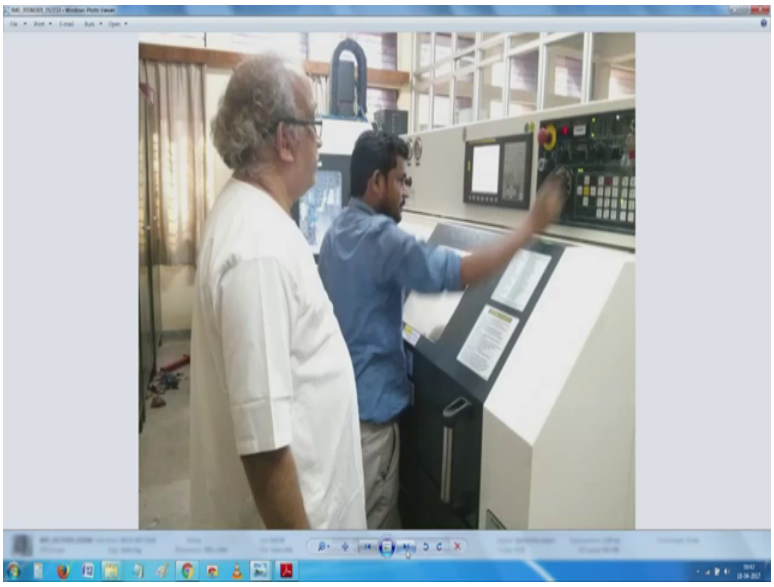

So, when these chips are there we need to protect 2 things. We need to protect one machine against the other data gets the operator invariably, all this new machines come with a wood unless you cover the wood the operation would not start and 2 things.

You have noticed this one is just a modified control panel at the back it has a fugit so or other what you call programmable logic controller. Then you have a display here. This one is a horizontal machining centre. You see that both of them have been they share the same place and In fact, does all designed originally such that they are isolated from the other part of the workshop.