Enclosure Design of Electronics Equipment
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Lecture - 38
Gasketing practice

You come here; the important thing is more imperfect, the mating surfaces the more critical is the function of the gasket.

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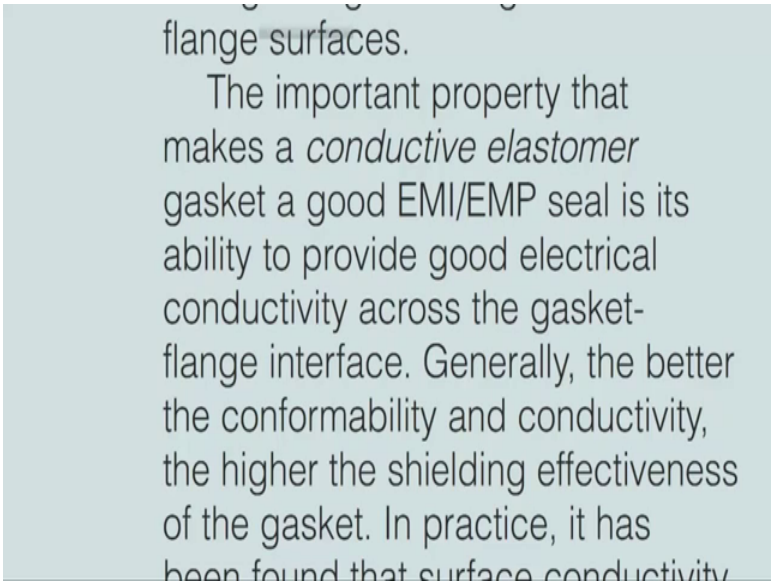

Perfect surfaces are expensive the final solution is a compromise between economics and performance. The important property that makes a conductive elastomer gasket, instead of saying it is the polymer and the what even elastic calls as little problem, because in intuitive understanding elastic gas some robbery material you know, we will say use for various places and an elastic in engineering design mean something which when you remove the strain they come in, when you remove the stress it will come back to the original point.

So, it looks very counterintuitive, but if you take a rubber ball and try to bounce it of a rubber flexible surface sensor it own bounce at all. But then otherwise if you take a very hard steel surface and then put a very hard steel ball at bounces. Because it is a perfectly elastic medium contrary, it to as you said known that rubber band illustrate has natural damping. So, we have a little issue I will skip it, now coming back to this thing.

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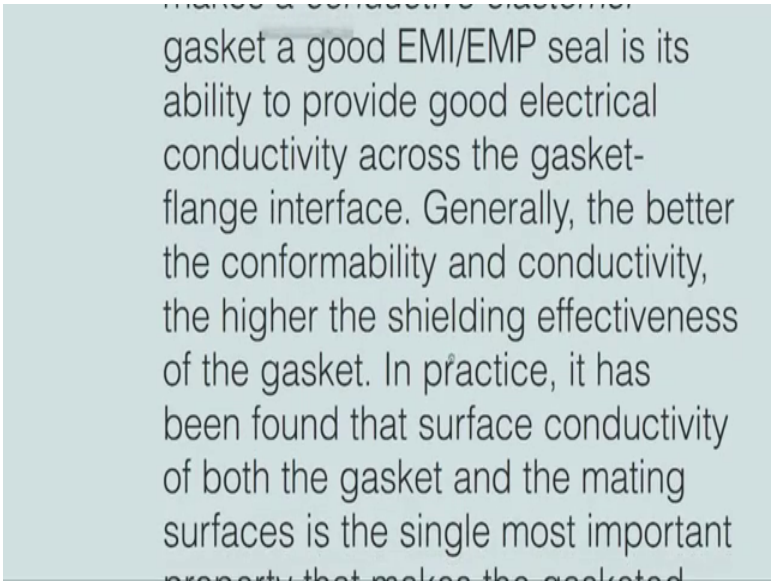

To the in the case of our electronics we need to have good electrical as well as, seal again say dust and other things.

In practice it has been found at the surface connectivity about the gasket and the mating surface is the single, most important property that makes the gasketed seem effective.

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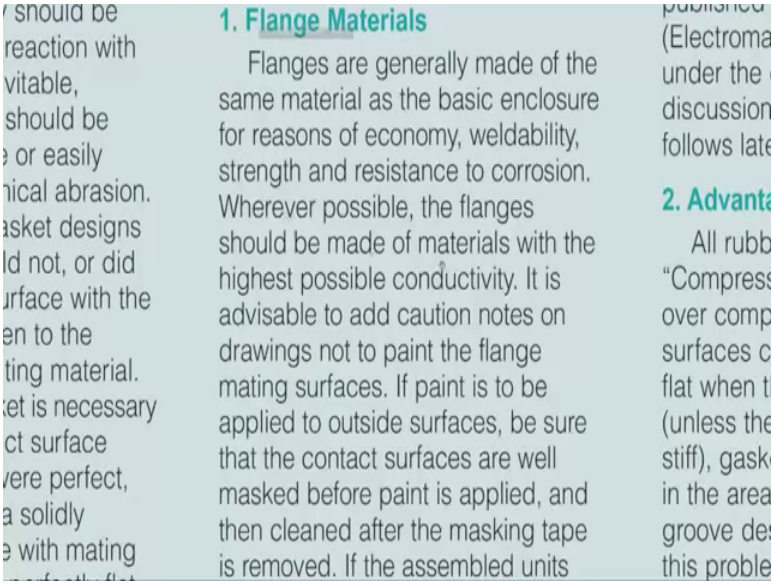

Once again, we need to go about working about simple flange materials. Flanges are made of the same material as the basic enclosure. And this is where I am sure at least some of you have faced it. Now seen that this is what I was talking to yesterday? It is

advisable to add caution nodes on drawings not to paint the flange mating surfaces. So, when I showed you that power control panel and which had a here thing, I hope you are able to recollect that power control panel which you had which you had the I think yesterday, you somebody able to paint before assembly we have a unspecified contact.

So, some condition settled more by accident it will continue otherwise it will not continue. This continuous to happen normal places probably it is not very critical, but in some places you becomes.

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You have seen that if they assembled unit is are subject to painting or repainting in the field, cautionary note in a conspicuous location adjacent the seal that the seal have to be must before printing.

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Once again I will take you back to the street light controller there. There it is not So much about the MIRMCSA such now we can get away with that what imagine, somebody has to mount a wireless sensor senside such things. You have done that also in the very earliest first lecture I showed you some soil moisture sensors farming and ad hoc network and all that.

So, there we try to use. You have seen there is very important thing.

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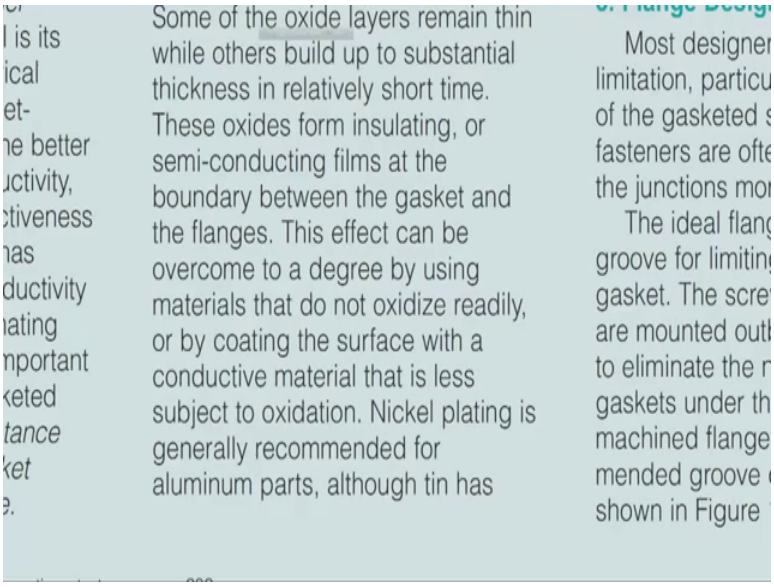

Gold why we continue to play things with gold is, it does not get oxidized. In the normal anywhere now it is an very beautiful base condition it is a noble ma material, how are in contrast silver oxidizes easily in the atmosphere. If you what to h silver and leave it in the environment very quickly it will term black including all those connectors and all that which are silver plated it forms a black oxidize; however, it is a relatively conductive it does not matter you take out the if it have an n type connecter, you can un mated and then you mated. And if it were to be it is very rarely it is silver plated all come with nickel were some other reason.

So, if we were to take a any b and c connecter anything, which are gold is very expensive. Only in very low I mean very high frequencies small sizes the use gold as an SMC indull SMA connectors alternatively, b and c as usually silver plated. So, if it turns black except that it will look sun slightly you can continuity use it without any risk of anything. You see here at the most oxides or hard oxide layers remind thin other build up to substantial thickness in a short time. If it convey overcome to a degree by using materials that do not oxidize readily or by coating the surface with a conductive material that is less subject to oxidation to a grooved design.

So, I will now move on.

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Oh we have an important thing here. If you leave any compressible material you have seen that nicely they have (Refer Time: 06:43) all compression set if over compressed.

So, this is where I was trying to point out you that the normal rubber or the elastic rubber bands we see around used with april, for a starting with the natural size the amount of strain it can taken can be if the natural sizes, let us say 100 millimeter is lay you can stretch it up to 300 millimeters for a few operations it will come back to that original 100 millimeter. So, strain can be 300 percent 200 to 300 percent.

How are a trolley elastic thing like steel strain will be usually single digit percentages. So, this is where the little issue comes what looks counter intuitive not all elastomers know we will come back fully to the shape which is started with. So, we saw here because flange surfaces cannot be held uniformly flat when the bolts are tightened. Gaskets tend to over compress in the area of the bolts. Proper groove design is required to avoid this problem of over compression. Groove provides metal to metal contact between the flange members reducing contact resistance, single groove we will surface for most designs adding a second groove parallel to the first will further reduce all they radiation by 6 dB which is a lot of problems.

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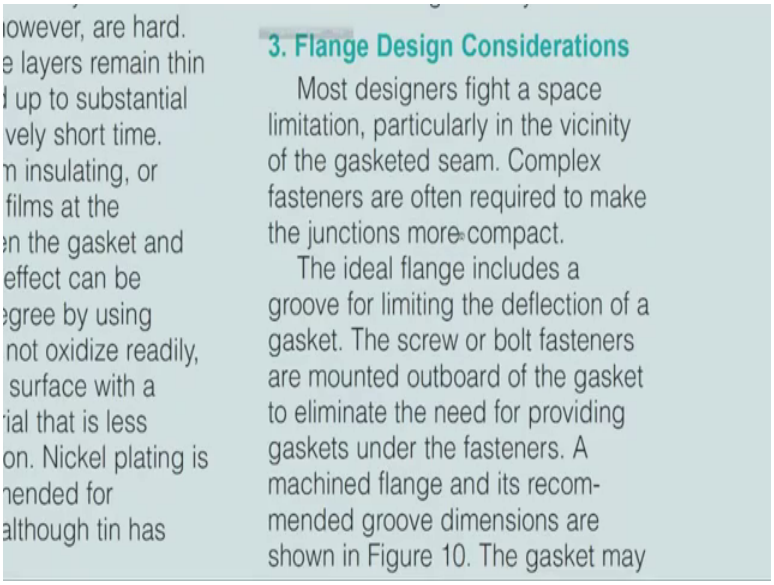

And the advantages you see here most designers fight a space limitation saying a maximum amount of space we want is inside the enclosure and then similarly outside we need though start them close together.

So, they does not seem to be enough space for really gasketing the design properly. This is the very reason we have seen this we want to start them close to each other. And then

inside we need to have the maximum amount of space. So, walls variable to manage, but when we come to the seam when we want to do the cover we end up with the invariable problem of, we have a flange here and then these are all extra space unnecessarily. So, what they do is people try to make the basic enclosures that is, what those pictures I have shown earlier. And all around wherever they fasteners are there depending on they how I had close the time, I think it is fine. They try to make sure that you are try to put up way the minimum amount of flange that is required for 2 things. One is both the surfaces to make in contact and only around this screw head or we around the bolt where you try to apply, that write to a provider a small circular flange. And inside generally are maintained flush and clean such that you can do various types of operations insight.

Especially stacking things and then making sure of various things. So, it is occasionally the mounting screw. In fact, if it is in the corners there is no problem, but anywhere else you end up with a small circular thing inside the equipment, wall 2 projections corners and then we have the nice design for the gasketed thing. Let me go a little faster you have seen that ideal flange includes a groove for limiting.

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The Deflection of a gasket the screw or bolt fasteners are mounted out board or a gasket eliminate need for providing under the fasteners a machined flange. And it is recommended groove dimensions are shown.

So, this is the important thing I thought you must see.

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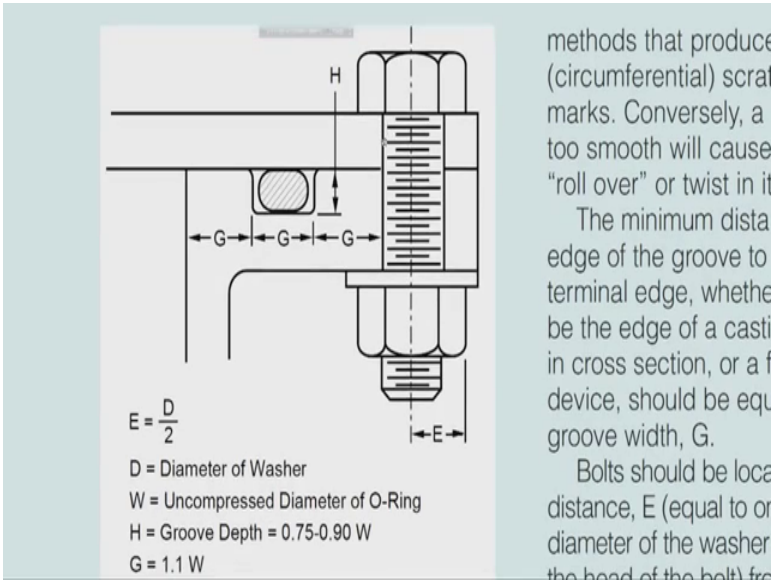

I am as happy as you that I have finally, come here. So, this is directly taken from probably practice that is done in what you call chemical industry, but is equally valid for us if you can somehow make sure that this to mate together this gasket is only for other applications. So, we have various operations including what is the diameter of the washer here and groove dept slowly we try to extend it to cabinets, seen this here. There is a very interesting thing and you start it is a nice beautiful circular pipe like I think it is actually a rod around settler pipe.

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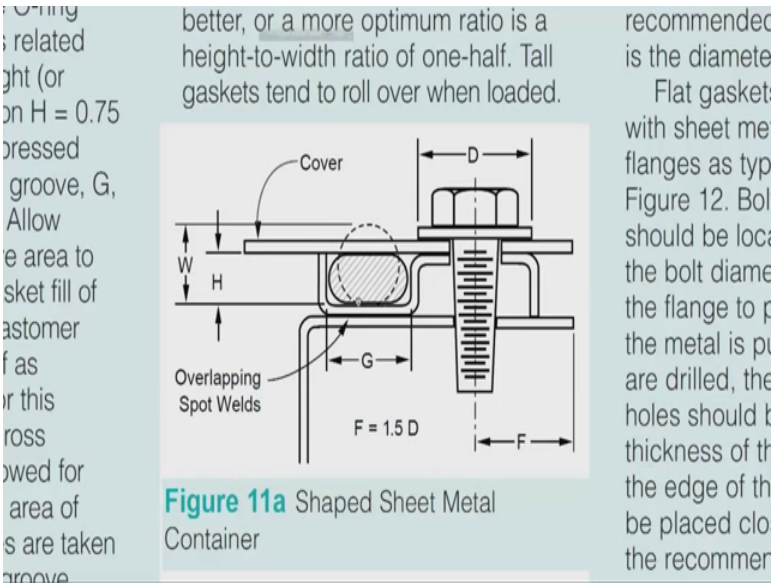

Once you compress it 2 things happen this 2 flanges meet, you have seen this no? And then this fills is space properly. This is where probably that a little lubrican not helps in saying that it is it is comfortably here. And one side you have seen this here this prevents that this being compressing and killing the whole thing properly. So, this whole structure this, this, this all this is part of one of the faces, the top part is the other cover and this can also be part of the cover also.

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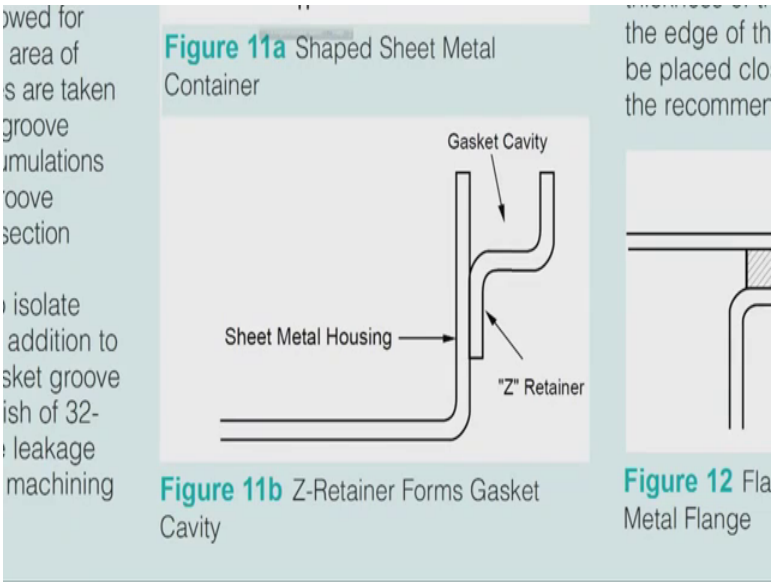

So, depending on this you have beautiful options here. So, this particular note is not only about all those how to tell, almost magic like you know, getting all those numbers and nomograms and all that it is a lot to do with the detailing that has to be done here.

So, if you go here, this is what I try to show you in the workshop. This is a properly done correct way of making things. You understood inside there is nothing and then the top cover, probably starts here goes up and then comes here. And inside this you can have the cavity for the gasket. Alternatively the top cover can be flushed also like this, flat is covering this and inside for alignment on this side there maybe one more small guiding plate. Moment you make it like this we can be very sure and absolutely no problem.

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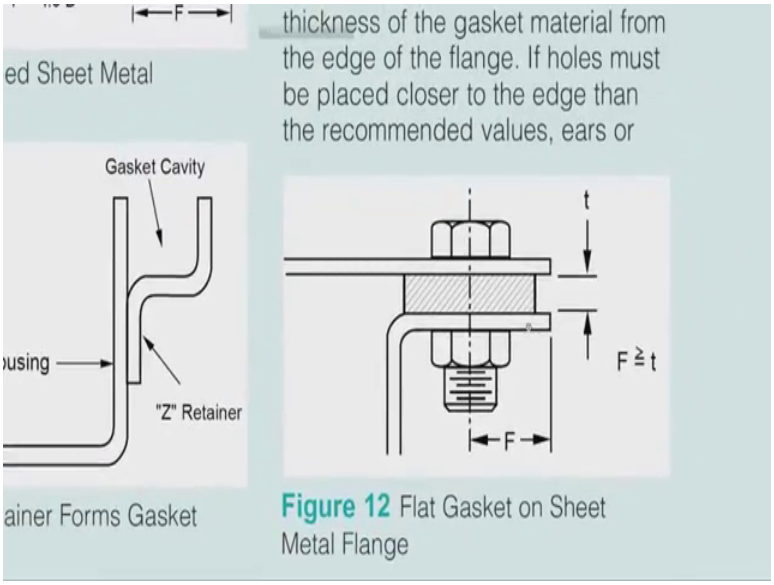

Yeah. So, we have this various types of formation of the gasket.

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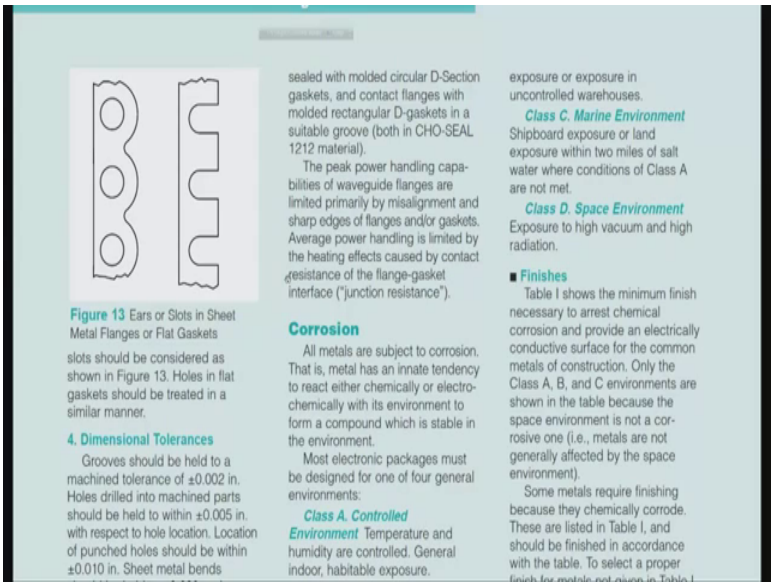
Figure 13 Ears or Slots in Sheet Metal Flanges or Flat Gaskets

slots should be considered as shown in Figure 13. Holes in flat gaskets should be treated in a similar manner.

4. Dimensional Tolerances

Grooves should be held to a machined tolerance of ±0.002 in. Holes drilled into machined parts should be held to within ±0.005 in. with respect to hole location. Location of punched holes should be within ±0.010 in. Sheet metal bends

sealed with molded circular D-Section gaskets, and contact flanges with molded rectangular D-gaskets in a suitable groove (both in CHO-SEAL 1212 material).

The peak power handling capabilities of waveguide flanges are limited primarily by misalignment and sharp edges of flanges and/or gaskets. Average power handling is limited by the heating effects caused by contact resistance of the flange-gasket interface ("junction resistance").

Corrosion

All metals are subject to corrosion. That is, metal has an innate tendency to react either chemically or electrochemically with its environment to form a compound which is stable in the environment.

Most electronic packages must be designed for one of four general environments:

Class A. Controlled Environment Temperature and humidity are controlled. General indoor, habitable exposure.

exposure or exposure in uncontrolled warehouses.

Class C. Marine Environment Shipboard exposure or land exposure within two miles of salt water where conditions of Class A are not met.

Class D. Space Environment Exposure to high vacuum and high radiation.

Finishes

Table I shows the minimum finish necessary to arrest chemical corrosion and provide an electrically conductive surface for the common metals of construction. Only the Class A, B, and C environments are shown in the table because the space environment is not a corrosive one (i.e., metals are not generally affected by the space environment).

Some metals require finishing because they chemically corrode. These are listed in Table I, and should be finished in accordance with the table. To select a proper

You have seen this know? The sheet metal itself has this opening sometimes the gaskets have all this openings, and the thing is all around the mounting screws they have to fit together. This is directly taken from the earliest probably automobile designs, if you take care especially we have a bike and if you take care that cylinder mechanism and all and the crankcase at the bottom.

Usually it is made in 3 parts you know the center that part which takes the what you call crankshaft and all that. That itself is either to one side or in the middle you have a nice cut, and then you have a beautiful gasket material. In that case because there all machined and probably lapped and join together they have apply a little bit of an adhesive shellac. And then the use a special gasket paper it is a thin cardboard probably it is around one millimeter (Refer Time: 16:23) after you apply in the correct sequence of tightening. That is from the center to outside that squeezes itself and then it can with stand the heat and the oil, and you can say until you next heater in our case we heat (Refer Time: 16:40) it just is nothing leaks.

So, we have as we go down, we have corrosion which is real.

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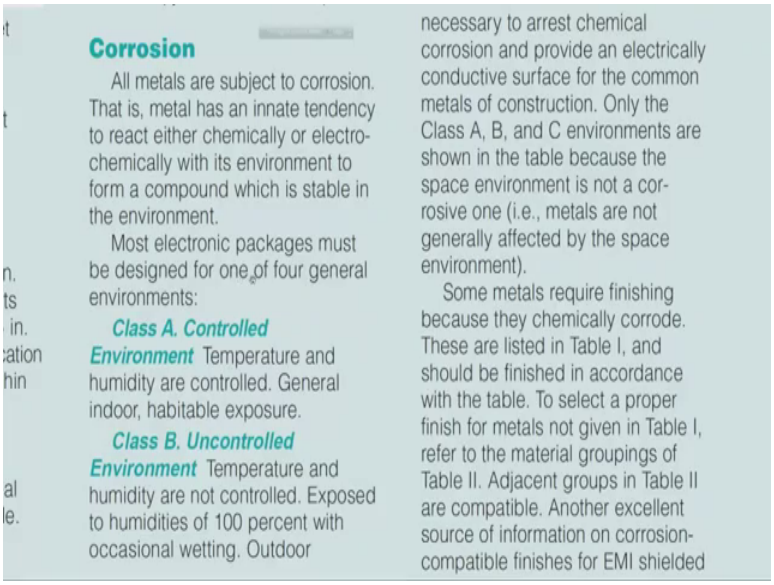

Corrosion

All metals are subject to corrosion. That is, metal has an innate tendency to react either chemically or electrochemically with its environment to form a compound which is stable in the environment.

Most electronic packages must be designed for one of four general environments:

Class A. Controlled Environment Temperature and humidity are controlled. General indoor, habitable exposure.

Class B. Uncontrolled Environment Temperature and humidity are not controlled. Exposed to humidities of 100 percent with occasional wetting. Outdoor

necessary to arrest chemical corrosion and provide an electrically conductive surface for the common metals of construction. Only the Class A, B, and C environments are shown in the table because the space environment is not a corrosive one (i.e., metals are not generally affected by the space environment).

Some metals require finishing because they chemically corrode. These are listed in Table I, and should be finished in accordance with the table. To select a proper finish for metals not given in Table I, refer to the material groupings of Table II. Adjacent groups in Table II are compatible. Another excellent source of information on corrosion-compatible finishes for EMI shielded

Most electronic packages must be design one of 4 general environments. One is class a controlled environment temperature and humidity are controlled indoor habitable exposure. So, that is we are able to get away with all that equipment which is very sophisticated. Actually the way you are getting your internet connection is probably you have a beautiful server room and then there are server racks, which also follow the 19 inch arrack standards. And then you have so many switches and I do not know bandwidth managers and I do not even know the words, and then something some cable comes and then what you say outside or only bunches of cables. And the beauty is the whole environment is controlled closely.

2 things are controlled. One is temperature we know how to control there is no problem. Stick up an essay on all the worlds or if you like as we have a cassette air conditioner somewhere in the middle. But you have another serious issue about it that is the movement is chill any air condensation takes place. So, how to you get rid out the water? It looks somewhat now sometimes it tricky. If you have to take a cool drink or water bottle. And you keep it outside you will notice that condensate forms on the outside. And in contrast let us say you take your cup of tea or coffee and you put a coaster or a cap on that you will say that condensation takes place. And then only you lift the coffee you will see a patch on the ground. Nothing there is no great anything I am sure you have figure it out, allow may to point out the condensation takes place on the cooler surface.

So, if it one and it such rated the moment it comes it goes and condenses on the cooler surface. So, now, take the example of here server racker. Somewhere where, we assume we started with reasonably dry air when I talk about dry air I feel you know r h should be around 20 percent. But then as you cool it you will see that the humidity goes up. Amount of humidity and if you are one of those unfortunate I want say unfortunate one of those what you call people who have to leave in a environment which is to start with has high humidity. You already start with 80 percent RH. So, the moment you cool it you end up with condensate everywhere. So, imagine one surface in that whole room faces is cold, what you called cold blast from the AC. While it looks fine the other surface by a some bad luck for us let us say there is a warmer that what you call also in inside and which is also saturated. First thing you will notice is, condensation starts on the inside of the cabinet.

Say in truly convert controlled environment, what is turn is special dehumidification action is taken. The simplest way to dehumidify is probably chill there until it loses all the heat sorry, until it will uses more heat than it is carrying the moment it that heat is carried away condensation takes place. And make sure that all is done out that this on which is in controlled. So, all the water is taken away instantly you can use that water back. If you can clean the whole thing and put it in a bucket, best ways you can use it in the UPS batteries sorry, for this little side thing. So, you see the moment that highly chilled air normal AC is and dull they usually they it outlines the adjusted around 12 degrees it is not a very bad thing.

Let us say you are able to get all they thing out of say there or 4 degrees centigrade a lot of the water we will get out. Then inside the ducts which are used where it heaters are used to bring it back to the ambient which we will enjoy which may be around 24, 22, 23, 24 degrees ambient. So, 2 things happen they are becomes a dryer they are is at the temperature you want. So, probably I am coming to a little towards the end of my time. But I would like to point out we remember the old refrigerators reduce the world frigidaire air just something which was done maybe around 20 years back. They used I have that black you know wires are they back tubes. You do not find the many more and I have only what called direct cool also existed. And not know what is direct and what is indirect cool.

So, you see there that device you see at the back which is outside the refrigerator is a condenser. So, all they evaporated refrigerant comes here it loses heat to the ambient. And after it closes see it to the ambient which is let us say the ambient is at 35 degrees. So, easily after around 40 degrees, that think know about 5 degrees sufficient for it will lose the heat by natural convection and then that is when it is again pumped inside the compressor and then intuitive operates. So, you can get any temperature you like inside. But suddenly around 20 years back things, I will change you do not see that black snake a coil at the back.

So, what happened think about it and then you also find a sticker on the side of the refrigerator on the side there is a sticker, you will feel this warm that is natural do not panic. If it is a sales man is going to tell you I will panic saying this what you told me last time when you sold me the fridge saying the condenser and the evaporator should be isolated. But now you are saying no by some magic away of pusher inside they things, which is just the opposite same sales man no who should who sold as a window AC said sir because of the system complexity both of them you know we have put them together you should not isolate them. You understand the output everything in a bugs and then made a hole in the wall and then pushed it into the box that same person tells me no it is not a very good thing because you know make in a big whole is adding some problems.

So, we now is made case flit AC, which a refrigerator was us split thing earlier we had the condenser inside and the I am sorry, evaporator inside in the condenser outside and suddenly now everything is in one box. So, now, you are think about it is not just a technical issue, not just a technical issue the issue is it pre packaged and is the technique

possible for you. Right now in the case of refrigerators and all that they have found out that you need to warm the enclosure else condensation takes place somewhere inner surface is called and then you have the metallic wall you have of course, is cladding or rather thing, but still the inner surfaces cold.

So, in it is not a very sealed or hermetically sealed enclosure. Chances are the moisture keeps getting their inside as it goes down in shut corroding the surfaces at the bottom. So, they have found at an obvious easier way saying why do not you warm it up which is done in the case of marine equipment. In the case of marine equipment there are heaters which are fitted along with the cabinets. But heaters are one thing other bay heaters are there the bay heaters are put such that, the whole thing is maintained it is slightly higher temperature than the ambient. Because in the marine atmosphere; however, hard you try to get rid of water inside. Still that too much of it is not just in the bilge even all they rooms everywhere you need it, but you can not sit inside a ship all the time sometime you have to come out and see where you are going.

So, there in the case of marine atmosphere they trick tremendous thing by using both bay heaters as well as dictators to ensure that the humidity is under control. So, you see here in the case of a uncontrolled environment humidity are not controlled expose to 100 percent with occasional waiting.

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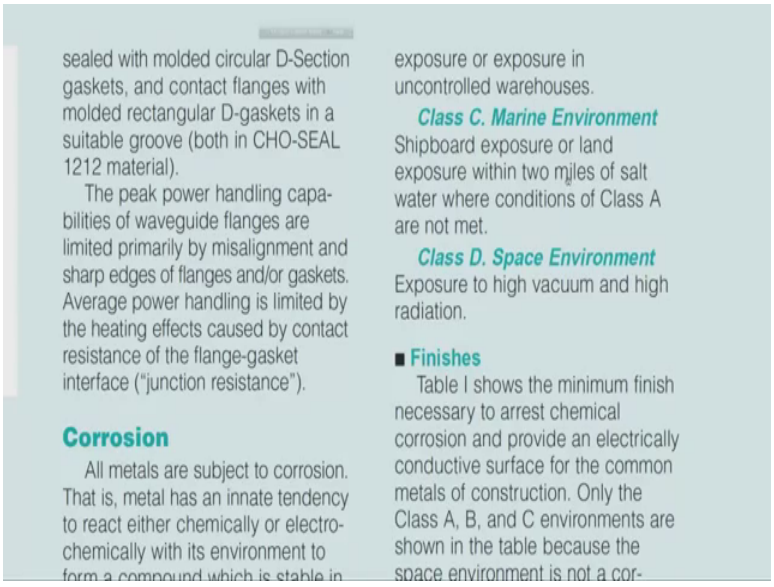
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Corrosion

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exposure or exposure in uncontrolled warehouses.

Class C. Marine Environment

Shipboard exposure or land exposure within two miles of salt water where conditions of Class A are not met.

Class D. Space Environment

Exposure to high vacuum and high radiation.

■ **Finishes**

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You have seen this? Outdoor exposure a exposure in uncontrolled warehouses. Whereas, need not be a very, what you call, not all the warehouses are controlled carefully. So, added to that now everything now has to cross some see or the other mostly let us across the atlantic and go to the other side or alternatively it has to come through probably or Mediterranean. And then it has to come there so, you have 2 things already you have all the containers and all that probably are full of moisture.

Now, you bring all the equipment and put them inside. Now you know have tough it is to install them inside. You see here ship board exposure or land exposure within 2 miles of saltwater where conditions of class a or not met. This happens all the time, right now things have changed to considerably in the better side for it. Not very long ago I had 40 years back most ceiling fans table fans had blades ceiling fan does a table fan had those blades made out of mild steel. And even now occasionally things like exhaust fans for various at not now some considerations that write use those otherwise corrodible materials. First thing you see that leading edge starts gathering dust and the moment you have dust a little bit of fungus forms and then fungus forms fungus also you know grooves nicely in the wet environment and the leading edge slowly becomes thicker.

So, in trying to dust what will you do you properly take a cloth and you try to clean it. And then after 2 or 3 cycle so, you will notice that you have cut your finger because it is become like a knife edge. Because all the rush status found there a spoiling the whole thing it is spoils the environment I mean the flow they are. So, if you carefully take enough care they still maintain those things, but we have got over that turn 2 things small things like this table fans and all invariably the blades are made with some polymer plastic, depending on and what you one probably the most commonly used is ABS occasionally you find polycarbonate, and there made transparent. I have even seen things which are made with transparent PVC with soft blades. So, accidentally if you touch it maximum you get a slap on the wrist. Nothing beyond that would mind your do not try do not put it because a very sharp.

Say you see that those things are now have been replaced with 2 things. One is ceiling sensor replaced with aluminium blades and then a tables fans are all replaced with other non metallic materials. So, the trusting does not take place. So, it happens here that any if you leave when the expose I mean area, where humidity is very high you end up with

this unwanted salinity in the atmosphere. So, there is a huge table here probably after this I will give it a break.

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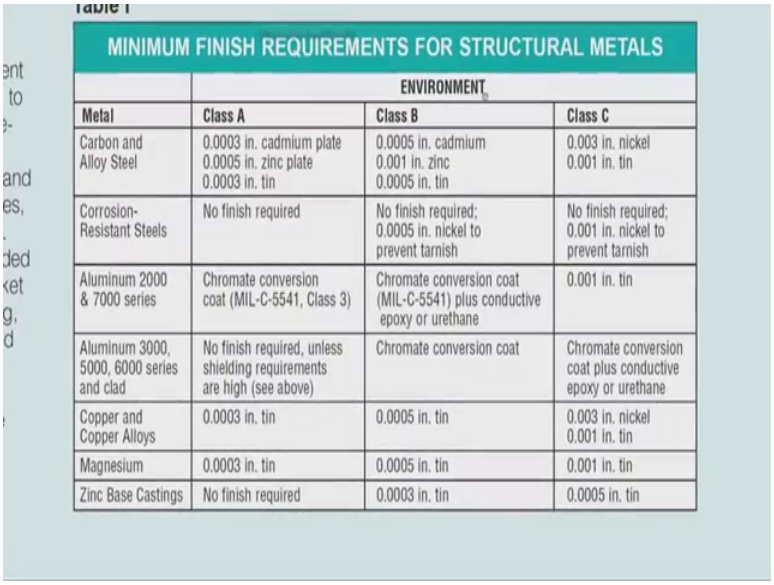

Table I

MINIMUM FINISH REQUIREMENTS FOR STRUCTURAL METALS

	ENVIRONMENT		
Metal	Class A	Class B	Class C
Carbon and Alloy Steel	0.0003 in. cadmium plate 0.0005 in. zinc plate 0.0003 in. tin	0.0005 in. cadmium 0.001 in. zinc 0.0005 in. tin	0.003 in. nickel 0.001 in. tin
Corrosion-Resistant Steels	No finish required	No finish required; 0.0005 in. nickel to prevent tarnish	No finish required; 0.001 in. nickel to prevent tarnish
Aluminum 2000 & 7000 series	Chromate conversion coat (MIL-C-5541, Class 3)	Chromate conversion coat (MIL-C-5541) plus conductive epoxy or urethane	0.001 in. tin
Aluminum 3000, 5000, 6000 series and clad	No finish required, unless shielding requirements are high (see above)	Chromate conversion coat	Chromate conversion coat plus conductive epoxy or urethane
Copper and Copper Alloys	0.0003 in. tin	0.0005 in. tin	0.003 in. nickel 0.001 in. tin
Magnesium	0.0003 in. tin	0.0005 in. tin	0.001 in. tin
Zinc Base Castings	No finish required	0.0003 in. tin	0.0005 in. tin

You see here metals carbon alloy steel aluminium. So, on and no copper (Refer Time: 30:13) magnesium zinc based finishes now class a b we are, slowly coming into something here you have seen this, probably it is old cadmium is band no. We have a serious issue, cadmium is environmentally once a except where you cannot for various reasons, one of the reasons being the other mating surfaces are already come will cadmium.

So, you cannot put a nickel plated cover with a cadmium plated this thing because it makes a perfect 1.2 old nickel cadmium sell good know nickel cadmium is 1.2 volts are right you know may be 1.2 5 or So. The electro chemical equivalents of them know they make that so, you cannot suppose the other point already comes with a cadmium plated, you cannot replaced with anything your force used cadmium again. Otherwise by a default everything is zinc with passivated with bichromate. This anti carrousel steels now finish is required absolutely and you see this beautiful this thing. Chromate conversion coating is done that is I; I am not very familiar with the process except that if you need to specify either zinc or basic aluminium itself you can do this chromate conversion. And aluminium 3000, 6000, 5000 all these are new modern materials with silicon, probably elements I do not know no traces of copper, and very, very complex metallurgy.

So, it is complex metallurgy. So, you would have come across 6065 bicycle tubes and also 707 something. So, we have 6 zeros 005 and then 70 I think 65 and so on, of this things. They are all instantly luckily for us they also do not need conductivity as so, here you know 6000 series no finishes required unless shielding requirements are high, otherwise no by default everything is given to a chromate conversion. That is it is heated cleaned surfaces activated de scaled and dipped in a chromating bath potassium michel mate further down everything (Refer Time: 32:57) by definition is tin plated. Advantage of tinplating is first of all it is slight bluish cluster is there, shines looks a little like chrome.

So in fact, several of the kitchen appliances you say all those you know metallic things here there fully strain less steel are if not it is a zinc plated it is harmless. I am sorry, a tin or a zinc one of those zincs tin or zinc plated very rarely you find nickel in that. So, the advantage for it is zinc can also be chromate it. Tin bright tin is absolutely no issue. Except when you are trying to use your remote control for the AC or for your TV or I do not know, for switching me off.

The battery contacts usually they come for some reason they come with nickel plating, not tin plating and then the wire which is connected to that is soldered and then something that spring which comes on top of it. The platings are not easily comfortable with that cell, which is use that cell which you put inside the recommend and what we put alkaline cells, some reason or something happens and it forms a lows contact, all you have to do is take it and rub it the rub this cell and also note write to clear the compartment you put it back, seems to work I just trying to give you a common example. And then I think I will before you switch me off I will stop. We will continue next time so.

Thanks for listening to this.