Course name: EMI /EMC and Signal Integrity: Principles, Techniques and Applications.
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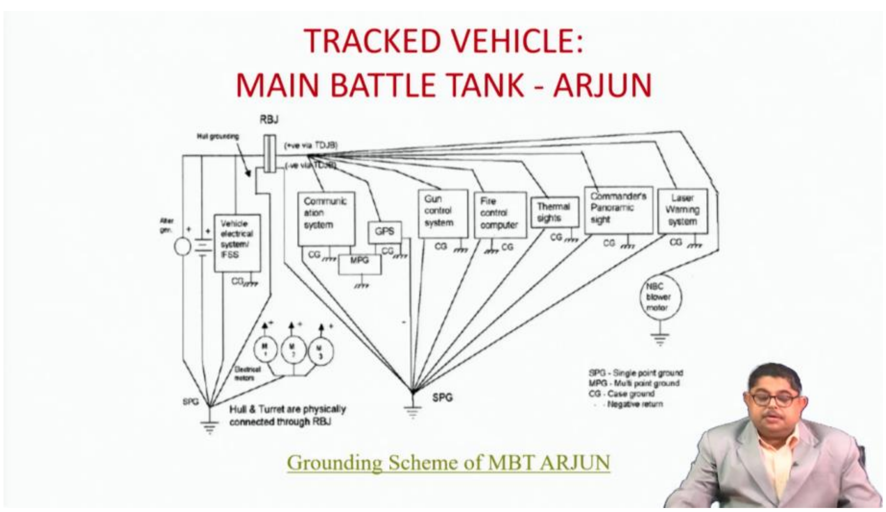
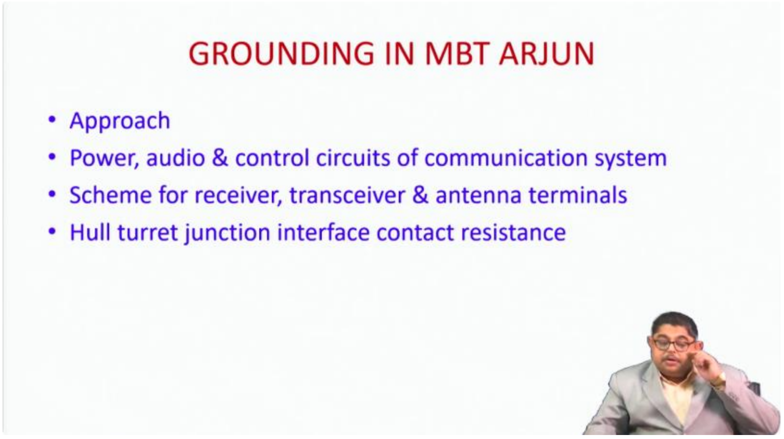
Week :12
Lecture 58: EMC Case Studies

Welcome to the lecture of the course on EMIMC and Signal Integrity Principles, Techniques and Applications. In this lecture, we will see some EMCK studies done at Sumit Chennai and I got this material from Dr. D. Subbaraw, Sumit Chennai. So, you see a Odejune which is our Indian Army s battle tank. So, this is the grounding scheme of MBT Odejune. So, you can see that hull and turret are physically connected through our BJ vehicle electrical system and here those terms that we have already seen the single point ground, multipoint ground, case ground, negative return all are shown. So, these are common case ground. Now, there are MPG, there is SPG etcetera. So, depending on the requirement various grounding schemes are there.



Now, when you try to find the grounding scheme, you will have to have the approach that power audio and control circuits of communication systems, they should be separately treated. Then you should have scheme for receiver, transmitter and antenna terminals, hull turret junction interface that will be that should be treated separately. So, these you need to understand a system EMC system engineer, he needs to understand that these are separate, their scheme should be separate. So, he should make ready the schemes for these categories separately.



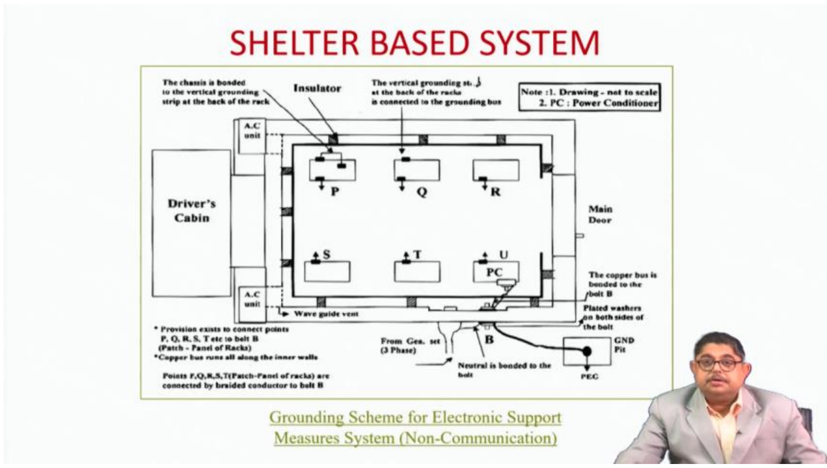
Now, these are the hull turret junction interface contact resistance. So, various measured resistances he has found, you see that the measured resistance is quite low except turret distribution junction box to transmitter. So, that is 24 milliohm and voltage you see that master junction box to in control junction box, there you are having a 60.83 millivolt, but they are all within the recommended limit. So, that, but this is the way you can test it.

HULL TURRET JUNCTION INTERFACE CONTACT RESISTANCE

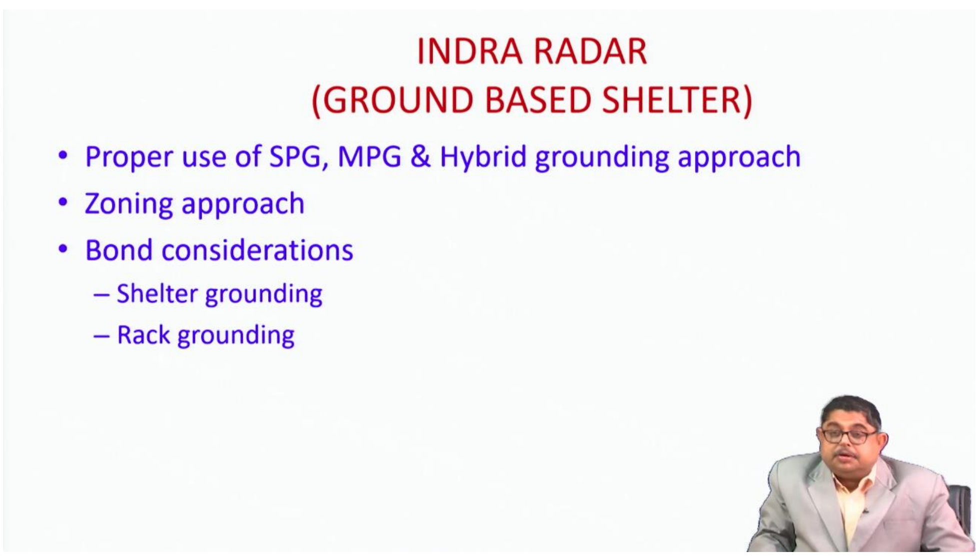
Hull-Turret Junction Interface Contact Resistance

Location	Measured Resistance (mΩ)	Voltage (mV)
Battery to Master Junction Box	1	0.68
Battery to Rotary Base Junction	1	0.56
Master Junction Box to Engine Control Junction Box	0	60.83
Master Junction Box to Rotary Base Junction	1	6.76
Rotary Base Junction to Turret Distribution Junction Box	1	3.8
Turret Distribution Junction Box to Hydraulic pump motor	2	1
Rotary Base Junction to Hydraulic pump motor	1	2.85
Turret Distribution Junction Box to Transmitter	24	0.109
Turret Distribution Junction Box to Transmitter	1	0.18
Transmitter to Receiver	1	0.08

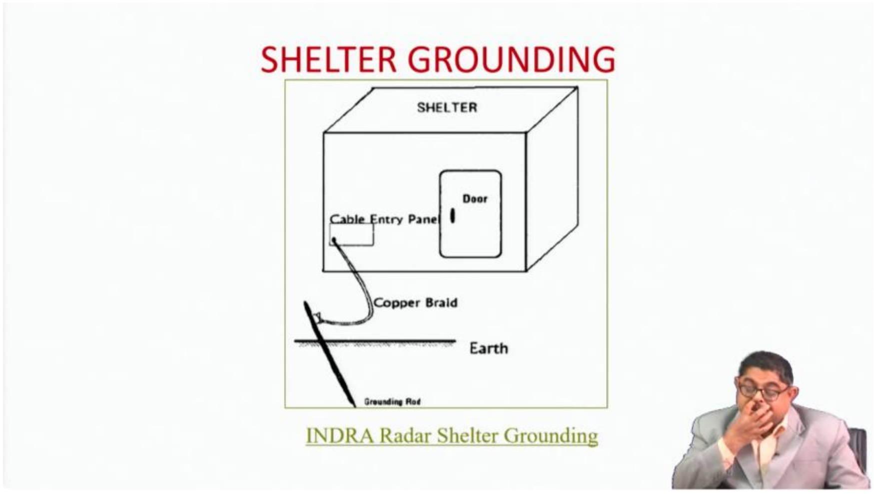
Shelter based system, so grounding scheme for electronic support measure systems, non communication things that means, the except communication you know power control and other things. So, those things how to ground this chassis is bonded to the vertical grounding strip at the back of the rack, provision exist to connect points various this PQRST etcetera to belt, patch panel of racks, copper bus runs along the inner walls. So, with this the and here P C means power conditioners, there will be various power conditioners to give you the proper signals. So, that is the PC box or your U box whatever you call it, then there are wave guides etcetera, how they are to be you see there are some gaskets put, there is some joints made. So, all these since we have individually discussed, so the grounding scheme here is a total system, but here you can identify those various things.



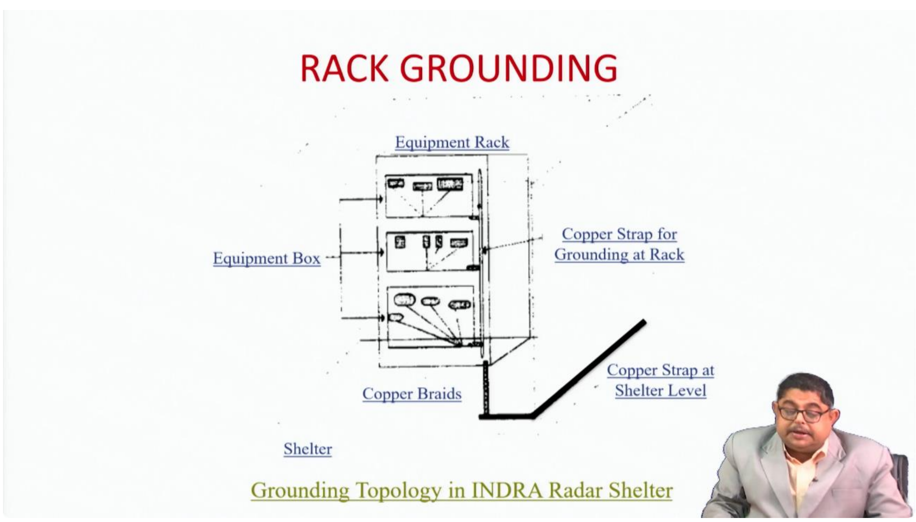
Now, a ground based filter in the radar, this is also Indian armies radar. So, you will have to have proper use of SPG, MPJ and hybrid grounding approach, then you will have to have zones, you separate various zones at zone level you do the grounding or bonding. Then bond consideration you should have shelter grounding, rack grounding etcetera.



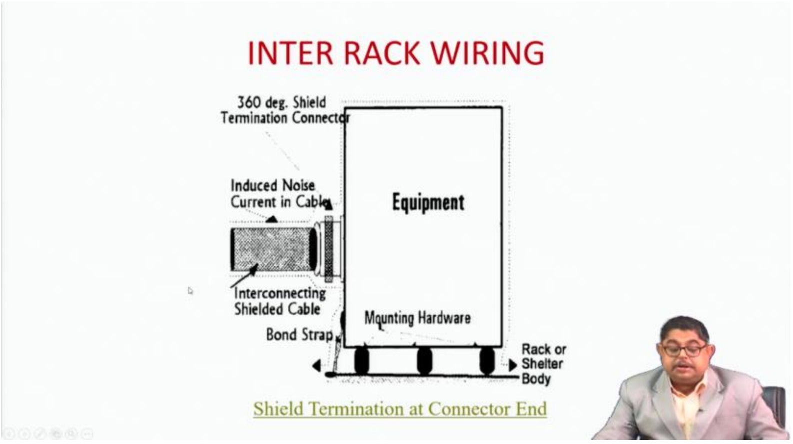
So, shelter grounding you see that there is a cable entry panel, so the door, so of the whole shelter, so that is grounded. So, with a copper bread, then you have a grounding rod which is going inside, so this is the shelter grounding. That means, when the radar is not moving it is in the shelter, you will have to ground it.



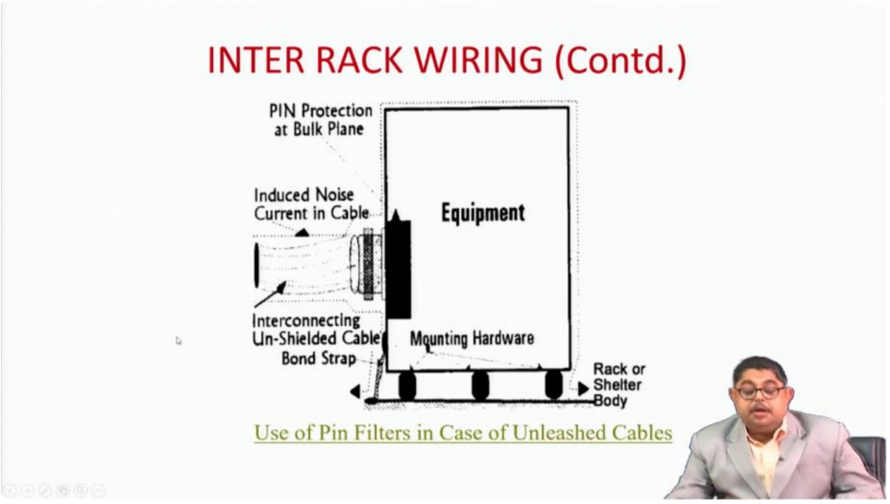
Then this is the rack grounding, you have a equipment rack where here it is shown three equipment boxes are put. So, the equipment rack is finally grounded, you see that copper strap at shelter level, copper strap for grounding at rack, this is the copper breads and the whole thing is now grounded. So, this is a rack, so the rack needs to be at shelter level if you can ground, the racks are made of metals. So, the whole thing only thing is this separate equipment boxes through this copper strap, they are all connected and that gets connected to the shelter grounding copper bread.



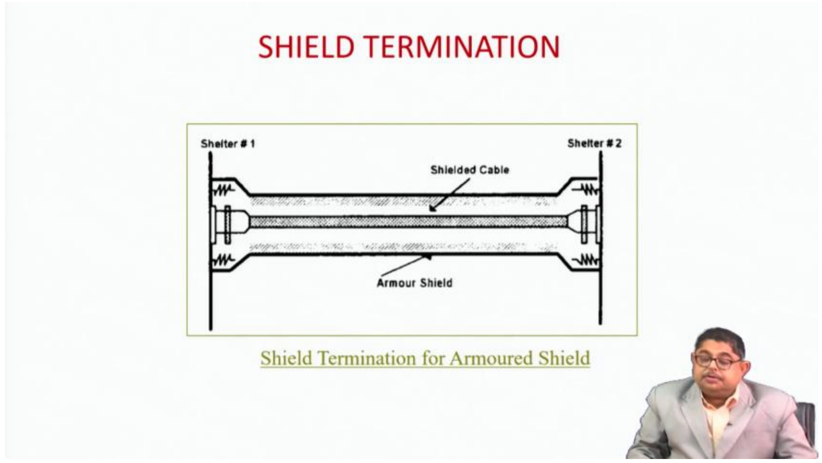
Inter rack wiring, so if you have various racks, so this is the way you can, this is the rack or shelter body. So, from this you go to the other racks in both the sides and you have shield termination at connector ends. So, that is shield termination connector, induced noise current in cables, so that is coming, so interconnecting shielded cable. So, this is a shielded cable with this you will go to another rack, bond strap is there, so mounting hardware is put with this bond strap.



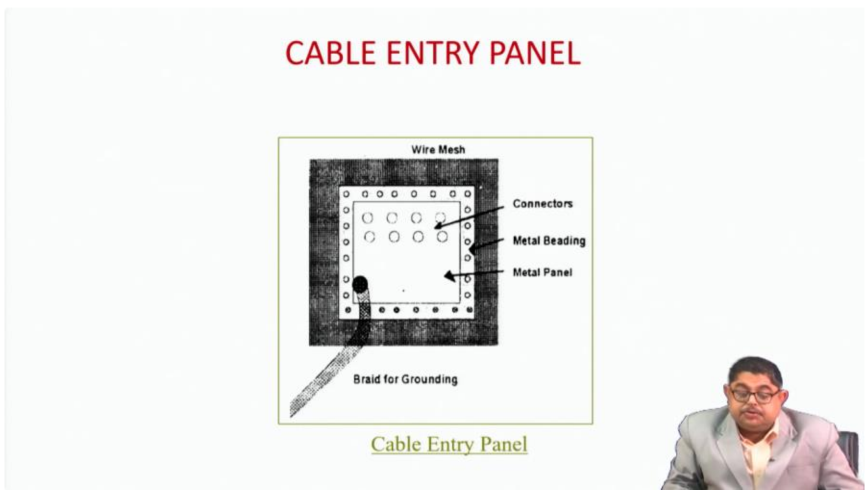
Inter rack wiring, again we are continuing the previous, pin protection at bulk plane induced noise current in cable, so you see with all those also there will be some induced noise. So, interconnecting unshielded cable, bond strap, so if you do unshielded cable this is the picture, whereas we also you see that shielded one you do not have almost any induced noise current. So, that is the why always shielded cable is prepared,



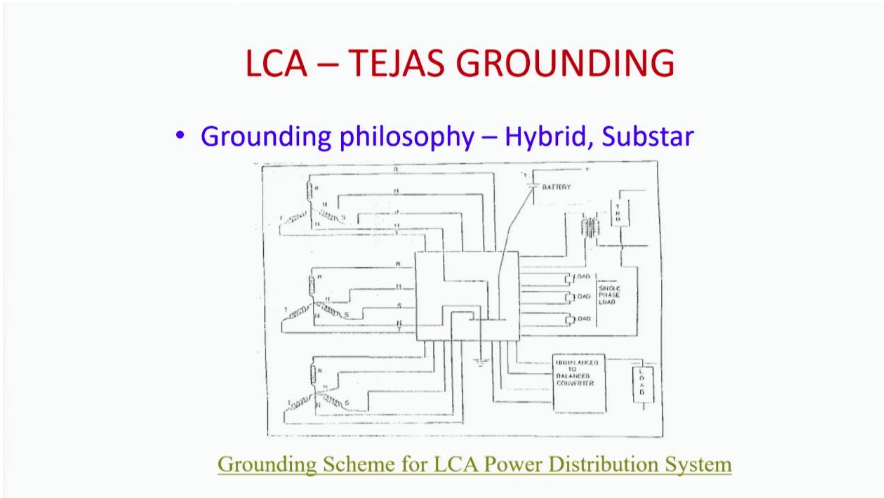
then shielded termination for armored shield. So, there is a cable, then there is a armored shield that is the body of the tank, so that acts as a shield, so shelter one, shelter two in between them you can see there is a lock there that is getting connected, so the type of the bond that you are seeing.



Then cable entry panel, there is as we discussed there is wire mesh throughout, then at the cable entry door you have the connectors, then metal breading is there and then metal panel is there which with which you are putting other circuitry here cable entry.

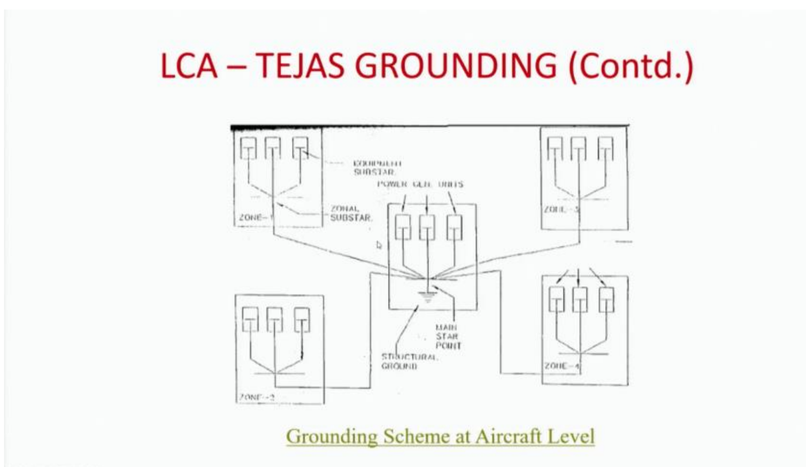


Then this is the aircraft level grounding, Tejas helicopter or light combat aircraft that counting scheme is this, so the scheme is conceptually hybrid and sub star. So, there is a, so there is star connection.



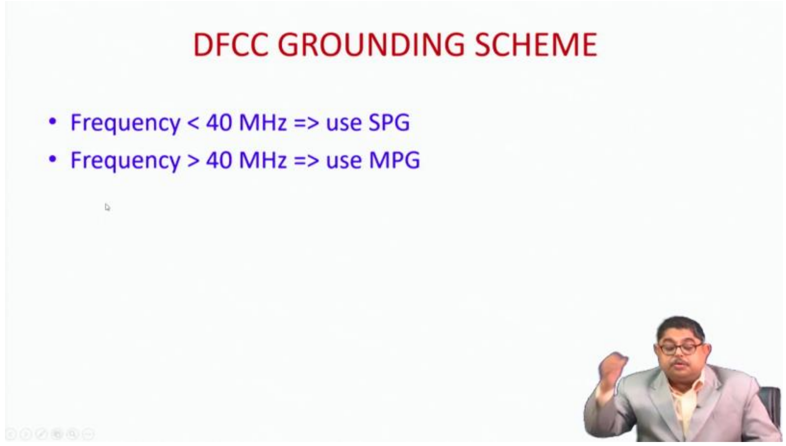
Grounding Scheme for LCA Power Distribution System

and this is at zonal level to zone 1, zone 2, zone 3, zone 4 you have these grounding schemes, main star point is you see the power generation you need there is your main star point from which you do the structural ground and also the main point all zone stars they are connected to this main star point and then finally, it is grounded that is LCS grounding scheme.

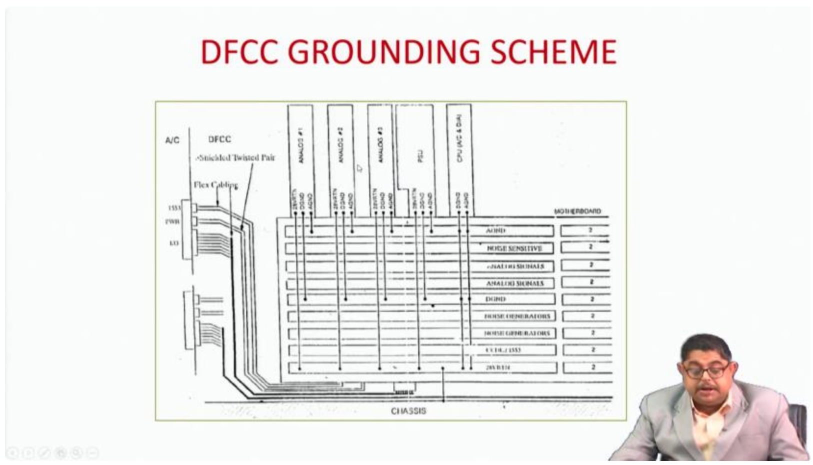


Grounding Scheme at Aircraft Level

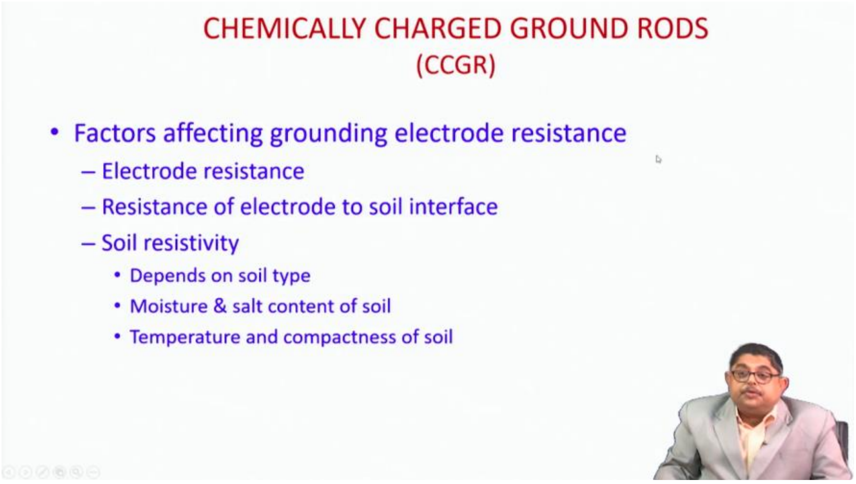
Now, it is recommended DFCC is a standard they say that if your frequency is less than 40 megahertz use SPG single point grounding, if it is above 40 megahertz use multiple point grounding.



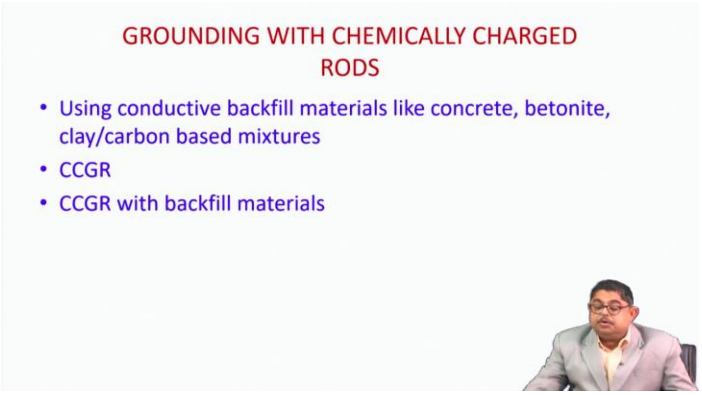
So, DFCC grounding scheme, so this is the chassis, this is various mother boards, so how you ground it that it is given here.



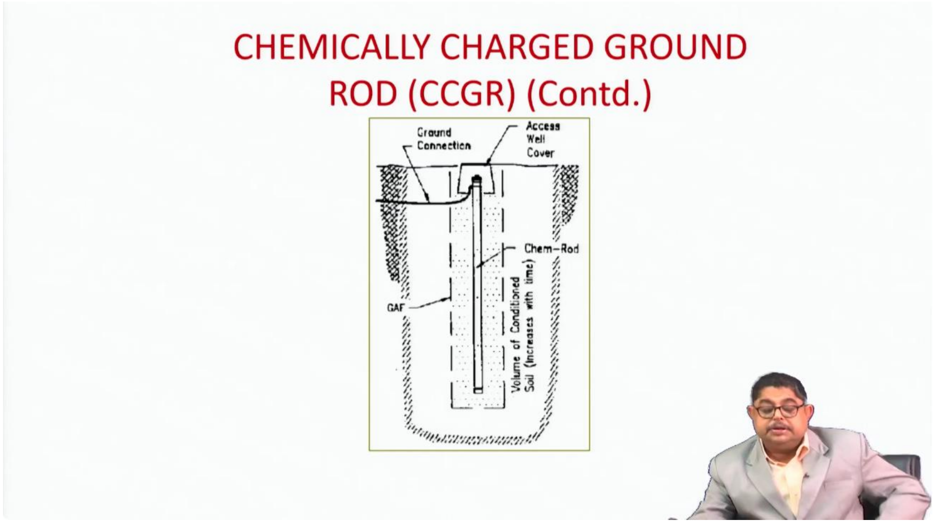
Now, also there is you will have to put your effort in making the ground rods you are seeing that in all these cases this grounding where now that how to design that is given here that you can have that grounding electrode resistance that we have seen that that should be kept below 2.5 milliohm I said that that is making ensuring that is very difficult by us, but you can have that grounding electrode resistance that should be kept below 2.5 milliohm actually the those sophisticated system like whatever we have seen they made that. So, factors affecting grounding electrode resistance is the electrodes own resistance and resistance of electrode to soil interface because electrode is going to the soil. So, there also there is an interface there also a resistance come. Now, soil resistivity depends on soil to soil type moisture and salt content of soil temperature and compactness of soil.



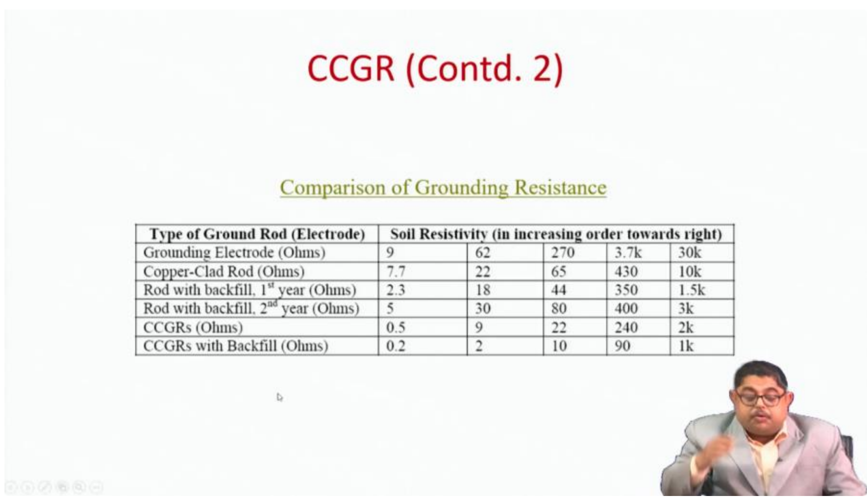
So, now a better method is instead of having just a simple metal rod using conductive back fill materials like concrete, betonate, clay, carbon based mixtures back fill means the when you dig a hole there first you fill it with this conductive back fill materials in one popular one is carbon, but these are also there you can make concrete, you can make betonate, you can make clay these are all conductive things. Now, then another scheme is you can chemically charge the rods and the best one is you back fill as well as you chemically charge the rod CCGR chemically charged grounding rod.



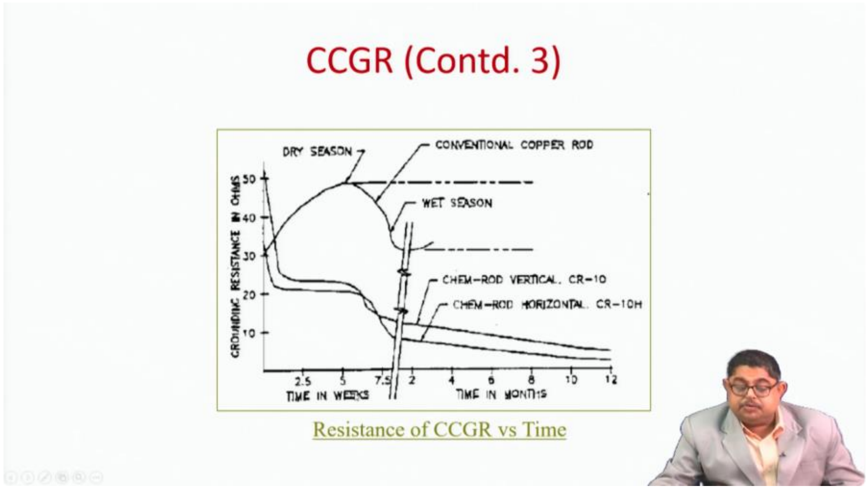
So, this is a chemically charged ground rod. So, this is the it has been shown the ground connection, this is the access well cover, then this is the chemical rod. Now, volume of conditioned soil. So, soil is put here increases with time then this is called a CCGR it is fabrication diagram.



Now, comparison of grounding resistance. So, if you have simple grounding electrode. So, soil resistivity becomes 962, 270, 600 k, 3.7 k, 30 k copper clad rod this is actually with time that means, with every year how you get it copper clad rod. So, soil resistivity is 7.7 rod with back fill first year. So, 2.3, 18, 44 etcetera rod with back fill second year, second year you see that means, as the time progresses more water goes into the soil. So, the resistivity increases. So, 530, 80 etcetera whereas, if you use CCGR you see with only CCGR no back fill 0.5 then next year it will increase to 9, 22 etcetera whereas, CCGR with back fill 0.2. So, obviously, CCGR with back fill is the best, but people may say that that will be very costly whether we need that.



So, that is why there is a crap of resistance of CCGR versus time. So, grounding resistance versus time you see that time in months. So, a conventional copper rod you see that it starts from 30 ohm then in this is the dry season when it is 30 ohm. So, it is going to 45 or 46 then it is in the coming down in the wet season and chemical rod that means, CCGR.So, that is called CR 10 one variety that with time it is coming down chemical rod horizontal CR 10 age that is still better. So, with time they are having better performance.



So, now if you do a cost comparison. So, suppose you have a, so the copper rod is coming down conventional one. So, resistance of one rod in ohm 160 ohm number of ground rods required one ohm and five ohm you require 523 and 83 rods. If your requirement is one ohm you require 523 rods because resistance of one rod is 160 ohm. So, you will have to make parallel connections to reduce that that is why 523 whereas, if you have requirement of five ohm you require 83 such rods and area required around the ground rod because each rod you will have to have certain space. So, that requires so much that 198000 square feet similarly for five ohm you require 38179 square feet. Now, installation cost is given in lakhs 17.18 2.72 installation cost in lakh rupees with land cost. So, that is you can see one crore here it is 16 lakhs for five ohm. Now, come to the installation cost best method that is CCGR with backfill. So, resistance of one rod is there 22 ohm. So, you require to have one ohm you require 53 rods. Now, let us see what is the installation cost for one ohm it is 13.28 lakhs whereas, for conventional one ohm it is 13.28 lakhs for conventional it was 17.18 lakhs. Similarly, for five ohm it is 83 lakhs whereas, here it is 2.72 lakhs and if you put the land cost now that is a various places there will be various land cost, but technically I think from here it can be proved that CCGR with backfill even if they lose that their initial cost is looks or looks that it is expensive, but ultimately to reach your goal technically whatever it gives that is the cost that you cost effective as well. You see there is definitely it is cost effective by all means and here you see that for if you have a requirement of five ohm then it is definitely cost effective if you have requirement of one ohm compare to one crore only 22 lakhs will be required with CCGR with backfill. So, please if you do it anywhere the grounding thing do CCGR with backfill materials that is the best method both technically as well as economically. I think with this case studies we have come to an end and we have done it with various system aspects etcetera we have seen. So, you should have a fairly good amount of exposure to what happens in EMC field. Thank you.