A Practical approach to assessing Human body discharge potential

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Abstract :

As a part of ESD Audit of exercises the body discharge potential of a individual on to the plate of a charge plate analyser were measured by making the individual place his palm on the plate when the analyser is on the charge mode but is not previously charged. These measurements have been made at eight industrial establishments and on a total of twenty six individuals . The establishments were spread across the country. The type of flooring involved are : I.nsulative Tiles, Insulative Carpet, ESD vinyl sheet, ESD Vinyl flooring and Epoxy Flooring. Relative humidity during measurements was higher than 35% .On the basis of the measurements following conclusions can be drawn: Geographical location appears to have no influence on the readings . There is a clear cut variation in the registered body voltages depending on the type of floor. It is maximum when the flooring is insulative and minimum (and less than 100V) when the flooring is dissipative.. The plate voltage appear to be an indirect estimate of the human body potential and probably can be used as such. The measurements were made when the individual is wearing ESD foot wear or ESD Heel straps. When the footwear shows a fail at 35megohms on the footwear tester with Foot Plate the Plate Body voltage is higher even on a dissipative floor. When the ESD Footwear/Heel Strap is worn there appears to be reduction in the plate voltage even on an insulative floor but on the insulative floor it is never less than 200V. The voltage is 100V or less when the Foot- Wear shows a pass at 35 meg on a footwear tester/ Pate and the flooring is dissipative . This measurement itself may be a quick index of the.human body potential. Further work is indicated.

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Introduction :

There is increasing recognition that considerable damage is caused through the human body model to sensitive Microelectronic devices. Hitherto emphasis was being laid on the measurement of surface to Ground resistance in a working area assuming that less than a particular value would ensure a low human body potential. Recently the concept of ensuring a low resistance pathway to ground by emphasising a particular value for the person to ground resistance and also the emphasis on the actual measurement of the human body potential of the individual have been introduced in the ESD standards (ANSI 5.20.20(2007)). Practically however the measurement of the human body potential is not easy and a simple way of assessing this has become important. One generally accepted method is to measure the potential using a charge plate analyser. It is yet to be firmly established whether this method really measures the 'body potential' of an individual and not 'the discharge potential' of the person to the charge plate.

However, with the need to assess the actual threat to a sensitive device in various work areas, the 'plate potential' on the charged plate by a person was considered as a satisfactory indicator during the course of ESD Audits conducted by the Authors at various locations. The results of these measurements are presented below.

Materials and Methods :

Relative Humidity :

A calibrated digital Humidity meter was used to make all RH measurements.

Surface to Ground Resistance Measurement : (STG)

A Monroe surface Resistivity meter with standard 5lb probes were used to make all surface to Ground measurements.

Person to Ground Resistance (PTF)

The person was asked to hold a probe on the palm, and the second cable from the SR meter was connected to the Grounding point. The person to Ground Resistance was measured when the person stands on the actual Flooring system while wearing ESD Footwear.

Body Plate Potential

A trek charge plate analyser (Model) was used for these measurements. During Measurements the instrument was suitably grounded.

Footwear Resistance :

The person wearing the Footwear keeps one Foot on the metallic Foot Plate. The meter is set to either 35 megohm or 100 megohm and Pass /Fail at that resistance is noted.

Results and Discussion :

The sBody Voltage measurements are presented in Table I.

Explanation of the Table :

Each capital letter at the left hand corner refers to a particular Industrial establishment. The name of the establishment has been omitted but its geographical location has been mentioned.

Under the serial number each numeral refers to a particular individual in the particular establishment on whom the measurements were made.

Total number of establishments =8

Total number of individuals = 26

Table 1. Discharge Potential Measurements

	Location	Floor characteristics			RH	Sl. No	Footwear	Voltage Plate	Remarks
		Type of Floor	STG	PTG					
A	Coimbatore	Marbonite	10×10^{12}	10×10^{12}		1	Fail-100 Meg	600V	
							Pass – 35 Meg #	500	
						2	Fail-100 Meg	750	
							Pass – 35 Meg #	400	
						3	Fail-100 Meg	600	
							Pass – 35 Meg #	500	
						4	Fail-100 Meg	630	
							Pass – 35 Meg #	230	
B	Hyderabad	Insulative Floor	10×10^{12}	10×10^{12}	39	1	Fail-100 Meg	320	
							Pass – 35 Meg #	200	
						2	Fail-100 Meg #	400	Wearing ESD Shoes
							Pass – 35 Meg	400	
						3	Fail-100 Meg	450	Wearing ESD Shoes
							Pass – 35 Meg	200	
						4	Fail-100 Meg	470V	Wearing ESD Shoes
							Pass – 35 Meg	400V	
						5	Fail-100 Meg	550V	Wearing ESD Shoes
							Pass – 35 Meg	350	
						6	Fail-100 Meg	300	Wearing ESD Shoes
							Pass – 35 Meg	730	
						7	Fail-100 Meg	470	Wearing ESD Shoes
							Pass – 35 Meg	340	

						8	Fail-100 Meg	350	Wearing ESD Shoes
							Pass – 35 Meg	240	
C	MADWRAI	Access Tiles	10×10^9	10×10^9	35	1	Pass-100 Meg	300V	Wearing ESD Shoes
						2	Pass-100 Meg #	500V	
						3	Pass-100 Meg #	1300	
						4	Pass-100 Meg #	1500	
d	BANGALORE	Compressed PVC Tiles	1.1×10^6	0.8×10^{-7}	35	1	Pass – 35 Meg #	90	
						2	Pass – 35 Meg #	70	
E	CHENNAI	ESD Vinyl Sheet	3.9×10^6	3.0×10^7		1	Pass – 35 Meg #	100	
F	BANGALORE	ESD Vinyl mat	1.6×10^8	0.8×10^8		1	Pass-100 Meg #	600V	
G	BANGALORE	Compressed PVC Tiles	1.1×10^7	1.1×10^7		1	Pass – 35 Meg #	80V	
H	PUNE	ESD Epoxy Floor	1×10^7	2×10^7	53%	1	Pass – 35 Meg #	85	
						2	Pass – 35 Meg #	40	
						3	Pass – 35 Meg #	90	
						4	Pass – 35 Meg #	85	

NOTE: # INDICATES PERSON WEARING ESD SHOES/HEEL STRAP

Several decades of experience of the Electronic Industry has vindicated the two namely: assumtons made by all the International ESD Standards(1), namely:

1. One of the ways Sensitive micro-electronic devices can be damaged is by the dicharge of Electrostatic charges into the device from a human body discharge.

2. The amount of discharge from a human body can be controlled by controlling the work Environment (including Personal Grounding methods) so that the discharge voltage is less than a permitted voltage.

Even though the word Human Body Potential is

Widely being used in the ESD literature, on the basis of two following points it can be argued that

what is being referred to is in reality the Human Body Discharge potential:

- The Circuit prescribed by the ESD standards the determine the HBM Voltage is meant to apply specific voltage into the pins of the device and observe the damage caused at that voltage. This voltage at which the damage is caused is called the HBM Voltage.
- What is really relevant to the Industry is the quantum of potential discharge going into the device. However, by basic definition, the Potential energy of Human Body is calculated using the equation.

Potential Energy = ½ CV2 where V is the body voltage and C is its

Capacitance

When we refer to Human Body Potential It would appear that we refer to this Potential Energy. It would appear therfore that the Human Body Potential and the Human Body Discharge Potential are two different entities which may be mutually dependent. For the purpose of this paper the discussion of this difference would be highly complicated and beyond its scope.

It is however enough to mention that the readings registered by the individual's hand on the plate of a charged plate Analyser in all probability is the 'discharge potential' of the individual on the plate and should be referred to as such. This reading would actually satisfy the conditions (a) and (b) mentioned above. For this reason these readings would be useful even if they may not actually be 'The Human Body potentials".

The Table below records the Human Body Discharge Potential from the hand of individuals under Test.

From the Table-1 it is apparent that the geogtaphic location of the establishment has no bearing the registered Plate discharge Voltages. This would be in keeping with the basic assumption made by the Standards and the Electronic Industry that the average value of the Human Body Potential is valid for all locations universally and that it can be controlled by controlling the environment in the ESD Controlled work area.

Apparently no such study has been carried out under Indian Conditions earlier.

It can be observed from the Table that there is a definite decrease in the Body Plate Voltage at controlled humidity when we move from an insulative floor to compressed PVC Tile Flooring. The Voltage is highest when the Floor is Marbonite or insulative carpet but is minimum on all other floorings which have a surface to ground resistance in the dissipative range. Probably therefore these plate discharge voltages are proportional to the "Human Body Potential", The requirement that the voltage of a person wearing ESD footwear standing on a ESD compatible Floor should be less than 100V is satisfied apparently on a dissipative Floor. Though it appears that on wearing an ESD Shoe or a Heel strap there is a reduction in the voltage, the figures should be taken with caution. It should be remembered that this reduction is apparent during the short period of testing. The level of static would probably be considerably higher during a work day when several movements over the insulative Flooring can generate high static and may thus result in the apparent reduction to be lesser.. In general one should expect a reduction in static generation due to friction when one of the two insulators namely the Floor and the Footwear are replaced by a dissipative Footwear. This is brought out by the Table.

The ESD/EOS Association technical Report (2) shows that a linear correlation exists between person to Ground Resistance and Human Body Potential. As per this correlation the Body voltage is less than 100V if the Person to Ground Resistance is less than 35 Megohms. It is therefore not surprising that the plate discharge voltage is more than 100V when the Foot- Ware worn by the individual shows a Fail on the Footwear tester. Here again, it is to be emphasised that the Pass/Fail reading on the Tester has been measured by pressing one Foot of the individual wearing the Footwear on a grounded metal Footplate clearly this Fail Reading reading does not include floor resistances.

It is remarkable that there is a clear increase in Plate Discharge Voltage when the individual wearing Footwear which shows Fail at 35Meg Ohms stands on an ESD floor and the plate discharge voltage is now measured

That this is not a stray observation but is reproducible makes it interesting. Footwear is apparently a major parameter which influences plate voltage of the individual when standard conditions of relative

Humidity and Flooring resistance are maintained. It would mean that the voltage reading could be roughly inferred by testing the individuals' Footwear on the Tester and hw then stands/ walks on the ESD floor wearing the same footwear.

SUMMARY;

On the basis of the above findings it can be concluded that measuring the ‘plate discharge potential’ of an individual would give us a rough estimate of his 'Human Body potential '. It is also observed that the plate discharge voltage would be higher than 100V when the resistance of the person 's footwear is measured with a Footwear-Tester and when Fail is indicated at 35Megohms. Both these measurements can be practically made easily in a work area.

Reference :

1. ANSI S20:20 (2007)..

2.ESD TR Handbook (1997)

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