ESD Control, ROI (Return On Investment)

ESD CONTROL & (HUGE) COST SAVINGS

Ryne C. Allen
Desco Industries Inc. (DII), Employee Owned
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INTRODUCTION

I Introduction to ESD Control Programs

ESD Control programs are an essential part of a quality process and are always needed when handling ESD sensitive electronic/semiconductor devices. The extent of the ESD Control program is determined by the ESD Sensitive (ESDS) devices themselves and how they are handled. Refer to article "How to Set Up an ESD Control Program" [1] for additional information.

One of the main reasons that companies deploy ESD Control programs is to save money. Increased throughput and decreased scrap can yield a Return On Investment (ROI) of up to 1,000% per [2]. A secondary reason is to comply with their customers' and ISO 9000 type programs' requirements. Whatever reason, setting up and implementing an ESD Control program will almost always produce favorable financial results.

II Cost Reduction via ESD Control Programs

Having ESD awareness and following through with an ESD Control program is essential in reducing quality failures due to ESD. ESD can affect product reliability with catastrophic damage which is readily apparent to latent degradation. Latent degradation is particularly expensive requiring costly inspection and rework cycles in-house or product failure in the field. Maintaining good ESD controls will improve product throughput or yield, increasing reliability in the field which improves customer satisfaction leading to increased future business.

One test equipment manufacturer noted that GMR heads were being damaged during or after testing. These heads are extremely sensitive to ESD, and require additional handling precautions.

It is very important when designing and implementing an ESD Control program to know the ESD susceptibility of the ESD Sensitive (ESDS) devices you are trying to protect. Classification of these devices should include all simulation models human body model (HBM), Machine Mode (MM), and Charged-device Model (CDM) that will properly characterize the devices' sensitivity when handled at various locations within the facility [6]. This will allow for the most economical program design.

Gene Chase, an ESD Consultant with ETS Inc., is quoted as saying "Millions of dollars are lost every year due to ESD [4]. Many of these incidents occur within the computer and communications industry." Examples of losses from ESD may be any of the following:

1. Lost Time
2. Loss of Connection
3. Loss of Data
4. Shocks to Personnel
5. Upset to A System Requiring A Re-Boot
6. Damage to Equipment
7. Equipment Hardware Failure

To properly determine the return on investment (ROI) from your ESD Control program, you must collect return, repair and scrap cost data before and after implementation.

Terry O'Malley, former AT&T ESD Manager, had collected data from several AT&T facilities both before and after instituting an ESD Control program. The data speaks for itself; see figure 1 for a graph of two facilities that were monitored. There was over a 50% savings in return and repair costs found at both facilities after initiating their ESD Control programs.

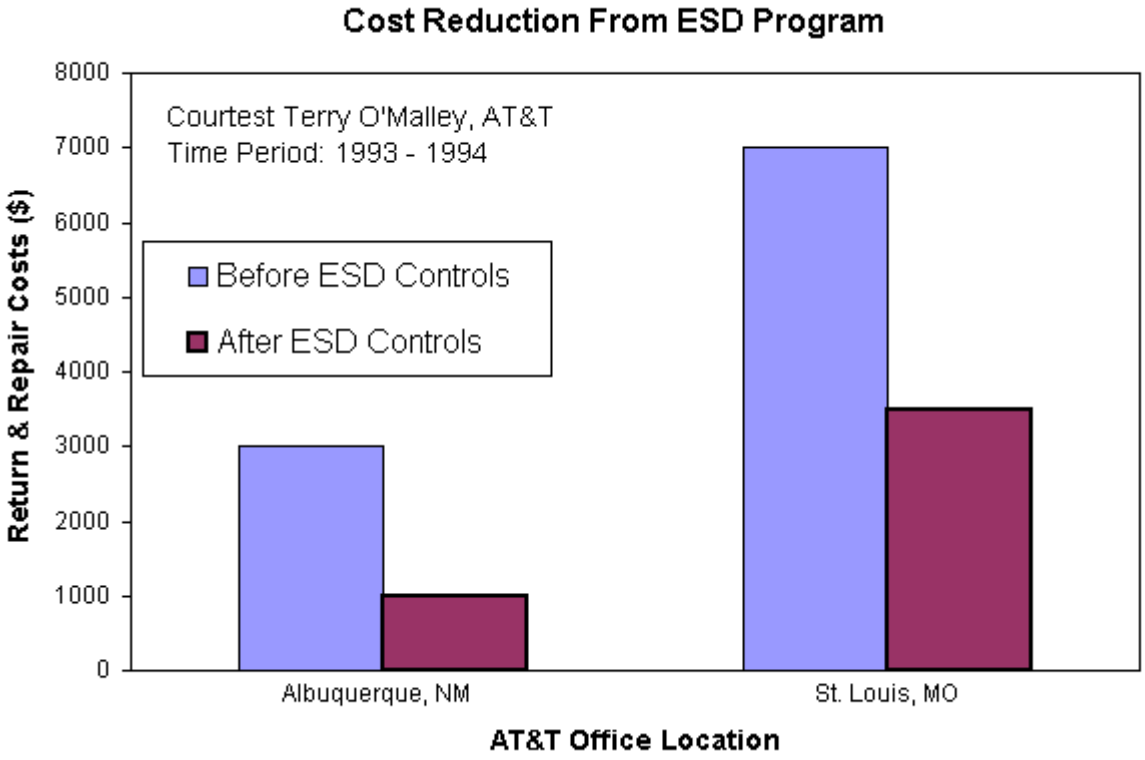

*Figure 1 – Cost Reduction From ESD Program, AT&T Office Location

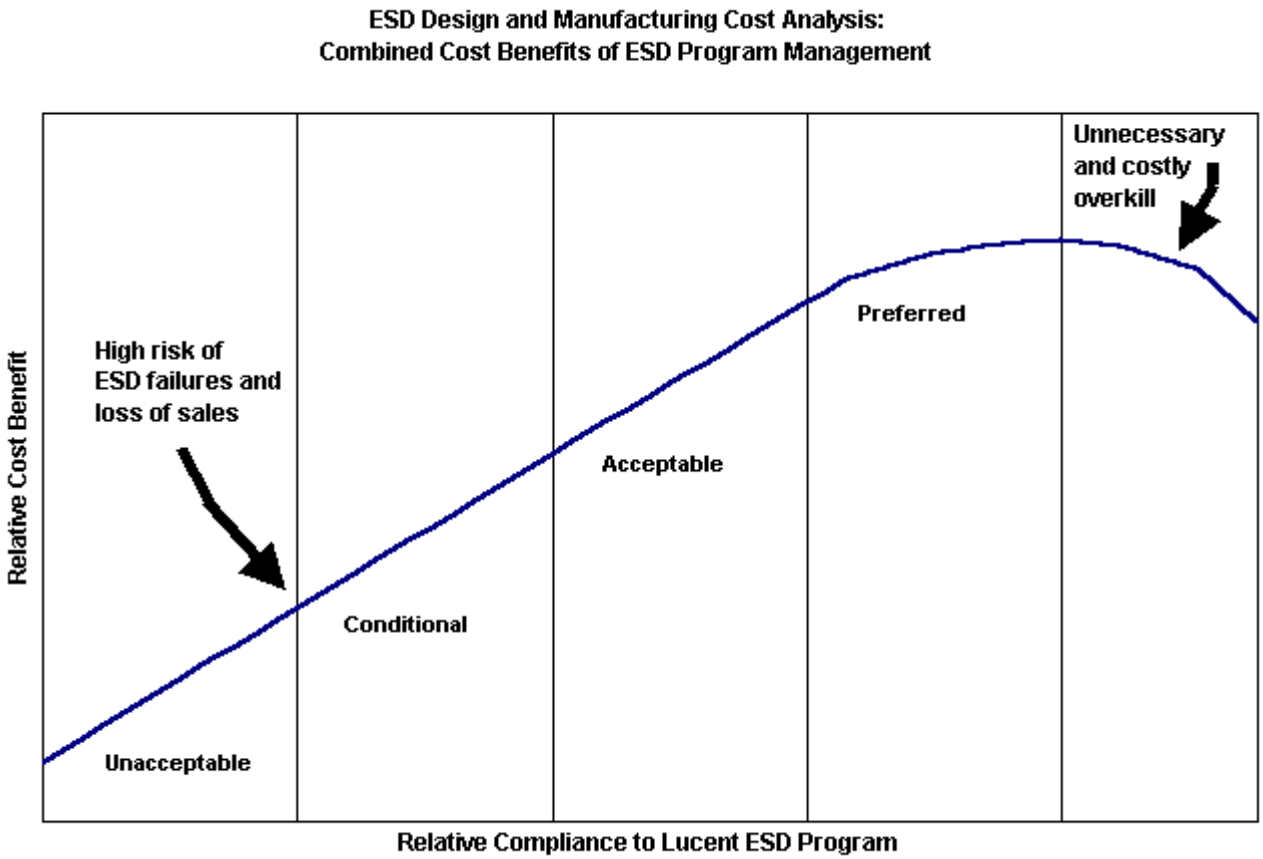

*Figure 2 - ESD Design and Manufacturing Cost Analysis: Combined Cost Benefits of ESD Program Management [2]

Figure 2 abstractly represents the relative cost benefits of Lucent's ESD Control program with the relative compliance to this program [2]. A typical return on investment (ROI) for a strict ESD Control program, like that used at Lucent Technologies, is typically 1,000 %. The design of the ESD Control program should be well thought out to minimize unnecessary costs in the program, but with this knowledge, major quality and reliability failures have been known to cost up to $10 million dollars each and jeopardize sales.

Protecting an ESDS device at all but one of the workstations is not acceptable. For the ESD Control program to be effective, it must be comprehensive and followed with discipline throughout the manufacturing, transport, and storage cycle. Management commitment is an important element of any effective ESD Control Program. ESD damage is not simple or inexpensive to identify. To improve quality and profits, management should be involved. Over 21% of failure analysis is due to electronics and industry studies showing that 30% of all electronic failures can be attributed to ESD.

Major companies including AT&T, Motorola, Hewlett Packard and IBM have been able to successfully track ESD damage cost and the resulting benefits of their ESD Control Programs. These companies have determined that ESD Control is an essential part of their success, one that results in significant investment pay-back, refer to Figure 1.

Even with an ESD Control program in place, a typical electronics company may lose 5% of revenue from all causes of product failure. Cost avoidance is the biggest issue when it comes to implementing an ESD Control program. Another source [5] states that a typical pay-back on an ESD control program is 95:1. For every one-dollar invested in ESD control, ninety-five dollars comes back as money saved [5].

V Increased Sensitivity to ESD Control and some causes

Difference in component sensitivity between through-hole and surface mount devices is dependent on the architecture and technology packaged. Typically, surface mount devices have much smaller architecture making them more susceptible to ESD than through-hole packaged devices. The width of the circuitry conductors is as small as 0.10 micrometer (equal to 0.0001millimeter or 0.000004 inch). To pack more and more circuitry into small packages, the spacing isolating circuitry has been reduced and can be as little as 300 m m. A human being cannot feel ESD voltage until it reaches approximately 3,000 volts. A discharge of static electricity is literally a little lighting bolt, producing heat that can easily burn through microelectronic architecture some rated with a withstand voltage as low as volts.

Technology Trends					
Year	1995	1998	2001	2004	2007
Feature size (mm)	0.35	0.25	0.18	0.12	0.10
Voltage (V)	3.5	2 - 3.5	1.50 – 1.9	1.0 – 1.5	1.0

- Source: Terry Welsher, Bell Labs, Lucent Technologies, 12/2/97 [5]

*Table I – Feature size and device power trends

For IC packaging, the Input/Output (I/O) count has climbed from 600 to 1,000 to well over this now. This implies that the spacing between the I/Os have decreased dramatically and where wire bonding is used, the air gap becomes that much smaller making the neighboring I/Os even more susceptible to ESD. This can be seen as Ball Grid Array (BGA) chips have been replacing through-hole pin chip technology

The increasing sophistication of electronic devices has continued to make electronic devices more and more susceptible to ESD related damage. This is a trend that is expected to continue.

Dry areas further add to the susceptibility of ESD Sensitive (ESDS) devices. Table II shows normal activity within a production facility where turboelectric charging levels of operators and

objects are given in voltages and shown to be dependent on relative humidity (RH). There can be over a 5 time increase in charge generation when the RH drops to 10%.

Table II
TYPICAL ELECTROSTATIC VOLTAGES*

EVENT	RELATIVE HUMIDITY		
	10%	40%	55%
Walking across carpet	35,000	15,000	7,500
Walking across vinyl floor	12,000	5,000	3,000
Motions of bench worker	6,000	800	400
Remove DIPs from plastic tubes	2,000	700	400
Remove DIPs from vinyl trays	11,500	4,000	2,000
Remove DIPs from Styrofoam	14,500	5,000	3,500
Remove bubble pack from PCBs	26,000	20,000	7,000
Pack PCBs in foam-lined box	21,000	11,000	5,500

*Source: AT&T ESD Control Handbook-1989

There are a slew of other factors that can add to the problems that need to be countered by a well designed ESD Control program, such as: employee knowledge with training; ESD Control products designed to protect the corresponding ESDS devices; program funding with management buy-in; employee compliance with internal discipline and audits, etc.

Conclusion:
A properly designed and successfully deployed ESD Control program is a proven money saver with an ROI of up to 1,000% per year. Another source reports that for every one-dollar invested in ESD control, ninety-five dollars comes back as money saved. Have you hugged your ESD Coordinator recently?

רח' הסתת 15, ת.ד. 319, א.ת. חולון 58856 • טל': 03-5509148 • פקס: 03-5507969 • yail@yail-noa.co.il • www.yail-noa.co.il

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About the Author

Ryne C. Allen graduated from Northeastern University with B.S.E.E, M.S.E.E., and MBA degrees. Prior to joining Desco Industries Inc. was chief engineer and lab manager at the Plasma Science and Microelectronics Research Laboratory at Northeastern University. Mr. Allen is a NARTE-certified ESD control engineer and the author of 27 published papers and articles. He is a member of the ESD Association and an active ADCOM member of the local Northeast Chapter of the ESD Association.