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Estimating Losses in the Complex Organization

ESTIMATING ESD LOSSES IN THE COMPLEX ORGANIZATION

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Purpose

During the past 25 years, engineers suspecting ESD damage in their operations have asked two questions of static control material vendors and industry consultants with consistent regularity:

1. How do I know static related problems are affecting our operation, and to what degree?
2. How do I define static impact in a manner that promotes management's attention and support?

The purpose of this tutorial is to provide basic guidelines to effectively estimate the potential dollar impact of ESD on an operational department, facility or corporation. In addition, it recommends a presentation format to management, which is intended to encourage their active support of static control measures.

General Discussion

As awareness of ESD has increased over the years, many companies have implemented programs designed to combat the effects of this pervasive problem. Often these efforts are directed at the symptoms of ESD losses as they manifest themselves in specific operations, rather than defining the problem cause and impact on a company, then isolating those causes that have specific control attributes. This "tunnel approach" directs attention to events (symptoms) within a portion of the company, away from true control of the variables involved (causes) that may be outside the limits of the operation in question. As a result, static control methods employed in these situations may not be as effective as desired, the returns on investment in control systems are minimized, and the credibility for the need of static control, in general, may be impinged.

Most company managers are directed in their day to day lives by a hierarchy of priorities. They respond with resources and action to those priorities that have been clearly defined as problem areas with specific causes, have a measurable value impact on the company, and an indication of the probable return on their investment (ROI) of time and resources.

The following approach:

1. Defines the potential dollar impact of ESD on a given operation;
2. Isolates those devices and assemblies responsible for the largest portion of potential loss;
3. Indicates the location(s) of greatest potential loss;
4. Provides a guideline for the ROI related to controlling the loss.

In addition, this procedure has the secondary benefit of indicating other problems not related to ESD losses, such as shrinkage, multiple inventories, mechanical problems, etc.

The Essence of Communication Problems: Lack of Information

The question most frequently asked of static control consultants by operations people is, "How do I convince my management that we have a serious static problem in our operation?" All managers, regardless of their level of authority or responsibility, usually have the organization's profitability at heart, and want to solve problems that incur loss or interfere with the manufacture of high quality products. Yet, it is difficult for line supervisors and engineers to enlist management's support in dealing with static problems when cost and quality impact information concerning those problems is not available, or conveyed to management.

On the other hand, the question often asked by corporate management is, "How bad is the static problem, really?" The "really" implies doubt. After all, static is invisible, and it is difficult for managers to obtain evidence of actual loss in their own facilities. Instead, management is usually faced with pressure from within the plant and from field operations to provide support for ill-defined static related situations. Those who are most familiar with the technical aspects of electrostatic problems may not be equally acquainted with the methods of organizational analysis upon which management must base its decisions. Consequently, management hears frequent calls for help, but cannot respond effectively because they are either:

1. Not informed as to the quantitative impact, location, cost, and value of solving the problem; or,

2. They are not sufficiently aware of the ramifications of ESD impact to ask appropriate and revealing questions required to obtain the data needed to make positive decisions.

The key to success lies not in harping to management about another production problem, but rather in presenting a well documented, compelling proposal for increasing short-term profits and long-term product reliability through static control. Throughput Analysis provides a means to evaluate the impact of static on the complex organization, and satisfy the managerial requirements for quantitative information, which lead to profitable static control programs.

Throughput Analysis is a general evaluation of quantity and flow of the devices and assemblies used in finished goods production. It incorporates the many factors of purchasing, inventory control, manufacturing, sensitivity analysis, repair operations and field service. The results of Throughput Analysis are the Device Utilization Data sheets, which provide various listings of sensitive devices used in the organization and are used for calculation of potential static loss. With fundamental evaluation, the Device Utilization Tables offer a bottom line estimate of potential ESD losses in the organization, and insight into dealing with the problem from both a management and operational point of view.

Defining the Overall Impact of ESD: Throughput Analysis

Throughput Analysis is a traditional evaluation technique. The concern in its implementation is acquiring the information necessary to perform the analysis. Once permission is obtained for information access, the actual analysis is relatively simple. Accurately conducted, Throughput Analysis can: indicate components that may be failing due to static, determine where in the operation most losses are occurring, estimate the total cost of potential static losses, and highlight areas in which immediate attention will yield the greatest short-term return.

Most important, Throughput Analysis provides the foundation for the development of the organization's static control program. Without performing an analysis of this type, one can not readily seek problem causes, estimate losses, set guidelines for reasonable investment to solve the problem(s), or project an expected return from corrective action. Management must have this information in order to support any program requiring commitment of company resources.

Assuming the process is conducted in a comprehensive and objective manner; management will appreciate the data gathering technique and its interpretation. If a significant static problem is shown to exist, Throughput Analysis will furnish the information required for management evaluation, and justification for decisive action.

Basic Steps of Throughput Analysis

Step One: Identify static sensitive components and determine the discrepancy between the volume purchased and actual use in production.

To illustrate, assume an electronics firm manufactures only one type of finished product. Each unit produced is composed of several devices and subassemblies, some of which are electrostatic discharge sensitive (ESDS). The first step is to identify the number of finished goods produced each year, and potential ESDS devices and subassemblies used in the production process during that period.

Production volume of finished goods is historical information and is obtained from plant manufacturing records. It would be wise to obtain both the original plan for finished goods volume as well as the actual production figures, and compare these numbers. If there is a deviation, where fewer products were produced than planned, one should seek the reasons for the lower production volume through interview with production management. Any reason for lower volume that may be related to rework, restricted parts availability, in process redesign, field problems, and so forth, should be noted as potential static related impact problems for future evaluation. For illustrative purposes, we will assume that 1,000 finished goods are produced by our hypothetical facility.

Electrostatic discharge sensitivity of parts and assemblies is the key yardstick in defining static control in any sensitive environment. The most sensitive ESDS device is the optimal criteria in static control program development, as charge generation levels in the process cannot be allowed to exceed this device's sensitivity without incurring catastrophic losses or creating latent defects. In the process of Throughput Analysis, device sensitivity is used to indicate that portion of devices and subassemblies used in the manufacturing process that may be considered static sensitive materials, and therefore subject to loss or damage. There are three fundamental sources for ESD sensitivity information.

1. Actual in-plant device sensitivity testing of all devices and assemblies used within the facility. This is a rather time consuming and expensive process, but it is most appropriate if other sources are not available.

2. Vendor test information and certification of ESD sensitivity testing.

3. Independent third party laboratory testing to current device standards.

At one time generic listings of device sensitivity were available based on "V-zap" testing, a form of discharge analysis that provided relative failure information. Today, there are several established test methods to assess device sensitivity to different failure modes. Our concerns are no longer limited to one type of device damage, and from a process point of view, we must be aware of several forms of ESD damage thresholds, including discharge from:

- The Human Body Model (HBM)
- Direct Charge Device Model (Socketed CDM)
- Inductive Charge Device Model (Non-Socketed CDM)
- Machine Model (MM)
- Other hybrids and potential process elements

Most companies use hundreds, even thousands of different devices in the manufacturing process. Specific device testing to several failure models for each device used is simply not cost effective or necessary. Rather, those devices that demonstrate the most frequent failure in-plant, in the field, discovered in repair or that fail during warranty are the most important devices to be considered.

As most companies' inventory and utilization figures are on computer, it may be most expedient to enter the critical device vender's sensitivity from their specification sheet. Unfortunately, vender specification sheet ESD thresholds are often "targets" for ESD control rather than actual device damage thresholds. Certainly, if device test data are available indicating specific sensitivity to various failure models, this data should be included in the device's inventory information. Another approach is to establish generic device categories by type and typical sensitivity. Once a guideline for sensitivity is established for your most critical devices, sort the current inventory using its sensitivity field as the primary criteria. It would be prudent to periodically update and maintain the ESDS threshold information using either vendor or actual test data whenever possible.

Returning to our example, we will assume that ten of our devices are electrostatic discharge sensitive (ESDS), and related information obtained thus far is summarized as shown in Table I.

DEVICE UTILIZATION DATA - TABLE I ESDS Devices Used in Production			
(1) Item No.	(2) ESDS Model	(3) ESDS Volts	(4) Data Source
1	HBM	60	TEST
2	CDM	500	VENDER
3	HBM	2000	VENDER
4	HBM	5000	VENDER
5	HBM	2500	VENDER
6	CDM	200	TEST
7	FIM	1100	TEST
8	HBM	1500	TEST
9	HBM	4200	VENDER
10	HBM	6000	VENDER

TABLE I

Certainly, this illustration is an oversimplification of reality. With thousands of parts used in a multitude of products, few organizations have accurate ESD damage threshold data available. In these situations, we assume all electronic devices and sub-assemblies are ESDS and proceed with Step 2, Device Utilization.

<u>Step Two</u>: Define ESDS device utilization, including average inventory levels & locations, requisitioning departments, purchase volume and unit cost.

By reviewing inventory control and purchasing records, one can determine the normal utilization factors related to the ESDS and other item(s). It is critical to document the following information for all listed devices.

1. The actual number of each item purchased to support the annual production period. Particular care should be given to starting inventory, purchases, and ending inventory. (In establishing actual purchase versus utilization volume for any device, be sure to exclude units currently on order that are not in plant inventory, or included in the evaluation period.)

2. The unit cost of each item.

3. The average inventory level throughout the production period.

4. Locations of inventory storage. This is particularly important in cases where external repair facilities are employed for customer service. This information may also prove helpful to ascertain latent static impact on product reliability. If this information is not readily available, customer service may provide data regarding warranty claims and other field related issues.

5. The identity of requisitioning departments. This answers the fundamental question of who is using these devices. There are obvious implications when one sees the same device being used by production, rework and field service repair departments.

For the purposes of our illustration, assume that Inventory Control will provide average inventory levels of parts in one location, and their requisitioning departments. Purchasing should be able to provide not only the order volume of the ESDS parts purchased, but their unit cost, and be able to confirm the requisitioning departments as well.

Suppose that Inventory Control and Purchasing departments indicate these units are purchased in the volumes and at current prices as shown in Table II., and the requisitioning departments are (A) Manufacturing, (B) Rework, and (C) Field Service Repair. With the information obtained thus far, one has a positive indicator that device purchase volume is inconsistent with production requirements, and that certain devices used in the finished product have some added cost impact on the operation

Referring to the bottom "TOTALS" line of Table II, 39,000 devices are required to produce the finished goods during the analysis period, and 3,900 devices are usually maintained in inventory. However, a total of 57,900 devices were purchased for this production period. The result is a negative deviation of 15,000 devices, valued at $48,240. These devices are not accounted for in terms of finished goods volume. Further evaluation of Table II reveals that Manufacturing requisitioned 10 percent more items than required to meet production needs; while Rework used 70 percent of the unit deviation, and Field Service accounted for the remaining 20 percent.

DEVICE UTILIZATION DATA – TABLE II Initial Review Of Item Need, Inventory, Purchases & Usage											
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Item No.	ESDS Volts	ESDS per F/G	ESDS Units Reqd/yr	ESDS Units Purch/yr	Unit Cost $	Avg. Invent. Each	Dev. Units Each	Dev. Cost x Units	Req. by MFGR. Units	Req. by REWORK Units	Req. by FLD.SRV Units
1	60	2	2,000	4,700	$10.60	200	-2,500	-$26,500	1,750	1,750	500
2	500	4	4,000	7,200	3.80	400	-2,800	-10,640	4,280	1,960	560
3	2000	6	6,000	8,000	2.23	600	-1,400	-3,150	6,140	980	280
4	5000	10	10,000	12,000	0.70	1,000	-1,000	-700	10,100	700	200
5	2500	1	1,000	1,400	1.10	100	-300	-330	1,030	210	60
6	200	2	2,000	4,600	0.90	200	-2,400	-2,160	2,240	1,680	480
7	1100	4	4,000	6,300	1.40	400	-1,900	-2,660	4,190	1,330	380
8	1500	6	6,000	8,800	0.80	600	-2,200	-1,760	6,220	1,540	440
9	4200	2	2,000	2,600	0.40	200	-400	-160	2,040	280	80
10	6000	2	2,000	2,300	1.80	200	-100	-180	2,010	70	20
TOTALS		39	39,000	57,900		3,900	-15,000	-$48,240	40,000	10,500	3,000

TABLE II

The deviations are not all caused by ESD; there may be secondary inventories, current backup orders, mechanical or handling faults, production change-over issues, but these are factors that can be clarified. It does mean that one should be concerned with a potential loss of some significance. In addition, based on the requisitioning department information, additional data should be pursued regarding these losses from Manufacturing, Rework or Field Service Repair departments as to their reasons for the high use of these items.

Step Three: Define burden costs associated with ESDS devices and assemblies.

When estimating the impact of static damage, one cannot assume that materials represent the sole cost of ESD losses. In fact, in most cases, labor, plant burden and field repair costs far exceed the value of static damaged devices and assemblies.[2]

With the assistance of the plant's Accounting department, a labor and burden factor is applied to each deviated item. The burden factor takes into account the actual labor required to replace an item, the cost of the facility, lights and power, the present value of funds tied up in rework inventory, warranty, customer service, repair support, and so forth. This may be an estimated average cost applied to all items, or an actual calculated cost based on specific analysis of each item. The former is the easiest to estimate with assistance from the plant's Accounting department; while the latter is time consuming and requires secondary analysis with experienced personnel. For expediency in obtaining an initial indication of total potential static impact, one should use an estimated average cost per unit during the first analysis. Further, more specific calculations can be made later if conditions warrant a comprehensive burden calculation.

Once the average burden per unit is determined, two additional columns should be added to the deviation section of the Device Utilization spread sheet. The first column is the estimated burden cost associated with each item. This is simply a calculation multiplying the total deviation units per item by the average burden cost per unit. The result is the non-material costs associated with each item listed in the deviation portion of the spread sheet. The second and final column is the sum of the material dollar cost and the total burden cost of each item. For illustrative purposes, we will assume the estimated average in-plant burden per unit is $14.50. Table III reflects this additional Device Utilization spread sheet calculations. Refer to columns [5] and [6] in Table III.

DEVICE UTILIZATION DATA – TABLE III Deviation With Burden Loss Estimate					
(1) Item No.	(2) ESDS Volts	(3) Deviation Each	(4) Deviation Cost x Units	(5) Burden $14.50ea.	(6) Lost Mat'l & Burden
1	60	-2500	-$26,500	-$36,250	-$62,750
2	500	-2800	-10,640	-40,600	-$51,240
3	2000	-1400	-3,150	-20,300	-$23,450
4	5000	-1000	-700	-14,500	-$15,200
5	2500	-300	-330	-4,350	-$4,680
6	200	-2400	-2,160	-34,800	-$36,960
7	1100	-1900	-2,660	-27,550	-$30,210
8	1500	-2200	-1,760	-31,900	-$33,660
9	4200	-400	-160	-5,800	-$5,960
10	6000	-100	-180	-1,450	-$1,630
TOTALS		-15,000	-$48,240	-$217,500	-$265,740

TABLE III

While the potential value of deviation units is a significant amount ($48,240.), the estimated burden associated with these devices is valued at $217,500; over four times the material costs. The total material and burden costs indicate that this facility is *potentially* losing approximately $265,000 in static related losses. Certainly, there are many other possible explanations for these missing units which **may not** be static related. As previously mentioned, some devices may be lost due to mechanical handling or solder problems. The point is: the deviations do exist; and, all unaccounted for items are known ESD sensitive devices.

Though a standard burden rate is used in our illustration, one should be acutely aware that burden costs vary dramatically depending on whether costs are incurred at board levels in-plant, or at the systems level in the customer environment. The average burden example of $14.50 per unit is assumed as an in-plant cost for an inexpensive consumer product. Medical surgical systems, advanced military and aerospace product in-plant burden costs can amount to several thousand dollars per device failure. In addition, Field service burden costs may add from a few hundred dollars for commercial products, to tens of thousands of dollars per unit for complex communication, major data processing or military system repairs. It is imperative that burden assessment be discussed in close detail with company or facility financial personnel to obtain a realistic reference for the analysis.

Defining the Overall Impact of ESD: The ABC Analysis

Raw data obtained in the initial phases of Throughput Analysis are summarized in the Device Utilization Data spread sheets. This compendium of information is the foundation for analysis of potential static problems. However, further processing is required before the information can be put to effective use.

The ABC Analysis portion of a plant study is based on a data sort of all items listed in the Device Utilization Data - Table III. The first data sort is based on the material value of suspected ESDS device losses, and is shown in Table IV. This may be considered by some as an optional step because the true value of any ESD loss includes burden costs. However, many organizations base their ESD control programs on cost of material losses as an initial indicator of static impact because material costs in these companies are extremely high when compared to related burden costs. Though a single data sort based on material costs is not recommended as the sole criteria for decision making, it provides an important view of estimated static impact.

DATA SORT BY UNIT DEVIATION MATERIAL COST – TABLE IV Includes % Material Loss & ABC Analysis Segments								
(1) Item No.	**(2)** ESDS Volts	**(3)** Deviation Each	**(4)** Deviation Cost x Units	**(5)** Burden $14.50ea.	**(6)** Lost Mat'l & Burden	(7) % Loss Matl Units	(8) % Loss Matl $	(9) ABC Analysis Segments
1	60	-2500	-$26,500	-$36,250	-$62,750	16.7%	54.9%	Class A
2	500	-2800	-10,640	-40,600	-$51,240	18.7%	22.1%	Class B
3	2000	-1400	-3,150	-20,300	-$23,450	9.3%	6.5%	34.1%
7	1100	-1900	-2,660	-27,550	-$30,210	12.7%	5.5%	Loss
6	200	-2400	-2,160	-34,800	-$36,960	16.0%	4.5%	
8	1500	-2200	-1,760	-31,900	-$33,660	14.7%	3.6%	Class C
4	5000	-1000	-700	-14,500	-$15,200	6.7%	1.5%	11.0%
5	2500	-300	-330	-4,350	-$4,680	2.0%	0.7%	Loss
10	6000	-100	-180	-1,450	-$1,630	0.7%	0.4%	
9	4200	-400	-160	-5,800	-$5,960	2.7%	0.3%	
TOTALS		-15,000	-$48,240	-$217,500	-$265,740	100.0%	100.0%	

TABLE IV

Using the cost per item times the estimated number of deviated units as the primary sorting reference [Column (4)] sort the entire item list from highest to lowest item cost deviation. Once sorted, classify the final list as follows:

Class "A" - Top 10% of listed items

Class "B" - Next 30% of listed items

Class "C" - Final 60% of listed items

Generally, the top 10 percent of the items listed in the ABC analysis (Class A Losses) account for 50 to 80 percent of total ESDS material dollar losses. The next 30 percent (Class B Losses) account for approximately 20 to 40 percent of deviation material costs. The remaining 60 percent of items listed usually account for less than 10 to 20 percent of the losses.

Referring to Table IV, our ABC Analysis by Material Cost indicates the following loss percentages by ABC classification:

Class "A" - Top 10% of listed items represents 54.9% of total estimated material losses.

Class "B" - Next 30% of listed items represents 34.1% of total estimated material losses

Class "C" - Final 60% of listed items represents 11.0% of total estimated material losses.

The second and most correct data sort incorporates both the material costs of the items in question and the related estimated burden expense. Using the "Total Material & Burden" cost per item as the primary sorting reference [Column (6) of Table III - V], sort the entire list from highest to lowest total item cost (burden plus material costs). Table V shows our illustrative data sorted in this manner, and includes percentage calculations for both the deviation of units as well as total cost of material and burden for each item. The dramatic impact of burden expense can be readily seen when Tables IV and V are compared.

If we classify Table V using ABC criteria, our loss distribution is as follows.

Class "A" - Top 10% of listed items represents 23.6% of total estimated material & burden losses

Class "B" - Next 30% of listed items represents 45.9% of total estimated material & burden losses.

Class "C" - Final 60% of listed items represents 30.5% of total estimated material & burden losses.

DATA SORT BY MATERIAL & BURDEN - TABLE V **ABC Analysis Classification Segments**					
(1) Item No.	**(3)** Deviation Each	(4) Deviation Cost x Units	**(5)** Burden $14.50ea.	**(6)** Lost Mat'l & Burden	**(7)** ABC Analysis Segments
1	-2500	-$26,500	-$36,250	-$62,750	Class A
2	-2800	-10,640	-40,600	-$51,240	Class B
6	-2400	-2,160	-34,800	-$36,960	45.9%
8	-2200	-1,760	-31,900	-$33,660	-$121,860
7	-1900	-2,660	-27,550	-$30,210	
3	-1400	-3,150	-20,300	-$23,450	Class C
4	-1000	-700	-14,500	-$15,200	30.5%
9	-400	-160	-5,800	-$5,960	-$81,130
5	-300	-330	-4,350	-$4,680	
10	-100	-180	-1,450	-$1,630	
TOTALS	-15,000	-$48,240	-$217,500	-$265,740	

TABLE V

The one item in Class "A" represents the single largest potential loss of $62,750. While the three Class "B" items represent a combined loss of $121,860. In other words, these four items account for almost 70 percent of the facility's total potential static impact.

We have identified the smallest portions of our inventory contributing the largest potential static losses, and located the operational boundaries of those losses by identifying the requisitioning departments. We have an idea of the likely value of static control, the components that are either most often affected or whose loss is most costly, and where those parts are most frequently used.

Of course, every organization is different, and may not have centralized information available for performing this initial analysis. However, the basic idea is adaptable to various organizational structures. Where each department or group of departments perform its own analysis, results can be combined, or compared in a manner that will yield the necessary information.

Decision Point: Proceed or Present

In some organizations, the time invested thus far in gathering information for the Device Utilization Data sheets and ABC sorting analysis is within the scope of the ESD Coordinator or Technical Manager. However, in most complex organizations management approval is needed for information access, use of computer facilities, financial investigation and so forth. At this point, the type, style and size of the organization determine whether one should proceed with identifying cause of the deviations related to ESDS devices, or present the findings of the ABC Analysis to obtain further management support.

Past experience indicates that, regardless of company style or size, most management groups want to know project and daily activity status on an ongoing basis, rather than be surprised by major departures in routine. The Throughput Analysis results could very well be considered a surprise by those who are not familiar with the scope of ESD impact. Consequently, one would be prudent to advise their management as to the method of analysis that will be conducted, the status of the project on an ongoing basis, and report initial ABC Analysis findings prior to initiating investigation of deviation causes. The status report should include the following information.

1. Estimated ESD material loss in dollars.
2. Estimated burden loss in dollars.
3. Total estimated burden and material loss.
4. Summary of Class "A", "B" and "C" estimated losses, including burden and material cost data.
5. Losses as a percent of ESDS device and assembly purchases.
6. A summary of the requisitioning departments experiencing the ESDS device activity, and an estimate of device deviation attributable to each area.
7. A condensation of the evaluation about to be undertaken to confirm suspected ESD losses, in terms of general procedures, anticipated time and resources required.
8. Secondary comments regarding production objectives versus actual volume attained, rework activity, field service repair problems, which may be related to initial ABC Analysis data.
9. A request for management support during the ESD causal investigation.

Much of the foregoing information is available from manipulation of the Device Utilization spread sheet and related Tables. Further information can be obtained by creating a Purchasing, Inventory & Deviation Cost Analysis as illustrated in Table VI.

PURCHASING ANALYSIS – TABLE VI Includes Percent of Estimated Units Lost & Percent of Total Dollars Lost by Items											
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Item No.	Unit Cost $	ESDS Units Reqd/yr	Required Purchase	Average Invent. Each	Averag e Invent. Cost	Actual ESDS Units Purch/yr	Actual Value of Unit Purch.	Devi- ation Each	Dev. % Loss Units	Dev. Cost x Units	Est. % Loss Total ESDS Purchases
1	$10.60	2,000	$21,200	200	$2,120	4,700	$49,820	-2,500	-53.2%	-$26,500	-20.4%
2	3.80	4,000	15,200	400	1,520	7,200	27,360	-2,800	-38.9%	-$10,640	-8.2%
3	2.23	6,000	13,350	600	1,335	8,000	17,800	-1,400	-17.5%	-$3,115	-2.4%
4	0.70	10,000	7,000	1,000	700	12,000	8,400	-1,000	-8.3%	-$700	-0.5%
5	1.10	1,000	1,100	100	110	1,400	1,540	-300	-21.4%	-$330	-0.3%
6	0.90	2,000	1,800	200	180	4,600	4,140	-2,400	-52.2%	-$2,160	-1.7%
7	1.40	4,000	5,600	400	560	6,300	8,820	-1,900	-30.2%	-$2,660	-2.0%
8	0.80	6,000	4,800	600	480	8,800	7,040	-2,200	-25.0%	-$1,760	-1.4%
9	0.40	2,000	800	200	80	2,600	1,040	-400	-15.4%	-$160	-0.1%
10	1.80	2,000	3,600	200	360	2,300	4,140	-100	-4.3%	-$180	-0.1%
TOTALS		39,000	$74,450	3,900	$7,445	57,900	$130,100	-15,000	-25.9%	-$48,205	-37.1%

TABLE VI

The summary should be objective, concise, and as brief as possible. One cannot draw many operative conclusions from the data until it is validated by actual investigation. The ABC Analysis represents **potential** and not actual ESD losses; this point must be made clear. The summary of our illustrated data is shown in Table VII (following page), and forms the basis for the interim management report.

Confirming Losses

Based on the construction of the foregoing tables and report, considerable information is available regarding the use of ESDS items. Class "A" and "B" items represent the smallest groups of items used in the organization which have the highest potential financial and quality impact on the company. Therefore, the actual handling, inventory factors, packaging and other logistical elements related to these devices must be reviewed in detail to confirm cause of their deviations. A detailed Process Capability & Transition Analysis (PCTA) should be conducted to confirm location and cause of ESD related problems[4].

The Interim Throughput Analysis Report and Device Utilization spread sheets indicate several interesting points, all of which aid the ESD Analyst in seeking problem cause(s), and developing corrective programs. The following examples illustrate a few things to look for.

1. Sixty percent of the devices listed in our illustration have ESD sensitivities of 2,000 volts, or less. In addition, 63% of estimated total ESD losses are associated with four items having sensitivities at, or below 1,500 volts. One should suspect that the facility's maximum allowed ESD voltage control point requires modification.

2. The Rework operation is utilizing 70% of all the ESDS deviation items. Thus the area of

major concern for loss analysis is at, or most likely before the rework operation.

3. Approximately 20 percent of deviation utilization is in Field Service repair. This may indicate:

   a. The product is not ESD safe for use in the typical customer's using environment;
   b. Latent defect may be incurred during production and testing; and/or,
   c. Packaging is not adequate product protection during shipment or storage.

Facility Evaluation[3] and PCTA[4] for static charge generation analysis are certainly indicated. There are several documents, methods and services available to define cause of static loss.

INTERIM THROUGHPUT ANALYSIS REPORT – TABLE VII
Estimated ESD loss summary

ESTIMATED ESDS MATERIAL LOSSES	-$48,205
ESTIMATED ESDS RELATED BURDEN LOSS	-217,500
ESTIMATED TOTAL ESD IMPACT	-$265,705

ESD LOSS DISTRIBUTION BASED ON ESDS UNIT DEVIATION BY CLASS	ESTIMATED MATERIAL COSTS	ESTIMATED BURDEN COSTS	ESTIMATED TOTAL COSTS
Class "A"	-$26,500	-$36,250	-$62,750
Class "B"	-16,450	-88,450	-104,900
Class "C"	-5,290	-92,800	-98,090
Total Estimates	-$48,240	-$217,500	-$265,740

ESDS DEVICE PURCHASING DATA

	REQUIRED PURCHASES	AVERAGE INVENTORY	ACTUAL PURCHASES	DEVIATION	PERCENT DEVIATION
UNITS (EA)	39,000	3,900	57,900	15,000	25.90%
Cost ($)	$74,450	$7,445	$130,100	$48,205	37.10%

NOTES:
1. Burden calculated at $14.50 per unit.
2. Areas requisitioning ESDS devices & assemblies are:

AREA	EST. % OF DEVIATION UTILIZATION
MANUFACTURING	10%
REWORK AREA	70%
FIELD SERVICE	20%

TABLE VII

Communicating With Management: The Bottom Line

Management is concerned with obtaining the maximum return on corporate investment while producing quality products and services. Without these objectives, there is no reason to maintain most business operations. Certainly, this must be obvious to all who work in the electronic industry. Consequently, it is not enough to estimate ESD losses. One must be able to project a reasonable return on investment for solving ESD problems in order to fully justify managements' financial support.

Return on investment means that when a defined cash outlay is made, those dollars will return significantly more dollars than originally imparted. Without knowing the specific cause of a given problem, nobody can define the ways, or cost, to solve it. However, in many practical applications of ESD problem analysis, this writer has never seen less than a 5:1 return on investment in one year. In most cases, proper static control yields a much higher ROI, but a 5:1 return is a bare minimum. Given that problem cause is accurately defined, solutions are available and compatible with many sensitive environments that confirm this minimum return on investment is quite conservative.

In other words, if one takes a conservative stance in reviewing the aforementioned illustrations, and supposes that no more than 80 percent of the estimated losses can be eliminated with proper static control technology, the following is a reasonable projection for return on investment:

80% of $265,740. = $212,592.

20% of $212,592. = $ 42,518.

Thus, management can be justified in providing at least $42,000 in dealing with this problem situation, if not more, depending on company policy and attitudes toward manufacturing control. However, astute managers realize that product quality and efficient production always return more than "even money" on well defined company investments.

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