



ESD Audits

Dangelmayer Associates' audits are conducted by Engineers with first hand manufacturing experience, advanced degrees and unparalleled expertise! Our audits provide findings reports, photographs of findings, detailed recommendations, and the assignment of corrective action priorities. Gaps will be identified between current best practices today's technological challenges such as Class 000, CDM, CBE, EOS and S20.20.

“Wow – this is really an excellent assessment and report! I was just thinking how our other consultants haven't really dealt with the quality system, so I appreciate you giving us a whole “turn-key solution”.

- Bob Herrick, PhD – Finisar, Senior Reliability Engineer

- 1) EPM Performance & Benchmarking™/Audit**
- 2) Advanced Technical Assessment/Audit**
- 3) S20.20 Pre-Assessment Audit**
- 4) Root Cause Analysis**

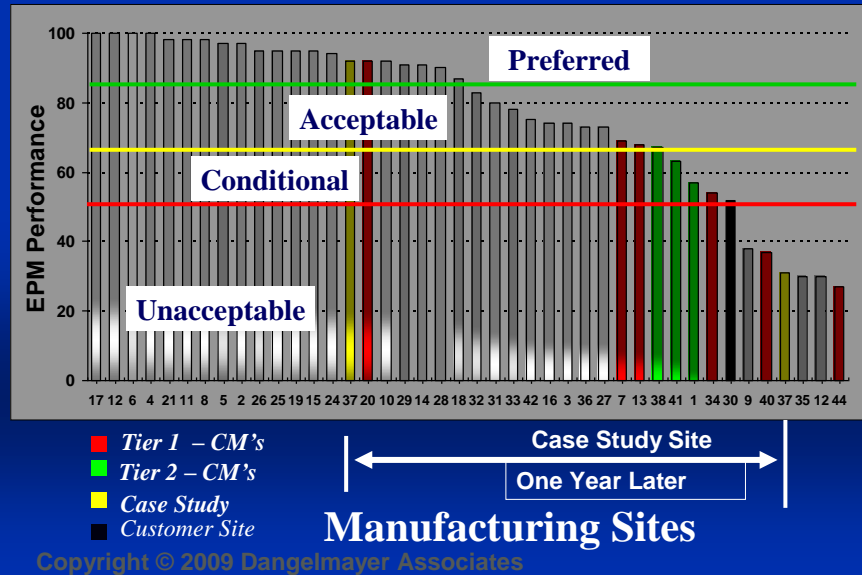
1) EPM Performance & Benchmarking™/Audit:

Note: Applications include manufacturing & supply chain

“You do not need to do this: survival is not mandatory.”

- Dr. W. Edwards Deming

EPM Performance Benchmarking™



Note:

1) May be used alone for benchmarking of individual or multiple sites or the supply chain

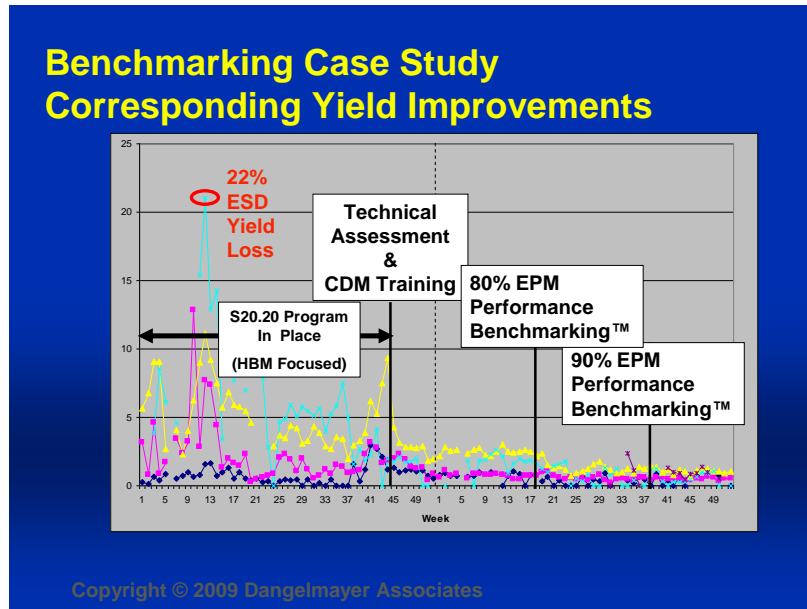
The EPM Performance & Benchmarking Assessments™ will be done over the phone. This may also be done independently without a technical assessment for benchmarking purposes of company locations and/or the customer's supply chain. It is an accurate tool for quantifying the quality of an ESD Program and for qualifying suppliers. For instance, a site may end up with a score of 37% and be in the high risk zone or 97% and be in the preferred zone.

The questions are designed to analyze the ESD quality system. This is because the quality system ultimately governs the outcome of a manufacturing process. Questions are asked such as "Has management formally appointed an ESD Program Manager?" and "Are current best practices such as CDM, CBE and Class 0 adequately addressed in the governing ESD requirements document?".

Extensive data confirms that the Performance Benchmarking Score™ correlates to manufacturing yield improvements (see example below).

Upon completion, this highly effective tool becomes a road map for improvement or development of a sound ESD Program. The metrics generated by this process provide management with capability to measure and track the ESD

program performance of individual sites as well as the corporation's relative position within the industry. The survey results are discussed in the Executive Summary of Annual Technical Assessment and are summarized in a PowerPoint presentation.



Example: Correlation between Yield and Performance Benchmarking Score™

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2) Advanced Technical Assessment/Audit:

Note: Conducted by Engineers with first hand manufacturing experience, advanced degrees and unparalleled expertise!

“Wow – this is really an excellent assessment and report! I was just thinking how our other consultants haven’t really dealt with the quality system, so I appreciate you giving us a whole “turn-key solution”.

- Bob Herrick, PhD – Finisar, Senior Reliability Engineer

This advanced technical assessment/audit, in concert with our EPM Performance Benchmarking™, Assessment provides the most comprehensive roadmap for improvement available today. Our assessments/audits provide findings reports, photographs of findings, detailed customized recommendations, and the assignment of corrective action priorities. Gaps will be identified to current best practices as well as to the Customer's choice of standard, such as Internal Requirements, S20.20 or EIA-625.

Technical Assessment Benefits:

- Provides detailed information that can be used for either improving programs or resolving ESD problems.
- Identifies problems and provides solutions to the root cause of existing failure mechanisms.
- Qualifies manufacturing facilities for present and future product requirements.
- Contributes to increased yields, process control, profitability, and customer satisfaction.

Technical Assessment/audit Highlights:

- This is our most comprehensive assessment/audit and is intended for the quality conscious company that is serious about not only solving ESD problems but also about preventing recurrence.
- A two day thorough sampling evaluation of the ESD process characteristics, ESD handling procedures/protocols, and state-of-the-art electrical and ESD event detection measurements of the ESD facilities automation, and test equipment.

- Emphasis will be placed on the analysis of automation/test equipment and charged device model mitigation techniques.
- Internal auditors will be invited to observe during the assessment and will be shown how to perform the assessments.
- Gaps will be identified to current best practices as well as to the standard of customer choice, such as Customer Requirements, S20.20 or EIA-625.
- Comprehensive documentation (approximately 50 pages) of specific findings and recommendations will be included along with photographs of findings and priorities for corrective actions.
- Technical explanations of findings will be shared during the assessment to facilitate customer understanding of the issues and any corrective actions that may be necessary.

State-of-the-art Test Equipment:

- Three varieties of ESD Event Detection Equipment
- Comprehensive set of ESDA ANSI Compliant test equipment

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3) S20.20 Pre-Assessment Audit:

Note: *Conducted by Engineers who have managed ESD manufacturing programs that were S20.20 Certified under their leadership.*

"I've audited literally hundreds of ESD programs and, without a doubt; this program is the best I have ever seen. It's a world class benchmark..."

- Bill Gifford, DNV ISO 9000 Registrar, S20-20 Lead Auditor.

This S20.20 Pre-Assessment Audit may be done solely for the identification of gaps to S20.20 and expert recommendations for achieving S20.20 certification on the first try. It may also be combined with our Advanced Technical Assessment as described above for a complete assessment of gaps to both S20.20 and current best practices.

A complete analysis will be conducted of the Administrative and Technical Elements of S20.20 such as the ESD Control Program Plan. Gaps to S20.20 will be succinctly identified along with customized expert recommendations for corrective actions.

S20.20 - 2007 Administrative Requirements:

- ESD Control Program Plan
- Training Plan
- Compliance Verification Plan

S20.20 - 2007 Technical Requirements:

S20.20 TABLE 1. Grounding / Equipotential Bonding Requirements

Technical Requirement	Implementing Process	Test Method	Required Limit(s)
Grounding / Bonding System	Equipment Grounding Conductor	ANSI/ESD S6.1	< 1.0 ohm impedance
	Auxiliary Ground	ANSI/ESD S6.1	< 25 ohms to the Equipment Grounding Conductor
	Equipotential Bonding	ANSI/ESD S6.1	< 1.0 x 10 ⁹ ohms

S20.20 -2007 TABLE 2. Personnel Grounding Requirement

Personnel Grounding Technical Requirement	Product Qualification1		Compliance Verification	
	Test Method	Required Limit(s)	Test Method	Required Limit(s)
Wrist Strap System ²	ANSI/ESD S1.1 (Section 5.11)	< 3.5 x 10 ⁷ ohms	ESD TR53 Wrist Strap Section	< 3.5 x 10 ⁷ ohms
Flooring / Footwear System –	ANSI/ESD STM97.1	< 3.5 x 10 ⁷ ohms	ESD TR53 Flooring Section	< 3.5 x 10 ⁷ ohms

Method 1			ESD TR53 Footwear Section	< 3.5 x 10 ⁷ ohms
Flooring / Footwear System – Method 2 (both required)	ANSI/ESD STM97.1	< 109 ohms	ESD TR53 Flooring Section	< 1.0 x 10 ⁹ ohms
	ANSI/ESD STM97.2	< 100 volts	ESD TR53 Footwear Section	< 1.0 x 10 ⁹ ohms

S20.20 -2007 TABLE 3. EPA ESD Control Items

Technical Requirement	ESD Control Item	Product Qualification ¹		Compliance Verification	
		Test Method	Required Limit(s) ²	Test Method	Required Limit(s)
EPA	Worksurface	ANSI/ESD S 4.1 and/or ANSI/ESD STM 4.2	< 1 x 10 ⁹ ohms and/or < 200 volts	ESD TR53 Worksurfac e Section	< 1 x 10 ⁹ ohms resistance to ground
	Wrist Strap Cord	ANSI/ESD S1.1	0.8 x 10 ⁶ to 1.2 x 10 ⁶ ohms	For compliance verification of a wrist strap system, see Table 2.	
	Wrist Strap Cuff	ANSI/ESD S1.1	Interior < 1 x 10 ⁵ ohms Exterior > 1 x 10 ⁷ ohms		
	Wrist Strap Cord Bending Life	ANSI/ESD S1.1	> 16,000 cycles		
	Footwear	ANSI/ESD STM9.1	< 1 x 10 ⁹ ohms	See Table 2	See Table 2
	Foot Grounders	ESD SP9.2	< 1 x 10 ⁹ ohms	See Table 2	See Table 2
	Flooring	ANSI/ESD S7.1	< 1 x 10 ⁹ ohms	See Table 2	See Table 2

	Seating	ANSI/ESD STM 12.1	< 1 x 10⁹ ohms	ESD TR53 Seating Section	< 1 x 10⁹ ohms resistance to ground
EPA	Ionization other than Room Systems	ANSI/ESD STM 3.1 - Discharge time - Offset voltage	User defined < ± 50 volts	ESD TR533 - Discharge time - Offset voltage	User defined < ± 50 volts
	Ionization (Room Systems)	ANSI/ESD STM3.1 - Discharge time - Offset voltage	User defined < ± 150 volts	ESD TR533 - Discharge time - Offset voltage	User defined < ± 150 volts
	Shelving	ANSI/ESD S4.1	< 1 x 10⁹ ohms	ESD TR53 Worksurface Section	< 1 x 10⁹ ohms resistance to ground
	Mobile Equipment (Working Surfaces)	ANSI/ESD S4.1	< 1 x 10⁹ ohms	ESD TR53 Mobile Equipment Section	< 1 x 10⁹ ohms resistance to ground
	Continuous Monitors	User defined	User defined	ESD TR53 Continuous Monitors Section	Manufacturer defined
	Garments	Static Control Garment (ANSI/ESD STM2.1)	< 1 x 10¹¹ ohms	ESD TR53 Garments Section	< 1 x 10¹¹ ohms
		Groundable Static Control Garment (ANSI/ESD STM2.1)	< 1 x 10⁹ ohms	ESD TR53 Garments Section	< 1 x 10⁹ ohms

Groundable Static Control Garment System (ANSI/ESD STM2.1)	< 3.5 x 10 ⁷ ohms	ESD TR53 Garments Section	< 3.5 x 10 ⁷ ohms
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4) Root Cause Analysis:

Note: Conducted by our most experienced Engineers and Scientists with advanced degrees and/or specialized expertise including product ESD designed-in protection.

We are uniquely equipped to efficiently locate the root cause of ESD damage in complex manufacturing operations due to our team of advanced engineering experts and over 200 years experience. We pioneered many aspects of ESD event detection techniques and have unequalled experience with these and other advanced auditing techniques. Thus, it is possible to readily analyze sophisticated automated or manual production lines and pinpoint the root cause of ESD failure.

Once the root cause has been identified we can draw on our depth of experience and technical understanding of the physics of ESD to efficiently resolve manufacturing issues or to redesign products to enhance designed-in protection.

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