

Environmental Testing Procedures

Course No. 425

FOR WHOM INTENDED This course is for test laboratory managers, engineers and technicians. It also helps quality and reliability specialists and acquisition personnel in government and military activities and their contractors. It is designed to serve the needs of personnel in a wide range of industries.

BRIEF COURSE DESCRIPTION The course begins with an introduction and review of the many factors that must be addressed in order to undertake a meaningful environmental test. The instructor next discusses various environmental test applications such as product development, reliability, acceptance, qualification, life cycle, fatigue, accelerated, functional, endurance etc. Specific types of environmental tests such as vibration, shock, climatic, ESS/EST are discussed in detail.

For each testing environment, the course covers discussion of physical test facilities and an overview of the test equipment, including instrumentation and fixtures. Students will gain familiarity with specific test procedures, including test levels and durations. The process starts with a review of all applicable documents, such as specifications and standards, and defining what is expected from the test. Options such as test tailoring and deviation from written requirements of test documentation will be explored.

The course is presented as a series of highly-interactive lecture/discussion sessions. Special-interest discussions are encouraged outside of the regular course sessions.

CERTIFICATE PROGRAMS This course is required for TTI's [Environmental Engineering Specialist](#) and [Climatic Test Specialist Certificate](#) Programs and is an elective for any other [TTI Certificate Program](#).

PREREQUISITES There are no definite prerequisites. However, this course is aimed toward individuals involved in a related technical field. Supervisors are invited to telephone or write to TTI on prospective attendees' backgrounds and needs.

TEXT Each participant will receive a [course workbook](#), which contains most of the view-graphs used during the presentation.

COURSE HOURS, CERTIFICATE AND CEUs Open courses meet seven hours per day. Upcoming presentation dates can be found on our current [open course schedule](#). Class hours/days for on-site courses can vary from 14–35 hours over 2–5 days as requested by our clients. Upon successful course completion, each participant receives a certificate of completion and one Continuing Education Unit (CEU) for every ten class hours.

For [schedules](#), [general information](#) and a [registration form](#) see TTI's web site.

Course Outline

Introduction to Environmental Test Procedures
Environment Simulation • Simulation Complexity • Test Tailoring
Test Facilities: Adaptability, Control Capability, Consistency

Environmental Testing
Objectives • Testing a Hypothesis • Development Testing
Design Verification Test • Conservatism and Margins
Qualification Testing • Development Tests: Accelerated Testing • "Life" Testing
Types of "Life" Tests
Short-Term: Step-Stress • Long-Term: Fatigue & Durability
Fatigue Life vs. Service Life • Acceptance Testing
Contractual Compliance Testing • Production Test • Monitoring Production Quality
Review of Vibration Theory: Degrees of Freedom • Single-Degree-of-Freedom (SDoF)
SDoF--Sinusoidal Relationships • Calculating Natural Frequency
Forced Vibration • Transmissibility • Effect of Damping • Isolation • Damping Ratio
Random Vibration: Special Definitions, Spectral Density, Calculating the RMS

Vibration Test Procedures
Sine Vibration Testing • Closed Loop Control • Sweep Rates • Resonant Search
Fixture Evaluation • Random Vibration Testing • Choice of Test Procedures
Types of Vibration tests: Swept Sine, Fixed Sine, Wide Band Random, Fixed Center
Frequency Narrow Random, Swept Narrow Random, Combinations
Vibration Test Method: Equipment Operation, Severities • Information Required
Tolerances: Sinusoidal and Random Vibration • Excitation Control Options
Test Set-up and Preparation • Test Procedures

Review of Shock Theory: What is Shock? • Measuring and Analyzing Mechanical Shock
Shock Response Spectrum • Shock Synthesis • Pulse Characterization
Classical Shock • Pulse Characterization • Pulse Compensation

Shock Test Procedures: Shock Tests: Purpose, Application • Effect of Environment
Pneumatic Drop Test Machine • Free-Fall Machine
Navy Impact Machines: "Light-Weight" Shock Tester, Pendulum Type
Transients: Moderate-Level and/or Mid-Frequency Transients, Low Frequency
Transients • Oscillatory Transients • Decaying Oscillatory Acceleration
Shock from Vibration Shaker • Equipment Operation, Severities • Tolerances
Control Strategy • Gravity and the Load Factor • Test Setup • Calibration
Sample Shock Test Procedures: Functional, Transit Drop, Bench Handling, Crash
Hazard, Rail Impact, Pyrotechnic Shock • Failure Criteria
Protective Packaging • Product Fragility • Damage Boundary Theory
Step Velocity and Step Acceleration • Damage Boundary Graph

Climatic Testing Procedures: Low Temperature • High Temperature
Temperature Shock • Temperature Cycling • Humidity
Humidity Cycling • Solar Radiation • Rain Test • Salt Fog
Sand and Dust • Industrial Atmosphere (Gaseous) • Fungus

Accelerated Testing: Reducing Test Time • Test Assumptions
Which Environmental Forcing Functions Are Best? • Rates of Test Acceleration
Accelerated Test Models • Miner's "Rule" • Principles of Test Time Compression
Two Types of Test Acceleration: Higher Frequency of Occurrence, Exaggerate Load
Levels • Accelerated Test Cautions

Environmental Stress Screening: Production Process Screening • What is ESS?
ESS vs. Hardware Test • Background • NAVMAT P-9492 • Environments
Screen Characteristics • Designing an ESS Process • Rules of Successful ESS

Application of Vibration in Environmental Stress Testing
What does Vibration do? • Excitation options: Electrodynamic • Repetitive Impact
ESS random vibration spectrum • Selecting a vibration screen
Linear vs. non-linear product response • Level of assembly
Hidden vibration test assumptions • Vibration surveys
Measurement philosophy • Accelerometers • Data acquisition
Appendix: ISO/IEC Guide 25 • ESS Experiment • MIL-STD-810E, F
Summary, Discussion • Award of Certificates for Successful Completion



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