

Environmental Testing Procedures

Course No. 425

Course Outline

FOR WHOM INTENDED 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 for personnel in a wide range of industries.

BRIEF COURSE DESCRIPTION The course introduces the factors that must be addressed to undertake a meaningful environmental test. The instructor discusses environmental test applications such as product development, reliability, acceptance, qualification, life cycle, fatigue, accelerated, functional, endurance etc. Specific environmental tests including vibration, shock, vacuum, acoustic, thermal, climatic, and accelerated testing are discussed.

For each environmental test area, the basic theory is introduced along with examples of various test applications so that the students can better appreciate the subject matter prior to delving into detailed test equipment, methods, and procedures. For each testing environment, the course discusses key features of test facilities as well as associated test equipment, including instrumentation and fixtures. Students will gain familiarity with specific test practices and procedures, including test levels and durations. This includes reviewing applicable specifications and standards, generating a test plan, and defining test expectations. Options such as test tailoring and deviation from written requirements 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. The course is aimed toward individuals involved in a related technical field. Supervisors may contact TTI regarding prospective attendees' backgrounds and needs.

TEXT Each participant will receive a [course workbook](#), which contains most of the viewgraphs 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 vary from 14–35 hours over 2–5 days as requested by client. 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.

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 • 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 • Forced Vibration • Transmissibility • Damping
Isolation • Random Vibration: Definitions, Spectral Density, Calculating the RMS

Vibration Test Procedures: Sine Vibration Testing • Closed Loop Control
Sweep Rates • Resonant Search • Fixture Evaluation • Random Vibration Testing
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, Preparation, Procedures • Failure Criteria • Force-limited testing

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

Shock Test Procedures: Shock Tests: Purpose, Application • Effect of Environment
Pneumatic Drop Test and Free-Fall Machines • Navy Impact, Pendulum Machines
Transients: Mid-Frequency, Low Frequency and Oscillatory Transients
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

Acoustic Testing Procedures: Acoustic Theory, Applications • Test Equipment:
Sound Generators • Microphone Selection • Test Chambers, Systems
Acoustic Testing Methods • Emissions • Noise Suppression, Cancellation

Vacuum Testing: Theory • Vacuum Level vs Application • Application Examples
Equipment: Low and High Vacuum Pumps, Gauges, Plumbing and seals
Vacuum Testing: System Operation • Leak Rate and Outgassing Measurements

Thermal Testing: Heat Transfer and Thermal Theory • Convection, Conduction
Thermal Equipment, Heaters & Chillers • Heat pipes • Instrumentation:
Thermocouples, RTDs and PRTs, IR non-contact probes, Colored crystals
Test Chambers and Systems: Atmosphere, Altitude, Humidity, Thermal Vacuum
Thermal Testing Methods: Atmospheric vs. Altitude or Vacuum
Thermal Cycling • Thermal Balance • Thermal Shock
Climatic Tests-For Commercial Devices • Low and High Temperature Tests
Additional Climatic Testing Procedures: Humidity • Humidity Cycling • Solar Radiation •
Rain Test • Salt Fog • Sand and Dust • Industrial Atmosphere • 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
Summary, Discussion • Award of Certificates for Successful Completion



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