

# Environmental Testing Procedures

## Course No. 425

**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 test application examples prior to delving into detailed test equipment, methods, and procedures. For each testing environment, the course discusses key features of test facilities and 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 student will receive 180 days access to the on-line electronic course workbook. Renewals and printed textbooks are available for an additional fee.

**COURSE HOURS, CERTIFICATE AND CEUs** 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.

**INTERNET COMPLETE COURSE** 425 features almost 16 hours of video as well as more in-depth reading material. All chapters of course 425 are also available as OnDemand Internet Short Topics. See the online course outline for details.

## Course Outline

Introduction to Environmental Test Procedures  
Environment Simulation & limitations • Similitude • Types of Environmental Tests  
Environmental Testing Program: Program Development • Environmental Engineering Management Plan (EEMP) • Product Life Cycle and Environment Definition • Test Requirements and Tailoring • Defining Test Methods and Alternatives • Detailed Environmental Test Plans • Performing an Environmental Test  
Environmental Testing Fundamentals: Types of Environmental Tests  
Exploratory or Development • Lifetime • Step-Stress • Fatigue • Qualification (Qual) Protoqualification • Acceptance • Production • Product Process Verification • ESS Re-Testing • Test Levels/Margins and Durations • MIL and Institutional Standards  
Integrated Product or Process Teams (IPTs) • Device Under Test Configuration Equipment • Instrumentation • Fixtures • Facilities • Personnel  
Introduction to Environmental Test Procedures: Importance and Limitations  
Necessity of Standards • Tailoring • Written Environmental Test Plan  
Requirements, Objectives, and Goals • Description of DUT • Test Methods, Levels and Tolerances • Performance Testing and Pass/Fail Criteria • Expected Results  
Test Equipment, Instrumentation, Facilities • Detailed Sample Test Procedures  
Vibration Theory: Degrees of Freedom • Mathematical Treatment of Vibration  
Forced Vibration • Transmissibility • Damping • Isolation • Random Vibration:  
Definitions, Spectral Density, Calculating RMS • Applications of Vibration Testing  
Vibration Test Equipment: Electrodynamical and Hydraulic Shakers • Expansion Heads and Mounting Cubes • Fixtures • Data Acquisition • Laser Doppler Vibrometry (LDV)  
Vibration Test Procedures: Modal Testing and Analysis • Sine Vibration Testing  
Closed Loop Control • Sweep Rates • Resonant Search • Fixture Evaluation  
Random Vibration Testing • Equipment Operation • Severities • Tolerances  
Control Options • Test Set-up, Preparation, Procedures • Failure Criteria  
Types of Vibration tests, Combinations • Force-limited testing  
Shock Theory: What is Shock? • Impact of Shock • Classical Shocks • Complex Shocks • Pyroshock • Measuring and Analyzing Shock • Shock Response Spectrum  
Shock Test Equipment: Apparatuses and Instrumentation • Drop Test, Free-fall and Pneumatic Machines • Arrestors • Pendulum & Sled Impact Machines  
Resonant Table • Hopkinson Bar • Pyroshock • Spring Hammer • Shakers for Shock Testing • Explosive & Ballistic Shock Testing • Crash Testing • Instrumentation  
Shock Test Procedures: Purpose, Application • Sequence • Choice of Test Procedures  
Types of Shock Tests • Oscillatory Transients • Procedures • Parameters and Tolerances: Classical Shock Waveform Pattern, Complex Shocks • Control Strategy • Gravity and the Load Factor • Test Preparation • Sample Procedures: Functional, Transit Drop, Bench Handling, Crash Hazard, Rail Impact, Pyrotechnic, Packaging  
Acoustic Testing Theory, Equipment and Procedures: Sound • Acoustics  
Applications • Test Equipment: Sound Generators • Microphone Selection • Test Chambers, Systems • Test 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, Radiation • Applications • Heaters & Chillers • Heat pipes • Instrumentation • 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: Solar Radiation • Rain Test • Humidity  
Salt Fog • Sand and Dust  
Accelerated Testing: Reducing Test Time • Test Assumptions • Environmental Forcing Functions • Rates of Test Acceleration • Accelerated Test Models • Miner's "Rule"  
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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