

# Environmental Stress Testing

## Course No. 270c

**FOR WHOM INTENDED:** This course is for those individuals such as quality and reliability specialists who specify screens and interpret results, project managers wishing to reduce life cycle costs, production and inspection managers whose people screen and interpret results, environmental test specialists who help develop optimum screens, and design engineers who use stress testing for product development and design verification.

**BRIEF COURSE DESCRIPTION** This course shows why Environmental Stress Screening (ESS) and Environmental Stress Testing (EST) are important steps in the development, design and manufacture of both commercial and military systems that require high-reliability performance. It demonstrates the purpose of ESS, which is to precipitate and make visible any existing latent flaws. Well-screened systems have greatly improved mean time between failure (MTBF) rates, their life cycle costs are lower, their reliability is higher. Environmental Stress Testing has long been a useful tool in the development and design of new products.

This course covers thermal and vibration environments and test facilities, how to develop an effective ESS process, and the characteristics of pneumatic "random" vibration systems for ESS. The instructor describes in detail four experiments undertaken to evaluate relative effectiveness of different screening processes and methods. Accelerated testing is discussed in an appendix.

The course is presented as a series of highly-interactive lecture/discussion sessions. Problems for individual and group solution are interspersed throughout the course to act as training aids and to evaluate class progress. Special-interest discussions are encouraged outside of the regular course sessions.

**PREREQUISITES** This course should be taken after the participant has completed TTI's Course No. 116, "[Fundamentals of Vibration and Shock](#)."

**CERTIFICATE PROGRAMS** This course may be used as an elective for any [TTI specialist certificate program](#).

**TEXT** Each student will receive a [course workbook](#) including most of the viewgraphs used in the presentation.

**NOT AFFILIATED WITH ANY VENDOR** TTI sells no hardware or firmware. Equipment manufacturers' field sales people may lack time to teach fundamentals. TTI training helps you to negotiate for the equipment you really need.

**COURSE HOURS, CERTIFICATE AND CEUs** Open courses meet seven hours per day. Up coming 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 [registration forms](#), see TTI's web site.

### Course Outline

#### Introduction

Basic environmental test considerations  
Product development • Production improvement  
Which environmental forcing functions are best?

#### Environmental Stress Screening

What is ESS? • ESS background  
Number of cycles and equipment complexity environments  
Satisfactory screen characteristics • Myths  
Precipitable flaw populations • Screening problems  
Failures vs. cycles • Stress vs. cycles • Exponential failure model  
How to design an ESS Process • Rules for successful ESS

#### Thermal Environments

Types of temperature testing: Constant • Cycling • Shock  
S-N curve • Endurance limits • Thermal profile  
Commonly used temperature ranges and change rates  
Heat transfer, air velocity  
Unpowered vs. powered thermal screens  
Thermal surveys • Thermal test facilities • Rescreening

#### The Application of Vibration in Environmental Stress Testing

Review of basics • 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

#### ESS Process Plan

Steps involved in beginning an ESS process • Typical PWA testing  
Proposed ESS overall plan • HALT, HASS • Margins  
Thermal cycling • Temperature step stress of typical PWA  
Humidity • Power cycling • Voltage margining • Four corners test  
Functional diagnostic tests • System aging test • Final system test

#### Pneumatic Vibration Systems

Theory of operation • Line spectrum "smearing" • ASD plot  
Mounting to table • Pneumatic control system  
Fixtures • Limitations • Temperature cycling

#### ESS Experiments

Traditional method: Temperature cycled method • Thermal profile  
Adding functional diagnostic tests to traditional method  
Vibration combined with temperature and power cycling  
Concurrent tri-axial random vibration and thermal cycling for PWAs

#### Appendix

Glossary • Accelerated testing

#### Summary, Final Exam

#### Award of Certificates for Successful Completion



## Technology Training, Inc.

(a tti group company)

Toll-free telephone:

866-884-4338 (866-TTi-4edu)

805/715-2638 Fax: 805/715-2650

E-mail: [Training@ttiedu.com](mailto:Training@ttiedu.com)

<http://www.ttiedu.com>