Product Reliability Webinar: Combined Environmental Conditions Testing
• Why and How of Product Reliability Testing
• Defining your product’s environment
  • What is unique?
• Combined Environment Methodologies
  • Background of the test inputs
  • Test parameters and standards
  • Test to level vs. test to failure
  • Typical results
• Summary
Why Test?

- Reliability: Ability of the product to meet design criteria
- Products will see many hazards throughout their life
  - Indoor/outdoor environment
  - Rough usage and handling
  - Operating conditions
  - Shipment and installation
- Regulatory Requirements
- Customer Satisfaction, Warranty, Liability
Things to consider prior to testing

- Design for reliability
  - Reference existing solutions
  - Thermal expansion/contraction
  - Material compatibility
  - Hardware backout (torque/threadlock)
  - Production process control
- Regulatory Requirements
  - Safety (optical, noise, mechanical, electrical, fire)
  - Product effectiveness
Establishing the Test Plan

- Design of Experiment (DoE)
  - Characterize environments EUT will see
    - Define test inputs to cover all environments
    - Consider **Combined Environments**
    - Remember shipping / distribution (severe!)
  - Determine acceptance criteria / inspections
    - Quantitative when possible
    - Cosmetic, functional, safety
- Start small
  - First: Test temperature and basic mechanical vibration
  - Second: Comprehensive testing (single environment)
  - Third: **Combined Environment Testing (as applicable)**
Questions?
Combined Environment Test Inputs

- Every product will see different environments
  - Sample EUT: Ruggedized Laptop Computer
- Test inputs discussed
  - Temperature + Vibration
  - Impact Testing + Temperature Extremes
  - Freefall Drop Testing + Temperature Extremes
  - Mechanical Cycling + Temperature Extremes
  - Temperature + Pressure
  - Fluid Submersion + Temperature + Pressure
  - Thermal Shock by Water Spray
Basic Temperature Testing

• Background
• Basic tests
  • Storage, shipment
  • Operating
    • Heat rejection, cyclic on-off, temp rise
    • Varied electrical inputs
• Test profiles
  • Static, cyclic and shock profiles
  • Operational stress tests ‘4 corners’
  • ASTM D4332, IEC 60601-1, IEC 60068-2-X, MIL-STD-810
• Common issues / results
  • Thermal expansion issues
  • Exceeding material limits, mechanical failures
• Background of “AGREE” Testing
• Typical Test
  • Cyclic functional operation
  • Temperature by application
  • X, Y, Z axis in single direction
  • Random frequency domain by application
    • Transport (1Hz – 300Hz)
    • Bare Product (5Hz – 2,000Hz)
• Test Standards
  • MIL-STD-883, MIL-HDBK-781
• Variations of Testing
• Common Issues / Results
  • Unsupported / surface mount component failure
  • Permanent failure to operate correctly
Impact Testing + Extreme Temperatures

• Background
• Typical Tests
  • Condition EUT or test at temperature
  • Steel ball
    • Simulates many sources of impacts
    • Variables are ball diameter / drop height
  • Hail
    • Terrestrial at terminal velocity (in air)
• Test Standards
  • IEC 60601-1, IEC 60950-1, UL 2218
• Common Issues / Results
  • Mechanical damage, cosmetic damage
Freefall Drop Testing + Temperature Extremes

- **Background / Defining the environment**
  - Cold conditioning is usually most severe
  - Waist-height drop for most handheld products

- **Test parameters**
  - Pre-conditioning (-40°C to +60°C are common)
  - Number of drops
  - Face, edge, corner
  - Height and impact surface (depends on weight)

- **Test Standards**
  - IEC 60601-1, IEC 60068-2-31, MIL-STD-810

- **Common Issues / Results**
  - Cracking, breakage, cosmetic damage
• Background
• Components to test
  • Hinges, switches, mechanical buttons
  • Connector insertion/removal
  • Touch screens
• Typical Test
  • Define possible operating temperatures
  • Define number of cycles
  • Define cycle force, speed, duration
  • Inspect periodically
• Test Standards / Norms
  • Various
• Common Issues / Results
  • Quick wear out, inelastic deformation
  • Change in actuation or insertion/removal force
  • Mechanical fatigue (especially with plastics)
  • Exceeding material limits, mechanical failures
• **Background**
  - Altitude, Pressure, Vacuum
  - Absolute vs. Gauge Pressure

• **Define environment (shipment and end use)**
  - Usually tested to ~14,000 feet elevation equivalent
  - Most aircraft cargo is pressurized to ~8,000 feet
  - Applicable for sealed volumes, potted parts

• **Common tests**
  - 1-hour duration to high and low temperature / pressure
  - Cyclic testing at temperature extremes
  - Operational testing (reduced convective cooling)
  - ASTM D6653, IEC 60068-2-13, MIL-STD-810

• **Common results**
  - Expanded/imploded parts
  - Unit overheating
• Background
• Fluid Submersion
  • High pressure (often at depth)
  • Low pressure sometimes performed
  • Consider operating the EUT
• Fluid Submersion + Temperature
  • Hard-freeze
  • Temperature extremes (non-freeze)
• Test Standards
  • IEC 60529
• Common Issues / Results
  • Water enters, EUT fails (usually electrical)
Thermal Shock by Water Spray

- Background
- Water Spray
  - Heat EUT to maximum operating temp
    - Usually +50°C to +60°C
    - Spray with cool water
- Test Standards
  - IEC 60529, ASTM G154
- Common Issues / Results
  - Water ingress
  - Implosion of parts
- Variations
Summary & Parting Thoughts

• Start by defining the environment
  • Establish acceptance criteria
• Test to single environmental inputs
  • Address failure modes
• Test combined environment inputs
• Expect to have findings & opportunities for improvement
• Don’t forget product shipping!
Any Questions
About WESTPAK, Inc.

Two Locations:

San Jose Laboratory
83 Great Oaks Boulevard
San Jose, CA 95119
408-224-1300

San Diego Laboratory
10326 Roselle Street
San Diego, CA 92121
858-623-8100

www.westpak.com
projects@westpak.com
Next Webinar

May 15, 2014
Life Science: Medical Device Packaging
Test Specifications Update and Review
Thank You!

Please feel free to contact us with any questions or assistance with your product reliability testing needs.

Mike Brown
mike@westpak.com

Herb Schueneman
herb@westpak.com

webinar@westpak.com