Agenda

- Why do product reliability testing?
- Prior to testing
  - Define the product’s environment
  - Design & materials considerations
- Test Technologies
  - Temperature, Shock, Vibration, Mechanical Cycling etc.
  - Test parameters and standards
  - Typical results
- Conclusions and Questions
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
  - Material compatibility
  - Hardware torque/thread locker
  - 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
    - Think about combined environments
    - Remember shipping (often most severe)
  - Determine acceptance criteria / inspections
  - Start small (EVT, DVT, Final Production)
    - Test temperature and mechanical handling
  - Test to level vs. testing to failure
Every product has different requirements
Test inputs will be covered
  • Temperature, Humidity, Altitude
  • Mechanical Drop, Shock, Vibration
  • UV Light, Salt Fog, Water Spray
  • Mechanical Characterization, Cycling
  • Solvent, Scuff Testing
Sample EUT
  • Laptop Computer
• Define temperature range
  • Operating, storage, shipment
  • Heat rejection, temperature rise
• Test profiles
  • Static, cyclic and shock profiles
  • Run unit stress tests
  • ASTM D4332, IEC 60601-1, IEC 60068-2-X, MIL-STD-810
• Common issues / results
  • Thermal expansion issues
  • Exceeding material limits, mechanical failures
Temperature / Humidity

- Define environment
  - Units are in % Relative Humidity (% RH)
  - Indoor, outdoor, shipment
  - Dew point and condensation
- Common tests
  - Shipment / outdoor (tropical, desert, freezing)
  - Indoors (nominal 4 point test)
  - Stress tests (Damp Heat, Humidity Freeze)
  - ASTM D4332, IEC 60068-2-X, MIL-STD-810
- Common Issues / Results
  - Oxidation / Corrosion
  - Electrical problems (often caused by condensation)
• Altitude, Pressure, Vacuum
  • Define environment (shipment, end use)
    • Usually tested to ~14,000 foot equivalent (meters, mBar or Torr)
    • Most aircraft cargo is pressurized to ~8,000 feet
    • Only applicable for sealed volumes, potted parts
  • Common tests
    • 1 hour duration to high and low pressures
    • Cyclic testing at temperature extremes
    • ASTM D6653, IEC 60068-2-13, MIL-STD-810
  • Common results
    • Expanded/imploded parts
Freefall Drop / Impact

- Define environment
  - For most handheld products waist height
- Test parameters
  - Number of drops
  - Face, edge, corner
  - Height and impact surface
- Test Standards
  - IEC 60601-1, IEC 60068-2-31, MIL-STD-810
- Common Issues / Results
  - Cracking, breakage, cosmetic damage
Mechanical Shock

- Damage Boundary Curve
  - Critical acceleration / velocity change
  - Waveform selection (half-sine / trapezoid)
- Typical Test
  - Half-sine duration (0.5ms – 18ms)
  - Peak G level (20-100G’s)
  - X, Y, Z axes both directions
- Test Standards
  - ASTM D3332, IEC 60068-2-27, MIL-STD-810
- Common Issues / Results
  - Unsupported / surface mount component failure
• Random vs Sine
  • Resonance Search
  • Use random if possible
  • Shipment and end use environment
• Typical Test
  • 3 hour total duration
  • X, Y, Z axis single direction
  • Suggest flat random profile, EUT operating
• Frequency Domain
  • Transport (1Hz – 300Hz)
  • Bare Product (10Hz – 2,000Hz)
• Test Standards
  • ASTM D3580, IEC 60068-2-6, IEC 60068-2-64, MIL-STD-810
• Common Issues / Results
  • Unsupported / surface mount component failure
  • Critical component resonance / failure
Ultraviolet Light (UV)

• Simulating outdoor sunlight
  • UV range 250nm-400nm
    • UVA (320nm – 400nm) UVB (280nm-320nm)
    • Elevated temperatures (+40°C to +80°C)
  • Materials selection or comparative testing
  • Automotive / indoor weathering

• Typical Tests
  • Florescent bulb vs full spectrum (MH / Xenon)
  • ASTM G151 (general) ASTM G154 (florescent bulb)

• Common Issues / Results
  • Fading, legibility, brittle plastics
• Salt Fog
  • Simulates corrosive atmosphere
  • Good comparative test
  • Others tests (acid, ammonia etc.)

• Typical Test
  • 48 hours of exposure
  • To surface of unit exposed

• Test Standards
  • ASTM B117, IEC 60068-2-11, MIL-STD-810

• Common Issues / Results
  • Corrosion of metals / uncoated parts
• Water Spray
  • Spray (level of severity, duration)
  • Submersion (specify depth)
• Mechanical
  • Fingers to dust
  • Mechanical hazards / live parts
• Test Standards
  • IEC 60529
• Common Issues / Results
  • Water: Results by weight, water gets in!
  • Mechanical: Pinch points or shock hazards
Mechanical Cycling

- Any moving component
  - Hinges and switches
  - Mechanical buttons
  - Touch screens
  - Connector insertion/removal

- Typical Test
  - Define number of cycles
  - Define cycle force, speed, duration
  - Inspect periodically
  - By hand or by machine

- Test Standards
  - Various

- Common Issues / Results
  - Quick wear out
  - Change in actuation or insertion/removal force
Define all mechanical inputs
- Insertion or removal Force
  - Tensile / compression
  - Torque
- Bend / twist
Test standards
- Various
- Specify min/max force, test speed
Common Issues / Results
- Are results acceptable to user?
• Steel ball
  • Many sources of impacts
  • Ball diameter / drop height
• Hail
  • Terrestrial at terminal velocity
• Test Standards
  • IEC 60601-1, IEC 60950-1, UL 2218
• Common Issues / Results
  • Mechanical damage, cosmetic damage
• Common solvents
  - Coffee, Cola, Sunscreen, Nail Polish Remover, Rubbing alcohol, hair spray, WD-40, gasoline, hand lotion, hand sanitizer, water, salt water.

• Typical Test
  - Apply and remove solvent many times
  - Soak EUT in solvent

• Test Standards
  - IEC 60601-1, IEC 60950-1

• Common Issues / Results
  - Paint, coating, plastic, metal damage or reaction
Other Test Parameters

• Typical input vs. worst case scenario
• Unique combined environments
  • Temperature / vibration
• Operating Inputs
  • High / Low Voltage
  • User inputs
• Safety
  • Do safety cut outs work (thermal)
  • Does device fail safely
• Cosmetic, functional, safety
Parting Thoughts

• Start by defining environment and regulatory requirements.
  • Establish acceptance criteria
• Think about design and material choices first
• Start with small portions of the test plan
  – Test as early as possible, expect to have findings
  – Take corrective action before finalizing tooling
• Don’t forget you have to ship it!
Questions
About WESTPAK, INC.

• Founded in 1986
• ISO 17025 accredited lab by A2LA
• Product and Package Testing
  • Dangerous Goods Packaging, Materials, Cold Chain

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Thank You

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

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