TEST METHODS
For Product Development

mHub February 12,2018

Deborah Brown

debbiebeth@gmail.com

Agenda

- What is a test plan & how to create
- Testing: Performance
- Testing: Quality
- Testing: Safety/Compliance
- When to test
- What to expect

Creating a Test Plan

2.1.3 Side-Load

Purpose

Verify the ability of the tool to withstand vibrations at maximum speed and repeated load application for a prolonged period of time.

Procedure

Connect a 120Vac power supply to the tool and load the tool to 5A. Cycle the tool for (60) seconds under load and (60) seconds at no-load until failure.

Requirement

Minimum life requirement is 200 hours. Confidence (85% confidence of 90% reliability) levels shall be verified through the use of Weibull plots. Final sample size may differ from initial plan due to test results.

2.1.4 Soft Grip

Purpose

Determine if the soft grip will adhere to the handles for the life of the tool.

Procedure

- Create several parallel cuts from the center of the soft grip through the outer edge. The cuts are to be perpendicular to the edge and score through the entire thickness of the soft grip.
- Expose (3) new housings to 120°F @ 95% relative humidity for 48 hours.
- Expose (3) new housings to 120°F no humidity for 48 hours.
- Expose (3) additional new housings to 0°F for 48 hours.
- Remove all housings and evaluate soft grip adhesion.

Requirement

The soft grip must not peel away from the handle. It must continue to show signs of adhesion.

Test	Test Description	Quantity	Quantity	Quantity
		Build 1	Build 2	Pre-Production
1.1.1	Motor Performance Test	3		
1.1.2	Temperature Rise Test	1		
1.1.3	No-Load Parameter Test	10	10	15
2.1.1	Hanging No-load	4	8	3
2.1.2	Collet Lock Endurance Test	3	3	
2.1.3	Side Load Endurance Test	4	8	3
2.1.4	Soft Grip Test		9	
2.2.1	Hand Use Test	4	4	2
2.3.1	High Temperature Test		3	
2.3.2	Low Temperature Test		3	
2.3.3	Temperature Cycling Test		3	
2.3.4	Temperature and Humidity		3	
2.3.5	Dust Box Test	3	3	
2.4.1	Accidental Collet Lock Activation/Jam Test	1	3	3
2.4.2	Collet Lock Strength Test	1	3	3
2.5.1	Collet Run Out Test	3	3	3
2.6.1	Temperature Rise**		3	
2.6.2	Abnormal Operation**	1	3	
2.6.3	Drop Test 1 Meter**		1	
2.6.4	EMC Test**		3	
2.6.5	No-load Sound Power		5	
2.6.6	Hand/Arm Vibration Test		5	
2.7.1	1 Meter Drop Test	3	3	
2.7.2	2 Meter Drop Test	3	3	
2.7.3	Switch Electrical Endurance Test		8 switches	
2.7.4	Switch Mechanical Endurance Test		8 switches	
2.7.6	Label Durability Test		9 labels	
2.7.8	Label Rub Test		3 labels	
2.8.2	Sensormatic Tag Test		1 kit	
2.8.3	West Memphis Ship Test		1 M/P	
2.8.4	Color Measurement Test		4 sets housings	
	Total	**40**	**90**	**30**

Test Plan

1. Written document defining product requirements for:
   - Performance – what does it do
   - Quality – how well does it do it
   - Safety/Compliance – don't hurt anyone while doing it
2. Plan Outlines:
   - Feature to be tested
   - Quantity
   - Methodology
   - Equipment to use
   - When in development cycle test
   - Performance or acceptance criteria (if known)

Test Plan

3. Inputs for feature to test:
   - Actually does what product is supposed to do
   - Multiple use situations
   - Various misuse considerations
   - Product lifetime and warranty
   - Jurisdictional authorities (UL, FDA)
4. Create at the very beginning; update as needed
5. Product will be broken while testing…it's for the greater good. Test to failure helps identified "over engineering"

Test Plan

TEST PLAN OUTLINE

1. Purpose
2. Procedure
3. Requirements
4. When to test
5. How many to test

DOCUMENTATION OF TEST

1. Procedure reference
2. Name, date, equipment used
3. Results obtained
4. Visual observations
5. Photos/video of set-up
6. Calibration date of equipment if critical

Testing for Performance

OR: Let’s make sure the product actually works

Performance Testing

How to define what the performance should be:

1. Respond to customer needs (with insight) – Voice of Customer
2. Benchmark testing against competition
   Strength, speed, comfort, UI/UX, features
3. Use “Key Data Sheet” to ensure all product features verified
4. Consider which design elements were improved along the way (forces, geometry…)

Ultimately YOU define the product performance and testing; this is part of corporate innovation and expertise

Performance Testing

How to test for a performance level?

1. Look to written procedures: ASTM, SAE, ISO, ANSI, IEEE
2. Make CERTAIN the feature/property under investigation will actually be evaluated
3. Consider automated testing: low cost pneumatics and PLC
4. Should be repeatable and consistent (gauge R&R). Results shouldn't depend on who is testing

Testing for Quality

OR: Let’s make sure all the products work, enjoyably, in many situations

Quality Testing

EVERYTHING BREAKS! So how much is enough?

Quality is a perceived feature, similar to value

Product quality costs money, put it in the right place

Quality Testing

TOPICS TO CONSIDER:

1. Drop testing
2. Where used: inside/outside/hot/cold/wet/dry/dark/daylight
3. User: old/young/male/female/short/tall/skinny/fat
4. Usage profile: minutes/hours/daily/monthly
5. Competition: value/professional/innovation
6. Transportation: vibration/packaging/handling

Quality Testing

WRITING PROCEDURE:

1. Similar to performance testing
2. Consider baseline testing if not certain of requirement
   - Lifetime endurance (hours)
   - Actuations (cycles)
   - Force (actuation and break)
3. Always test more than one!
4. Safety factors where needed
5. Use statistics to determine test quantity and limits

Quality Testing

Metrology:

1. Gauges: force, torque, pressure, temperature, blocks
2. Measurement: scales, callipers, micrometer, CMM, shadow graph
3. Hardness
   - Metal- Rockwell
   - Plastic/rubber – Shore durometer

Automated fixtures

Human use testing

Quality Testing

HOW TO HANDLE FAILURES:

1. Accept that they're going to happen – all the time, to every team, regardless of computer calculations
2. Determine if it is a design issue or manufacturing defect. Do parts match the drawings? (this is why drawings and specifications are needed)
3. Work with your supplier to modify: material, tolerance, geometry, component
4. Determine if requirement was set correctly

Testing for Compliance

OR: Best practices, be safe, be legal, and develop trust with customers

Compliance Testing

This testing is NOT optional!

Addresses

- Safety hazards: shock, fire, chemicals
- Environmental issues: energy efficiency, emissions, clean technology CEC
- Health issues: BPA, carcinogens

Required to sell in:

- City/State/County
- Store (i.e. HomeDepot, PetSmart)
- Specific jurisdiction (hospital, hotel, dormitory)

The BEST thing for your product is to design with Recognized Components (UR), especially for electrical components

Determining Compliance Tests & Certification

UL Online Directory of Standards: UL.com standardscatalog.ul.com

Trade Associations

NFPA

Local building codes (online)

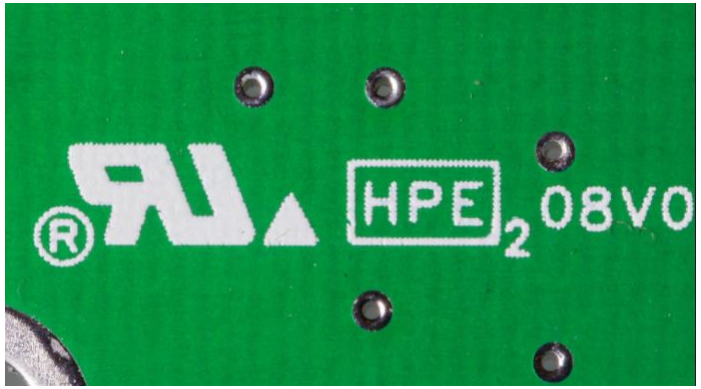
CPSC

FDA – food & drug safety

AHRI – voluntary compliance for interoperability

Overview of UL and Requirements

1. UL: publishes safety standards, tests to those standards, and authorizes use of a Listed/Classified/Recognized mark to the products.
2. UL does NOT enforce standards! Local codes or agencies (i.e. building inspector, fire marshal) require that products are tested and marked by *ANY* listing agency. Typically UL, CSA or ETL are accepted.
3. Local codes or agencies may require UL standards, but CSA/ETL can test and list per a UL standard
4. Large stores (Home Depot/Target) may also require products they sell to have a Mark to limit their liability. But for home use, you are free to buy products without UL
5. UL has 3 different levels of testing and marking: LISTED – CLASSIFIED – RECOGNIZED COMPONENT



Summary of Companies and Marks

Company	Role	Mark
UL (Underwriters Laboratories)	Publish safety standards Test in accordance with standards Certify to the standards	
CSA (Canadian Standards Association)	Similar to UL in Canada, now North America	
ETL (Intertek)	Test in accordance with standards Certify to the standards	
CE	Publish standards Does NOT test or list “self certifying”	
Demko/Semko/VDE EU country marks	Test in accordance with standards Certify to the standards	
CCC (Chinese Safety Mark)	Regulatory mark Test/certify with Authorized Certification Body (ACB)	

When To Test

When to Test - Performance

- INNOVATIVE FEATURE:
  - Early in development to make sure product is possible!
  - At beginning of cycle with supplier to confirm alignment on design

- CUSTOM PRODUCT:
  - First product from supplier – especially if prototype level
  - First product off custom tooling
  - Each lot after until product/process is stable

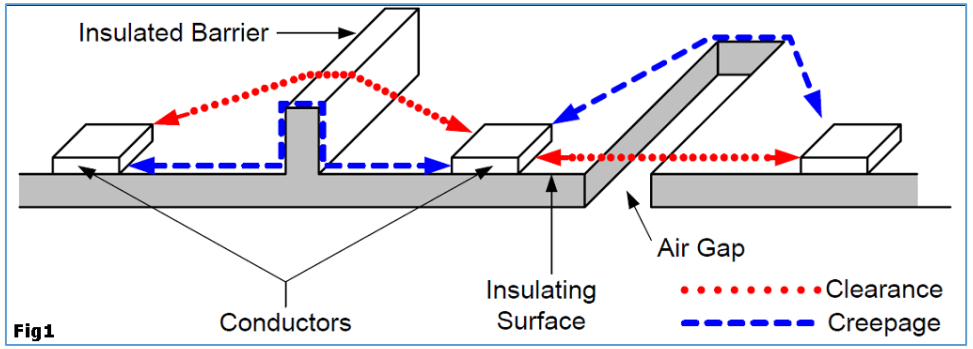
- AFTER PRODUCT IN MARKET BASED ON USER FEEDBACK

When to Test - Quality

- INNOVATION:
  - Early prototypes only as possible to identify design challenges
- CUSTOM PRODUCT:
  - First product off custom tooling, identify design changes
  - Each lot after until product/process is stable
  - Continual through production – spot check to document continued compliance
- SUPPLIER CHANGES:
  - New material (cost reduction)
  - New process

When to Test - Compliance

- INNOVATION:
  - Identify relevant standards and design compliance into product!
- CUSTOM PRODUCT:
  - First product off custom tooling if possible
  - Continual through production – spot check to document continued compliance
- OFF THE SHELF PRODUCT:
  - Confirm certification markings (UL/UR) are sufficient for application
  - Your documents to supplier MUST state UL Listing requirement
- FINISHED PRODUCT:
  - Work with agency (UL/CSA/ETL) to confirm ‘passing’ prior to full submittal



WHAT TO EXPECT OF PRODUCT TESTING


broken
hard
frustrating
long
work
sad
gg
confusion
despair
confusing
complex
expensive
defeated
challenge
challenges
confidence
technically
technical
subsystem
preferences
focus
doesn
perseverance
experimentation
selecting
forward
aren
crush
ly
development
huge
plans
word
sadness
testing
assumptions
tested
disproved
found
nature
find
costs
frequently
confident
aerospace
live
innovation
judged
test
solution
highlights
fluid
developing
projects
move
frequency
changed
solve
number
design
alternatives
agony
evaluated
refined
engineers
conceived
competing
initial
reveal
knowledge
typical
solutions
ultimately
unpredictable

and in the end, despite all that, following you passion will make it worth while

PROMISE!