Hands on HALT and HASS

Practical Advice

for

Accelerated Testing

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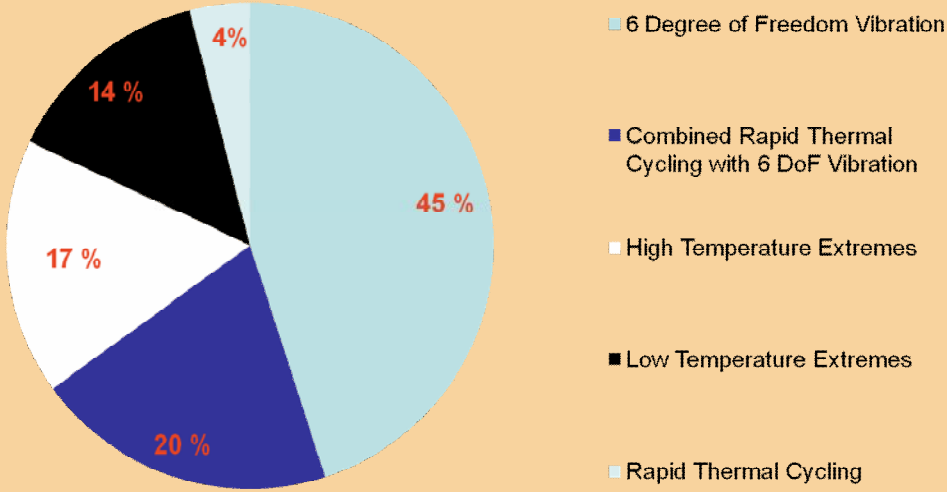
A Series of Tests is Necessary



Accelerated, But Not Instantaneous

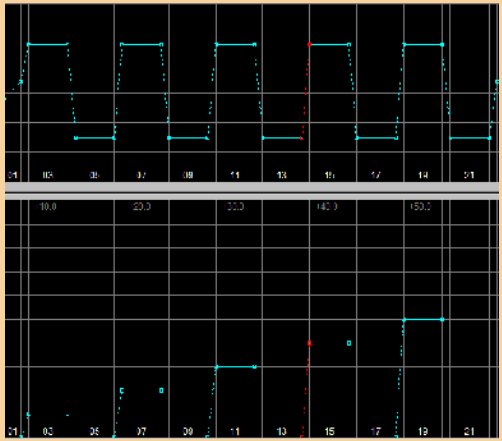
- The following tests should be done as step stress
  - Cold only
  - Heat only
  - Vibration only

The following guidelines apply

- Change rates as fast as possible
- Dwell or soak time 10 minutes or as long as it takes to stabilize the product and run diagnostic tests
- Start at room temperature (typically about 25 °C)
- When a failure is found, go back to the previous, less stressful, step

Combined Tests

- Thermal Swings
- Single Environment with 6DoF Vibration
- Thermal Swings with 6DoF Vibration
- Use data from single environment tests



How Much Time Should It Take?

TEST	Cold	Hot	Vibe	Swings	Heat or Cold + Vibe	Swings + Vibe
TIME	2’ 40”	3’ 35’	3’ 40”	2’ 32”	1’ 30”	2’ 32”

Assumptions

- Cold test uses10° C steps
- Hot test uses 5° C steps
  - Can be 10° C throughout, or start at 10° C and change to 5° C as you get close to melting point
- Vibe test starts at 3 g's and moves up 3 g's each step

Further Assumptions

- 5 thermal swings for both the thermal swing test and thermal swings with 6 DoF
- Chamber high temperature goes to 200°C and -100°C
- Times assume no failure is found, which is rare. These figures would be worst case scenario

What If There Is a Failure?

- In all but thermal swings tests, go back to the previous step which will be less stressful
- If the failure is no longer evident, step back up to the step where failure occurred
- If the failure does not go away, bring product back to laboratory ambient conditions and do failure analysis

Common Mistakes

- Building the prototype to “pass” the test in a different configuration than the end product will be in
- Trying to protect the product by using padding on the vibration table – remember, scratches don’t matter because this product WILL NOT ship
- Ignoring a failure

Sensor Placement

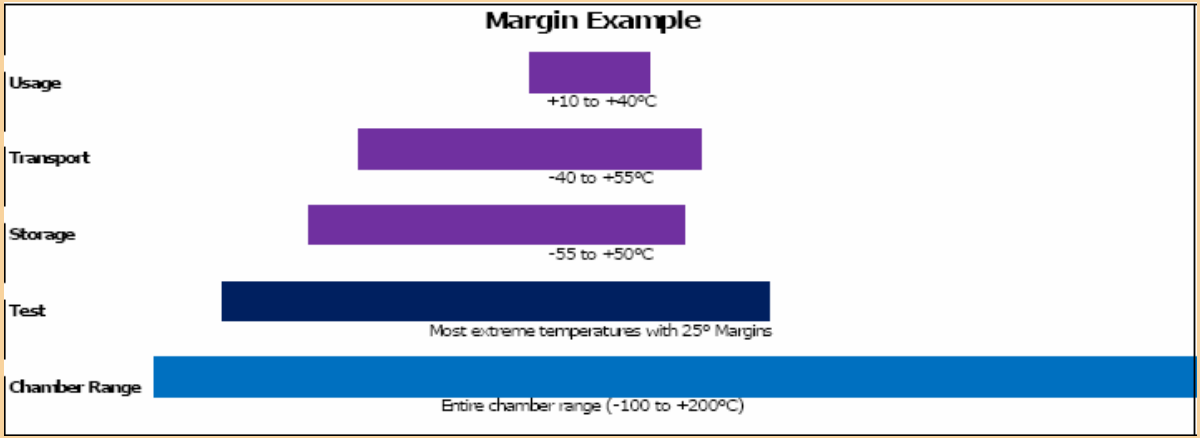
- The product thermocouple should be ON the product NEAR or ON the most sensitive component (heat producing or one of concern)
- Accelerometer
  - Ideally, on product in Z axis
  - Secondarily, on the fixture
  - If first two choices are not possible, on table top, never table bottom

More Cautions

- Remember that cables see the same temperature as the product – make sure that they are suitable for the testing temperatures

- If there is a fire, DO NOT open the door. Turn on cooling and the nitrogen will remove the extra oxygen, putting the fire out

Margins


Margin Example
Usage
+10 to +40°C
Transport
-40 to +55°C
Storage
-55 to +50°C
Test
Most extreme temperatures with 25° Margins
Chamber Range
Entire chamber range (-100 to +200°C)

HALT and HASS Comparison

HALT	HASS
Purposely take product to its failure limits	Take only the first product to its failure limits, then use that information to formulate screens
Pre-production and prototype stage	Production stage
Step stress	Managed profiles
Product is never shipped to customer (Destructive test)	All products passing can be shipped to customer (Non-destructive test)
A discovery test	A pass/fail test
Typically one product at a time tested	Typically many items at a time tested
To test design marginality	To detect process shifts

Testing Levels

- Level Name
  - UDL
    - Upper Destruct Limit
  - UOL
    - Upper Operating Limit
  - Product Specification
  - LOL
    - Lower Operating Limit
  - LDL
    - Lower Destruct Limit

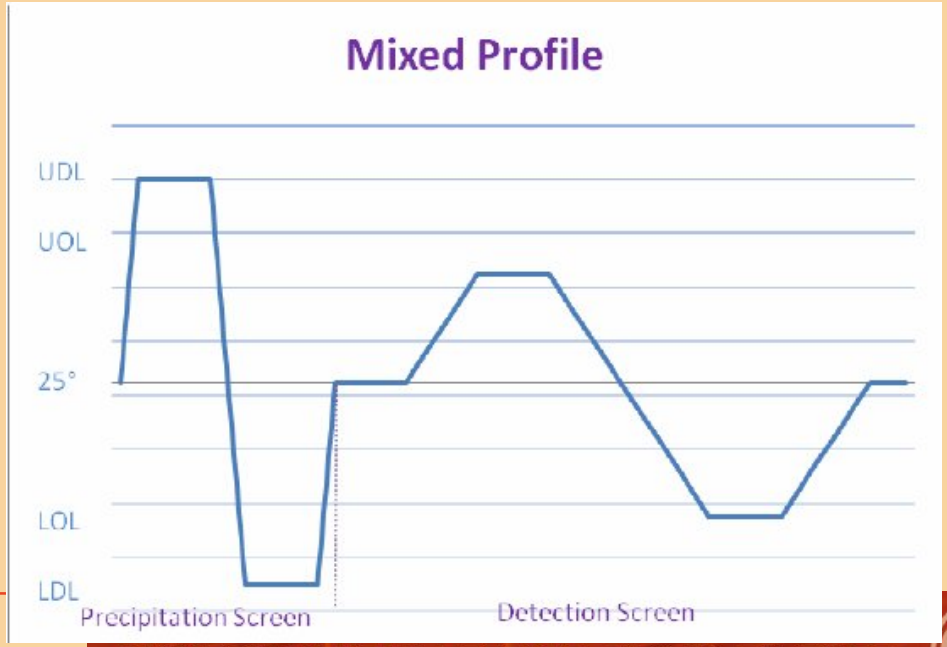
- What it Means
  - Operating limit – the point at which a unit has a soft, or recoverable, failure
  - Destruct limit – the point at which a unit has a hard, or unrecoverable, failure
  - Operating margin – the gap between the spec and the soft failure
  - Destruct margin – the gap between the spec and the hard failure

How to Calculate Temperatures

High temperature calculation

90°	UOL (soft failure point)
-	
25°	minus room temperature
65°	temperature margin between room temperature and soft failure
x	
.80	80%
52°	result
+	
25°	add to room temperature
77°	high temp for profile

Two Styles of HASS Profile



Differences Between Screening Styles

Precipitation	Detection
More extreme temperatures, going beyond OL	Less extreme temperatures, staying within 80-85% of OL
Looking to change defects from latent (dormant) to patent (active)	Good for field returns where a latent defect is already known
Vibration levels at half of DL	Tickle vibration, very low levels
Stimulation	Simulation
HALT beneficial in advance	Good field data most beneficial

More Differences

- For the Precipitation Screen, the ramp rate is as fast as possible
  - Up to 100°C/minute on air
- For the Detection Screen, a slower ramp
  - Typically 5° to 30°C/minute on air
- Different ramps can find different failures
- Dwell time needs to be long enough for product stabilization and for a diagnostic check before the next ramp begins

In Conclusion

- Remember that HALT is a discovery test, each one an experiment
- Learn from the mistakes of others so that you can avoid making them yourself
- HASS has double check measures so that you can verify the screening strength

Enjoy Yourself as You Test

- You are making products that are:
  - More reliable
  - Safer
  - Faster to market
  - Less expensive
  - Fully understood
- Each of us has a chance to make a difference