DynaQual Test Labs

Introduction to HALT (Highly Accelerated Life Testing)

HALT is a product reliability test method focused on identifying defects in products so they can be corrected before entering the commercial phase.

Customers use HALT/HASS testing to verify and validate designs, qualify manufacturing processes, and specify components. The tests involve rapid temperature changes and random vibration stress modes, under a controlled environment while monitoring the process. The technique differs from conventional qualification plans in that the system's weakest components are identified by accelerating their fatigue. Most verification test programs only confirm the specification of the system, not taking into account the robustness of the product beyond the upper or lower limits. HALT identifies all possible failure modes and in a shorter time span than traditional stress screening does.

The 5-step HALT process may identify failure modes, requiring corrective actions, including design changes. To verify the effects of these changes, abbreviated HALT tests, or RAPID HALT tests can be performed, where a full HALT is truncated to three of the five standard steps, focusing on the more stressful stages.

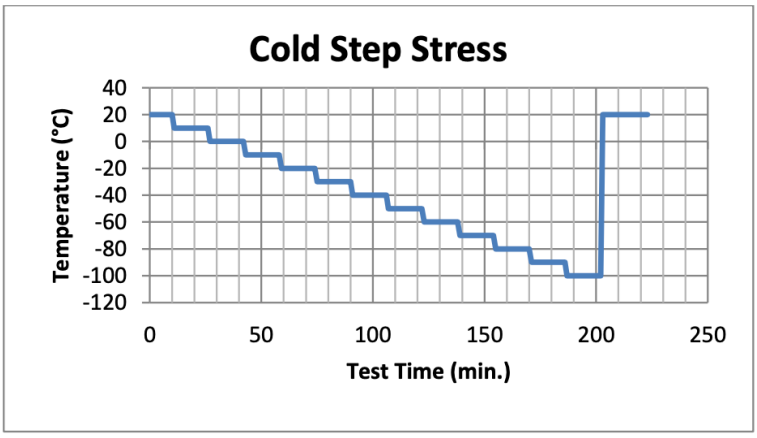
When all design defects have been reduced or eliminated and the product is deemed ready for production, a HASS (Highly accelerated Stress Screen) is commonly used to identify failure modes introduced during the manufacturing production process. It is also useful in screening undetected failures during burn-in processes. Finding these problems before the product is released can result in a significant reduction in warranty costs.

HALT/HASS testing uncovers weaknesses in product design and specification. With appropriate action, the operating limits of the product can be clearly identified and extended as far as possible, resulting in a more stable reliable product which can be introduced more quickly to market.

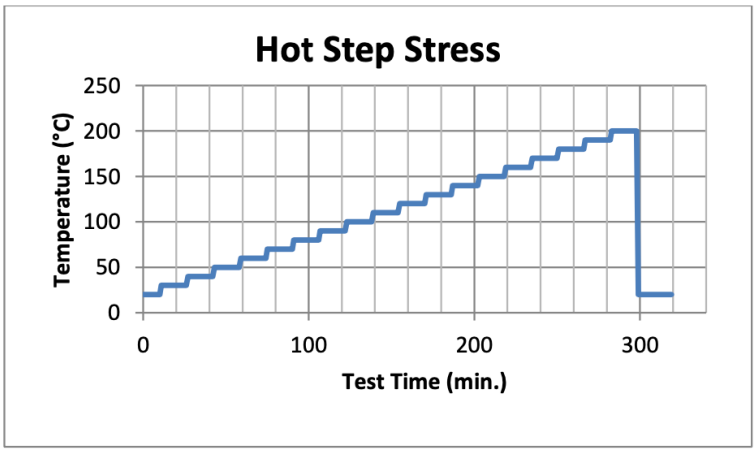
Classic HALT - is typically conducted in 5 steps

1. **Cold Step Stress**
2. **Hot Step Stress**
3. **Rapid Thermal Cycling**
4. **Vibration Step Stress**
5. **Combined Thermal with Vibration**

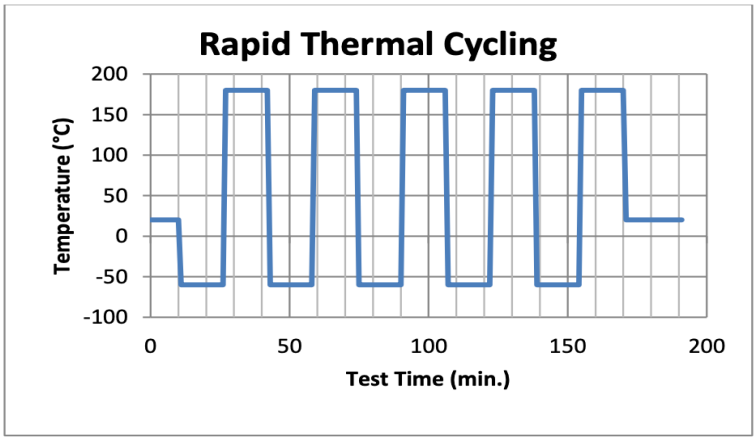
1. **Cold Step Stress**
- Start at room temperature
- Cool down in 10°C steps to lower operating or destruct limit
- Dwell times are typically 15-20 minutes to stabilize product



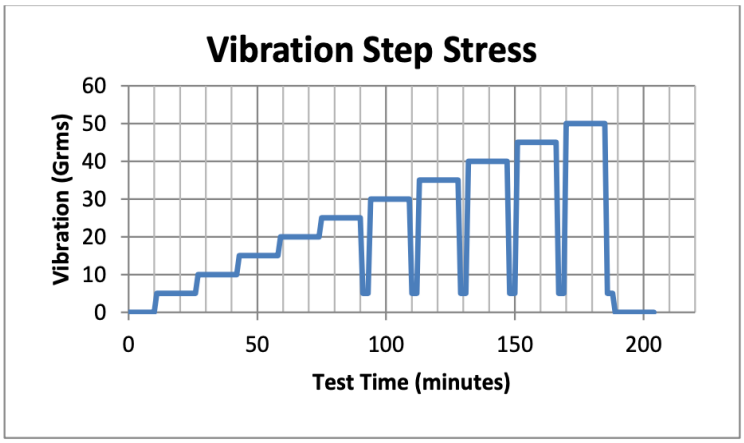
2. **Hot Step Stress**
- Start at room temperature
- Heat up in 10°C steps to upper operating or destruct limit
- Dwell times are typically 15-20 minutes to stabilize product



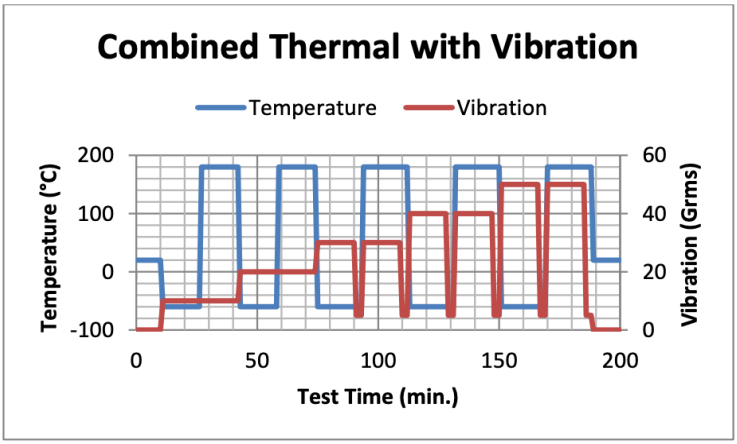
3. **Rapid Thermal Cycling**
- Cycle between the upper and lower operating limits
- Maximum rate of change the chamber is capable of
- Test a minimum of 5 cycles
- Dwell times are typically 15-20 minutes to stabilize product



4. **Vibration Step Stress**
- Entire test performed at room temperature
- Wideband random vibration applied in 5 Grms increments
- Steps applied until operating or destruct limits reached
- Dwells of 15 minutes
- Utilize “tickle vibration” above 20 Grms



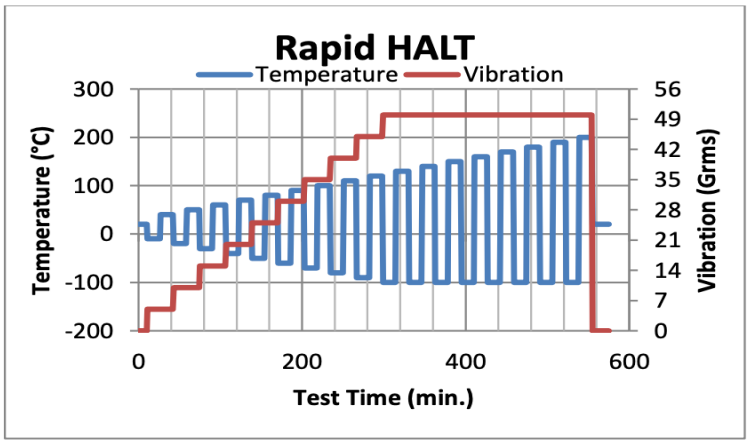
5. **Combined Thermal with Vibration**
- Rapid thermal cycling combined with vibration step stressing
- Uses the same limits as Rapid Thermal Cycling
- Vibration follows limits discovered in Vibration Step Stress
- Dwell times are typically 15-20 minutes to stabilize product
- "Tickle vibration" also used here



Rapid HALT

When to perform Rapid HALT
- Re-HALT of corrective actions from a previous HALT,
- Annual re-HALT of a product to verify margins are stable, or
- HALT testing simple products with simple test requirements.

Rapid HALT Features:
- A shorter more efficient form of HALT
- Combines Thermal and Vibration step stressing
- Takes approximately 50% of the time of Classic HALT
- Cooling steps of 10°C begin at room temperature
- Vibration steps of 5 Grms at the same time
- Dwell time of steps is contingent on product heat transfer rates
- Typical dwell times are 15-20 minutes
- A hot and cold temperature ramp is programmed at each dwell



Definitions

Destruct limits

The stress level where one or more of the product's operating characteristics is no longer within specification causing damage that does not recover when the stress is reduced, i.e. a hard failure. There is often an upper and a lower destruct limit.

Operational Limit

The stress level prior to which one or more of the product's operating characteristics is no longer within specification. The product recovers when the stress is reduced, i.e. a soft failure. There is often an upper and a lower operating limit.

Operating Margin

The difference between the operating limit and the destruct limit is called the operating margin. The wider the margin, the more durable or robust the product is. There is often an upper and a lower operating margin.

Fundamental Limit of Technology

Examples of technology limits for a product are plastic deformation or melting point.