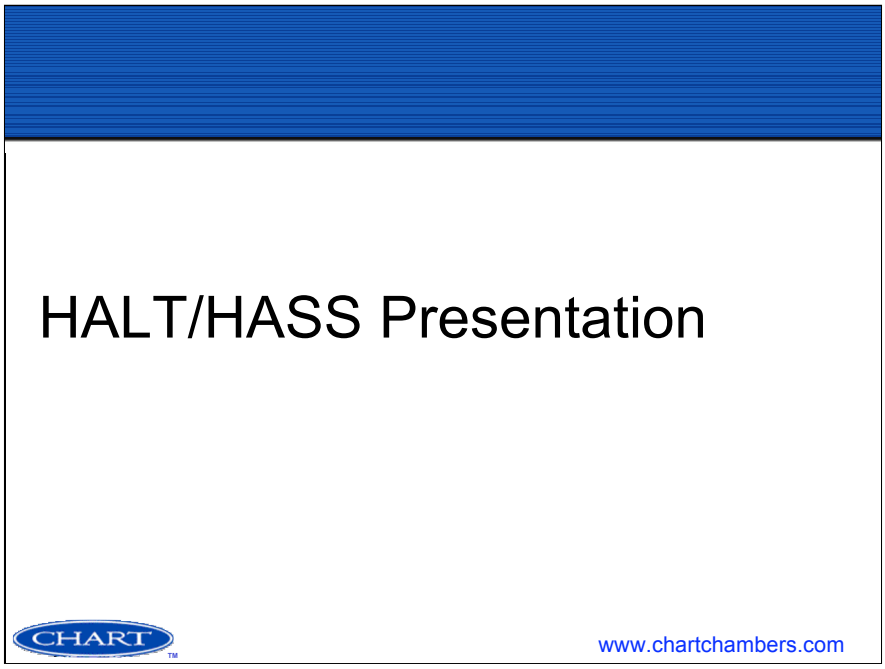
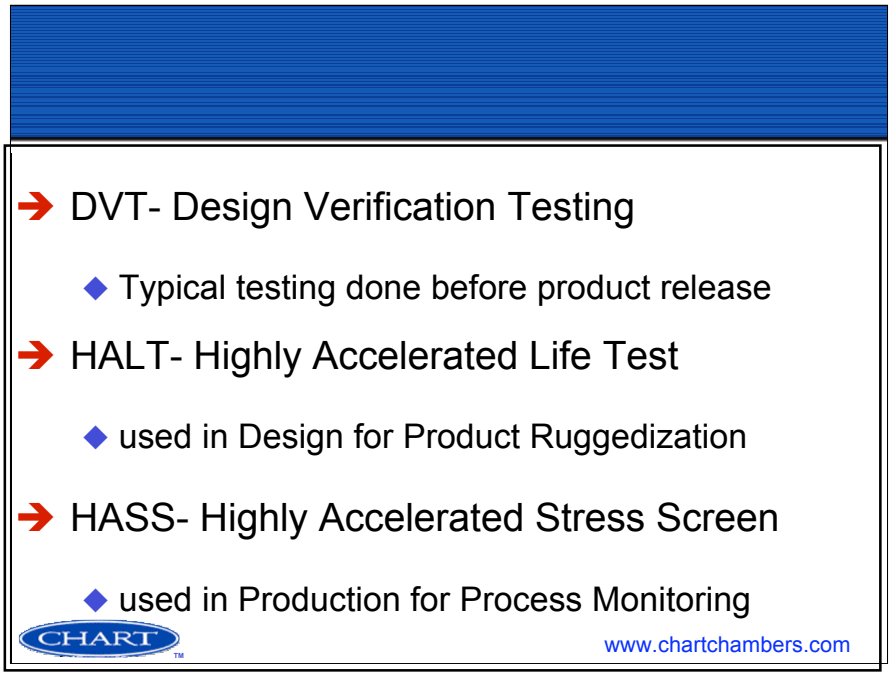


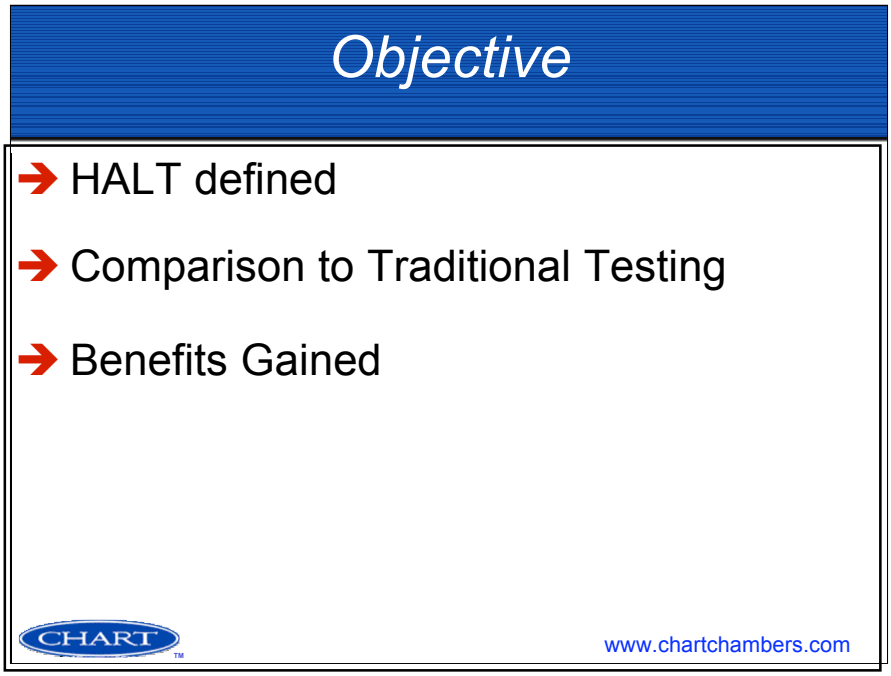

This presentation is an introduction to accelerated testing techniques. These techniques will be referred to as HALT and HASS during this presentation.




Traditional testing/Design Verification Testing is typically done after the product is designed and released to manufacturing. It simulates what the product is going to see in its intended environment.

As you can see HALT is used in the design phase to ruggedize the product and remove design related weaknesses. HASS, is used to identify process and vendor problems during the production process.

The origin of these techniques dates back to the early 80's when there was a growing dissatisfaction with the prevalent reliability techniques. Let's start by discussing HALT.




This a brief agenda on what we are going to discuss.

Definition of what HALT is and is not

How does it differ from traditional testing and philosophies?

What can be gained from using this technique?

## *HALT* - What Is It?

- HALT is used to find the weak links in the design and fabrication processes of a product during the design phase.
- The stresses are not meant to simulate the field environments at all, but to find the weak links in the design and processes using only a few units. The stresses are stepped up to well beyond the expected field environment until the "fundamental limit of the technology" is reached.

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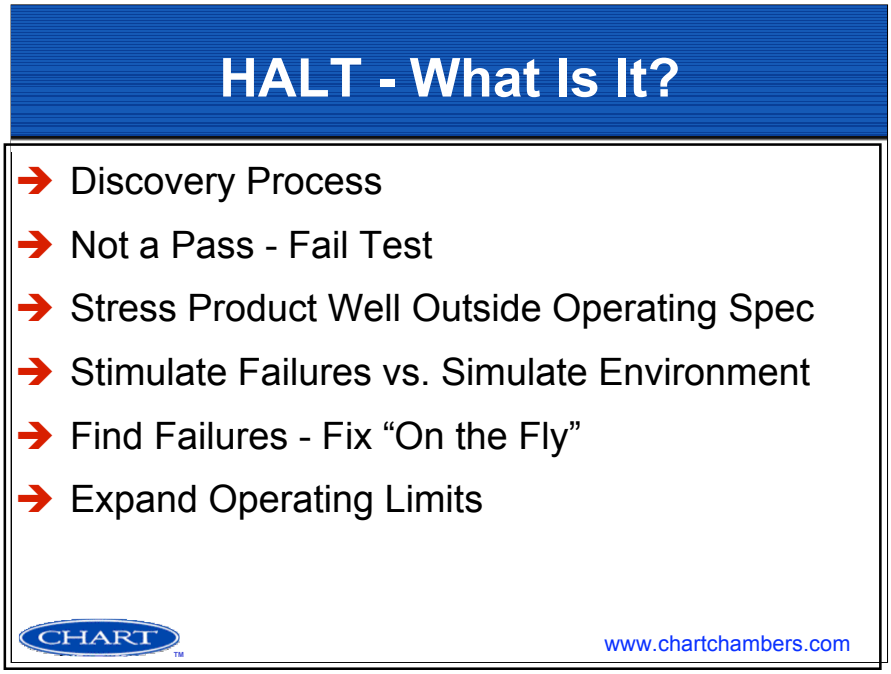
Fundamental limit of the technology – Product tested beyond the spec limit, but up to a point. For example, if you are testing a part that has plastic, you test it only below the melting point of plastic, which is the fundamental limit of the technology.



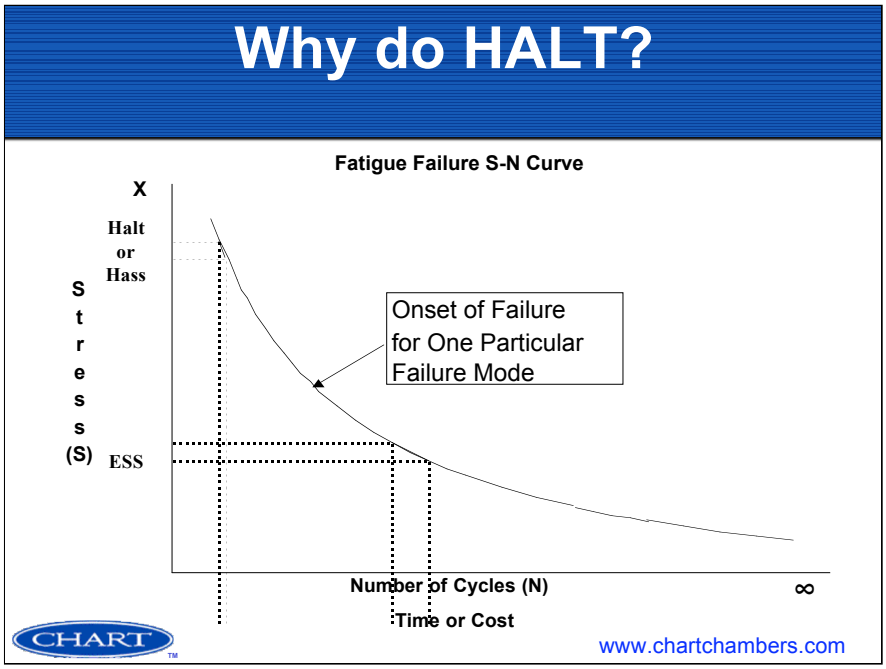

Probably the best way to look at HALT is to describe it as a discovery process. You are trying to find the strengths and weaknesses; basically understand more about your product

It is not a pass/fail test. You are going to push the product well beyond its operating environment to find what breaks.

You are not simulating an environment.

As you find failures you fix them, band aid them or isolate them from the stress so you can continue testing.

When do you stop HALT? When you have reached the fundamental limit of the technology (e.g., plastic melts) or when changes to resolve problems are not financially feasible.




This is a good graph that shows the usefulness of HALT.

With testing at lower stress levels, it takes you more time and more money to detect failures. But with the high stresses associated with HALT, you can detect failures a lot quicker.

# Why do HALT?

- You need to beat your competitor to market, but make sure that your product is going to last.
- HALT accelerates the testing process. (Companies can't afford a 20 year test to see if a light bulb is going to last 20 years)
- With HALT you are able to find out within a matter of days what you might not have been able to find out for years.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# Why Do HALT?

**Finding design weaknesses as early in the product design cycle As possible, can add substantially to the bottom line**

- $40 Design Phase
- $200 Before Procurement
- $400 Before Production
- $16,000 Before Shipment
- $680,000 At Customer Site


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# Margin Discovery Process…

**HALT is very different from qualification testing in that it is not a pass/fail test; it is a process of discovery and optimization**

➔ In HALT what you are looking for are the operating limits and the destruct limits.

➔ These are the points where the system ceases to work as specified but will return to operation if the stress is removed (operating limit) and ceases to operate even if the stress is removed (destruct limit).

➔ In HALT we are trying to maximize the operating and destruct margins of the product, by increasing these margins we reduce the possibility that variations in products will result in product failures in the field.

# Things to Consider Before Testing

- Be thoroughly familiar with the product to be tested. You should know as much as possible of the end environment that it will be placed in, then test accordingly.
- You need to constantly monitor the product, for some failures are intermittent and would not get caught if you just take a reading at the beginning and at the end.
- Before the testing begins, What will be considered as a failure; is it the first intermittent failure? Or is it all way to a hard failure??


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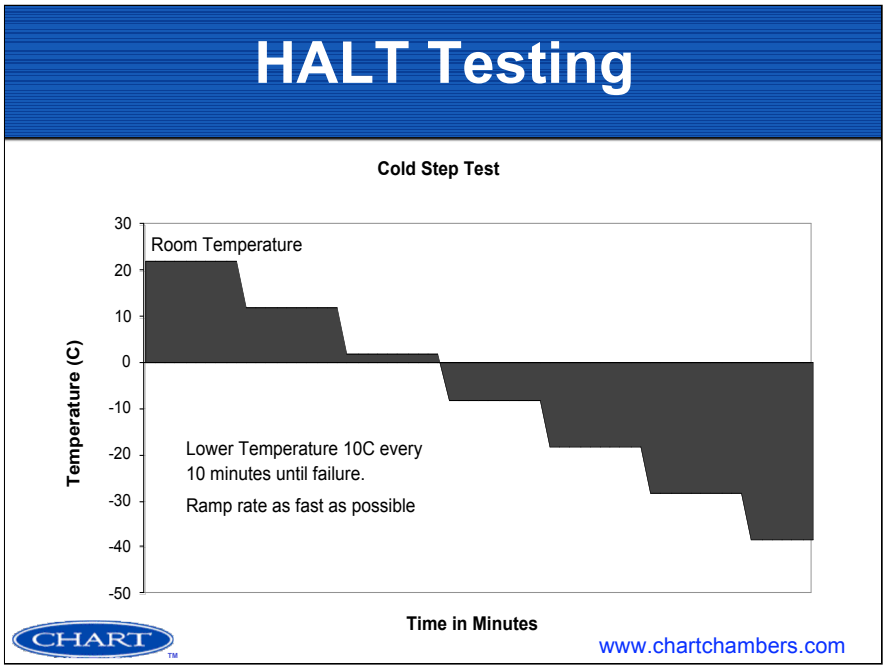
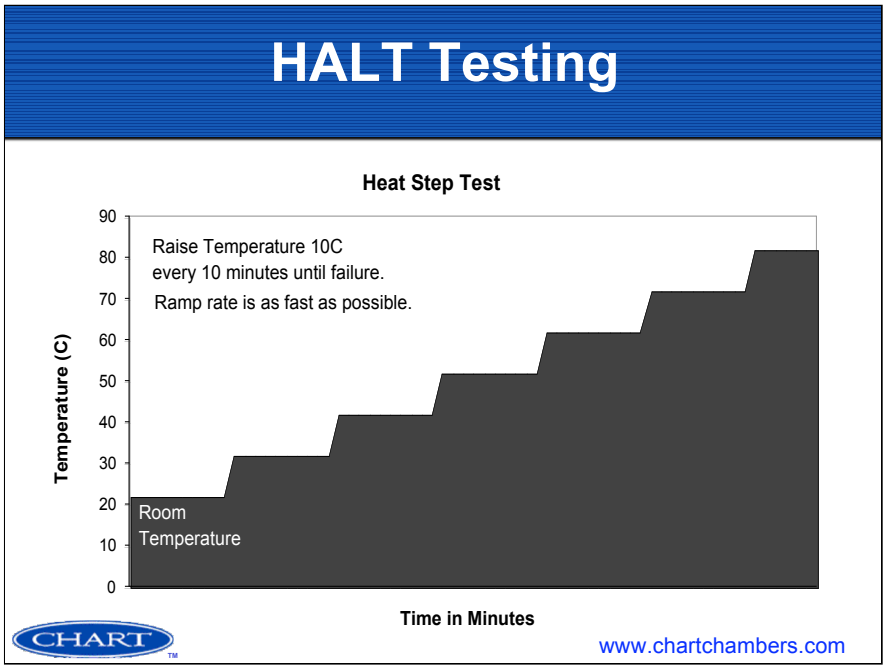
# HALT Testing

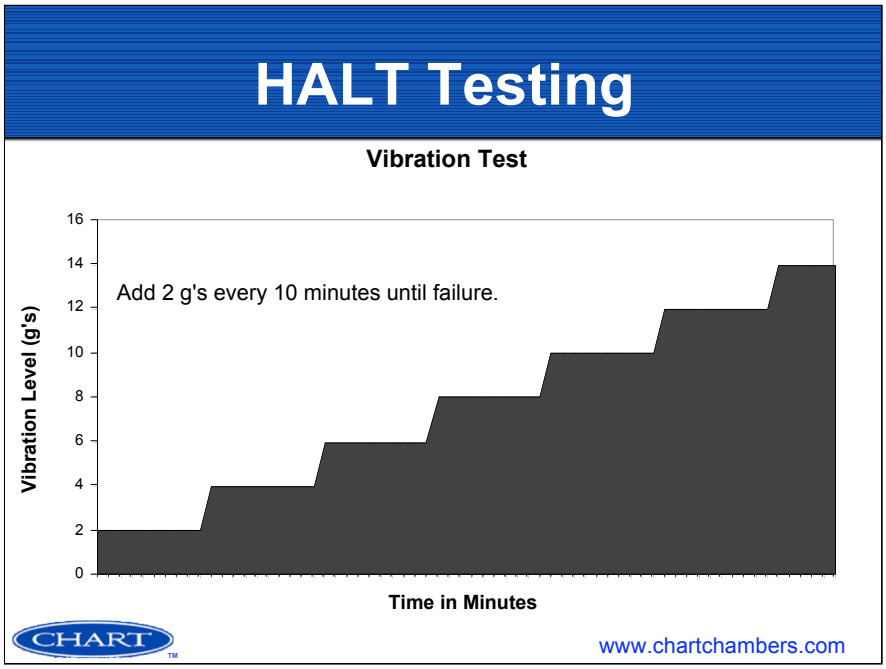
- There is no one right way to run HALT
- HALT is a series of tests
- The best way to start is by testing using single environments, then run with combined environments for comparison
- Typical tests:
  - Cold only, Heat only, Vibration only, Heat with Vibration and Cold with Vibration



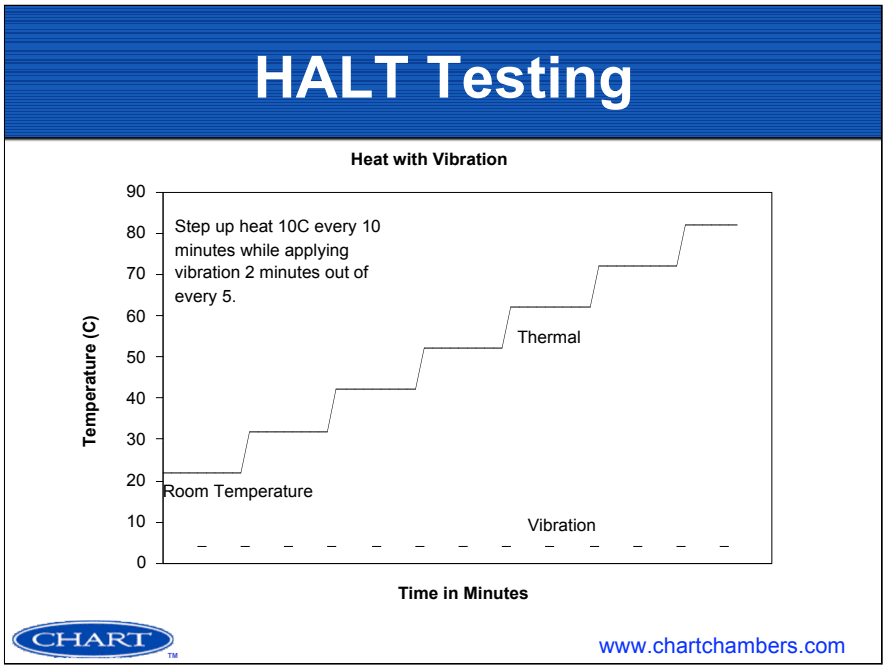

This is an example of the cold step. You start at Ambient conditions and lower the temperature in 10°c increments. The graph shows to stay at every step for 10 mins, but this totally depends on the product size and if that is enough time for the entire product to stabilize at that temperature.



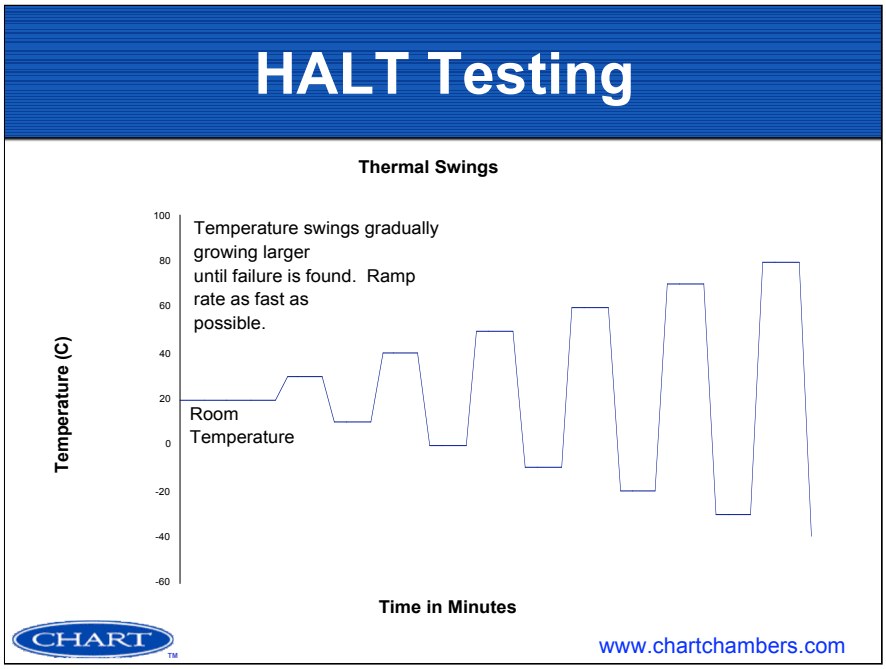

This is an example of the heat step, similar to the previous graph but obviously we are increasing the temperature.




This is an example of the vibration step, similar to the previous graph but obviously we are increasing the vibration level.

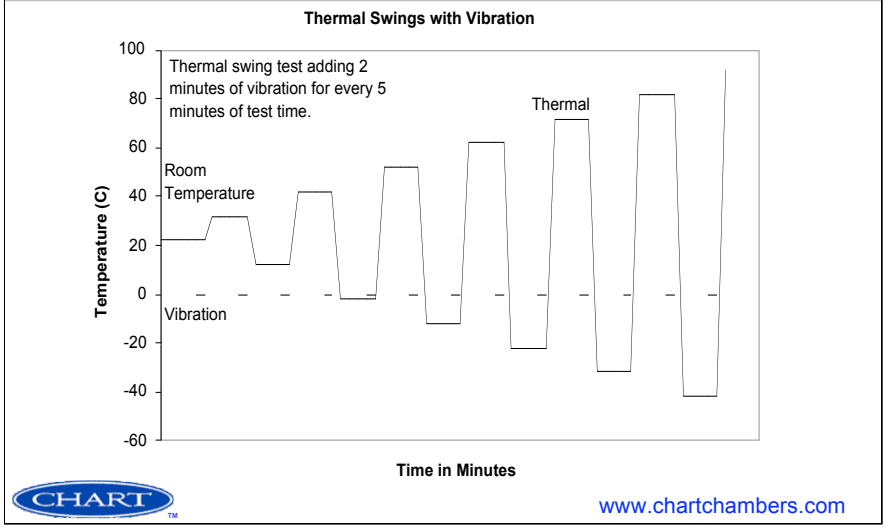



This is an example of step heating with steady vibration.




Here you are seeing gradual temperature swings growing larger until failure is found.

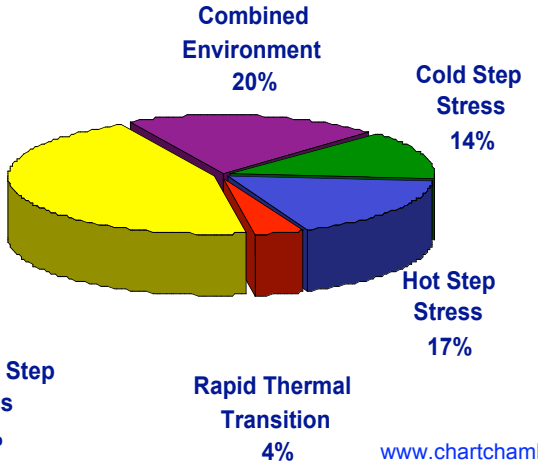
# HALT Testing




Here you are seeing step vibration and gradual temperature swings growing larger until failure is found.

# Summary Of Halt Results

Typical Failure Percentage by Stress Type

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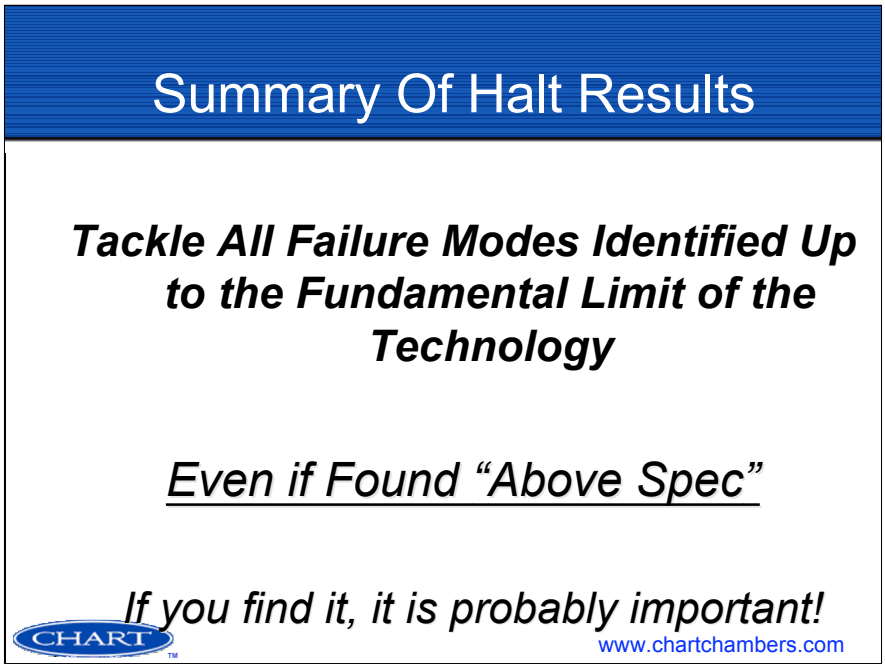


Again, the reason it is important is because failures found by exposing a product to high stress above its spec limit equates to failures that the product would see during normal operation for an extended period of time.

## HALT Chamber Design

- High Thermal Ramp rates are achieved with open Nichrome heater wire design for heating and direct Nitrogen atomization in the plenum for cooling

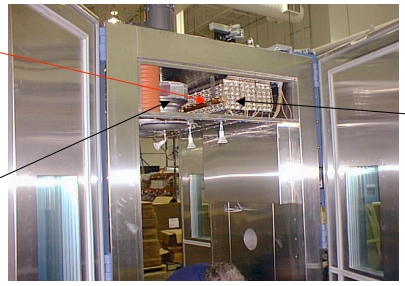


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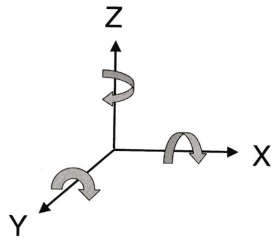
Chart Chambers produces high thermal stress levels required for HALT.

# HALT Chamber Design

High vibration stresses are achieved with a six degrees of freedom vibration table; Allows accelerations in six axes (3 Linear & 3 Rotational)

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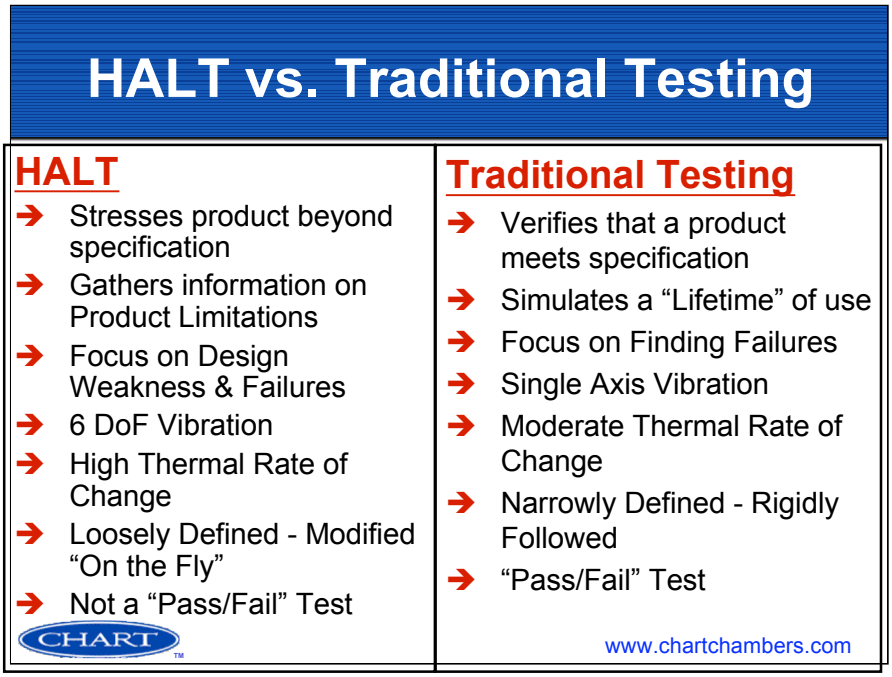
The Vibration Technology used for HALT is very unique versus traditional testing. Traditional vibration testing uses a single axis Electrodynamic shaker which accelerates/excites the product in one direction. In HALT, once the product is mounted to the table, it is exposed to vibration in six axes, which is called six degrees of freedom. The pnuematically actuated hammers are positioned in such a way that acceleration is generated in the x, y and z axis and also rotation about those axis.




These are some of the differences between HALT and traditional testing.

# HALT Benefits

- Faster Time to Market
- Increased Reliability >> More Robust Products
- Greater Customer Satisfaction
- Lowered warranty cost through higher MTBF
- Minimized chance of product recalls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# HASS- Highly Accelerated Stress Screen


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# HASS - What Is It?

HASS is a screening process that uses accelerated techniques to uncover manufactured product weakness and flaws. The process requires the use of HALT results, and other product specific information to design the initial profile, and then tune it for optimal effectiveness.


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# HASS - What Is It?

- Discovery Process used in production for manufacturing process monitoring
- Screens are designed based on HALT findings
- (Combined Environment of Temperature and Vibration)
- Screens Strong Enough to Detect Latent Defects
- Screens Do Not Take Significant Life Out Of the Product


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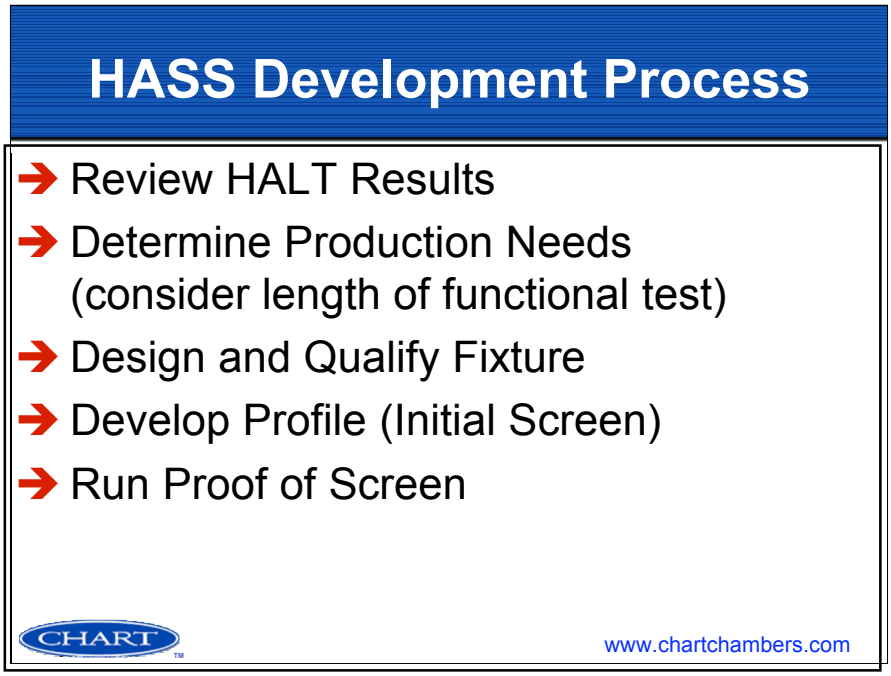


**Proof of screen-** The process of showing that the screen does not remove too much life from a product and that the product is still suitable for shipment to customer

# Profile Development

- Profile Development Starting Point
  - Test Within Op Limits (Detection Screen)

    Temp (Rule of Thumb - 80% of cumulative range of UOL and LOL)

    Vibe (Rule of Thumb 50% of Operational Limits)

# Profile Development

- Incorporate Precipitation Screen (designed to precipitate flaws)
  - Test Beyond Op Limits, but within Destruct

    Temp (Rule of Thumb - 50% of difference between OL & DL)

    Vibe (Rule of Thumb 50% of Destruct Limits)

# Proof- of Screen (two steps)

- Determine Screen Effectiveness:
  - Use production units and Execute the profile one time
- Perform Product Life Valuation:
  - Execute profile numerous times (30+ times) for greater confidence

# Benefits Gained from HASS

- Quickly detect shifts in manufacturing processes
- Increased Reliability - More Robust Products
- Increased Out-of-Box Quality
- Faster Time to Market


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