Return On Investment for HALT Tests

Dr. Edmond L. Kyser

The goal of an AST (Accelerated Stress Test, or Overstress Test) program is to make ***cost effective*** improvements in the field reliability of the hardware being tested by selective use of stresses beyond the design limit stress of the product. The major elements of such a program are shown in Figure 1.

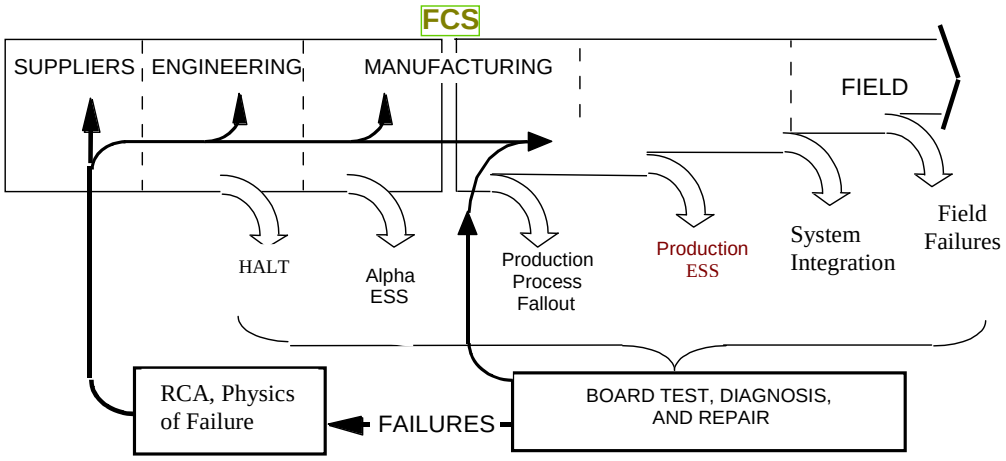

Figure 1. Elements of an AST program

The elements of an AST program are, in normal sequence of application,

HALT – A step-stress to failure test on earliest available hardware and software, typically 1 or 2 units
Alpha ESS – A production screen on first-available production hardware, typically 20 to 50 units
Production ESS – A production screen on hardware after FCS, typically run on 100% of production
ESS of field returns – A production screen on field returns, typically 1% to 10% of production

The decision whether or not to perform AST on a specific product is a typical example of the quality vs. cost problem with which many companies struggle. Unfortunately, reliability data is never available until several months or even years have elapsed, if at all. This paper will examine the economics of HALT independent of the other elements of AST.

During a recent IEEE workshop on Accelerated Stress Testing, I conducted a survey of attitudes towards AST to determine if there was a 'common experience' among industry practitioners that could be leveraged as the science evolves. The issue was defined as "Within your company, where do you see support for or opposition to AST, and why?" The survey results represent the opinions of 32 individuals from 22 corporations active in AST. The resulting leading categories of opposition and support are shown in Figure 2. (For a more complete discussion, and a statistical approach to determining the profitability of AST, see [1])

Reasons for HALT Support (Benefits)		
#	***Stated Reason***	***Comments***
25	Increased reliability / quality	Hard to measure - hard to quantify benefits
9	Sales advantage / customer satisfaction	Same as above, but more difficult to quantify

Reasons for HALT Opposition (Costs)		
#	***Stated Reason***	***Comments***
19	Additional cost	Virtually all opposition is cost based - Easier to measure than benefits
5	Additional Time	A variant of the above

Figure 2 Support for and Opposition to HALT

Many separate stakeholders of the corporation are involved in HALT. The majority of the costs is easily identified and can be quantified with a high degree of accuracy. The benefits, while identifiable, possess the following characteristics: They are highly uncertain, difficult to quantify with any degree of accuracy, difficult to measure, and are not immediately realized. The benefits are realized by the corporation as a whole, essentially through downstream cost-avoidance (lower field service and warranty costs) and through increased sales (product reputation). HALT is high in both organizational and technical complexity. Technical complexity arises from the large number of strategic and operational decisions and processes that need to be in place for a HALT program to function in an efficient manner. Organizational complexity is inherent when

- Costs and benefits are realized by different groups.
- Uncertainty allows a variety of advocates and opponents to champion opinions without fear of refutation by data.
- There is a lack of strong cross-functional leadership from management.

Having made much of the difficulties of evaluating HALT, how are we to proceed? There are several simplifications which are appropriate. The dominant factors in calculating the Return on Investment (ROI) for HALT are likely to be improved reliability and test costs. For simplification purposes hoose to disregard the following likely HALT benefits:

- Decreased time-to-market
- Reduced design and warranty costs
- Lengthened warranty period
- Demonstrated product reliability
- Product differentiation

CONCLUSIONS

Return On Investment (ROI) for HALT can be estimated on a single year basis, neglecting several 'imponderable' factors. Dominant costs are test unit cost, labor, depreciation, and engineering for corrective action. Dominant benefits are field returns prevented. Finally, yield and failure data must be obtained to verify the initial estimates. The resulting data should be used to improve HALT decisions for future products such as the selection of stresses.

For the complete ROI Case Study, please visit the QualMark technical library and download the information to determine your ROI.

ACRONYMS

AST	Accelerated Stress Test
CPU	Central Processing Unit
ESS	Environmental Stress Screen
HALT	Highly Accelerated Life Test
FCS	First Customer Ship
MTBF	Mean Time Before Failure
NTF	No Trouble Found
PRR	Part Replacement Rate
PWA	Printed Wire Assembly
RCA	Root Cause Analysis
ROI	Return On Investment
WPC	Whole Product Cost

REFERENCES

[1] Edmond L. Kyser, Eugene R. Hnatek, and Mark H. Roettgering, "The Politics Of Accelerated Stress Testing", Proc. Institute of Environmental Sciences and Technology, 2000

{2} Edmond L. Kyser, "Return on Investments for HALT Tests", 2004