Accelerated Life Test – Your Key to New Product Success

*"No one wants to learn from mistakes, but we cannot learn enough from successes to go beyond the state of the art."...*Henry Petroski

I recently ran across the above quote and thought immediately of **Accelerated Life Testing (ALT)**. At issue is a **fundamental philosophy of testing to failure** in order to learn more than can be learned when no failure occurs.

Prior to the Second World War, mechanical systems were relatively simple in capability and complexity. Most portions of a system seldom failed and when they did were easily fixed. Due to technological advances, systems became increasingly complex. Complexity created new problems, namely more capable but more fragile systems. From this evolving reality the Department of Defense (DoD) created the disciplines of **reliability** and maintainability **engineering**.

In the past, many commercial companies based their reliability programs on those of the government and adopted many government standards, revising them as necessary for their purpose. Within the last few years, however, commercial industries in the United States have undergone what has been described as chaotic change. This change, which continues today, is a response to an **increasingly competitive world marketplace** in which **quality and reliability have become the foundation of success**. Unfortunately, progress in quality and reliability has been led, or at least is perceived to have been led, by countries other than the US. In at attempt to "catch up", US commercial companies have been aggressively developing or enhancing tools and methods for achieving high levels of quality and presumably, reliability.

With the implementation of ISO-9000 and Six Sigma quality control, the occurrence of product failures due to seemingly random manufacturing defects can be practically eliminated. **The root cause of product failures can be determined and fixed**. Reliability problems today can be corrected with design or manufacturing process changes. However, some change can be expensive and cost is always an overriding consideration. Design to meet customer/market requirements with an appropriate design margin is the best approach. **How do you verify those design margins? – Accelerated Life Test.**

Accelerated Life Tests have been widely used as a common industrial practice. Similar terms with narrower definitions are often used in the literature. Highly Accelerated Life Test (HALT), Highly Accelerated Stress Screen (HASS), and Highly Accelerated Stress Audit (HASA) are methods used by manufacturers to expose products to extreme environmental conditions, improve their design, eliminate product and process weakness, and improve product quality and reliability.

Reliability test techniques and tools have been developed to a fine art for electronic systems and components. **Unfortunately, many companies** that manufacture mechanical systems and components **have not taken advantage of the powerful techniques of accelerated life testing** and statistical data analysis.

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ALT of products can be used for the following purposes at both component and system levels:

- **Identify design and manufacturing defects** to eliminate or reduce them through better design, better manufacturing and assembly, and better component selection.
- **Quality control and qualification** to monitor product reliability and take corrective actions as needed; qualify changes in design, manufacturing, components, and suppliers.
- **Measure and demonstrate reliability** to assess whether to release a design to manufacturing or product to a customer; estimate warranty and service costs, and failure rates; satisfy a customer requirement; show that product reliability surpasses customer specifications.
- **Baseline comparisons** to choose and evaluate among designs, processes, components, and suppliers.

Knowing when and how a product will fail gives designers valuable, actionable information to improve the design and quality of the product. Accelerated Life Testing involves acceleration of failures with the purpose of assessing the life characteristics of the products tested. ALT can be classified as qualitative accelerated life testing or quantitative life testing. In **qualitative accelerated testing**, engineers are mostly interested in **identifying failure modes** and fixing the problem. In **quantitative accelerated life** testing, engineers are more interested in estimating the field **reliability of the product**.

The most **significant potential problem** with quantifiable accelerated testing is that failure **modes produced might not be modes occurring under normal operating conditions**. For this reason, decisions on an ALT need to involve the collaboration of managers, design engineers, reliability engineers and statisticians. It is critical that ALT be approached with caution to avoid introducing failure modes that will not be encountered in normal use. Thus, not only developing the test conditions and acceleration factors are critical, but also **correlating the failure modes produced by ALT with those that occur in the field**. This correlation is most meaningful when performed on a statistical basis, utilizing sound statistical analysis tools and techniques based on a database of known, quantified field failure modes.

It is imperative that any component or system manufacturer **conduct a statistically significant**, statistically verifiable **reliability test** before introducing a new product design or design change to the market. For today's system manufacturers, **high reliability is mandatory**. Given the long life of most components and the systems they are used in, the only way to verify the required reliability level is through Accelerated Life Test on the system level.

There are a variety of qualitative **Accelerated Life Tests** used by refrigerant compressor manufacturers, ranging in **duration from 10 days to 10 weeks**. These tests have been developed to realistically identify design weaknesses and potential failure modes in a product whose **life expectancy is 10 to 20 years**.

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There are several major air conditioning manufactures that conduct quantifiable, system level accelerated life tests. All new compressor designs, including minor design changes are tested in systems using a well defined quantifiable accelerated life test. One manufacturer claims that **16 weeks of this system test produces a statistically verified failure rate equal to 5 years** of field use. It is important to note that this is a system level test. Not only is valuable compressor reliability data gathered, but also reliability information for all system components.

Innovative Thermal Solutions has extensive experience and knowledge in refrigerant compressor development and compressor application as well as compressor and HVAC system Accelerated Life Test. This knowledge and experience can be extended to any mechanical or thermal component or system. We welcome the opportunity to help your company develop and implement this critical technology to **insure the success of your new product**.

 Bob Utter, Senior Consultant and owner of Innovative Thermal Solutions, LLC has over thirty years experience developing new mechanical and heat transfer technology, and holds 29 patents in the field.
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