Top 3 Failure Modes During Distribution Testing

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Abstract

The best way to avoid a possible recall due to product damage during distribution is to subject your packaged product to a series of distribution tests, often referred to as package performance testing. We offer a brief primer on the topic and list the Top 3 Failure Modes During Distribution Testing encountered at WESTPAK's accredited test laboratories.

"From the beginning of a project, Elaine is quick, helpful and extremely friendly to assist, generate a quote and answer any questions I may have."

M.P.

Background and Introduction

Countless hours and significant investments are made in the design and development of a new product. When your product is finally ready for production release, how confident are you it will safely reach the end-user without damage?

The package system design cannot be completed or verified until a final product is available. Package system development is usually an iterative process requiring time and resources to complete. Frequently, package development is neglected in the schedule altogether or not given sufficient time to complete as the product launch date closes, placing notable pressure on the package system designers.

What is Distribution Testing?

Distribution testing in a laboratory provides a consistent and repeatable basis for evaluating the ability of products and their packaging systems to withstand the distribution or shipping environment's hazards. Testing consists of subjecting packaged products to various tests such as vibration, impact, compression, and altitude extremes. Distribution tests replicate real-world distribution hazards, at the three-sigma level, that may be encountered.

The optimum package system consists of a product and a package that together provide sufficient protection during distribution without costly materials or wasteful over-packs.

Laboratory testing provides repeatability and consistency. If your product or package is redesigned, it can be subjected to the same test inputs as its predecessor. This approach offers valuable data, comparative results, and enables the best configuration to be recognized.

Distribution Hazards – Top 3 Failure Modes

Vibration Hazards

Vibration is unavoidable in the distribution environment. Whether the source is a truck, train, airplane, or even a bicycle, there is a 100% chance that a packaged product will be subjected to vibration by the time it reaches the customer.

Figure 1 – Vibration Testing

The most typical product/package failure from vibration hazards is the cushion system's inability to attenuate (dampen) the resonances of the product sufficiently. Using a cushion material that is improperly loaded (weight/area) can cause the product to resonate at higher amplification, eventually leading to fatigue, reduced reliability, or product failure.

One can determine if this is a potential issue by performing vibration testing in a laboratory environment. If the cushion system is not adequately attenuating the product's critical frequencies, a

simple cushion redesign or using a cushion of different density may be all that is required to resolve the issue. In more extreme cases, product design may require revision, which is sometimes necessary.

Impact Hazards

A cushioning system must also properly absorb mechanical shock during an impact, enough so that the shock level experienced by the product is lower than its fragility.

The most common impact failure results from an incorrect cushion material or static loading specified for the application leading to physical damage or, worse, the product arriving dead on arrival (DOA). Cushioning material that is too stiff is similar to not having a cushioning system at all. However, an insufficiently firm cushion may result in the cushion system bottoming-out during impact with the product contacting the impact surface.

Either mistake in the package system design can result in the transfer of impact energy directly to the product exceeding its robustness.

Figure 2 – Impact Testing

Fortunately, one can quickly and easily determine a package system's ability to sustain impacts by subjecting it to a series of impact tests in a controlled laboratory environment.

Compression Hazards

In the distribution environment, the ability to withstand compressive loads during stacking is determined by both the product and the package system. As soon as the outer package (or shipper)

fails to accommodate the load, compressive forces are distributed directly onto the product. Ideally, the product can withstand the subjected loading.

Using a lower cost material, such as recycled, may reduce material costs, however, may result in compression failures as sometimes observed during testing.

Figure 3 – Compression Testing

A compression test can quickly determine how much load the package system can sustain and, if it does, how the package may fail in the distribution environment.

"Thanks guys, we rely on your experience and knowledge. It saves us a ton of time being able to rely on your engineering rigor, thorough review, and ability to deal with ambiguity."

S.E.

Conclusion

During the design process, teams must be aware of the hazards the product will encounter during distribution. Package system design to ensure protection from these hazards should be considered a crucial step in the development process.

Laboratory testing provides repeatability and the opportunity to evaluate and compare design options. Such testing can usually be accomplished in less than a day and can fully assess the package system's effectiveness. Once identified, problem areas can be addressed and resolved.