

MEDICAL DESIGN BRIEFS

Medical Device Packaging Validation Testing IOI

Package validation testing has always been an important aspect of many medical device development processes. Today, it isn't just new packaging that manufacturers need to worry about — economic and environmental conditions are also driving manufacturers to revalidate their packaging.

The green movement is causing many companies to look at providing functional yet environmentally friendly packaging for their devices — not always an easy task. In this scenario, green-friendly packaging must still meet the rigors necessary to protect the device.

Economic conditions are causing device manufacturers and packaging material suppliers to look for ways to save costs. A manufacturer that has been using the same validated packaging materials for years may face revalidation if the materials provider changes a resin or other key material. The same is true if the manufacturer has been using expensive materials and has the directive to find alternate materials that are less expensive.

When looking at revalidation, it is important to identify all affected areas rather than focus on the packaging changes. These can include: the sterilization method that is or will be used and any residuals there may be; the different types of materials and how they complement each other; and how a device will be packaged and shipped.

There are three basic packaging validation performance characteristics manufacturers need to think about with new packaging or changes in their packaging due to evolving conditions:

- **Integrity.** The integrity test identifies the characteristics that prevent the ingress of microorganisms under specified conditions

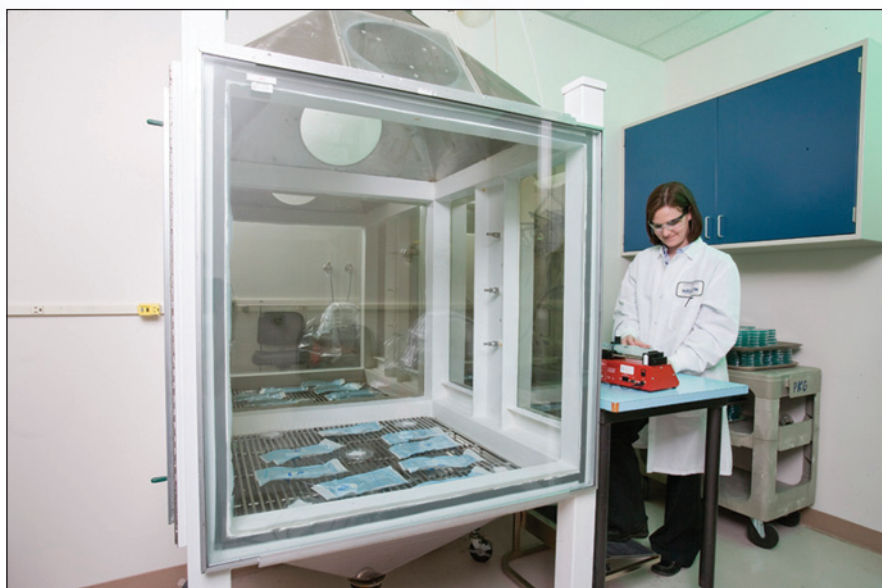


Fig. 1 – A lab technician uses an integrity testing chamber to test the characteristics that prevent the ingress of microorganisms for packaging validation.

- **Strength.** The strength test measures how much force is needed to open the packaging.
- **Microbial Barrier.** This test demonstrates that porous materials can provide adequate microbial barrier properties.

Validation Testing

The Food and Drug Administration requires all manufacturers to prove the overall integrity and safety of packaging. Understanding the validation tests can help manufacturers better develop packaging that will both protect their product and meet FDA requirements.

The standard requirements for terminally sterilized medical devices (ISO11607) states that manufacturers must choose one test from each category. A packaging test matrix outlining the cat-

egories and test options available to manufacturers to meet the requirements is available at <http://bit.ly/pvTocn>.

Within each category there are a few different tests to choose from. The test options under the three categories include:

Integrity Category — Validates the overall integrity of the packaging.

Bubble Emission Test. The bubble emission test is a 'whole package' integrity test. It is conducted by inflating the package to a pressure within its tolerance range and completely immersing it in water. Bubbles originating from a single point indicate a failure in the packaging integrity. This test is used for porous and nonporous packaging.

Dye Migration Test. The dye migration test is conducted by adding blue dye to the interior of the package and allowing

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the weight of the dye to rest on the seals. If a seal is compromised, a visible blue channel is seen at the failed point in the seal. This test is not appropriate for foil packages or packages where it is not possible to see the passage of the dye through the material as it provides visual evidence of integrity.

Dye Immersion. The purpose of the test is to evaluate the integrity of a closure system on items such as vials, bottles, etc. This test involves immersing samples in a solution of methylene blue. The samples are challenged by vacuum immersion and examined for evidence of the dye. When performing this test, it is essential to include the appropriate controls that are run as part of the test system.

Strength Category — Validates the strength of the packaging.

Seal Peel Test. The seal peel test identifies the amount of force it takes to open a package. Utilizing a tensile machine, a one-inch sample of the package is placed into grips and the pounds per square inch are measured.

Burst Test. This test identifies the weakest seal on the package and provides the pressure needed to compromise or burst the seal. It is especially important in assuring that the packaging can withstand the rigors of shipping and extreme altitudes such as regional elevation. The test is conducted by increasing air pressure within the package until it bursts. When performing this test on porous

materials, it is imperative to seal the surface before testing.

In conjunction with the burst test, a creep test can be conducted. The creep test is similar to the burst test, but instead of increasing pressure until it bursts, the package is inflated and held for an extended period of time or until failure has been reached, recording the time length. In order to perform this test, the burst test must provide the set point, which is 80 percent of the average burst pressure. This test determines if a weak seal will slowly 'creep' to burst at a lower pressure.

Microbial Barrier Category — Validates that the packaging is providing a barrier against microorganisms.

F1608 Microbial Ranking. This test can only be conducted on porous materials and provides a log reduction value of the organisms penetrating packaging material. The test is conducted by taking a 47 mm disk of the porous material and exposing it to aerosolized organisms. The test then determines how many organisms were able to pass through the material. The result is a Log Reduction Value (LRV) that converts into an efficiency rating. For example, a 6.1 LRV equals a 99.999 percent efficiency rating.

Whole Package Aerosol Challenge. This test is fairly similar to the F1608 test, but instead of a material sample disk it tests the entire package. The test is conduct-

ed by taking a whole, sterilized package, hanging it in a chamber by a non-critical seal, and exposing the samples to an aerosolized organism. After the appropriate exposure period, the exterior of the package is decontaminated. Finally, the contents of the package are tested to determine if the indicator organism was able to penetrate the packaging.

Where to Look When a Failure Occurs

Once the validation is complete, it does not need to be repeated unless something in the process changes. If any changes to equipment, product, or packaging are made, an evaluation regarding revalidation should be performed to ensure that aspects such as sterility, safety, and efficacy have not compromised the original validation.

What happens if a validation packaging test fails? The simplest answer (outside of a lab error) is that the process and/or materials need to be evaluated to determine the cause of the failure. Here are a few items worth considering when a failure does occur.

Integrity Validation Failures

- **Failure of Bubble Emission Test.** Bubble Emission failures can often be attributed to a product rubbing through a material, more commonly known as abrasion. Folded material packaging can also be the cause, especially when using pouches that are too large. The folds can become weak and cause leaks. Pointed or sharp medical devices can also cause failures when not properly secured within the packaging.
- **Failure of Dye Migration Test.** This kind of failure is usually due to a problem with the sealer and can generally be attributed to a setting related to temperature, time, or pressure. Tray lids not sitting in the right location on the sealer can also leave gaps that can cause a failure. Other possible causes to investigate include oversealing, a flaw in a raw material, operator failure, or other equipment failures.
- **Failure of Dye Immersion Test.** This type of failure can usually be attributed to incorrectly seating stoppers and over or under crimping the cap.

Strength Validation Failures

- **Seal Peel.** These test failures are usually similar to the causes found in the Dye Migration test. Keep in mind that the Seal Peel test doesn't necessarily look

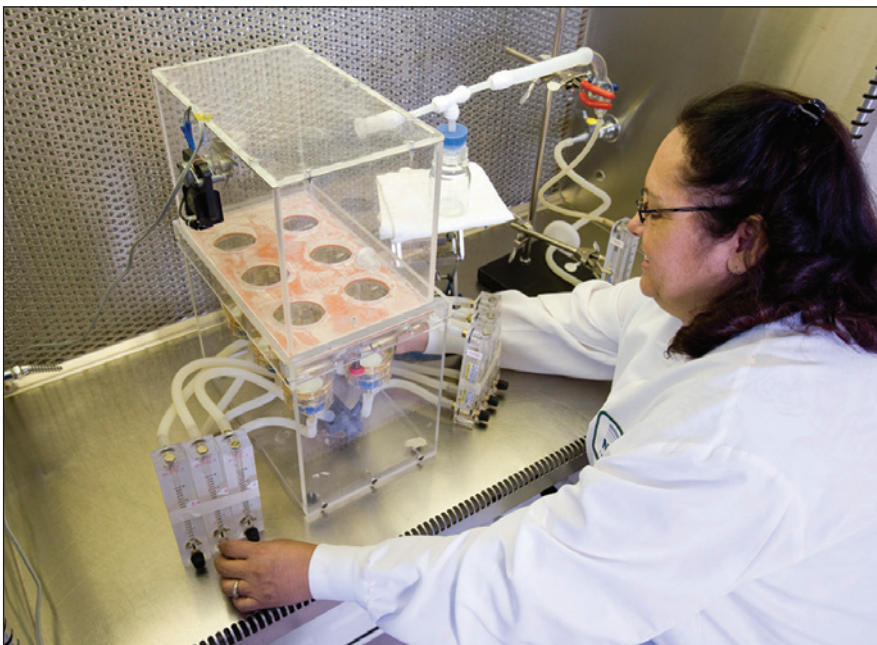


Fig. 2 – A Microbial Ranking test is conducted on porous materials and provides a log reduction value of the organisms penetrating packaging material.

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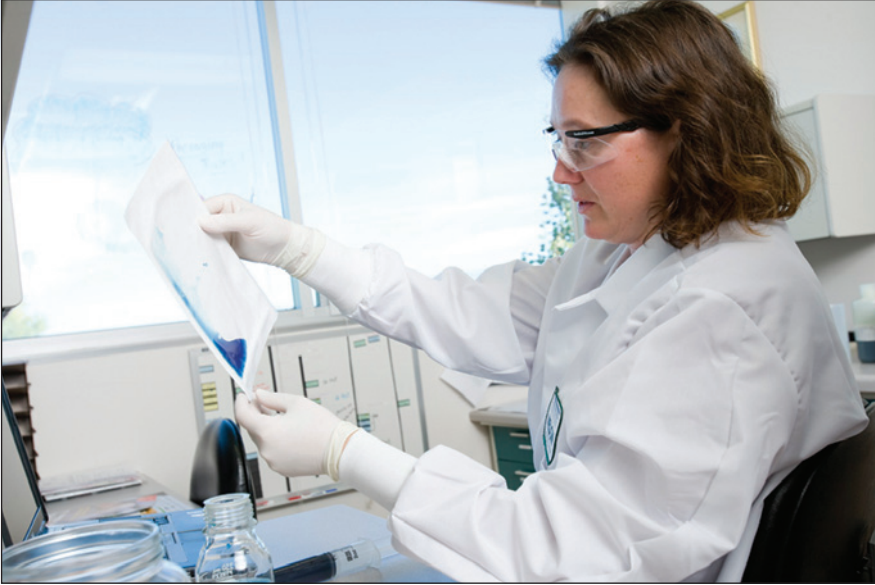


Fig. 3 – A Dye Migration Test tests packaging seals for weakness. A visible blue channel is seen at the failed point in the seal.

the product being manufactured. It is a fairly complex test and should be tailored specifically to meet varying packaging needs. To discuss test failures, it is best to arrange for a one-on-one consultation with a professional.

Conclusion

Whether manufacturers are changing a material in their device packaging, looking for ways to cut costs, considering green alternatives, or simply launching a new device with new packaging materials, a clear understanding of the standards and tests used to validate packaging is paramount.

It is important to remember that once validation has occurred, it is not necessary to do it again unless one of the variables in the packaging has changed (new material, new design, change in a provider, etc.). Once complete, the packaging process becomes a seamless part of the overall production line, ensuring the delivery of safe-to-use and well protected medical devices.

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for failures so much as it helps manufacturers set and monitor the strength specifications for their packaging; the test helps optimize the sealing parameters of their sealing equipment.

- **Burst.** The Burst test provides variable data — it is not a pass or fail test. Focusing on the sealing equipment

can usually help identify the cause. The Creep test identifies if the packaging will hold at pressure over time. Sterilization processes that utilize vacuum draws can contribute to creep failures if they are pulled too fast.

Microbial Validation Failures

Microbial Validation is dependent on

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