Package Integrity Testing

Optimizing Packaging and Minimizing Waste
Overview

Product characteristics from a “package viewpoint”

Review the Functions of a Package

The Package Design Function in a Qualitative Environment

The Package Test Function in a Qualitative Environment
  The critical elements...
  The sequence, the sample size,

Final Evaluation – When Do We Know We’ve Done It Right...
## Product Characteristics from a Package

<table>
<thead>
<tr>
<th>A Type</th>
<th>Viewpoint</th>
<th>B Type</th>
<th>Suitable for Qualitative Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Is it “breakable” (impact sensitive)?</td>
<td>Slight</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Temperature sensitive?</td>
<td>Some</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Humidity sensitive?</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Compression sensitive?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Altitude sensitive</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Ozone sensitive?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Vibration sensitive?</td>
<td>Slight</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Sterile (bug sensitive)?</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Scuff sensitive?</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
Package Integrity Testing Focuses on “B” Type Products That Are

Slightly breakable and sensitive to impacts
Somewhat temperature sensitive
Sensitive to changes in altitude
Slightly sensitive to vibration
Compression sensitive
Sensitive to Ozone
Must remain sterile
Sensitive to scuffing
Not sensitive to humidity
“A” products can be evaluated and tested quantitatively. These can (and normally should) be handled according to a “Package Performance” design and test procedure. (refer to Westpak Webinar “Developing and Evaluating the Optimal Package”)

“B” products cannot be evaluated or tested quantitatively. They must be handled in a qualitative manner using a “Package Integrity” procedure. That’s the topic of this webinar.
Functions of a Package

- Preservation / Protection
- Containment
- Sell the Product / Motivation
- Convenience / Ease of Transport
- Stacking and Storage
- Printed Information (Communication)
Preservation

• Protection and preservation from being breached and contaminated
  • Microbes
  • Air / Oxidation
  • Moisture
  • Toxins

• FACT: More than 30% of global food production is wasted due to improper packaging
Contain the Product
(to Prevent Spillage or Loss)

- Mainly liquids
  - Soda, syrup, oil
- Many small items
  - Cans of corn, jar of pickles
To Sell the Product

• Product Characteristics
  • “Low Fat”
  • “10% more free”
  • “Organic”
  • “Compatible with USB 2.0!”
• Product Warnings!!
  • Dangerous and Hazardous Goods
Protection During Transportation and Ease of Transportation

- Protection
  - Fragile products

- Ease of transport
  - 12 cans of soda in a carton
  - 288 cans of soda on a pallet
    - (24 cartons of 12 cans each)
Stacking and Storage

- Reduce storage space by utilizing stack-ability of each unit
Printed Information

- Additional Information for the consumers
  - Ingredients
  - Recipes
  - Compatibilities
  - Instructions
  - Safety Concerns
What Does This Mean?

Exactly this:

The package design must account for each of the “product sensitivities” that are likely or even possible in the distribution and storage environment (where the package does its job).
OK! How Do I Do This?

Here’s how:

Make certain that the test of the product/package system in the lab is a VERY good representation of the actual shipping/storage environment.

(more about this later….)
Package Design for “B” Type Product
(Qualitative Analysis)

For each product sensitivity, determine the best material, fabrication, or process that does the best job and is

• readily available
• compatible with the product
• compatible with the end use environment
• environmentally sound
Package Design for “B” Type Product

Protection  
Convenience  
Utility  
Motivation  
Sterility  
Identity  
Communications  
Safety  
Legal  
PACKAGE DESIGN
Package Design for “B” Type Product
(Qualitative Analysis)

For example:

<table>
<thead>
<tr>
<th>Package Function</th>
<th>Design Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture Protection (Preserve)</td>
<td>Nylon (PA) film</td>
</tr>
<tr>
<td>Sterile Barrier (Protection)</td>
<td>Tyvek header on the primary pouch</td>
</tr>
<tr>
<td>Convenience (Contain)</td>
<td>Thermoformed PET tray</td>
</tr>
<tr>
<td>Protection (and Stack-ability)</td>
<td>Corrugated shipper</td>
</tr>
<tr>
<td>Communications (Inform/Sell)</td>
<td>Inner folding carton, labels, etc.</td>
</tr>
<tr>
<td>Utility (Ease of Transport)</td>
<td>Hand-holds</td>
</tr>
</tbody>
</table>

… and so on. Each package function has its own identified material, element, or component.
Package Design for “B” Type Product
(Qualitative Analysis)

The final package design for “B” Type products brings all of these elements together in a workable and functional system capable of safe and efficient product storage and delivery.

Now, for the test.
(Does it work?)
How Will Your Packaged Product Fare During Distribution?
The Four Product/Package Cases

- Case 1: Adequate Packaging
- Case 2: Under Packaging
- Case 3: Over Packaging
- Case 4: Product Improvements
  - Less Packaging
Measuring the Distribution Environment

• How do we measure the distribution environment?
• What factors are we concerned with?
• What tools do we have at our disposable?
• Can we leverage existing data?
How Do We Measure the Distribution Environment?

- Subject the package system to a distribution cycle that is representative of what the package will normally experience during transportation.

- Record every single event in the distribution cycle that may affect package integrity.
What Factors Are We Concerned With?

What Can We Record?

- Impacts (Drops)
- Vibration
- Temperature
- Humidity
- Pressure (Altitude)
What Tools Are Available?

• Typically, the distribution environment is measured with field data recorders that records every potentially hazardous event that occurs during distribution.

• These tools also will time stamp each occurrence so therefore each specific event can be mapped to a certain time during distribution.
Can We Leverage Pre-Existing Data?

• Yes!!
  • There are many published studies that are widely available on the internet that records specific routes of travel

• No!! 😞
  • Every product’s distribution environment may be unique to that specific route depending on where the product originates and the path it takes to its final destination.
Distribution Study Example: The MADE Study
(Measurement & Analysis of the Distribution Environment)

• Main Focus: revalidate previously measured drop data
  • Drops during the distribution environment
    • How many?
    • From what height?
• The setup
  • Field data recorder was mounted on wood blocks in a package and sent around the world
    • 25 pound box to simulate a computer
• The Results
  • Highest drop found in all 6 round trips was 58 inches (one occurrence)
  • There were very few drops over 36 inches
    • Less than 1.5%
  • There were very few drops over 14 inches
    • Less than 5%
Distribution Study Example: The MADE Study

Figure 3.2.5
Number of Impacts vs. Drop Height for FedEx & UPS
Typical Drop Test Inputs According to Widely Used Test Standards

25 Pound Box

- ASTM D4169 at Assurance Level I (Most Severe)
  - 11 Drops at 21 inches and
  - 1 Drop at 42 inches

- ISTA 2A
  - 10 Drops at 32 Inches
Typical Drop Test Inputs According to Widely Used Test Standards

So why do widely used test standards (ASTM D4169 and ISTA 2A) appear to over-test packages?!!?
Bringing the Distribution Environment in the Lab

- Typically test standards such as ASTM D4169 and ISTA 2A will be a more vigorous test than what a package will experience in the distribution environment.

- This is done for the following reasons:
  - Acceleration factor
    - Amplify test inputs to build a level of confidence in the packaging and accelerate testing
  - Sample size (or lack thereof!)
  - Shorten the test
Common Sense Goes a Long Way!

• Example: If your package system will always be unitized on a pallet, should you subject your palletized package system to free fall drops?
  • No! Only if the system will be handled with a crane
  • If yes, 12” drop height should be the maximum

Remember, all distribution cycles are unique to transportation route and should be tailored accordingly!
What does a typical distribution cycle look like?

Different Environmental Conditions

Package is Dropped Off and Sorted

Package Might be Stacked

Package is Delivered

Vehicle Vibration (Truck)

Vehicle Vibration (Air)
Bringing the Distribution Environment in the Lab
What does a typical distribution cycle look like?

- Conditioning
- Initial Manual Handling
- Vehicle Stacking
- Loose Load Vibration
- Vehicle Vibration
- Final Manual Handling
The Final Evaluation

• A “successful” test depends largely on how one defines “success”!!

• This in turn depends largely on the nature and function of the product itself.
The Final Evaluation

In general, a successful supply chain is one where the product arrives in exactly the shape you want it to be in the customer’s hands.

Some product types can tolerate a defined amount of minor damage (scuffing) or even major problems (a broken candy bar).

It’s product specific.
The Final Evaluation

For example:

<table>
<thead>
<tr>
<th>Product Type</th>
<th>% Acceptable Damage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Devices</td>
<td>0.0</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>0.0</td>
</tr>
<tr>
<td>Prepared Food Products</td>
<td>0.5 - 1.0</td>
</tr>
<tr>
<td>Consumer Cleaning Products</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td>OTC Drugs &amp; Medical Supplies</td>
<td>0.5 - 1.0</td>
</tr>
<tr>
<td>Consumer Products</td>
<td>0.5 - 5.0</td>
</tr>
<tr>
<td>Industrial Bagged Products</td>
<td>2.0 - 8.0</td>
</tr>
<tr>
<td>Furniture</td>
<td>2.0 - 8.0</td>
</tr>
</tbody>
</table>

*Author’s judgment, not industry standards
The Final Evaluation
Package Integrity Testing

Remember:

• This is a Pass/Fail (qualitative) test
• There is no “margin” analysis available
• Your product may be over-packaged, perhaps grossly so
• The test requires a valid sample size
• Also requires accurate simulation of the distribution environment
The Final Evaluation

For some product types (Med Devices), a complete package post-test morphology is required to help guarantee successful results:

- Burst test – measures residual seal strength
- Peel test – measures pouch opening force
- Bubble leak test – checks for a microbial path
- Dye penetration test – checks for seal “inclusions”

(ISO 11607)
The Final Evaluation

The test requires accurate and adequate documentation to prove successful results; there are no numbers to prove the point.
Final Remarks

• 80% of the “packaging dollar” is devoted to products that benefit from Package Integrity Testing (Qualitative Analysis)

• This is the most frequently conducted type of package test and evaluation.

• The most “sustainable” package is one that is well thought-out, uses materials wisely, and is tested correctly.
Sustainability

• It’s worth noting that 30% of most landfills are packaging waste

• Most packages are overdesigned due to the evaluation techniques used (pass/fail) and other factors (political, etc.)

• Thus the landfill/sustainability issue may be largely a function of our abilities to properly judge how to best evaluate the suitability of a package for a given function without overdesign and needless waste
Sustainability

It’s estimated that astute package design combined with intelligent product design (more rugged) could reduce our trash in landfills by an additional 15 – 20%. This would be huge! We owe it to future generations to pursue this with urgency!
Final Remarks (con’t)

• Use of “Package Performance Test Stds” (ASTM series, ISTA, etc.) may or may not lead to an optimum package design.

• There is no substitute for astute knowledge of the package optimization process, careful design of the product/package system, and professional testing of the end result.
QUESTIONS?
THANK YOU!
LOCATIONS

Two Westpak Locations

San Jose Laboratory
83 Great Oaks Boulevard
San Jose, CA 95119
408-224-1300

San Diego Laboratory
10326 Roselle Street
San Diego, CA 92121
858-623-8100

www.westpak.com
Projects@westpak.com