ELECTRONICS PROTECTION
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Testing for Ingress Protection of Portable Electronic Devices

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Today's consumers expect to be able to use their full-featured mobile devices anywhere, whether they are skiing on top of a mountain, talking on the phone while running through a rainstorm, or taking underwater pictures in the Caribbean. They also expect these devices to be small and lightweight, and most of these devices have audio components that require one or more openings in their housings to enable sound waves to be transmitted. Testing devices for ingress protection is one of the essential elements of the engineering cycle to ensure they can withstand the environmental conditions they encounter.

Manufacturers generally protect their mobile devices from exposure to environmental contaminants by using rugged seals in the housings. They have traditionally used the International Standard IEC 60529 criteria to validate their protection against contaminants. The testing protocols in this standard were originally developed for industrial electronics in larger enclosures such as construction and worksite devices, large shipping containers for transporting equipment and stationary equipment on telecommunication towers.

Although the IEC 60529 defines specific levels of protection, the testing protocols are limited and do not account for real-world conditions that portable electronics encounter. As a result, manufacturers usually do one of two things; either they ignore the standard, which can compromise reliability, or they spend substantial time and effort trying to comply with the standard. In this case, the result can be an over-engineered instrument that doesn't appeal to the consumer's desire for a small, lightweight device.

The portable device industry needs testing protocols that are more focused on consumer electronics and how they are used. W. L. Gore & Associates has developed multiple testing methods that address particulate and liquid protection in the real-world conditions these devices encounter. With these protocols, test results are more reliable, which results in improved durability of portable electronics.

Materials Testing

To protect the audio components of portable devices, most manufacturers install protective vents over the transducer opening. Under IEC 60529, these vents are tested as a component of the assembled device and as such, are not independently rated. Therefore, their performance is not evaluated until the device is completely assembled. For portable devices, different material constructions can be used depending on the design of the device housing. For example, if a housing has open holes near the transducers, a tight non-woven material is needed for protection. However, if the housing has louvered openings, the slats provide some level of contaminant protection, so the material can have a more open weave. Therefore, engineers often want to evaluate the performance of various venting materials and housing designs to identify the best combination for their specific application, but IEC 60259 does not define testing protocols for this scenario.

Particulate Testing

IEC standard 60529 testing protocols evaluate materials based on their ability to block particulates of 50 microns (µm) or larger. This results in two challenges for the portable electronics industry. First, portable electronics are exposed to a variety of particulates that are usually much smaller than 50 µm, particulates that range from 1 to 30 µm such as human hair, carpet fibers, pet dander and smoke fumes (Figure 1). Devices are not tested against these real-world particulates.

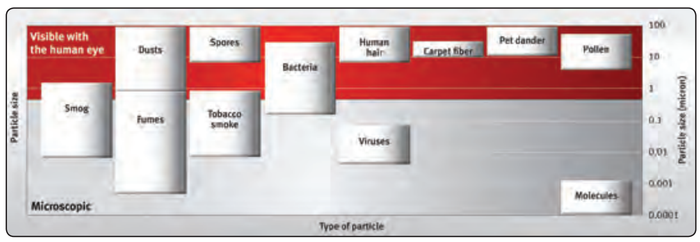

Figure 1. Portable electronic devices are often exposed to particulates smaller than 50 µm.

Second, if a device is tested, it may fail due to improper material selection. Many manufacturers simply specify a maximum pore size for the venting membrane, and they select materials based on their pore size specification. Particulate shape and surface area have a more direct impact on the level of protection a material can provide than pore size does. Woven and non-woven materials are used in vents that provide dust and splash protection. Because a woven material has a uniform pore size (defined by the width of the open square between fibers), the material is able to capture only spherical particulates equal to or greater than the material's defined pore size. For example, a human hair has a surface area equal to or larger than the specified pore size of many woven materials, yet it can still pass through the material because of its shape (Figure 2). On the other hand, non-woven materials are able to capture particulates of various shapes and sizes because of their three-dimensional structure. They are also more likely to maintain consistent airflow

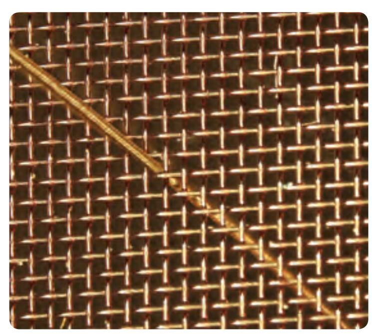

Figure 2. A human hair's shape enables it to pass through a woven material with a smaller pore size.

because they capture particulates in a torturous path not limited by a specific pore size.

To address the needs of the portable electronics industry, Gore's engineers developed a protocol that focuses on particulates that are as small as one micron. They worked with an independent laboratory to modify the ASHRAE 52.2 test protocol, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*. The new method evaluates a material's ability to capture particulates of different sizes at various flow rates similar to the conditions portable devices encounter. For example, testing two materials — one woven and one non-woven — with similar airflow and acoustic resistance properties indicated that the non-woven material's capture efficiency rate improved as particulate size increased, with almost twice the efficiency at 8.5 µm, when compared to the woven material's efficiency.

Spray Testing

Consumers often use their devices as they are walking through the rain, or they may set the device next to a sink and splash it with water. Therefore, these devices need to be protected against liquid spray. Because the IEC standard does not provide for testing empty housings, Gore has developed a test protocol that consistently categorizes spray-resistant materials. The test assesses both the amount of time required for water to penetrate a specific material and the amount and speed at which water passes through the material during the test. This testing protocol has shown a significant variation in the amount of water that spray-resistant materials allow to enter a housing. For example, when a woven and an open, non-woven material with equivalent acoustic resistance were tested under the same conditions, the woven material allowed 14 ml of water to pass through, whereas the non-woven material allowed only 9 ml of water to pass through.

Shallow Immersion Testing

Many of today's portable electronic devices are not intended to be fully immersed into water for long periods. Instead, the consumer may drop the device in a sink of water or a rain puddle. This type of event decreases the length of time in the water but increases the amount of pressure when the device hits the water. The IEC Standard 60529 IPx7 requires full submersion in one meter of water for 30 minutes and does not address contact pressure. No standard to-date addresses the condition of dropping a device into shallow water. Therefore, Gore has developed a test protocol for shallow immersion appropriate for portable electronics. This protocol takes into account the pressure exerted onto the device when it is dropped into water, better simulating the environment typical of portable electronics.

Consistency in Testing

The goal of testing is to ensure consistent results that indicate reliable performance of the device, which means that test results should be similar every time the device is tested in the same conditions. When test results vary, the development time is increased to determine why the assembled device failed.

While adequate for large enclosures, the IEC 60529 showerhead protocol, as specified, can deliver different results on the same device. The construction of the showerhead (e.g., geometry, hole size, hole position and flow rate) and the duration of the test are clearly specified in the standard. However, some of the specifications are quite broad, and they can directly influence test results of devices with openings. The IEC standard does not specify

- A location of the device openings in relation to the spray
- A fixed distance between the showerhead's center and the device surface
- Movement of the showerhead

For portable electronics, consistent positioning of the device in relationship to the showerhead provides the most uniform test results, and moving the showerhead ensures the most rigorous challenge of the protective housing. Gore has designed a custom test protocol that includes specific locations, distances, and movement for the showerhead when testing portable electronic devices (Figure 3). This protocol ensures that results will be consistent from one test to the next.

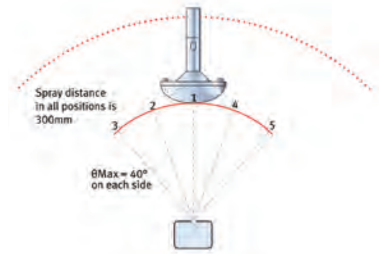

Figure 3. Gore's Showerhead Protocol ensures consistent test results.

Another consistency issue with the IEC standard is its pass/fail criteria. Once testing is completed, the standard states that a device passes as long as it continues to function. However, it does not define "function," which can lead to very subjective results in acoustic devices, particularly those with multiple features. Does a device pass as long as it can be turned on and off, or does every feature have to operate successfully? For example, one lab may pass a device as long as the electronics do not short out, yet another lab may fail a device with only a slight reduction of acoustic performance. Before any testing process begins, Gore defines specific, measurable criteria to determine whether a device passes or fails.

Conclusion

Although IEC Standard 60529 provides testing protocols for electronic housings, these protocols are designed for industrial applications, most of which are in stationary positions outdoors. The protocols for today's portable electronics need to address the environmental challenges these devices encounter.

One of Gore's core values is to ensure that its products are engineered to meet or exceed the needs for customers' specific applications, a concept referred to as "fitness for use." To align with this core value, Gore has developed testing protocols to ensure consistent results when testing the water and particulate protection of portable electronics (Figure 4). These protocols enable Gore's engineers to collaborate with customers during the design phase and ensure that the venting materials provide the appropriate protection without compromising sound quality.

Gore Test Method	Description
Particulate	Tests materials for real-world particulates less than 50 microns, such as hair and pet dander
Water Spray	Evaluates materials during product development, delivering consistent, quantifiable results
Water Immersion	Tests portable devices being dropped into shallow water, including contact pressure and quick immersion
Showerhead Spray	Tests portable devices for maximum exposure to water spray

Figure 4. Gore's test methods that evaluate portable electronic devices in real-world conditions.

For more information about Gore's test methods, visit www.gore.com/pevtesting, or call 800-523-4673 and request a copy of the white paper, "Improved Consistency in Testing for Water and Particulate Protection."

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