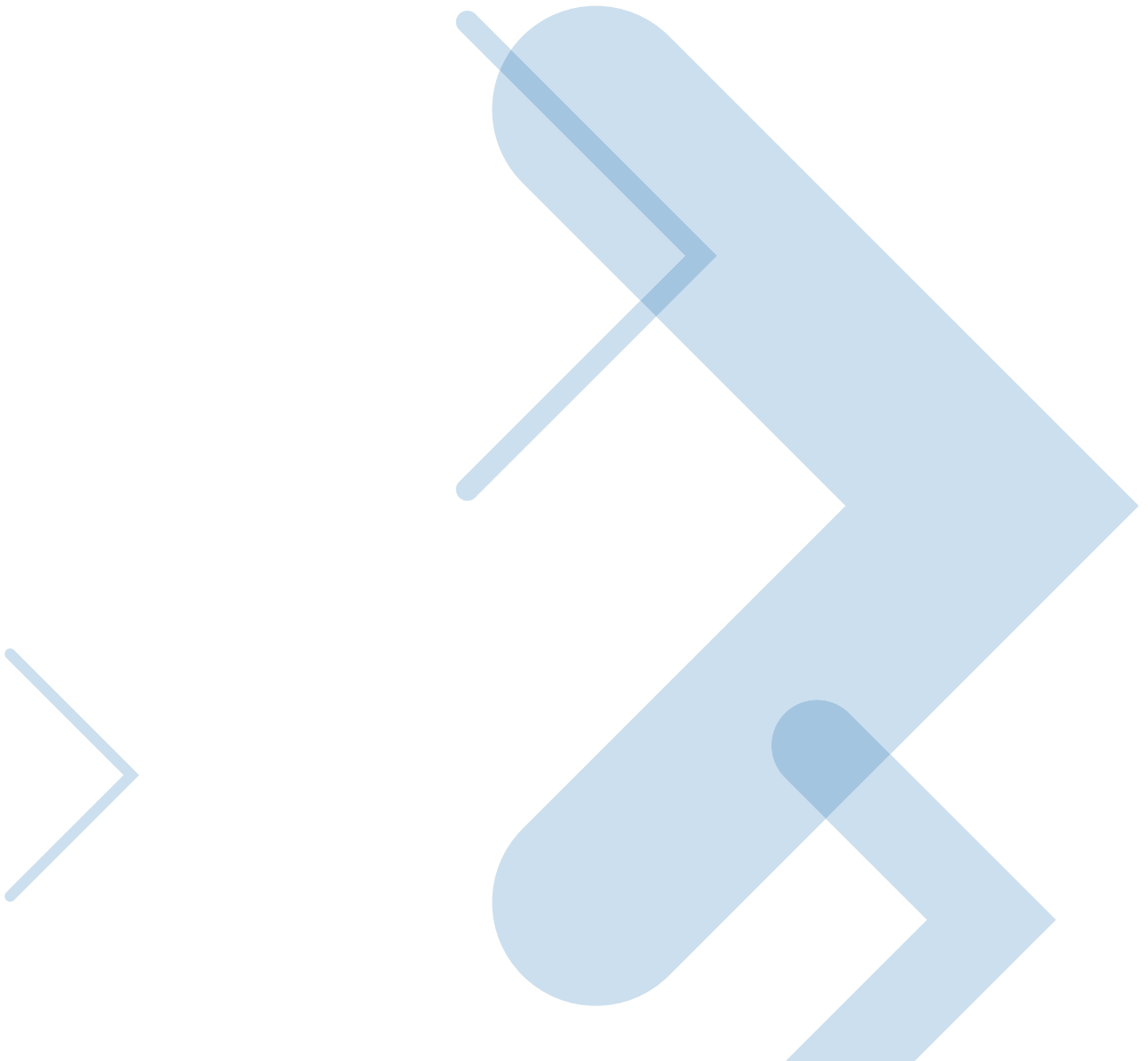


What Does It Mean To Be Rugged?

Stringent Testing Helps Ensure Equipment Reliability on the Front Lines



When you're fighting a warehouse fire at 11 below zero, you can't worry about your radio freezing up. If your patrol car is broadsided during a high-speed pursuit, your computer can't be torn free to become a dangerous projectile. When you're staking out a remote location in the desert or on or drilling for oil in the North Sea, your radio can't have its buttons and switches clogged by sand or salt. To make sure users out in the field have technology they can rely on under extreme circumstances, a number of organizations have developed stringent wireless industry testing standards and procedures. By designing and testing their equipment to these worldwide standards, manufacturers verify that their wireless devices will perform to specifications under even the harshest conditions.

Wireless technology is revolutionizing the ways first responders and others who work under difficult circumstances work better and safer. Whether they are firefighters, police officers, EMTs, miners, construction workers, military personnel or others, wireless technology makes voice and data communications faster and more reliable. Actually, it makes them more reliable in two ways. When most people think of network reliability, they think of ensuring that communications are available whenever and wherever you need them. But there's another kind of reliability that's just as important.

Physical Reliability

This second kind of reliability concerns the physical condition and durability of the equipment. What if your handheld falls during a foot pursuit? What if you spill a soda on your laptop's keyboard? What if your portable radio is completely immersed in a creek? Strange things can and do happen to wireless devices. Many of them are unpreventable. That's why the wireless industry spends an extraordinary amount of time and resources to make our equipment as impervious to physical damage and environmental conditions as possible.

Where is ruggedized wireless technology most commonly needed? Typically, it is the optimal technology for mission-critical applications of police and fire departments and of EMTs and doctors providing care in the field. But ruggedized equipment can also be the technology of choice for other applications such as field service operations, mining and construction sites, shop floor usage in manufacturing organizations, transportation and distribution industries and in personnel operating in extreme climates from the arctic to the Equator.

Ruggedized Technology Categories

There are four unofficial categories of ruggedized equipment. There are normal commercial-grade products that do not typically face rugged conditions, and so don't need extra protection. There are commonly referred to as "durable" models such as the computers you see advertised on television being dropped in airports. These somewhat improve durability with such features as spill-proof keyboards, accelerometers and hard-shell cases.

There are also "semi-rugged" models that conform to certain standards and guard against difficult, but usually not extreme environments. Then there are fully rugged laptops and handhelds that conform to the industry's most stringent standards to promote reliability in the most extreme conditions on earth.

International Testing Standards

It's easy to see why global industry standards are needed, especially for wireless equipment that must perform in the world's harshest environments. That's why various government agencies and industry groups around the globe have developed and published a number of performance and reliability standards. Many also specify detailed testing procedures to ensure standards adherence. Most standards have intensifying degrees of testing that measure various levels of ruggedization required for durable, semi-rugged and fully rugged equipment.

Today's most widely used ruggedness standards include those from four highly respected sources: the International Electrotechnical Commission (IEC), the European Committee for Electrotechnical Standardization (CENELEC) which publishes the European IP (Ingress Protection) standards for electrical equipment, and the United States military.



Motorola XTS 5000 radio screen-impact test.

- **International Electrotechnical Commission (IEC) Standards.** The IEC is a not-for-profit international standards organization that develops and publishes a series of standards for electrical, electronic and related technologies. These range from wireless computers to office technology, home appliances and more. The IEC has established a specific global system to facilitate conformity testing of Electrotechnical Equipment and Components (IECEE). Standards are described numerically; for example, the most current safety standard covering all telecommunications, business and computer equipment in the U.S. and Canada is 60950-1.

The IEC also provides the industry with three global conformity assessment systems that certify that technology systems and components are in compliance with its international standards. The organization enjoys international acceptance as a National Certification Body (NCB) able to provide certification reports and certificates that are recognized and accepted by participating NCBs around the world.

- **European IP (Ingress Protection) Standards.** Water and dust are two of the elements most commonly encountered in harsh environments. Unfortunately, they can also be exceptionally harmful to sensitive computer and electronic equipment. IP standards use numeric ratings to classify the amount of protection provided against water and dust by the products being tested. Standards use both letters and numbers. In the typical code IP65, for example, the IP identifies the standard, Ingress Protection. The number 6 identifies the highest level of protection from dust and particulates and the number 5 a slightly lower degree of protection from liquids.



A Motorola MW810 workstation undergoes testing for dust intrusion.

The most widely used IP standards for ruggedized computers and equipment are IP65 and IP54. In each, the IP code shows the level of protection the product provides. When a product is rated IP65, it is completely protected against dust and airborne particles as well as against water jets that simulate the product being washed. An IP54-rated product, on the other hand, is protected against dust in somewhat less harsh environments and against splashing water only. To simulate the most difficult conditions, IP ratings can also go higher. For example, an IP68 rating provides complete dust protection and water protection against total immersion.

- **Military Standards (MIL-STD-810F).** These are a series of stringent standards developed and published by the U.S. Department of Defense and the U.S. Army specifying a variety of environmental conditions that tested items are likely to experience in actual field usage. The MIL-STD-810F, a significant revision of the previous 810E standard, is one of the most comprehensive and effective standards in use today, and as such, is used extensively not just in the U.S., but throughout the world.

The standards emphasize the design and testing of equipment, providing evidence that the equipment will operate to specifications in the environmental conditions the equipment is likely to encounter during its useful life. The standards specify chamber test methods designed to replicate conditions the equipment will confront in a range of difficult environments. The tests themselves are identified with the standards specification (MIL-STD-810F) followed by a method number (Method 510.3) and explanation (Sand and Dust Testing).

MOTOROLA'S COMPREHENSIVE TESTING PROCEDURES

Motorola's testing process is as stringent as the standards we comply with, including all the standards described in this report, with emphasis on MIL-STD-810F and IP54 and IP65 testing procedures. Motorola tests products in three phases: design, pre-production and post-production. In the design and development phase, equipment is usually tested at least three times, with test results informing engineers how to improve product design. But we don't stop there. We fully test prototypes before they go into full production. Once in production, we do spot testing of regular production units from the lines of Motorola and third-party manufacturers to ensure that production models are as reliable as the prototypes. In addition, we continually perform Accelerated Life Testing (ALT)—a simulation of five years' worth of use in the field—to help ensure long-term performance and reliability.

Although the U.S. Army does not provide or imply certification, compliance with the standards helps assure purchasers they will have optimal equipment performance under even the most extreme conditions.

Equipment “Torture Tests”

To make certain tested equipment conforms to their standards, most standards organizations provide exceptionally detailed instructions and procedures for product testing. Manufacturers follow these detailed “torture tests” to the letter, ensuring reliable performance under the most difficult and dangerous conditions around the globe. Major tests normally performed include:

- **Water Intrusion.** When water or rain penetrates a device, they can cause short circuits and corrosion. Many manufacturers test their rugged products against both MIL-STD-810F and IP54, IP64, IP66 water and rain intrusion standards. Testing for rain intrusion is normally done in a rain chamber that drenches products with jets of water of varying intensities from all possible angles, as well as for dripping water for different periods of time. Fully rugged models are also tested with full immersion, to IP68 and MIL-STD-810F, Method 512.4.
- **Salt and Fog.** In coastal and marine environments, salt and fog can cause electronic equipment to short circuit or rust, affecting performance both short and long-term. Manufacturers normally test to the MIL-STD-810F Method 509.3 standard using the specified five percent saline solution.
- **Humidity.** Conditions of extreme humidity can cause computers and electronic devices to corrode and malfunction over time. Typical tests are to MIL-STD-810F Method 507.3 specifications, which specify 95 percent relative humidity and worst-case scenario high temperatures up to 75°C.



The APX™ 7500 Mobile Radio is rated IP55: protected against dust and low-pressure jets of water.

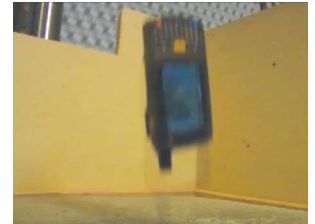
- **Dust Intrusion.**

Dust and sand intrusion in deserts, shorelines, mines, construction sites, or other environments can cause movable parts like buttons and keypads to clog and malfunction. Often manufacturers test to both MIL-STD-810F, Method 510.3 for sand and dust testing and IP standards for blowing dust.



- **Drop Testing.**

In the field, it's common for handhelds and other devices to be knocked over or fall. For laptop computers, manufacturers test to MIL-STD-810F Method 516.5 with 3- to 4-foot free-fall drops to concrete, and also with tip-over tests. For portable computers and devices, drop tests of four feet or more are conducted—in some cases, while the equipment is in operation. The equipment is expected to remain fully operational after multiple drops.



- **High and Low Temperatures.** Communications and computing equipment must work reliably in extreme temperatures, so manufacturers test their technology under operating conditions of minus 35°C (MIL-STD-810F Method 502.3) and plus 60°C (MIL-STD-810F 501.3). In addition, equipment is often stored under extreme temperature conditions, and is expected to work to specification when put into service. Many manufacturers tests equipment storage in extreme low temperatures down to minus 57°C (also MIL-STD-810F Method 502.3) and high temperatures up to 85°C (also MIL-STD-810F 501.3). These tests are especially important for public safety and enterprise markets, including construction, transportation, mining, utilities and more.

RUGGEDIZED TECHNOLOGY AND TOTAL COST OF OWNERSHIP

How do municipalities and enterprises decide how much ruggedness their equipment needs? In many cases, cost is the deciding factor. As organizations try to adapt to shrinking budgets, cost cutting has become a priority. Non-ruggedized technology can be chosen, even for mission-critical applications, simply because it is initially less expensive. In too many cases, however, this decision is a case of being penny-wise and pound-foolish. For, as a recent study by VDC Research shows, although rugged devices may initially be more expensive than commercial-grade equipment they have a significantly lower failure rate over the product's useful life. That presents a clear advantage in overall total cost of ownership (TCO).

- **Temperature Shock.** Equipment is often transported by airplane, or used outdoors and brought inside, meaning it can be under extreme cold for long periods of time, then deposited or stored in extreme heat. Equipment is tested under these precipitous temperature fluctuations to MIL-STD-810F Method 503, testing equipment that has gone from storage of minus 57°C to 80°C and vice versa.
- **Sun Exposure.** Equipment that is installed in, or must work in, unrelenting sunshine—such as in parking lots, on mountain tops, in deserts and more—is tested to MIL-STD-810F Method 505.4 standards for enclosure and performance damage from solar radiation. Tests normally last from three to seven days, and are conducted in a specially designed solar chamber.
- **Shock and Crash Testing.** Mobile and vehicle-mounted products are tested to make sure they are installed correctly by subjecting them to worst-case scenario accident impact tests. MIL-STD-810F Method 516.4 tests are exceptionally stringent. Equipment must continue to operate correctly under 75Gs, or 75 times the force of gravity. Drop tests of varying heights to a steel floor are also conducted. Equipment must stay intact, mounted and continue to be 100 percent functional.
- **Vibration.** Vibration testing to MIL-STD-810F Method 514.5 measures how equipment reacts to different levels of vibration, which can cause wire chafing, intermittent electrical contacts, display misalignment and other issues. Tests are conducted in both standard vehicles such as cars and trucks and under the more severe vibrations caused by more vibration-prone vehicles such as motorcycles, tanks and others.
- **Low Pressure.** High altitudes and dropping pressure, such as in aircraft or on mountains, can cause membranes in parts such as speakers, microphones and keypads, to malfunction. Manufacturers conduct low-pressure performance tests to MIL-STD-810F Method 500.3 that ensure 100 percent equipment functionality.

Demanding Tests for Demanding Users

Technology manufacturers put so much effort into rigorous and strenuous testing procedures for one reason only: to keep the first responders and field personnel who rely on their equipment safe and productive. When fully rugged equipment is used in mission-critical situations, and under difficult environmental conditions, it must always operate to specifications. As the testing processes outlined in this report show, technology manufacturers do not leave mission-critical performance to chance. Equipment is tested as though lives depend on it—because very often, they do.



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