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In This Issue . . .

Tektronix Environmental Labs — Proving Ground for Product Reliability

No matter how much foresight and planning go into the design and manufacture of a new product, it must be rigorously tested before release for sale to Tektronix customers, to ensure that it meets published performance specifications and will operate reliably under adverse environmental conditions. The following article by Herb Zajac, manager of Tek's Environmental Labs, explains how his group meets this challenge.

Our business is environmental stress, the stress produced by the product itself or imposed on the product by weather, transportation, carelessness, warfare, and by other electronic products. We are equipped to simulate these stresses and determine whether a product can survive the adverse electromagnetic, mechanical, and atmospheric conditions that Tek products sometimes must endure.

Business units consult us about designing to resist environmental stress. With our experienced staff, complete facilities, and ready access to outside resources, we are prepared to help designers anticipate and solve environmental problems at any time, but this help is most effective while the product is on the drawing board. Because we have the equipment to analyze vibration problems in production machinery, manufacturing groups also use our services.

Jim Smiley is testing the flammability of a plastic.

In the labs, we conduct both operating and nonoperating tests. Nonoperating tests simulate environmental stress of shipment or storage and are more severe than tests the instrument must pass while operating.

There are three labs within Environmental Labs. All three labs test products for operator safety.

The Electromagnetic Compatibility Lab (EMC) tests for radiated and conducted electromagnetic interference *from* Tek products. Further, the EMC Lab tests the reaction of Tek products *to* external electromagnetic interference. This lab also does x-ray emmissions tests and electrostatic-discharge tests. In addition, tests relating to Federal Communications Commission (FCC) and Food and Drug Administration (FDA) regulations are performed here.

The Dynamics Lab performs shock, vibration, and transit tests on packaged products, and also conducts accelerated-life tests. The Dynamics Lab has, or can build, mechanical-stress-testing equipment suitable for industry-recognized procedures.

The Atmospheric Lab evaluates product reactions to humidity, temperature, ozone and sulfate atmospheres, salt spray, and ultraviolet light. This lab also tests for flammability.

The sources of our test procedures are usually the appropriate military specifications, not because they are the most rigid (some Tek specs are more rigid), but because they spell out the test methods in sufficient detail to insure repeatability (see "Demystifying Military Specifications," **Field Engineering News,** August 1980).

The Electromagnetic Compatibility Lab

The Electromagnetic Compatibility (EMC) Lab conducts three kinds of tests: One, *emissions tests,* where we measure the radiation a product produces while operating. Two, *susceptibility tests,* where we check whether radiation from other sources will prevent normal operation of a Tek product. Three, *conducted-interference tests,* where we check whether products connected to the same power line will interfere with each other.

Bob Woolhiser using a Tektronix 7L12 Spectrum Analyzer to test for electromagnetic radio-frequency interference conducted from a Tek product (not in picture). The antennae in the foreground is used for radiated-emissions testing.

Joe Sanelle (left) and Tom Basta test a large Tek-made CRT for resonances on a shake table.

The EMC Lab makes conducted-emissions tests on all three wires of the power cord (including the ground wire). Measurements are made on each wire using a one-turn current transformer around the wire. The output of this transformer is measured with a spectrum analyzer or an amplitude-calibrated receiver. These tests are made at frequencies from 30 Hz to 50 MHz.

In *radiated-emissions testing,* calibrated antennas pick up electromagnetic radiation from a product. We measure this "signal" with a spectrum analyzer or amplitude-calibrated receiver. We perform radiated magnetic-field tests at frequencies ranging from 30 Hz to 30 KHz.

Susceptibility testing subjects a product to external sources of electromagnetic radiation. We test by injecting signals in the range from 30 Hz to 400 MHz. We also subject the product to magnetic-field radiated signals from 30 Hz to 30 kHz and radiated electric-field signals from 14 kHz to 1 GHz.

The EMC Lab conducts *electrostatic-charge tests* to determine the charge build-up on a product (or parts of a product) and the susceptibility of a product to external electrostatic charge. These tests are important because semiconductors are charge-sensitive.

The Dynamics Lab

The Dynamics Lab conducts three types of tests on products, components, and subassemblies: engineering safety-factor evaluation, use-environment tests, and transit environment tests.

Engineering safety-factor evaluation tests determine the fragility of a product with a vibration-search test and a shock test. In a vibration-search, we observe a product's movements as the vibration frequency is slowly varied from 10 Hz to 55 Hz (or higher). A strobe lamp detects undesirable motion; we particularly look for mechanical resonances or

extreme responses. The shock-test sequence stresses mechanical structures and components until they fail or indicate that they are about to fail.

Use-environment tests simulate "normal" conditions of mechanical stress. The tests include the *qualification shake,* a test that simulates operation in a moving vehicle or transportation of a product.

Another use-environment test is the *bench-handling test,* which drops a product onto a bench at various angles, simulating a product's movements during normal use and servicing.

Probes, small accessories, parts, and components receive a high-G shock of short duration that simulates normal use. In the "real world," small parts or accessories are often dropped on a hard surface; they are expected to survive, even when the G-forces reach 100 to 1000. (One "g" of force is the force generated on a mass by the acceleration of gravity; thus 1000 g's would cause a mass of one pound to "weigh" 1000 pounds.)

With mild vibration and shock, we test, cameras, equipment in racks, probe boxes, and other items that are fastened to or plugged into another product.

The *transit-environment test,* bounces a product (in its shipping carton), simulating a truck ride on a bumpy road.

The *transit-handling test* is a series of drops on the corners, edges, and faces of a packed shipping carton from as high as four feet.

Mechanical and *electromechanical testing* are other major functions of the Dynamics Lab. All the moving parts in Tek products are "cycled"; that is, switches, potentiometers, handles, and cables are turned, flexed, lifted, wound, or unwound. During these tests, we measure or monitor torque, resistance change, continuity, and wear. These tests often require a special fixture to hold a part, to apply or measure forces, or to monitor some condition of the unit under test. The lab can build fixtures and devices to measure almost any physical parameter. For example, we have built load cells to measure loads ranging from a fraction of a gram to many tons. We regularly measure static and dynamic forces, torques, displacements, and resistances.

The Dynamics Lab also uses high-speed photography to record events such as CRT implosion and what happens to a product during shock tests. We also use high-speed photography to catch high-speed motions in machine malfunctions.

The Atmospheric Lab

The Atmospheric Lab is responsible for high-temperature, low-temperature, humidity, altitude, salt-atmosphere, rain, splashing-water, and immersion testing.

High- and low-temperature tests determine if temperature extremes will degrade electrical or mechanical properties. Failures caused by temperature extremes include cracking of plastic parts with metal inserts, lead-bond failure in integrated circuits and transistors, adhesive-bond failure, and plastic deformation at high temperatures.

Humidity testing exposes a Tektronix product to a sequence of carefully controlled temperature and humidity conditions in a chamber. The chamber is to the right of Jim Smiley, who is adjusting a strip-chart recorder to log test conditions.

Jo Ann McCollister preparing a CRT for high- and low-temperature tests in a test chamber.

Tek Staff of the labs: Seated from left to right, Herb Zajac (manager), Jim Smiley, Ruth Ann Rose and Jo Ann McCollister. Standing, from left to right, Tom Basta, Bob Woolhiser, Henry Benitez, and Bill Verhoef.

At low temperatures, we test to assure that a product will operate properly. Extreme cold can cause changes in electrical value or mechanical failures in components.

Condensation tests determine what occurs when a product is moved from a cold environment to a warm humid one, causing condensation on cold parts.

Humidity testing determines the effect of surface moisture on components and circuitry. Many plastics and adhesives absorb moisture rapidly, causing deformed, cracked or crazed (minute cracking in surface layers) parts, and bond failures.

Another effect of humidity is current leakage across high-impedance input circuits or across high-voltage circuits. We induce these effects by cycling temperature up and down in a high-humidity chamber. Humidity testing can also reveal inadequate removal of conductive or corrosive contaminants on circuit boards.

Corrosion effects cause electrical, mechanical, and appearance problems. Corrosion often results from improper choices of metal alloys, finishes, and metal combinations. An extreme example of metal incompatability is the use of cadmium-plated screws to secure gold-plated circuit boards. This combination of dissimilar metals produces ion migration and combination effects that can cause catastrophic mechanical and electrical failures. We induce these failures with humidity tests.

Altitude tests simulate shipment in nonpressurized air transports and product operation at high altitudes. At high altitude, high-voltage breakdown problems and corona (a halo of ionized gas molecules) may occur in high-voltage circuitry. Corona generates ozone which can break down finishes and insulation.

The *storage-elevation test* (at 50,000 feet) assures that components, such as capacitors or gas-filled components, do not leak.

Lab engineers perform *salt-spray tests* to determine whether external finishes and parts of a product deteriorate on exposure to salt-corrosive environments. The salt-spray test lasts 50 hours in a 20% salt-spray environment (a much higher concentration than is ever found in nature).

The *ultraviolet-exposure test* simulates the effects of sunlight on exterior parts and finishes. This test is far harsher than the real world.

The *sulfide-atmosphere corrosion test* is performed on gold-plated circuit boards and plated parts such as switch contacts. The test checks the quality and integrity of gold-plated film and its ability to prevent corrosion of the underlying copper or other conductive material.

For more information, contact one of the following at d.s. 50-132, ext. B-7887:

EMC Lab	Bob Woolhiser
Dynamics Lab	Bill Verhoef
Atmospheric Lab	Jim Smiley

The Environmental Labs are located on the first floor of building 50. The delivery station is 50-132. Additional facilities are located in Building 92, Walker Road, managed by Henry Benitz, ext. WR-1326.

A videotape describing the testing capabilities of the Environmental Labs is available from Herb Zajac, ext. B-7887. ■