Hardware Test Standards

There are numerous independent technical standards that have been devised to help consumers compare and evaluate hardware products.

This Glossary of Hardware Test Standards explains the standards that Trimble uses to evaluate the ruggedness of the Nomad, Ranger, Recon and Yuma computers. We have provided this glossary to help you understand what level of ruggedness these standards signify.

512.4-Immersion in Water

Experience has shown that a temperature differential between the test item and the water can affect the outcome (leakage) of an immersion test. Increasing the test item temperature above the water temperature for the immersion test usually includes heating of the test item to establish a pressure differential (while cooling) to determine if the seals or gaskets leak under relatively low-pressure differential, and to induce expansion/contraction of materials. Although desired, establishing a specific temperature differential for fording tests is often impractical due to the size of the materiel.

How Trimble Tests for Immersion

The minimum requirements to pass the immersion test are heating a unit for an hour to a core temperature of 49 C (120° F). Within a minute after the removal from the heat source, the device is plunged into 22 C (72° F) degree water to a depth of 1 meter, and kept there for 30 minutes. The unit must function properly at completion of test to pass.

Recon, Ranger, Nomad and Yuma all passed the test.

510.4-Sand and Dust

This test method is divided into two procedures.

- The small-particle procedure (dust, fine sand) is performed to ascertain the ability of equipment to resist the effects of dust particles which may penetrate into cracks, crevices, and joints.
- The blowing sand test is performed to determine whether materiel can be stored and operated under blowing and conditions without experiencing degradation of its performance, effectiveness, reliability, and maintainability due to the abrasion (erosion) or clogging effect of large, sharp-edged particles.

Examples of some problems that could occur as a result of exposure of material to blowing sand and dust are:

- Abrasion of surfaces.
- Penetration of seals.
- Erosion of surfaces.
- Degradation of electrical circuits.
- Clogging of openings and filters.
- Physical interference with mating parts.
- Fouling of moving parts.

Recon is tested for 6 hours at 23 C (73° F) and 6 hours at 70 C (158° F) for Procedure I, blowing dust. It is then tested for Procedure II, blowing sand (2.2 g/m^3) for 90 minutes per face, 6 faces total.

Ranger, Nomad and Yuma: Procedure I and II compliant under 8 hours of operation with blowing talcum powder.

516.5-Shock/Drop

Shock, commonly referred to as drop, tests are performed to assure that materiel can withstand the relatively infrequent, non-repetitive shocks or transient vibrations encountered in handling, transportation, and service environments. Mechanical shocks will cause a piece of equipment to respond at both forced and natural frequencies. This response, among other things, can cause:

- Failures due to increased or decreased friction, or interference between parts.
- Changes in dielectric strength, loss of insulation resistance, variations in magnetic and electrostatic field strength.
- Permanent deformation due to overstress.
- More rapid fatiguing of materials.

Recon, Ranger, Nomad and Yuma are all tested in accordance with Procedure IV, Transit Drop, for items weighing less than 45.4 kg (100 lbs.), and under 91 cm (36 in.) in its largest dimension. Test items are dropped on each face, edge and corner, for a total of 26 drops at room temperature, from a height of 122 cm (4 ft.). Twelve additional drops were conducted; six at –30 C (–22 °F) and six at 60 C (140 °F) for a total of 38 total drops.

Recon, Ranger and Nomad testing was conducted on a plywood on concrete surface.

Yuma testing was conducted on a plywood on steel surface.

514.5-Vibration

Vibration testing is performed to determine the resistance of equipment to vibrational stresses expected in its shipment and application environments. Vibration can cause:

- Wire chafing.
- Loosening of fasteners.
- Intermittent electrical contacts.
- Touching and shorting of electrical parts.
- Seal deformation.
- Component fatigue.
- Display / Touch Panel misalignment.
- Cracking and rupturing.
- Excessive electrical noise.

Recon, Ranger, Nomad and Yuma all passed the following tests:

- Procedure I, General Minimum Integrity: Power Spectral Density = 0.04G^2/Hz, 20 to 1000Hz, descending 6dB/oct to 2000Hz. Three axes are tested, 1-hour per axis.
- Procedure II, Vibration and Loose Cargo: a Logarithmic sweep 5 to 500Hz beginning at 0.20" displacement. Three axes are tested, 30 minutes per axis.

501.4-High Temperature

High temperatures may temporarily or permanently impair the performance of the test item by changing the physical properties or dimensions of the material composing it. Examples of some other problems that could occur as the result of high temperature exposure are as follows:

- Parts binding from differential expansion of dissimilar materials.
- Materials changing in dimension, either totally or selectively.
- Gaskets displaying permanent set.
- Closure and sealing strips deteriorating.
- Fixed-resistance resistors changing in values.
- Electronic circuit stability varying with differences in temperature gradients and differential expansion of dissimilar materials.
- Transformers and electromechanical components overheating.
- Shortened operating lifetime.
- High pressures created within sealed cases.

- Discoloration, cracking or crazing of organic materials.

Recon is tested to the Hot Dry (A1) and Hot Humid (B3) conditions of seven 24-hour cycles at 65 C (149° F).

Ranger, Nomad and Yuma are tested to the *Extreme induced conditions* standard of seven 24-hour cycles at 70 C (158° F).

502.4-Low Temperature

Low temperatures have adverse effects on almost all basic materiel. As a result, exposure of test items to low temperatures may either temporarily or permanently impair the operation of the test item by changing the physical properties of the material composing it. Therefore, low temperature test must be considered whenever the test item will be exposed to temperatures below standard ambient. Examples of some problems that could occur as the result of exposure to cold are:

- Hardening and embrittlement of materials.
- Binding of parts from differential contraction of dissimilar materials and the different rates of expansion of different parts in response to temperature transients.
- Changes in electronic components (resistors, capacitors, etc.).
- Stiffening of shock mounts.
- Cracking and crazing, embrittlement, change in impact strength, and reduced strength.
- Static fatigue of restrained glass.
- Condensation and freezing of water.

Recon is tested to the Basic Cold (C1) standard of one 24-hour cycle at -30 C (-22° F).

Ranger is tested to the *Severe Cold* standard of one 24-hour cycle at -40 C (-40° F).

Nomad is tested to Procedure I, II, III (-35 C (-31° F) operating, -40 C (-40° F) storage).

Yuma is tested to Procedure I, II, III (–30 C (-22° F) operating; –40 C (-40° F) storage).

503.4-Temperature Shock

Temperature shock tests are conducted to determine if materiel can withstand sudden changes in the temperature of the surrounding atmosphere without experiencing physical damage or deterioration in performance. As a result of exposure to sudden temperature changes, operation of the test item may be affected either temporarily or permanently. Examples of problems that could occur as a result of exposure to sudden changes in temperature are:

- Shattering of glass.
- Binding or slackening of moving parts.
- Separation of constituents.
- Stiffening of shock mounts.
- Changes in electronic components.
- Electronic or mechanical failures due to rapid water or frost formation.
- Differential contraction or expansion of dissimilar materials.
- Deformation or fracture of components.
- Cracking of surface coatings.
- Leaking of sealed compartments.

Recon, Ranger, Nomad and Yuma are temperature shock tested using two thermal chambers set at -20 C and 60 C (-4° F and +140° F), with a 4-hour minimum soak and a 5-minute maximum transfer time between chambers. A total of four cycles are conducted through both chambers.

507.4-Humidity

Moisture can cause physical and chemical deterioration of material to include surface effects such as corrosion, and biologic growth; changes in material properties due to moisture penetration, and electrical or mechanical performance effects due to condensation. Typical problems that can result from exposure to a warm, humid environment include:

- Swelling of materials due to moisture absorption.
- Loss of physical strength.
- Changes in mechanical properties.
- Degradation of electrical and thermal properties in insulating materials.
- Electrical shorts due to condensation.
- Binding of moving parts due to corrosion or fouling of lubricants.
- Oxidation and/or galvanic corrosion of metals.
- Loss of plasticity.
- Accelerated chemical reactions.

Recon is exposed to temperature and humidity levels more severe than those that occur in documented service scenarios. 10 cycles are performed - a cycle being 12 hours at 60 C (140° F) and relative humidity of 95%, and 12 hours at 30 C (86° F) with relative humidity of 85%.

Ranger Series is tested in accordance with *Procedure III - Aggravated*. Procedure III exposes the test item to combined high temperature and humidity levels more severe than those that occur in documented service scenarios. 10 cycles are performed - a cycle being 12 hours at 60 C (140° F) and relative humidity of 95%, and 12 hours at 30 C (86° F) with relative humidity of 85%.

Nomad is tested at 90% relative humidity, through 10 temperature cycles at -20 C (-4° F)/ and 60 C (140° F).

Yuma is tested at 90% relative humidity, through 10 temperature cycles at 0 C (32° F)/ and 70 C (158° F).

500.4-Low Pressure/Altitude

Low-pressure (altitude) chamber tests are performed to determine if materiel can withstand, and operate in, a low-pressure environment, and withstand rapid pressure changes. Examples of some problems that could occur as a result of exposure to reduced pressure are:

- Rupture or explosion of sealed containers.
- Change in physical and chemical properties of low-density materials.
- Erratic operation or malfunction of equipment resulting from arcing or corona.
- Overheating of equipment due to reduced heat transfer.
- Failure of hermetic seals.

Recon is tested to 15,000 feet at 23 C (73° F). Rapid decompression is performed at 2,000 feet per minute.

Ranger and Nomad are tested to 15,000 feet at 23 C (73° F) using Procedures I, II and III.

Yuma is tested to 15,000 feet at 5 C (41 °F) and 40,000 ft. at –30 C (–22 °F), MIL-STD-810F, Method 500.4, Procedures I, II, III.