NON-DESTRUCTIVE EVALUATION FACILITY

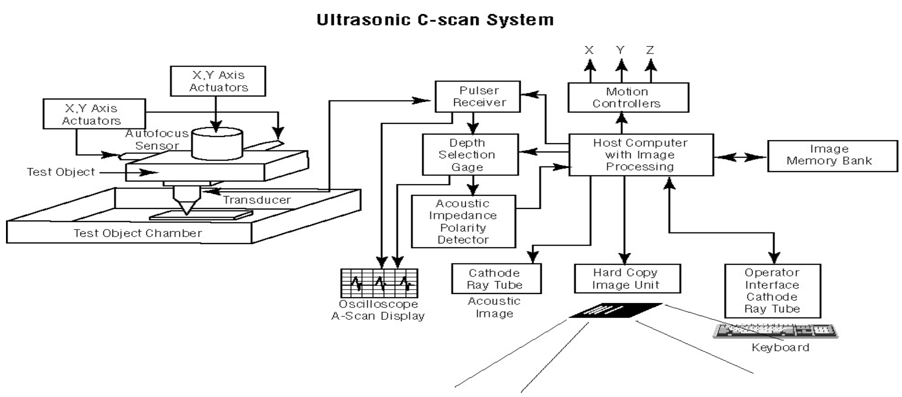
Purpose:

To nondestructively inspect and evaluate the interior of test and flight hardware for Space Shuttle and other NASA propulsion programs.

Ultrasonics

Ultrasonic nondestructive testing is the use of ultrasonics to examine or test materials without destroying the material. Ultrasonic testing involves the conversions of electrical energy into useful high frequency (commonly from 0.5 MHZ to 25 MHz) mechanical waves which propogate and interact with internal features of the material under test. An ultrasonic test may be used to measure the thickness of a material or to examine the internal structure of a material for possible discontinuances such as voids and/or cracks. Ultrasonics at the Marshall Space Flight Center consists of immersion and contact methodologies. The immersion methods are typically implemented with automated equipment while the contact methods are usually manual and hand-held.

MSFC immersion ulltrasonics consist of an immersion tank with 10 degrees of freedom with capability to inspect complex shaped hardware such as combustion chambers, rotors, nozzles, etc., with inspection envelopes 3 feet x 5 feet x 3 feet. The broadband frequency capability ranges from 150 KHz to 50 MHz. C-Scan capability along with Time-of-flight data is available.



Phased array technology can be used as a bubbler or contact method. It has the capability to scan flat panels up to 24” x 24” with 5 MHz and 10 MHz and at least 32 element transducers. The resolution of these scans and the versatility (electronic scanning with multiple angles) makes this method far superior to conventional ultrasound. Information is typically shown in A-scan, B-Scan, C-Scan and sectorial views.

Useful in the area of composite inspection and characterization are ultrasonic spectroscopy and resonance bond testers. MSFC has several of these types of units which can interrogate materials with mechanical and ultrasonic resonance. This is typically done with very versatile swept frequency pulsers.

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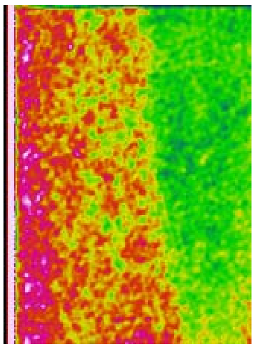

There are several non-contact ultrasonic methods in industry: laser, air, electromagnetic, etc. At MSFC, electromagnetic generation and detection of ultrasound via EMATs is available around 2 MHz. This is a purely non-contact approach and is currently hand-held.

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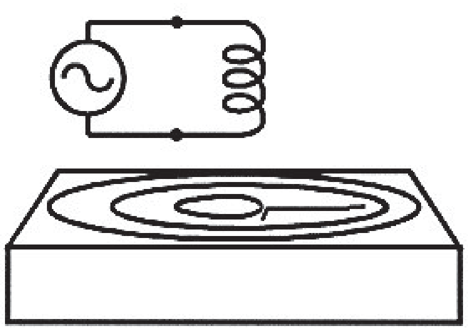
EDDY Current Capabilities

The aerospace industry, in an effort to conserve fuel and increase payload limits, is perpetually inventing new alloys and structures that are lighter in weight yet strong enough to bear the loads of launch and mission life. This often results in components that have little tolerance for even the smallest of surface flaws. The eddy current techniques being developed at MSFC can be a useful tool in identifying such flaws.



Eddy current is a nondestructive testing technique that uses magnetic fields to induce circular or "eddy" currents on the surface of conductive parts. A coil of wire at the end of a probe is energized with AC currents and held in close proximity to the material's surface by either mechanical or manual means. The difference in resistance to current flow between the coil and the eddy current generated on the part's surface is displayed in one of several modes on the screen of the test instrument. A crack or surface discontinuity on the part represents an increased resistance to current flow. Also, the higher the conductivity of a material, the shallower the eddy current depth of penetration below the surface of the material. For this reason, eddy current is considered primarily to be a surface and near-surface inspection technique. The only limitation to this technique is that it cannot be used on magnetic materials.

The eddy current equipment available at MSFC is adaptable to almost any inspection situation, whether in the lab or in the field. A total of five benchtop units, along with their accompanying array of probes and surface adapters, may be used to test for surface defects, make conductivity measurements in support of alloy verification and sorting, measure the thickness of non-conductive coatings such as paint and primer over metallic bases, and inspect both bolts and bolt holes. Probe adaptors allow a variety of surface contours to be tested also. While most work is done in the laboratory, all of the equipment may be carried into the field as well.

Projects currently employing this technique include Reusable Solid Rocket Motor (RSRM), Super Light Weight Tank (SLWT), Space Station, and many in-house developmental programs such as Friction Stir Welding. All of the equipment is located in Building 4702.

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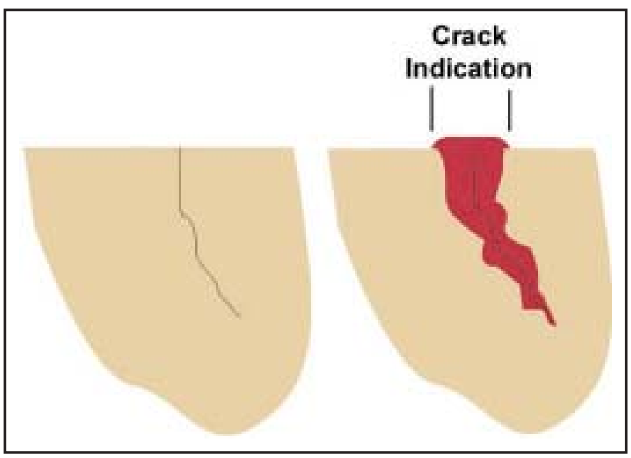
Non-Destructive Evaluation Facility

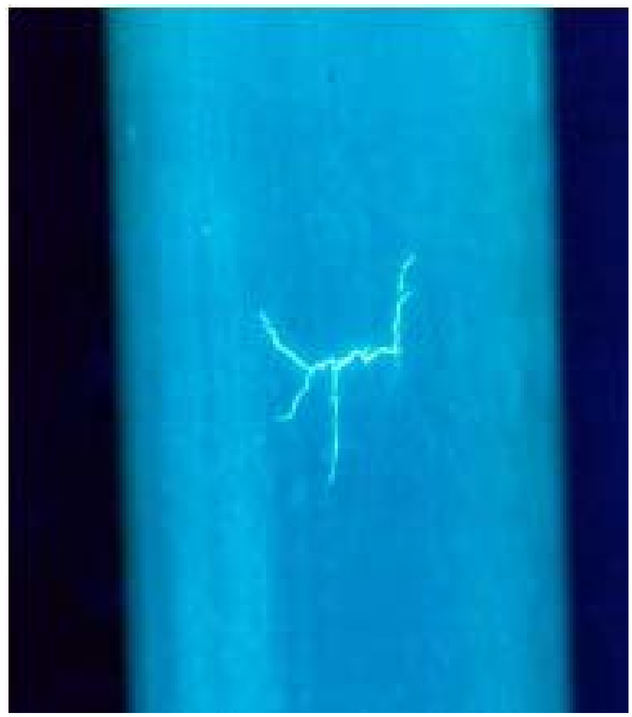
Liquid Penetrant Inspection

Penetrant inspection is a nondestructive test for defects open to the surface in parts made of non-porous material. It is used with equal success on such metals as aluminum, magnesium, brass, copper, cast iron, stainless steel, and titanium. It may also be used on ceramics, plastics, molded rubber, and glass. The technique is based on the ability of a liquid to be drawn into a surface-breaking flaw by capillary action.

Penetrant inspection will detect such defects as surface cracks or porosity. These defects may be caused by fatigue cracks, shrinkage cracks, shrinkage porosity, cold shuts, grinding and heat treat cracks, seams, forging laps, and bursts. Penetrant inspection will also indicate a lack of bond between joined materials.



Penetrant inspection depends upon a penetrating liquid entering the surface opening and remaining in that opening, making it clearly visible to the operator. It calls for visual examination of the part after it has been processed, but the visibility of the defect is increased so that it can be detected. Visibility of the penetrating material is increased by the addition of visible or fluorescent dye.



Liquid penetrant inspection is a widely used inspection technique at MSFC. Current projects using this technique include Solid Rocket Booster (SRB), External Tank (ET), Space Shuttle Main Engine (SSME), Space Station, and others.

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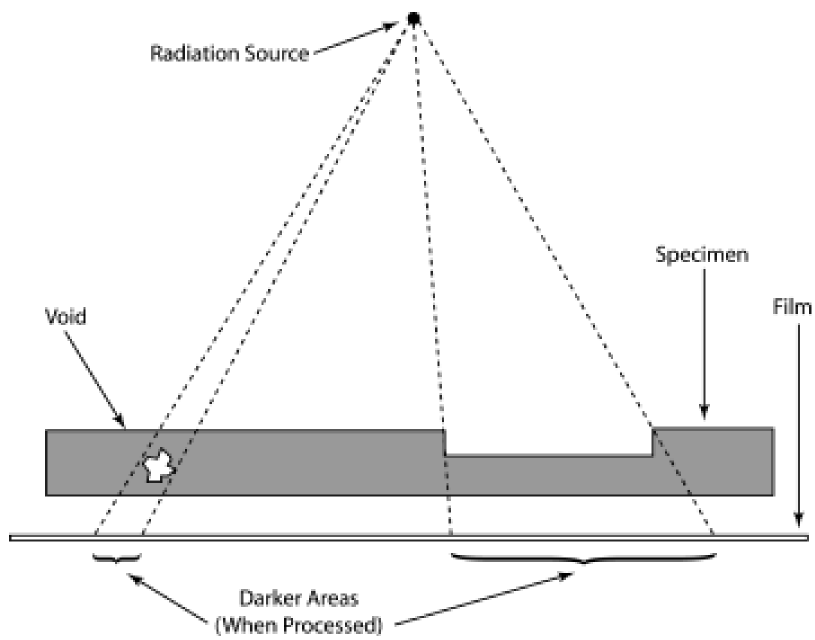
NON-DESTRUCTIVE EVALUATION FACILITY

Radiography

Radiography is a nondestructive inspection technique that uses x-rays (penetrating radiation) to detect internal and gross structural flaws in various materials and components. X-rays are a form of electromagnetic radiation with wavelengths from 10^{-13} m to 10^{-9} m in the electromagnetic spectrum. The x-rays are produced inside of an x-ray tube consisting of a cathode and an anode. A voltage applied across the cathode results in the acceleration of the electrons toward the anode. When the electrons abruptly strike the anode, the deceleration of the electrons results in the production of x-rays. The x-rays are either transmitted or attenuated by the object under inspection to image any flaws. Radiography is used to inspect castings, welds, brazed joints, electronic assemblies space components and aircraft. It is typically used for the detection of cracks, porosity, voids and inclusions.

The x-ray facility in Building 4702 has a RADView x-ray film digitizer with a 5 mega pixel display monitor. The digitizer runs on a Windows NT operating system. This system can be utilized to digitize exposed x-ray film, which can be saved and incorporated into reports.



MSFC has two x-ray facilities located in buildings 4702 and 4711. Both facilities have a Comet Philips x-ray system and a Kodak Automatic Film Processor. The maximum potentials/amperages on the x-ray systems in building 4711 and 4702 are 220 kV//15mA and 320 kV/15 mA respectively. The x-ray facility in Building 4702 also houses a Sperry portable x-ray system and a Lorad panoramic x-ray system. The maximum potentials/amperages for the portable and panoramic x-ray systems are 160 kV/4 mA and 200 kV/10 mArespectively. These x-ray systems offer the capability to inspect aluminum, stainless steel, titanium and composite materials. These x-ray systems are capable of inspecting up to 3.0 inches of aluminum and up to 1.5 inches of stainless steel.

MSFC is currently augmenting its capabilities with a High Resolution Digital Radiography System. This x-ray system will utilize a charged couple device camera as the detector instead of x-ray film. The system will be able to acquire digital images after an x-ray exposure. MSFC is also procuring another filmless radiography system, which will utilize a phosphor plate instead of x-ray film. A laser scanner will be used to produce a digital image from the phosphor plate after it is exposed.

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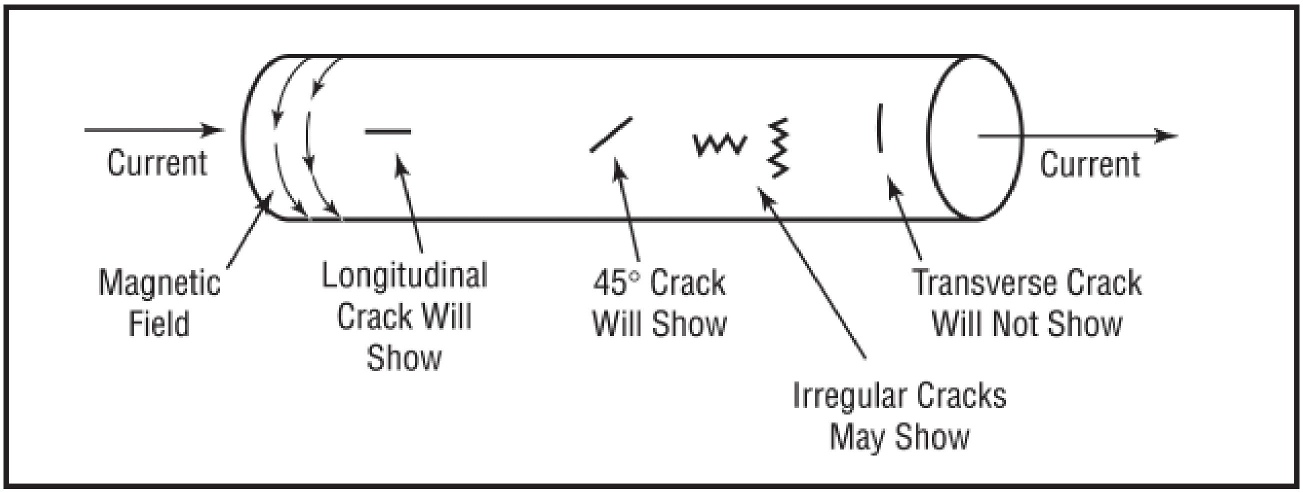
Non-Destructive Evaluation Facility

Magnetic Particle Facility

In addition to the aerospace industry, many manufacturing facilities have employed magnetic particle testing as a quick means for interrogating the surface condition of magnetic materials and parts. For this reason, MSFC maintains the capability of performing this nondestructive inspection technique both in-house and in the field.



Magnetic particle testing makes use of the inherent conductive properties of iron-laden materials to produce indications of surface and near-surface flaws.

Current is passed through the part under test either by connecting terminals to each end of the part (direct method) or by passing the part through an energized coil of wire to induce current into the part (indirect method). The direct method produces a circular field, yielding longitudinal cracks, while the indirect method produces a longitudinal field, resulting in transverse or circumferential crack detection. To visibly enhance crack identification, either a dry powder of magnetic particles in a fluorescent liquid suspension are applied just prior to induction of the magnetic field. Optimum contrast between surface appearance and crack indication is desired and affects the decision between dry versus wet particle application. Also, the fluorescent suspension tends to be more sensitive to tighter and shorter surface discontinuities.

At MSFC a bench-type facility is maintained for testing parts approximately four feet in length and shorter. Portable magnetic yokes are also available for testing larger parts in sections and for application of the technique in the field. A demagnetizing unit is available for reducing the effects of residual fields left in the parts after testing.

Projects currently employing this technique include Reusable Solid Rocket Motor (RSRM) and several in-house experiments. This equipment is located in Building 4702.

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