Designation: E 1571 – 96

An American National Standard

Standard Practice for Electromagnetic Examination of Ferromagnetic Steel Wire Rope[1]

This standard is issued under the fixed designation E 1571; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the application and calibration of instruments that use the electromagnetic, the magnetic flux, and the magnetic flux leakage test method to detect flaws and changes in metallic cross-sectional areas in ferromagnetic wire rope products.

1.1.1 This practice includes rope diameters up to 2.5 in. (63.5 mm). Larger diameters may be included, subject to agreement by the users of this practice.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 543 Practice for Agencies Performing Nondestructive Testing[2]

E 1316 Terminology for Nondestructive Examinations[2]

3. Terminology

3.1 *Definitions*—See Terminology E 1316 for general terminology applicable to this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dual-function instrument*—a wire rope NDT instrument designed to detect and display changes of metallic cross-sectional area on one channel and local flaws on another channel of a dual-channel strip chart recorder or another appropriate device.

3.2.2 *local flaw (LF)*—a discontinuity in a rope, such as a broken or damaged wire, a corrosion pit on a wire, a groove worn into a wire, or any other physical condition that degrades the integrity of the rope.

3.2.3 *loss of metallic cross-sectional area (LMA)*—a relative measure of the amount of material (mass) missing from a location along the wire rope and is measured by comparing a point with a reference point on the rope that represents maximum metallic cross-sectional area, as measured with an instrument.

3.2.4 *single-function instrument*—a wire rope test instrument designed to detect and display either changes in metallic cross-sectional area or local flaws, but not both, on a strip chart recorder or another appropriate device.

4. Summary of Practice

4.1 The principle of operation of a wire rope nondestructive testing instrument is as follows:

4.1.1 *Electromagnetic Instrument*—An electromagnetic wire rope testing instrument works on the transformer principle with primary and secondary coils wound around the rope (Fig. 1). The rope acts as the transformer core. The primary (exciter) coil is energized with a low frequency alternating current (ac), typically in the 10 to 30 Hz range. The secondary (search) coil measures the magnetic characteristics of the rope. Any significant change in the magnetic characteristics in the core (wire rope) will be reflected as voltage changes (amplitude and phase) in the secondary coil. Electromagnetic instruments operate at relatively low magnetic field strengths; therefore, it is necessary to completely demagnetize the rope before the start of an examination. This type of instrument is designed to detect changes in metallic cross-sectional area.

4.1.2 *Direct Current and Permanent Magnet (Magnetic Flux) Instruments*—Direct current (dc) and permanent magnet instruments (Figs. 2 and 3) supply a constant flux that magnetizes a length of rope as it passes through the test head (magnetizing circuit). The total axial magnetic flux in the rope can be measured either by Hall effect sensors, an encircling (sense) coil, or by any other appropriate device that can measure absolute magnetic fields or variations in a steady magnetic field. The signal from the sensors is electronically processed, and the output voltage is proportional to the volume of steel or the change in metallic cross-sectional area, within the region of influence of the magnetizing circuit. This type of instrument measures changes in metallic cross-sectional area.

4.1.3 *Magnetic Flux Leakage Instrument*—A direct current or permanent magnet instrument (Fig. 4) is used to supply a constant flux that magnetizes a length of rope as it passes through the test head (magnetizing circuit). The magnetic flux leakage created by a discontinuity in the rope, such as a broken wire, can be measured with a differential sensor, such as a Hall effect sensor, sensor coils, or by any appropriate device. The

[1] This practice is under the jurisdiction of ASTM Committee E-7 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.07 on Electromagnetic Method.

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[2] *Annual Book of ASTM Standards*, Vol 03.03.

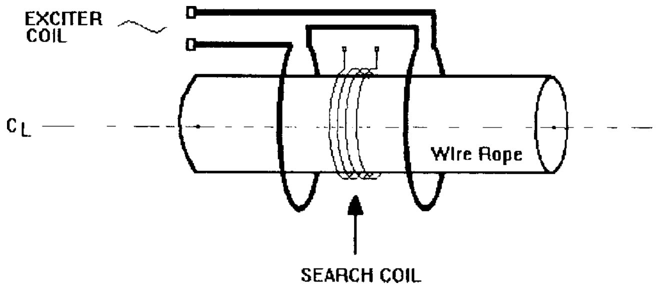

FIG. 1 Schematic Representation of an Electromagnetic Instrument Sensor-Head

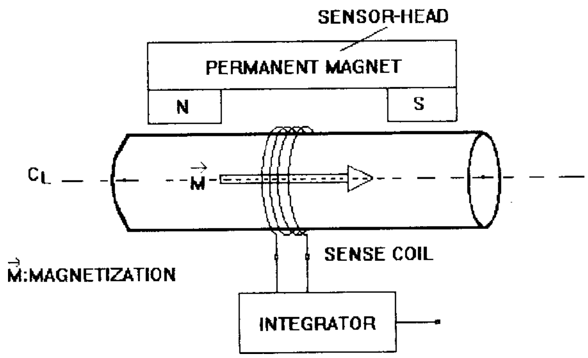

FIG. 2 Schematic Representation of a Permanent Magnet Equipped Sensor-Head Using a Sense Coil to Measure the Loss of Metallic Cross-Sectional Area

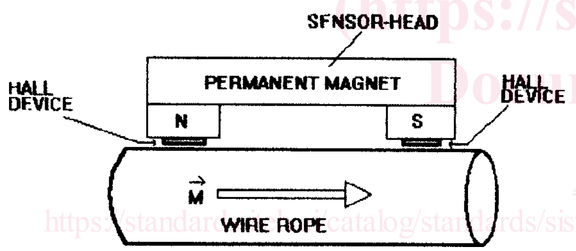

FIG. 3 Schematic Representation of a Permanent Magnet Equipped Sensor-Head Using Hall Devices to Measure the Loss of Metallic Cross-Sectional Area

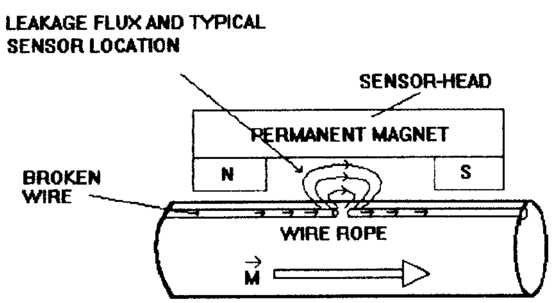

FIG. 4 Illustration of the Leakage Flux Produced by a Broken Wire

signal from the sensor is electronically processed and recorded. This type of instrument measures LFs. While the information is not quantitative, some conclusions can be drawn as to the presence of broken wires, internal corrosion, and fretting of wires in the rope.

4.2 The examination is conducted using one or more techniques discussed in 4.1. Loss of metallic cross-sectional area can be determined by using an instrument operating according to the principle discussed in 4.1.1 and 4.1.2. Broken wires and internal (or external) corrosion can be detected by using a magnetic flux leakage instrument as described in 4.1.3. The examination procedure must conform with Section 9. One instrument may incorporate both magnetic flux and magnetic flux leakage principles.

5. Significance and Use

5.1 This practice outlines a procedure to calibrate an instrument and to use the instrument to examine ferromagnetic wire rope products in which the electromagnetic, magnetic flux, magnetic flux leakage, or any combination of these methods is used. If properly applied, the electromagnetic and the magnetic flux methods are capable of detecting the presence, location, and magnitude of metal loss from wear and corrosion, and the magnetic flux leakage method is capable of detecting flaws such as broken wires and corrosion pits.

5.2 The instrument's response to fabrication, installation, and in-service-induced flaws can be significantly different from the instrument's response to artificial flaws such as wire gaps or added wires. For this reason, it is preferable to detect and mark (using set-up standards that represent) real flaws whose characteristics will adversely affect the serviceability of the wire rope.

6. Basis of Application

6.1 The following items require agreement by the users of this practice and should be included in the inspection contract:

6.1.1 Acceptance criteria.

6.1.2 Determination of LMA, or the display of LFs, or both.

6.1.3 Extent of rope examination (that is, full length that may require several setups or partial length with one setup).

6.1.4 Calibration method to be used: wire rope reference standard, rod reference standards, or a combination thereof.

6.1.5 Maximum time interval between equipment calibrations.

6.2 *Wire Rope Reference Standard (*Fig. 5*)*:

6.2.1 Type, dimension, location, and number of artificial anomalies to be placed on a wire rope reference standard.

6.2.2 Methods of verifying dimensions of artificial anomalies placed on a wire rope reference standard and allowable tolerances.

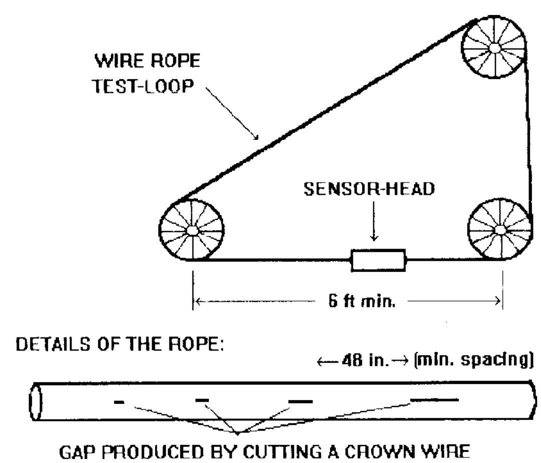

FIG. 5 Example of a Wire Rope Reference Standard