INTERNATIONAL

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Standard Terminology for Nondestructive Examinations[1]

This standard is issued under the fixed designation E1316; 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.

INDEX OF TERMS

Section

1. Scope

1.1 This standard defines the terminology used in the standards prepared by the E07 Committee on Nondestructive Testing. These nondestructive testing (NDT) methods include: acoustic emission, electromagnetic testing, gamma- and X-radiology, leak testing, liquid penetrant testing, magnetic particle testing, neutron radiology and gauging, ultrasonic testing, and other technical methods.

1.2 Committee E07 recognizes that the terms examination, testing and inspection are commonly used as synonyms in nondestructive testing. For uniformity and consistency in E07 nondestructive testing standards, Committee E07 encourages the use of the term examination and its derivatives when describing the application of nondestructive test methods. There are, however, appropriate exceptions when the term test and its derivatives may be used to describe the application of a nondestructive test, such as measurements which produce a numeric result (for example, when using the leak testing method to perform a leak test on a component, or an ultrasonic measurement of velocity). Additionally, the term test should be used when referring to the NDT method, that is, Radiologic Testing (RT), Ultrasonic Testing (UT), and so forth. (Example: Radiologic Testing (RT) is often used to examine material to detect internal discontinuities.)

1.3 Section A defines terms that are common to multiple NDT methods, whereas, the subsequent sections define terms pertaining to specific NDT methods.

[1] This terminology is under the jurisdiction of Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.92 on Editorial Review.

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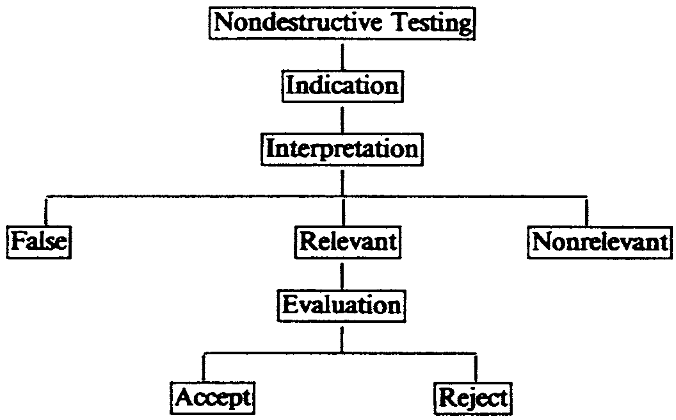
1.4 As shown on the chart below, when nondestructive testing produces an indication, the indication is subject to interpretation as false, nonrelevant or relevant. If it has been interpreted as relevant, the necessary subsequent evaluation will result in the decision to accept or reject the material. With the exception of accept and reject, which retain the meaning found in most dictionaries, all the words used in the chart are defined in Section A.



2. Referenced Documents

2.1 *ASTM Standards:*[2]

NOTE 1—This standard defines the terminology used in the standards prepared by Committtee E07 on Nondestructive Testing and published in the *Annual Book of ASTM Standards*, Volume 03.03.

3. Significance and Use

3.1 The terms found in this standard are intended to be used uniformly and consistently in all nondestructive testing standards. The purpose of this standard is to promote a clear understanding and interpretation of the NDT standards in which they are used.

4. Terminology

Section A: Common NDT Terms

The terms defined in Section A are the direct responsibility of Subcommittee E07.92, Editorial Review.

acceptable quality level—the maximum percent defective or the maximum number of units defective per hundred units that, for the purpose of sampling test, can be considered satisfactory as a process average.

calibration, instrument, *n*—the comparison of an instrument with, or the adjustment of an instrument to, a known reference(s) often traceable to the National Institute of Standards and Technology (NIST). (See also **standardization, instrument**.)

cognizant engineering organization—the company, government agency or other authority responsible for the design, or end use, of the material or component for which nondestructive testing is required

DISCUSSION—In addition to design personnel, the cognizant engineering organization could include personnel from engineering, material and process engineering, stress analysis, nondestructive testing, quality assurance and others, as appropriate.

defect, *n*—one or more flaws whose aggregate size, shape, orientation, location, or properties do not meet specified acceptance criteria and are rejectable.

discontinuity, *n*—a lack of continuity or cohesion; an intentional or unintentional interruption in the physical structure or configuration of a material or component.

evaluation—determination of whether a relevant indication is cause to accept or to reject a material or component.

examination, *n*—a procedure for determining a property (or properties) or other conditions or characteristics of a material or component by direct or indirect means.

NOTE 2—Examples include utilization of X-rays or ultrasonic waves for the purpose of determining (directly or by calculation) flaw content, density, or (for ultrasound) modulus; or detection of flaws by induction of eddy currents, observing thermal behavior, AE response, or utilization of magnetic particles or liquid penetrants.

false indication, *n*—an NDT indication that is interpreted to be caused by a condition other than a discontinuity or imperfection.

flaw, *n*—an imperfection or discontinuity that may be detectable by nondestructive testing and is not necessarily rejectable.

flaw characterization, *n*—the process of quantifying the size, shape, orientation, location, growth, or other properties, of a flaw based on NDT response.

imperfection, *n*—a departure of a quality characteristic from its intended condition.

indication—the response or evidence from a nondestructive examination.

DISCUSSION—An indication is determined by interpretation to be relevant, non-relevant, or false.

inspection, *n*—see preferred term **examination**.

interpretation—the determination of whether indications are relevant or nonrelevant.

interpretation, *n*—the determination of whether indications are relevant, nonrelevant, or false.

Nondestructive Evaluation—see **Nondestructive Testing**.

Nondestructive Examination—see **Nondestructive Testing**.

Nondestructive Inspection—see **Nondestructive Testing**.

Nondestructive Testing (NDT), *n*—the development and application of technical methods to examine materials or components in ways that do not impair future usefulness and serviceability in order to detect, locate, measure and evaluate flaws; to assess integrity, properties and composition; and to measure geometrical characteristics.

nonrelevant indication, *n*—an NDT indication that is caused by a condition or type of discontinuity that is not rejectable. False indications are non-relevant.

reference standard, *n*—a material or object for which all relevant chemical and physical characteristics are known and measurable, used as a comparison for, or standardization of, equipment or instruments used for nondestructive testing. (See also **standardization, instrument**.)

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

relevant indication, *n*—an NDT indication that is caused by a condition or type of discontinuity that requires evaluation.

standard—(1) a physical reference used as a basis for comparison or calibration; (2) a concept that has been established by authority, custom, or agreement to serve as a model or rule in the measurement of quality or the establishment of a practice or procedure.

standardization, instrument, *n*—the adjustment of an NDT instrument using an appropriate reference standard, to obtain or establish a known and reproducible response. (This is usually done prior to an examination, but can be carried out anytime there is concern about the examination or instrument response. (See also **calibration, instrument**.)

test, *n*—see preferred term **examination**.

Section B: Acoustic Emission

The terms defined in Section B are the direct responsibility of Subcommittee E07.04 on Acoustic Emission Method.

acoustic emission (AE)—the class of phenomena whereby transient elastic waves are generated by the rapid release of energy from localized sources within a material, or the transient waves so generated. Acoustic emission is the recommended term for general use. Other terms that have been used in AE literature include (1) stress wave emission, (2) microseismic activity, and (3) emission or acoustic emission with other qualifying modifiers.

acoustic emission channel—see **channel, acoustic emission.**

acoustic emission count (emission count) (N)—see **count, acoustic emission.**

acoustic emission count rate—see **count rate, acoustic emission (emission rate or count rate) ($\dot{N}$).**

acoustic emission event—see **event, acoustic emission.**

acoustic emission event energy—see **energy, acoustic event.**

acoustic emission sensor—see **sensor, acoustic emission.**

acoustic emission signal amplitude—see **signal amplitude, acoustic emission.**

acoustic emission signal (emission signal)—see **signal, acoustic emission.**

acoustic emission signature (signature)—see **signature, acoustic emission.**

acoustic emission transducer—see **sensor, acoustic emission.**

acoustic emission waveguide—see **waveguide, acoustic emission.**

acousto-ultrasonics (*AU*)—a nondestructive examination method that uses induced stress waves to detect and assess diffuse defect states, damage conditions, and variations of mechanical properties of a test structure. The AU method combines aspects of acoustic emission (AE) signal analysis with ultrasonic materials characterization techniques.

adaptive location—source location by iterative use of simulated sources in combination with computed location.

AE activity, *n*—the presence of acoustic emission during a test.

AE amplitude—see $\mathbf{dB_{AE}}$.

AE rms, *n*—the rectified, time averaged AE signal, measured on a linear scale and reported in volts.

AE signal duration—the time between AE signal start and AE signal end.

AE signal end—the recognized termination of an AE signal, usually defined as the last crossing of the threshold by that signal.

AE signal generator—a device which can repeatedly induce a specified transient signal into an AE instrument.

AE signal rise time—the time between AE signal start and the peak amplitude of that AE signal.

AE signal start—the beginning of an AE signal as recognized by the system processor, usually defined by an amplitude excursion exceeding threshold.

array, *n*—a group of two or more AE sensors positioned on a structure for the purposes of detecting and locating sources. The sources would normally be within the array.

arrival time interval (Δt_{ij})—see **interval, arrival time.**

attenuation, *n*—the decrease in AE amplitude per unit distance, normally expressed in dB per unit length.

average signal level, *n*—the rectified, time averaged AE logarithmic signal, measured on the AE amplitude logarithmic scale and reported in dB_{ae} units (where 0 dB_{ae} refers to 1 μV at the preamplifier input).

burst emission—see **emission, burst.**

channel, acoustic emission—an assembly of a sensor, preamplifier or impedance matching transformer, filters secondary amplifier or other instrumentation as needed, connecting cables, and detector or processor.

NOTE 3—A channel for examining fiberglass reinforced plastic (FRP) may utilize more than one sensor with associated electronics. Channels may be processed independently or in predetermined groups having similar sensitivity and frequency characteristics.

continuous emission—see **emission, continuous.**

count, acoustic emission (emission count) (N)—the number of times the acoustic emission signal exceeds a preset threshold during any selected portion of a test.

count, event (N_e)—the number obtained by counting each discerned acoustic emission event once.

count rate, acoustic emission (emission rate or count rate) ($\dot{N}$) —the time rate at which emission counts occur.

count, ring-down—see **count, acoustic emission,** the preferred term.

couplant—a material used at the structure-to-sensor interface to improve the transmission of acoustic energy across the interface during acoustic emission monitoring.

cumulative (acoustic emission) amplitude distribution F(V)—see **distribution, amplitude, cumulative.**

cumulative (acoustic emission) threshold crossing distribution F_t**(V)**—see **distribution, threshold crossing, cumulative.**

dB$_{AE}$—a logarithmic measure of acoustic emission signal amplitude, referenced to 1 µV at the sensor, before amplification.

$$\text{Signal peak amplitude } (dB_{AE}) = (dB_{\ 1\mu V\ at\ sensor}) = 20 \log_{10}(A_1/A_0) \quad (1)$$

where:
A_0 = 1 µV at the sensor (before amplification), and
A_1 = peak voltage of the measured acoustic emission signal (also before amplification).

Acoustic Emission Reference Scale:

dB_{AE} Value	Voltage at Sensor
0	1 µV
20	10 µV
40	100 µV
60	1 mV
80	10 mV
100	100 mV

DISCUSSION—In the case of sensors with integral preamplifiers, the A_O reference is before internal amplification.

dead time—any interval during data acquisition when the instrument or system is unable to accept new data for any reason.

differential (acoustic emission) amplitude distribution F(V)—see **distribution, differential (acoustic emission) amplitude f(V).**

differential (acoustic emission) threshold crossing distribution f_t**(V)**—see **distribution, differential (acoustic emission) threshold crossing.**

distribution, amplitude, cumulative (acoustic emission) F(V)—the number of acoustic emission events with signals that exceed an arbitrary amplitude as a function of amplitude V.

distribution, threshold crossing, cumulative (acoustic emission) F_t (V)—the number of times the acoustic emission signal exceeds an arbitrary threshold as a function of the threshold voltage (V).

distribution, differential (acoustic emission) amplitude f(V)—the number of acoustic emission events with signal amplitudes between amplitudes of V and $V + \Delta V$ as a function of the amplitude V. $f(V)$ is the absolute value of the derivative of the cumulative amplitude distribution F(V).

distribution, differential (acoustic emission) threshold crossing f_t (V)—the number of times the acoustic emission signal waveform has a peak between thresholds V and $V + \Delta\ V$ as a function of the threshold V. f_t(V) is the absolute value of the derivative of the cumulative threshold crossing distribution F_t (V).

distribution, logarithmic (acoustic emission) amplitude g(V)—the number of acoustic emission events with signal amplitudes between V and αV (where α is a constant multiplier) as a function of the amplitude. This is a variant of the differential amplitude distribution, appropriate for logarithmically windowed data.

dynamic range—the difference, in decibels, between the overload level and the minimum signal level (usually fixed by one or more of the noise levels, low-level distortion, interference, or resolution level) in a system or sensor.

effective velocity, *n*—velocity calculated on the basis of arrival times and propagation distances determined by artificial AE generation; used for computed location.

emission, burst—a qualitative description of an individual emission event resulting in a discrete signal.

NOTE 4—Use of the term burst emission is recommended only for describing the qualitative appearance of emission signals. Fig. 1 shows an oscilloscope trace of burst emission signals on a background of continuous emission.

emission, continuous—a qualitative description of emission producing a sustained signal as a result of time overlapping and/or successive emission events from one or several sources.

NOTE 5— Use of the term *continuous emission* is recommended only for describing the qualitative appearance of emission signals. Fig. 2 and Fig. 3 show oscilloscope traces of continuous emission signals at two different sweep rates.

energy, acoustic emission event—the total elastic energy released by an emission event.

energy, acoustic emission signal—the energy contained in an acoustic emission signal, which is evaluated as the integral of the volt-squared function over time.

evaluation threshold—a threshold value used for analysis of the examination data. Data may be recorded with a *system examination threshold* lower than the *evaluation threshold*. For analysis purposes, dependence of measured data on the *system examination threshold* must be taken into consideration.

event, acoustic emission (emission event)—a local material change giving rise to acoustic emission.

event count (Ne)—see **count, event.**

event count rate ($\dot{N}e$)—see **rate, event count.**

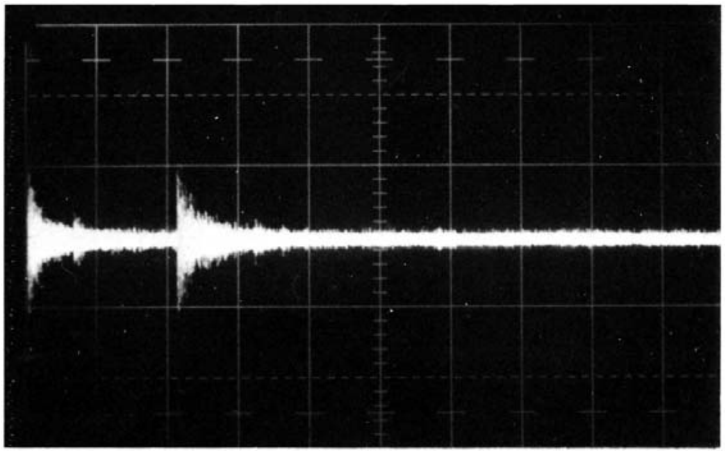


FIG. 1 Burst Emission on a Continuous Emission Background. (Sweep Rate—5 ms/cm.)

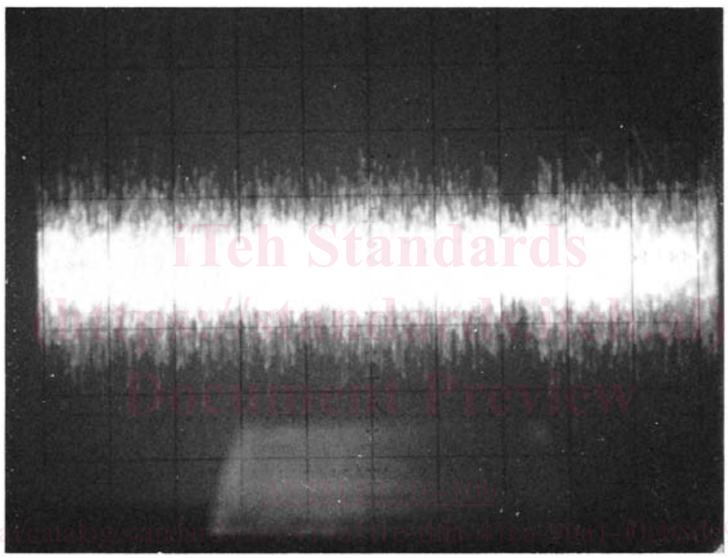


FIG. 2 Continuous Emission. (Sweep Rate—5 ms/cm.)

examination area—that portion of a structure being monitored with acoustic emission.

examination region—that portion of the test article evaluated using acoustic emission technology.

Felicity effect—the presence of detectable acoustic emission at a fixed predetermined sensitivity level at stress levels below those previously applied.

Felicity ratio—the ratio of the stress at which acoustic emission is detected, to the previously applied maximum stress.

NOTE 6—The fixed sensitivity level will usually be the same as was used for the previous loading or examination.

first hit location—a zone location method defined by which a channel among a group of channels first detects the signal.

floating threshold—any threshold with amplitude established by a time average measure of the input signal.

hit—the detection and measurement of an AE signal on a channel.

instrumentation dead time—see **dead time, instrumentation.**

interval, arrival time (Δt_{ij})—the time interval between the detected arrivals of an acoustic emission wave at the *ith* and *jth* sensors of a sensor array.

Kaiser effect—the absence of detectable acoustic emission at a fixed sensitivity level, until previously applied stress levels are exceeded.

DISCUSSION—Whether or not the effect is observed is material specific. The effect usually is not observed in materials containing developing flaws.

location accuracy, *n*—a value determined by comparison of the actual position of an AE source (or simulated AE source) to the computed location.

location, cluster, *n*—a location technique based upon a specified amount of AE activity located within a specified length or area, for example: 5 events within 12 linear inches or 12 square inches.

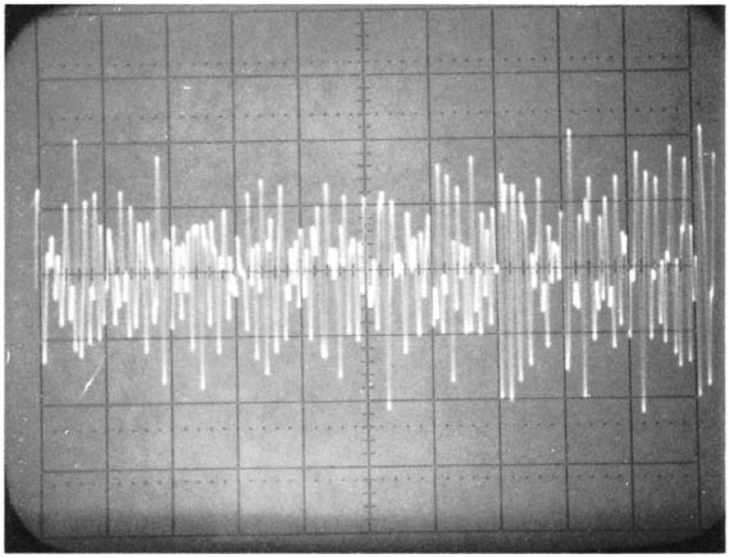


FIG. 3 Continuous Emission. (Sweep Rate—0.1 ms/cm.)

location, computed, *n*—a source location method based on algorithmic analysis of the difference in arrival times among sensors.

NOTE 7—Several approaches to computed location are used, including linear location, planar location, three dimensional location, and adaptive location.
(a) *linear location, n*—one dimensional source location requiring two or more channels.
(b) *planar location, n*—two dimensional source location requiring three or more channels.
(c) *3D location, n*— three dimensional source location requiring five or more channels.
(d) *adaptive location, n*—source location by iterative use of simulated sources in combination with computed location.

location, continuous AE signal, *n*—a method of location based on continuous AE signals, as opposed to hit or difference in arrival time location methods.

NOTE 8—This type of location is commonly used in leak location due to the presence of continuous emission. Some common types of continuous signal location methods include signal attenuation and correlation analysis methods.
(a) *signal attenuation-based source location, n*—a source location method that relies on the attenuation versus distance phenomenon of AE signals. By monitoring the AE signal magnitudes of the continuous signal at various points along the object, the source can be determined based on the highest magnitude or by interpolation or extrapolation of multiple readings.
(b) *correlation-based source location, n*—a source location method that compares the changing AE signal levels (usually waveform based amplitude analysis) at two or more points surrounding the source and determines the time displacement of these signals. The time displacement data can be used with conventional hit based location techniques to arrive at a solution for the source site.

location, source, *n*—any of several methods of evaluating AE data to determine the position on the structure from which the AE originated. Several approaches to source location are used, including zone location, computed location, and continuous location.

location, zone, *n*—any of several techniques for determining the general region of an acoustic emission source (for example, total AE counts, energy, hits, and so forth).

NOTE 9—Several approaches to zone location are used, including independent channel zone location, first hit zone location, and arrival sequence zone location.
(a) *independent channel zone location, n*—a zone location technique that compares the gross amount of activity from each channel.
(b) *first-hit zone location, n*—a zone location technique that compares only activity from the channel first detecting the AE event.
(c) *arrival sequence zone location, n*—a zone location technique that compares the order of arrival among sensors.

logarithmic (acoustic emission) amplitude distribution g(V)—see **distribution, logarithmic (acoustic emission) amplitude.**

overload recovery time—an interval of nonlinear operation of an instrument caused by a signal with amplitude in excess of the instrument's linear operating range.

performance check, AE system—see **verification, AE system**.

pressure, design—pressure used in design to determine the required minimum thickness and minimum mechanical properties.

processing capacity—the number of hits that can be processed at the processing speed before the system must interrupt data collection to clear buffers or otherwise prepare for accepting additional data.

processing speed—the sustained rate (hits/s), as a function of the parameter set and number of active channels, at which AE signals can be continuously processed by a system without interruption for data transport.

rate, event count ($\dot{N}e$)—the time rate of the event count.

rearm delay time—see **time, rearm delay.**

ring-down count—see **count, acoustic emission, the preferred term.**
sensor, acoustic emission—a detection device, generally piezoelectric, that transforms the particle motion produced by an elastic wave into an electrical signal.
signal, acoustic emission (emission signal)—an electrical signal obtained by detection of one or more acoustic emission events.
signal amplitude, acoustic emission—the peak voltage of the largest excursion attained by the signal waveform from an emission event.
signal overload level—that level above which operation ceases to be satisfactory as a result of signal distortion, overheating, or damage.
signal overload point—the maximum input signal amplitude at which the ratio of output to input is observed to remain within a prescribed linear operating range.
signal strength—the measured area of the rectified AE signal with units proportional to volt-sec.

DISCUSSION—The proportionality constant is specified by the AE instrument manufacturer.

signature, acoustic emission (signature)—a characteristic set of reproducible attributes of acoustic emission signals associated with a specific test article as observed with a particular instrumentation system under specified test conditions.
stimulation—the application of a stimulus such as force, pressure, heat, and so forth, to a test article to cause activation of acoustic emission sources.
system examination threshold—the electronic instrument threshold (see **evaluation threshold**) which data will be detected.
transducers, acoustic emission—see **sensor, acoustic emission.**
verification, AE system (performance check, AE system)—the process of testing an AE system to assure conformance to a specified level of performance or measurement accuracy. (This is usually carried out prior to, during and/or after an AE examination with the AE system connected to the examination object, using a simulated or artificial acoustic emission source.)
voltage threshold—a voltage level on an electronic comparator such that signals with amplitudes larger than this level will be recognized. The voltage threshold may be user adjustable, fixed, or automatic floating.
waveguide, acoustic emission—a device that couples elastic energy from a structure or other test object to a remotely mounted sensor during AE monitoring. An example of an acoustic emission waveguide would be a solid wire of rod that is coupled at one end to a monitored structure, and to a sensor at the other end.

Section C: Electromagnetic Testing (ET) Terms

The terms defined in Section C are the direct responsibility of Subcommittee E07.07 on Electromagnetic Methods.
absolute coil—a coil (or coils) that respond(s) to the total detected electric or magnetic properties, or both, of a part or section of the part without comparison to another section of the part or to another part.
absolute measurements—measurements made without a direct reference using an absolute coil in contrast to differential and comparative measurements. (See also **absolute coil**).
absolute readout—the signal output of an absolute coil. (See also **absolute coil**.)
absolute system—a system that uses a coil assembly and associated electronics to measure the total electromagnetic properties of a part without direct comparison to another section of the part or to another part (see **absolute coil**.)
acceptance level—a level above or below which specimens are acceptable in contrast to rejection level.
acceptance limits—levels used in electromagnetic sorting which establish the group into which the material under examination belongs.
amplitude distortion—same as **harmonic distortion.**
amplitude response—that property of an examination system whereby the amplitude of the detected signal is measured without regard to phase. (See also **harmonic analysis and phase analysis**.)
annular coil clearance—the mean radial distance between adjacent coil assembly and part surface in electromagnetic encircling coil examination.
annular coils—see **encircling coils.**
artificial discontinuity—reference discontinuities, such as holes, grooves, or notches, that are introduced into a reference standard to provide accurately reproducible sensitivity levels for electromagnetic test equipment.
band pass filter—a wave filter having a single transmission band; neither of the cut-off frequencies being zero or infinity.
bobbin coil—see **ID coil.**
bucking coils—same as **differential coils.**
circumferential coils—see **encircling coils.**
coil, absolute—see **absolute coil**.
coil, reference—see **reference coil**.
coil size—the dimension of a coil, for example, length or diameter.
coil spacing—the axial distance between two encircling coils of a differential system.
coil, test—the section of the probe or coil assembly that excites or detects, or both, the electromagnetic field in the material under examination.
comparative measurements—measurements made in which the unbalance in the system is measured using comparator coils in

contrast to differential and absolute measurements. (See also **comparator coils**.)

comparative readout—the signal output of comparator coils. (See also **comparator coils**.)

comparative system—a system that uses coil assemblies and associated electronics to detect any electric or magnetic condition, or both, that is not common to the specimen and the standard (see **comparator coils**).

comparator coils—two or more coils electrically connected in series opposition but arranged so that there is no mutual induction (coupling) between them such that any electric or magnetic condition, or both, that is not common to the specimen and the standard, will produce an unbalance in the system and thereby yield an indication.

conductivity—the intrinsic property of a particular material to carry electric current; it is commonly expressed in percent IACS (International Annealed Copper Standard) or MS/m (MegaSiemens/metre).

coupling—two electric circuits are said to be coupled to each other when they have an impedance in common so that a current in one causes a voltage in the other.

cut-off level—same as **rejection level.**

defect resolution—a property of an examination system that enables the separation of indications due to defects in a sample that are located in proximity to each other.

depth of penetration—the depth at which the magnetic field strength or intensity of induced eddy currents has decreased to 37 % of its surface value. The depth of penetration depends upon the coil size, the frequency of the signal, and the conductivity and permeability of the material. It is related to the coil size at low frequencies and is equal to the skin depth at high frequencies. Related synonymous terms are standard depth of penetration and skin depth. (See also **skin effect**.)

diamagnetic material—a material whose relative permeability is less than unity.

NOTE 10—The intrinsic induction Bi is oppositely directed to the applied magnetizing force *H*.

differential coils—two or more coils electrically connected in series opposition such that any electric or magnetic condition, or both, that is not common to the areas of a specimen being electromagnetically examined will produce an unbalance in the system and thereby yield an indication.

differential measurements—measurements made in which the imbalance in the system is measured using differential coils in contrast to absolute and comparative measurements. (See also **differential coils**.)

differential readout—the signal output of differential coils. (See also **differential coils**.)

differential signal—an output signal that is proportional to the rate of change of the input signal.

differential system—an electromagnetic examination system that uses coil assemblies and associated electronics to detect an electric or magnetic condition, or both, that is not common to the areas of the specimen being examined. (See also **differential coils**.)

eddy current—an electrical current caused to flow in a conductor by the time or space variation, or both, of an applied magnetic field.

eddy current testing—a nondestructive testing method in which eddy current flow is induced in the material under examination.

DISCUSSION—Changes in the flow caused by variations in the specimen are reflected into a nearby coil, coils, Hall effect device, magnetoresistive sensor or other magnetic field sensor for subsequent analysis by suitable instrumentation and techniques.

edge effect—the disturbance of the magnetic field and eddy–currents due to the proximity of an abrupt change in specimen geometry (edge). This effect generally results in the masking of discontinuities within the affected region. (This effect is also termed the **end effect**.)

effective depth of penetration (EDP)—for (a) thickness, the minimum depth beyond which an examination system can no longer reliably detect a further increase in specimen thickness, or (b) defects, the limit for reliably detecting metallurgical or mechanical discontinuities by way of conventional continuous wave (CW) eddy current instrumentation and sensors. The EDP point is approximately three times the standard depth of penetration.

effective permeability—a hypothetical quantity that describes the magnetic permeability that is experienced under a given set of physical conditions such as a cylindrical specimen in an encircling coil at a specific frequency. This quantity may be different from the permeability of the particular metal being examined in that it takes into account such things as the geometry of the part, the relative position of the encircling coil, and characteristics of the magnetic field.

electrical center—the center established by the electromagnetic field distribution within a test coil. A constant intensity signal, irrespective of the circumferential position of a discontinuity, is indicative of electrical centering. The electrical center may be different from the physical center of the test coil.

electromagnetic testing—a nondestructive test method for materials, including magnetic materials, that uses electromagnetic energy having frequencies less than those of visible light to yield information regarding the quality of examined material.

encircling coils—coil(s) or coil assembly that surround(s) the part to be examined. Coils of this type are also referred to as annular, circumferential, or feed-through coils.

end effect—see **edge effect.**

end effect—the loss in sensitivity to discontinuities located near the extreme ends of the tube as the ends of the tube enter or leave the test coil.

feed-through coils—see **encircling coils.**

ferromagnetic material—a material that, in general, exhibits the phenomena of magnetic hysteresis and saturation, and whose permeability is dependent on the magnetizing force.

fill factor—(a) for encircling coil electromagnetic testing, the ratio of the cross-sectional area of the specimen to the effective cross-sectional core area of the primary encircling coil (outside diameter of coil form, not inside diameter which is adjacent to specimen); (b) for internal probe electromagnetic testing, the ratio of the effective cross-sectional area of the primary internal probe coil to the cross-sectional area of the tube interior.

filter—a network that passes electromagnetic wave energy over a described range of frequencies and attenuates energy at all other frequencies.

gate—same as **rejection level**.

harmonic analysis—an analytical technique whereby the amplitude or phase, or both, of the frequency components of a complex periodic signal is determined.

harmonic distortion—nonlinear distortion characterized by the appearance in the output of harmonics other than the fundamental component when the input wave is sinusoidal.

IACS—the International Annealed Copper Standard; an international standard of electrical conductivity.

ID coil—a coil or coil assembly used for electromagnetic testing by insertion into the examination piece as in the case of an inside probe for tubing. Coils of this type are also referred to as inside coils, inserted coils, or bobbin coils.

impedance—the total opposition that a circuit presents to the flow of an alternating current, specifically the complex quotient of voltage divided by current.

impedance analysis—an analytical method that consists of correlating changes in the amplitude, phase, or quadrature components, or all of these, of a complex signal voltage to the electromagnetic conditions within a specimen.

impedance plane diagram—a graphical representation of the locus of points, indicating the variations in the impedance of a test coil as a function of basic examination parameters.

incremental permeability—the ratio of the change in magnetic induction to the corresponding change in magnetizing force when the mean induction differs from zero.

initial permeability—the slope of the induction curve at zero magnetizing force as the specimen is being removed from a demagnetizing condition (slope at origin of BH curve before hysteresis is observed).

inserted coil—see **ID coil.**

inside coil—see **ID coil.**

lift-off effect—the effect observed in an examination system output due to a change in magnetic coupling between a specimen and a probe coil whenever the distance between them is varied.

magnetic history—magnetic condition of a ferromagnetic part under examination based on previous exposures to magnetic fields.

magnetic leakage flux—the excursion of magnetic lines of force from the surface of a specimen.

magnetic saturation—that degree of magnetization where a further increase in magnetizing force produces no significant increase in magnetic flux density (permeability) in a specimen.

modulation analysis—an analytical method used in electromagnetic testing that separates responses due to various factors influencing the total magnetic field by separating and interpreting, individually, frequencies or frequency bands in the modulation envelope of the (carrier frequency) signal.

noise—any nonrelevant signal that tends to interfere with the normal reception or processing of a desired flaw signal. It should be noted that such noise signals may be generated by inhomogeneities in the inspected part that are not detrimental to the end use of the part.

nonferromagnetic material—a material that is not magnetizable and hence, essentially not affected by magnetic fields. This would include paramagnetic materials and diamagnetic materials.

normal permeability—the ratio of the induction (when cyclically made to change symmetrically about zero) to the corresponding change in magnetizing force.

off-line testing—eddy current tests conducted on equipment that includes the test coil and means to propel individual tubes under examination through the coil at appropriate speeds and conditions.

on-line testing—eddy current tests conducted on equipment that includes the test coil and means to propel tubes under examination through the coil at appropriate speeds and conditions as an integral part of a continuous tube manufacturing sequence.

optimum frequency—that frequency which provides the largest signal-to-noise ratio obtainable for the detection of an individual material property. A different optimum frequency may be associated with each material property.

paramagnetic material—a material that has a relative permeability slightly greater than unity and that is practically independent of the magnetizing force.

permeability, a-c—a generic term used to express various dynamic relationships between magnetic induction, B, and magnetizing force, H, for magnetic material subjected to a cyclic excitation by alternating or pulsating current. The values of a-c permeability obtained for a given material depend fundamentally upon the excursion limits of dynamic excitation and induction, the method and conditions of measurement, and also upon such factors as resistivity, thickness of laminations, frequency of excitation, and so forth.

NOTE 11—The numerical value for any permeability is meaningless unless the corresponding *B* or *H* excitation level is specified. For incremental permeabilities not only must the corresponding d-c *B* or *H* excitation level be specified, but also the dynamic range (ΔB or ΔH).

permeability, d-c—permeability is a general term used to express relationships between magnetic induction, *B*, and magnetizing force, *H*, under various conditions of magnetic excitation. These relationships are either *(1)* absolute permeability, which in general is the quotient of a change in magnetic induction divided by the corresponding change in magnetizing force, or *(2)* relative permeability, which is the ratio of the absolute permeability to the magnetic constant (γ_m).

NOTE 12—The magnetic constant γ_m is a scalar quantity differing in value and uniquely determined by each electromagnetic system of units. In the unrationalized cgs system γ_m is 1 gauss/oersted and the mksa rationalized system $\gamma_m = 4\pi \times 10^{-7}$ H/m.

NOTE 13—Relative permeability is a pure number which is the same in all unit systems. The value and dimension of absolute permeability depends on the system of units employed.

NOTE 14—For any ferromagnetic material, permeability is a function of the degree of magnetization. However, initial permeability, μ_o, and maximum permeability, μ_m, are unique values for a given specimen under specified conditions.

NOTE 15—Except for initial permeability, μ_o, a numerical value for any of the d-c permeabilities is meaningless unless the corresponding *B* or *H* excitation level is specified.

NOTE 16—For the incremental permeabilities $\mu\Delta$ and $\mu\Delta\, i$, a numerical value is meaningless unless both the corresponding values of mean excitation level (B or *H*) and the excursion range (ΔB or ΔH) are specified.

phase analysis—an analytical technique that discriminates between variables in a part undergoing electromagnetic testing part by the different phase angle changes that these conditions produce in a signal. (See also **phase detection**.)

phase angle—the angular equivalent of the time displacement between corresponding points on two sine waves of the same frequency.

phase detection—the derivation of a signal whose amplitude is a function of the phase angle between two alternating currents, one of which is used as a reference.

phase-sensitive system—a system whose output signal is dependent on the phase relationship between the voltage returned from a pickup or sensing coil and a reference voltage.

phase shift—a change in the phase relationship between two alternating quantities of the same frequency.

probe coil—a small coil or coil assembly that is placed on or near the surface of examination objects.

probe coil clearance—the perpendicular distance between adjacent surfaces of the probe and examination part; also lift-off.

recovery time—the time required for an examination system to return to its original state after it has received a signal.

reference coil—a coil or probe, which may be used in conjunction with the appropriate material, to electrically balance a comparative system.

rejection level—the value established for a signal above or below which specimens are rejectable, or otherwise distinguished from the remaining specimens.

selectivity—the characteristic of an examination system that is a measure of the extent to which an instrument is capable of differentiating between the desired signal and disturbances of other frequencies or phases.

sensitivity control—the control in the instrument that adjusts the amplifier gain, and is one of the factors that determines the capacity to detect discontinuities.

signal gradient—same as **differential readout**.

signal-to-noise ratio—the ratio of values to signal (response containing relevant information) to that of noise (response containing nonrelevant information).

skin depth—see **depth of penetration.**

skin effect—the phenomenon wherein the depth of penetration of electric currents into a conductor decreases as the frequency of the current is increased. At very high frequencies, the current flow is restricted to an extremely thin outer layer of the conductor. (See also **depth of penetration**.)

speed effect—the phenomenon in electromagnetic testing of which the evidence is a change in the signal voltage resulting from a change in the relative motion between the specimen and a test coil assembly.

standard depth of penetration (SDP)—see **depth of penetration.**

test coil—the section of the coil assembly that examines the material under examination in a comparative system; the coil used to examine the material in an absolute or differential comparative system.

test quality level—see **rejection level.**

three way sort—an electromagnetic sort based on a signal response from the material under examination above or below two levels established by three or more calibration standards.

threshold level—the setting of an instrument that causes it to register only those changes in response greater or less than a specified magnitude.

threshold setting—the setting of the instrument that causes it to register only those changes in eddy-current response greater than a specified magnitude.

NOTE 17—Sensitivity and threshold settings usually are indicated by arbitrary numbers on the control panel of the testing instrument. These numerical settings differ among instruments of different types. It is, therefore, not proper to translate a numerical setting on one instrument to that of another type. Even among instruments of the same design and from the same manufacturer, sensitivity and threshold settings may vary slightly when detecting the same discontinuity. Therefore, undue emphasis on the numerical value of sensitivity and threshold settings is not justified.