

GLOSSARY

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INTRODUCTION

Most of the definitions in this glossary are adapted from the text in this volume and from the third edition of the *Nondestructive Testing Handbook*, (ASNT 1998, 2012). The definitions in this glossary have been modified to satisfy peer review and editorial style. For this reason, references in this glossary should be considered not attributions but rather acknowledgments and suggestions for further reading.

The definitions in the *Nondestructive Testing Handbook* should not be referenced for inspections performed according to standards or specifications or in fulfillment of contracts. Standards writing bodies take great pains to ensure that their documents are definitive in wording, technical accuracy, and harmony with related specifications. People working to written contracts or procedures should consult standards when appropriate (ASTM).

This glossary is provided for instructional purposes. No other use is intended.

A

absolute pressure: Pressure above absolute zero value, or pressure above that of space empty of all molecules. Equal to sum of local atmospheric pressure and gauge pressure. Compare *gauge pressure*.

absolute temperature: Temperature above absolute zero value. Absolute zero temperature is expressed as 0 K or $-273.15\text{ }^{\circ}\text{C}$ ($-459.67\text{ }^{\circ}\text{F}$). Compare *ambient temperature*.

acceptable quality level (AQL): Maximum percent defective (or the maximum percentage of units with rejectable discontinuities) that, for the purposes of sampling tests, can be considered satisfactory as a process average.

acceptance criterion: Benchmark against which test results are to be compared for purposes of establishing the functional acceptability of a part or system being examined.

acceptance level; acceptance limit: (1) Test signal value used to establish the group to which a material under evaluation belongs. (2) Measured value or values above or below which test objects are acceptable. Also called *rejection level*.

acceptance standard: (1) Specimen, similar to the product to be tested, containing natural or artificial discontinuities that are well defined and similar in size or extent to the maximum acceptable in the product. (2) Document defining acceptable discontinuity size limits. See also *reference standard; standard*.

accumulation test technique: Detecting the total amount of leakage by enclosing the component under test within a hood, bag, box, shroud, or container. For pressure testing, any gas leaking from the component accumulates in the space (volume) between the component and the enclosure. For vacuum testing, any gas leaking into the component accumulates in the leak detector sampling the evacuated component. Accumulation of tracer gas in a measured time period allows evaluation of the leakage rate.

accuracy: Degree of conformity of a measurement to a standard or true value.

acoustic emission testing (AE): Passive nondestructive testing method that monitors a component or assembly for transient elastic waves and converts these ultrasonic waves into electrical signals. Acoustic waves may be produced by the formation or movement of microstructural dislocations during crack propagation, melting, phase transformations, or thermal stresses.

acoustic leak testing: In leak testing, technique that uses elastic waves in the frequency range of 30 to 100 kHz, which are generated by the flow of fluids through leaks.

air flow: In leak testing, flow of air from the probe inlet to the sensitive element of the halogen leak detector that carries the tracer gas from the leak to the sensing diode.

alkali ion diode: Sensor type for halogen gases. In this device, positive ions (cations) of an alkali metal are produced on the heated surfaces (usually platinum) of the diode. One electrode is at a negative potential and attracts cations that are released when a halogen gas passes between the sensor electrodes. Provides an output current to operate the indicator on the halogen leak detector.

ambient temperature: Temperature of immediate surroundings. Also called *atmospheric temperature* or *dry bulb temperature*.

anode: Positively charged terminal, which may corrode electrochemically during production of an electric current. Compare *cathode*.

anomaly: Variation from normal material or product quality. (1) In nondestructive testing, a nonrelevant indication. (2) In nondestructive testing, an unintentional or undesired material condition that may qualify as a defect. Compare *defect*; *discontinuity*.

artificial discontinuity standard: See *acceptance standard*.

artificial source: In acoustic leak testing, a point where elastic waves are created to simulate an acoustic generator. The term also defines devices used to create the waves.

ASNT: American Society for Nondestructive Testing.

ASNT Recommended Practice No. SNT-TC-1A: See *Recommended Practice No. SNT-TC-1A*.

atmospheric conditions: See *atmospheric pressure*; *standard temperature and pressure*.

atmospheric pressure: Ambient pressure caused by the weight of the earth's atmosphere. Because the weight of the earth's overlying atmosphere varies inversely with altitude, atmospheric pressure decreases with elevation. Also called *barometric pressure*. See also *standard atmospheric pressure*. Compare *gauge pressure*; *absolute pressure*.

automated system: Acting mechanism that performs required tasks at a determined time and in a fixed sequence in response to certain conditions.

B

background: Formations on or signals from a test object that constitute the background to a discontinuity. The higher the level of background noise, the more difficult it is to distinguish a discontinuity. Background signals may arise from visual, acoustic, chemical, electrical, or radiation sources that the sensor responds to. See also *sensitivity*; *signal-to-noise ratio*.

background contamination: Tracer gases in a test system that initiate a response from the leak detector and are not attributable to a leak, but may make detection of leaks more difficult.

backstreaming: Movement of pumping fluids from the pump back to the vacuum chamber. Also called *diffusion*.

baffle: System component, typically a plate, that condenses pump fluids before they reach the vacuum chamber, and returns fluid to the pump.

barometer: Pressure gauge used to measure the atmospheric pressure.

barometric pressure: See *atmospheric pressure*.

bell jar: Example evacuated test chamber. See also *vacuum pressure testing*.

black light: See *near ultraviolet*.

bourdon tube: Gauge that measures pressure through displacement. Types include C-type, spiral style, and helical type.

bubble leak testing: Positive pressure test where leakage is indicated by formation of bubbles in the solution film by escaping gas. Methods include immersion, vacuum box, and bubble solution tests.

C

calibrated leak: Instrument or specimen providing a known *conductance*, or leakage rate, for purposes of reference or comparison. See also *standard*.

capillary action: Tendency of liquids to penetrate or migrate into small openings, such as cracks, pits, or fissures. The positive force that causes movement of certain liquids along narrow or tight passages.

carrier fluid: (1) Liquid that acts as a transport mechanism for the active materials. (2) In penetrant testing and leak testing, fluid in which fluorescent and dyes or particles are dissolved or suspended.

cathode: Negatively charged terminal in an arrangement that produces current by chemical reactions. Compare *anode*.

celsius (centigrade): Temperature scale based on 273 K (0 °C = +32 °F) as the freezing point of water and 373 K (100 °C = 212 °F) as the boiling point of water at standard atmospheric pressure. A relative scale related to the kelvin scale (0 °C = 273.12 K; 1 °C = 1 K).

certification: With respect to nondestructive test personnel, the process of providing written testimony that an individual has met the qualification requirements of a specific practice or standard. See also *qualification*.

certified: With respect to nondestructive test personnel, having written testimony of qualification. See also *qualified*.

choked flow: Phenomenon where, while pressure downstream is gradually lowered, velocity through an orifice increases until it reaches the speed of sound in the fluid. Also called *sonic flow*.

cleanup time or cleanup: Time (time constant) required after a tracer gas has ceased to enter a leak test system, for the system to reduce its signal output to 37 percent of the signal indicated before the tracer gas had ceased to enter the leak testing system.

code: Standard enacted or enforced as a law. Compare *recommended practice*; *standard*.

cold cathode ionization gauge: Ion gauge in which the ions are produced by a cold cathode discharge, usually in the presence of a magnetic field that lengthens the path of electrons between the cathode and anode. Compare *hot filament ionization gauge*.

cold light: See *fluorescence*.

cold trap: Device that condenses vapors and prevents oil or water molecules from entering a vacuum chamber.

color contrast penetrant: Testing fluid incorporating a nonfluorescent dye, which provides enhanced visibility to discontinuities when used with proper inspection technique and when viewed under white light.

complete testing: Testing of an entire production lot in a prescribed manner. Sometimes complete testing entails the inspection of only the critical regions of a part. One hundred percent testing requires the inspection of the entire part by prescribed methods. Compare *sampling, partial*.

conductance: Of a tube, manifold, or leak path, flow characteristics expressed as a volumetric flow rate in m³/s. See also *leakage rate; mass flow rate; rotameter; throughput*.

D

defect: Discontinuity whose size, shape, orientation, or location (1) makes it detrimental to the useful service of its host object or (2) exceeds an accept/reject criterion of an applicable specification. Some discontinuities do not exceed an accept/reject criterion and are therefore not defects. Compare *anomaly; discontinuity; indication*. See also *flaw*.

detector probe: Adjustable or fixed device through which air and/or tracer is drawn into the leak test instrument and over the sensing element or detector. Response is measured in units of Pa·m³·s or std cm³/s. Standard flow rate is measured at standard temperature and pressure. Also called *sampling probe; sniffer probe*.

detector probe test: Pressure leak test in which the leakage of a component, pressurized with a tracer rich mixture, is detected by scanning the test object with a *detector probe* connected to an electronic leak detector. Leakage tracer gas is pulled from the leak through the probe inlet to the sensing element to cause a visible or audible signal on the indicator of the leak test instrument.

diffusion: Process by which molecules intermingle as a result of concentration gradients or thermal motion. Spreading of a gas through other gases or solids within a volume.

discontinuity: Interruption in the physical structure or configuration of a test object. After nondestructive testing, a discontinuity indication may be interpreted as a defect. Compare *anomaly; defect; indication*.

drift (electronic): Change in output reading of an instrument, usually due to temperature change.

dry bulb temperature: See *standard temperature and pressure*.

dynamic testing: Testing in which the system under test is pumped continuously. See also *hood test*.

E

elastomer: Natural or synthetic rubber. In leak testing, elastomers are often used as gasket material to make a tight seal in a vacuum system.

examination, general: Test or examination of a person's knowledge, typically (in the case of nondestructive testing personnel qualification) a written test on the basic principles of a nondestructive testing method and general knowledge of basic equipment used in the method. (According to ASNT's guidelines, the general examination should not address knowledge of specific equipment, codes, standards, and procedures pertaining to a particular application.) Compare *examination, practical; examination, specific*.

examination, practical: In certification of nondestructive testing personnel, a hands-on examination using test equipment and sample test objects. Compare *examination, general; examination, specific*.

examination, specific: In certification of nondestructive testing personnel, a written examination that addresses the specifications and products pertinent to the application. Compare *examination, general; examination, practical*.

F

flammability: Tendency to combust, considered to be characteristic of liquids having flash point below 60 °C (140 °F) and a vapor pressure not exceeding 275 kPa (40 lb_f/in.²) at 37.8 °C (100 °F).

flash point: Lowest temperature at which vapors above a volatile, combustible substance ignite in air when exposed to an ignition source.

flaw: Imperfection or unintentional discontinuity. See also *defect* and *discontinuity*.

flow measurement: Determining the extent of leakage by measuring the rate of flow of gas into or out of a system or component under test. See also *rotameter*.

fluorescence: Phenomenon of absorption of electromagnetic radiation and its reemission at a lower energy (longer) visible light wavelength. Fluorescence in NDT may be a material's response to ultraviolet or ionizing radiation. The emission ceases as soon as the exciting energy is removed. Differs from phosphorescence, which continues to emit after excitation energy is removed.

foam leak test: Bubble leak test technique in which the tracer gas blows a hole through a blanket of foam covering the test object, thus indicating the location of the leak. Compare *immersion leak test*.

G

gauge pressure: Pressure above or below atmospheric pressure at the measurement location.

gas ballast: Gas (air) admitted into the pumping chamber of a mechanical pump to inhibit condensation of vapors in the chamber.

getter: Reactive material that traps gas and removes it from a vacuum chamber. Several metals such as titanium, zirconium, and tantalum can act as getters for gases.

H

halide: Compound of two or more elements, one of which is a halogen.

halogen: Any of the nonmetallic elements — fluorine, chlorine, bromine, and iodine — or any gaseous chemical component containing one or more of these elements.

halogen detector probe test: Pressure leak test in which the leakage of a component, pressurized with a halogen rich mixture, is detected by scanning over the test object boundary surface with a probe connected to a halogen leak detector. Halogen gas is pulled from the leak through the probe inlet to the sensing element to cause a visible or audible signal on the indicator of the leak test instrument.

halogen leak detector: Leak detector that responds to tracer gases containing a halogen. Normally not very sensitive to the elemental halogen gases, but very good when used with a gas that contains a halogen. Also called *halogen sensitive leak detector*; *halide leak detector*.

heated immersion test: Bubble test where the heating causes buildup of internal pressure in a test object and the formation of bubbles at leak sites.

helium: Monomolecular, noble gas with atomic weight of four, commonly used as tracer gas in leak testing. Because of helium's small molecular size and rarity (5 $\mu\text{L/L}$ in air) it is an excellent tracer gas.

hermetic seal: Fusion seal that is leaktight.

holes: Any void remaining in an object as a result of improper manufacturing processing. Also called *gas holes*; *cavities*; *air locks*.

hood test: Quantitative dynamic test in which a sample under vacuum is enclosed within a volume filled with tracer so that the entire part is simultaneously evaluated.

hot filament ionization gauge: Absolute pressure gauge that monitors ion current proportional to gas density at pressures less than 0.1 Pa (0.8 mtorr). Electrons produced by a heated filament ionize the gas (the thermionic phenomenon) and produce a positive ion current that flows to a wire collector. This current is proportional to gas density over the absolute pressure range below 0.1 Pa for a given gas composition. Filaments may be of pure metal (such as tungsten), or oxide coated (such as yttria or thoria coated iridium). Also called *bayard-alpert gauge*. Compare *cold cathode ionization gauge*.

I

ideal gas: Theoretical perfect gas comprised of randomly moving isolated particles that only interact upon elastic collision.

immersion leak test: Technique in which the test object is pressurized and then submerged in detection fluid. The formation of bubbles from the object indicates a leak; the absence of bubbles indicates leaktightness. Compare *foam leak test*.

implosion: Collapse of pressure boundary or wall of a containment vessel or structure when evacuated and subject to atmospheric or higher external pressure.

indication: Nondestructive test response that requires interpretation to determine its relevance. Compare *defect; discontinuity; indication, false; indication, nonrelevant*.

indication, false: (1) Test indication that could be interpreted as originating from a discontinuity but that actually originates where no discontinuity exists in the test object. (2) Indication due to misapplied or improper testing. Compare *indication, nonrelevant; defect*.

indication, nonrelevant: Indication that has no relation to a discontinuity that might constitute a defect. Test response caused by geometry or by a physical condition that is not a discontinuity (a change of section, for instance).

indication, relevant: Indication from a discontinuity (as opposed to a false indication) requiring evaluation by a qualified inspector, typically with reference to an acceptance standard, by virtue of the discontinuity's size or location.

inert: Substance that does not readily combine or react with other substances. Examples of inert gases are helium, neon, and argon. Also called *noble gases*.

infrared radiation: Electromagnetic energy with a wavelength between 750 nm (400 THz) and 1 mm (300 GHz). Compare *visible light; ultraviolet radiation*.

infrared thermography: Imaging of a temperature field through the emitted infrared radiation. Thermography uses an instrument or system that displays infrared radiant energy from a target surface on a thermal map, or thermogram, where color hues or gray shades can be related to the temperature distribution on that surface. See *infrared radiation*.

inlet: Opening, flange, connection, or coupling on a leak detector or leak test system through which tracer gas may enter from a leak in a test object.

integrated leakage rate test: Leakage test performed on an entire system or component by pressurizing the system to the calculated peak containment internal pressure related to the design, and then determining the overall integrated leakage rate.

interpretation: Determination of the significance of test indications from the standpoint of their relevance or nonrelevance. The determination of the cause of an indication or the evaluation of the significance of discontinuities from the standpoint of whether they are detrimental or inconsequential.

ion current: Current that flows at all times from the positive emitter (heater) to the negative cathode collector of the heated anode (alkali ion) halogen vapor detector. This current increases in the presence of halogenated gases. See also *hot filament ionization gauge*.

ionization gauge: High vacuum gauge that depends on the measuring of electrical ion current resulting from ionization of gas. Examples include hot filament ionization (bayard-alpert gauges) gauges; cold cathode ionization gauges (penning gauges or philip gauges); and alphasatron gauges.

irradiance: Total radiant power, in watts per square meter (W/m^2), falling upon a known surface area at a given angle.

isobaric: Having constant pressure.

K

knudsen number: Ratio of mean free path to characteristic dimension of the system (O'Hanlon 1989).

L

laminar flow: Class of viscous flow where velocity distribution of fluid in a cross section of a tube is parabolic. Compare *viscous flow*.

laser: Device producing a monochromatic, spatially, and temporally coherent beam of radiation. Acronym of **light amplification by stimulated emission of radiation**.

leak: Opening that allows the passage of a fluid.

leak detector: Device for detecting, locating, or measuring leakage.

leak testing (LT): Nondestructive testing method for detecting, locating, or measuring leaks or leakage in pressurized or evacuated systems or components.

leakage: Measurable quantity of fluid escaping from a leak.

leakage design basis accident: Calculated peak containment internal pressure related to the design basis accident.

leakage rate: Quantity of leakage fluid per unit time that flows through a leak at a given temperature as a result of a specified pressure difference across the leak. See also *conductance*; *mass flow rate*; *throughput*.

leaker penetrant: Penetrant especially designed for leak detection.

leech box: Double compartmented box in which the outer compartment is evacuated and then the inner compartment is pressurized to produce a pressure differential across the test boundary under the inner compartment.

lid stiffness: In leak testing of hermetically sealed packages, the material characteristic that defines the amount of lid deflection from a specific pressure differential.

LT: Leak testing.

M

manifold: Collection of vacuum hardware such as valves, piping, and chambers connected together to form a test system.

manometer: Instrument for measuring pressure (or pressure differentials) of gases and vapors. Historically, a manometer utilized a liquid column to measure pressure.

manual zero: Control on a test instrument that allows the user to zero the instrument panel meter.

masking: Covering of a portion of a test object so as to prevent tracer gas from entering leaks that may exist in the covered section.

mass flow rate: Amount of matter passing a point per unit time. Mass flow is measured in kilograms per second. Compare *volumetric flow rate*.

mass spectrometer: Analytical technique that detects the identity and amount of elements and molecules present in a sample by first ionizing, separating the ions through electromagnetic forces, and then measuring their mass-to-charge ratio. Data is presented as a mass spectrum of ion signal as a function of the mass-to-charge ratio. In leak testing, use of a mass spectrometer leak detector specially tuned for helium detection is common. Compare *spectrometer*.

mass spectrometer leak detector: Mass spectrometer with design factors optimized to produce an instrument that has high sensitivity to a single tracer gas.

mass-to-charge ratio: Ratio of mass (kilogram) to electrical charge (coulomb) of a molecule, or the atomic mass of the molecule divided by the atomic charge of the molecule (O'Hanlon 1989).

mean free path: Average distance a gas molecule travels between successive collisions with other molecules in the gas or vapor state. See also *knudsen number*.

micro: Prefix that divides a basic unit of measure by one million.

mole: The amount of a substance required, in grams, to contain 6.02×10^{23} atoms. This number happens to correspond with the number of carbon-12 atoms in 12 gram sample.

molecular flow: Phenomenon occurring when the mean free path length of gas molecules is greater than the largest cross sectional dimension of a leak or the tube through which flow is occurring. See also *knudsen number*.

molecular weight: For a gas, the mass of 22.4 L (0.8 ft³) at standard temperature and pressure.

motion feedthrough: Function provided by rotary or linear drives that penetrates the vacuum boundary to operate valve or pump or perform another function inside the vacuum system. See also *vacuum grease*.

N

NDC: Nondestructive characterization.

NDE: (1) Nondestructive evaluation.
(2) Nondestructive examination.

NDI: Nondestructive inspection.

NDT: Nondestructive testing.

near ultraviolet: Pertaining to electromagnetic radiation with wavelengths between 315 and 400 nm. Fluorescent tracer liquids for leak testing use ultraviolet energy centered around 365 nm.

near ultraviolet filter: Device used to modify the emission spectrum from an ultraviolet radiation source by eliminating most visible light and high energy (far ultraviolet) radiation.

nondestructive characterization (NDC): Branch of nondestructive testing concerned with the description and prediction of material properties and behaviors of components and systems.

nondestructive evaluation (NDE): Another term for nondestructive testing. In research and academic communities, the word evaluation is often preferred because it emphasizes interpretation by knowledgeable personnel. See also *nondestructive examination*; *nondestructive inspection*.

nondestructive examination (NDE): Another term for nondestructive testing. In the utilities and nuclear industry, examination is sometimes preferred because testing can imply performance trials of pressure containment or power generation systems.

nondestructive inspection (NDI): Another term for nondestructive testing. In some industries (utilities, aviation), the word inspection often implies maintenance for a component that has been in service.

nondestructive testing (NDT): Determination of the physical condition of an object without affecting that object's ability to fulfill its intended function. Nondestructive testing techniques typically use a probing energy form to determine material properties or to indicate the presence of material discontinuities (surface, internal, or concealed). See also *nondestructive evaluation*; *nondestructive examination*; *nondestructive inspection*.

O

optical leak testing: Leak testing method using optical means such as holographic laser interferometry. Optical leak testing is used, for example, on microelectronic and pharmaceutical packaging.

outgassing: Forms of gas coming from material in a vacuum system. Includes gases adsorbed on the surface, dissolved in material, trapped in pockets, and those due to evaporation.

overall integrated leakage rate: Total leakage through all paths including containment welds, valves, fittings, and components that penetrate a primary reactor containment system, expressed in weight percent of contained air mass per day.

P

partial pressure: Pressure a gas would exert if alone in a container.

parts per million (ppm): Concentration of a specific gas in another gas or gas mixture. For example, a tracer gas concentration might be 10 ppm in air or nitrogen. The more specific term $\mu\text{L/L}$ is preferred, to indicate proportion by volume.

penetrant: Liquid capable of entering discontinuities open to the test surface and adapted to the penetrant test process by being made highly visible in small traces. Fluorescent penetrants fluoresce brightly under ultraviolet light, and visible penetrants are intensely colored to be readily visible on developer backgrounds when illuminated with visible light.

penetrant leak testing: Technique of penetrant testing in which the penetrant is applied to one surface of a test material while the opposite surface is tested for indications that would identify a leak or void passing through the material thickness.

permeation: Passage of fluid into, through, and out of a solid barrier having no holes large enough to permit more than a small fraction of molecules to pass through any one hole.

pirani gauge: Bridge circuit that measures the effect of gas conductivity changes corresponding to pressure variations. Measures pressure from atmospheric down to 0.1 Pa (1 mtorr).

pressure differential: Difference in pressure between two sides of a pressure boundary.

pressure proof test: Test of system at pressure considerably above the allowable working pressure to demonstrate structural capability. See also *structural integrity test*.

pressure testing: Technique of leak testing objects pressurized with a tracer gas with the subsequent detection and location of any existing leaks with a sampling probe (a qualitative test). Tests performed by increasing the pressure inside a test boundary to a level greater than the surrounding atmosphere and detecting leakage by systematic examination of the outside of the test surface. Leaks are located at time of detection; however, it is impossible to accurately determine a total leakage rate for the object being pressure tested.

probability of detection (PoD): The probability of finding an anomaly of given characteristics, under precise conditions, while using a specific test procedure.

probe: In leak testing, the physical means for sensing a gaseous leak, typically a tube having a fine opening at one end, used for directing or collecting a stream of tracer gas. Detector probes are used for pressure testing and tracer probes are used for vacuum testing.

probe gas: Tracer gas that issues from a fine orifice in a tracer probe so as to impinge on a restricted (small) test area.

process control: Application of quality control principles to the management of a repeated process.

process testing: Initial product testing to establish correct manufacturing procedures, and then by periodic tests to ensure that the process continues to operate correctly.

proportioning probe: Probe that can vary the tracer gas concentration in the sample at the sensor, typically by mixing pure air with sample gas from the probe inlet port. Ratios of mixture between 100 percent pure air (obtained from an outdoors source or by filtering ambient air through charcoal) and 100 percent leak sample gas are attainable without great changes in total flow from the probe. The proportioning probe used in halogen leak testing lets the user operate in an atmosphere with up to 1000 $\mu\text{L/L}$ tracer gas background contamination. It proportions the amount of atmosphere allowed to enter the probe with its own (recirculating) fresh air supply.

pump, adsorption: Pump that creates a vacuum by collecting gas on the interior surfaces of the pump. Pressures of 2 Pa (20 μbar) are readily attained. The pump has a finite capacity but may be regenerated for additional use. See also *backstreaming*; *baffle*.

pump, cryogenic: Pump that condenses chamber gas on a cold surface of 4 to 80 K (–269 to –194 °C). Cooling is provided by liquid gas such as liquid helium or by refrigeration. See also *backstreaming*; *baffle*.

pump, diffusion: High vacuum pump with no moving mechanical parts that uses a vapor jet to sweep gas from the vacuum chamber and achieve pressures as low as 1 nPa (10 ptorr).

pump, displacement: Mechanical pump that physically sweeps gas out of a volume and creates a vacuum. Rotary piston and rotary vane pumps are two examples. A displacement pump can achieve pressures in the 0.1 to 1.0 Pa (10 to 1 mtorr) range. See also *backstreaming*; *baffle*.

pump, fore: Mechanical pump in a helium mass spectrometer that performs initial evacuation of a system to a pressure of 0.1 Pa and then accepts the exhaust from the high vacuum pump such as a diffusion pump. The forepump lowers pressure to less than 10 kPa into which the diffusion pump can exhaust its gas.

pump, ion: Pump that combines electric and magnetic fields to ionize gas and trap the gas inside the pump, thus removing it from the vacuum chamber. See also *ionization gauge*.

pump, mechanical: Mechanical device with pumping fluid and seals that physically removes a portion of the gas from a system with each revolution of the armature. A mechanical pump can pump a chamber down to about 0.1 Pa (0.75 mtorr). See also *gas ballast*; *roots blower*.

pump, sorption: Pump consisting of a sieve and liquid nitrogen with ability to pump to 0.1 Pa (1 mtorr).

pump, turbomolecular: Molecular turbine that drives gas out of a vacuum chamber, achieving a high vacuum pressure in the 10 nPa (0.1 ntorr) range.

pumping speed: Volumetric speed at which gas is transported, expressed in cubic meters per second.

pure air supply: In leak testing, air that has been cleaned of halogen contamination by means of an activated charcoal filter. This term is sometimes also used to describe any nonreactive gas, such as nitrogen, that contains no halogen contamination and to which the leak detector is not sensitive.

Q

qualification: Process of demonstrating that an individual has the required amount and the required type of training, experience, knowledge, and capabilities. See also *qualified*.

qualified: Having demonstrated the required amount and the required type of training, experience, knowledge, and abilities. See also *qualification*.

quality: Ability of a process or product to meet specifications or to meet the expectations of its users in terms of efficiency, appearance, longevity, and ergonomics.

quality assurance: Administrative actions that specify, enforce, and verify a quality program.

quality control: Physical and administrative actions required to ensure compliance with the quality assurance program. May include nondestructive testing in the manufacturing cycle.

R

radioactivity leak test: Leak test using radioactive tracer gas such as krypton-85, detected by its emission of radioactive decay products.

recommended practice: Set of guidelines or recommendations. Compare *code*; *standard*.

Recommended Practice SNT-TC-1A: Personnel Qualification and Certification in Nondestructive Testing: Set of guidelines for employers to establish and conduct a nondestructive testing personnel qualification and certification program. *SNT-TC-1A* was first issued in 1968 by the Society for Nondestructive Testing (SNT, now ASNT) and has been revised every few years since.

reference standard: (1) In NDT, an object containing known discontinuities and used to establish a baseline for comparison and standardization of nondestructive test inspection equipment. (2) Standard, generally having the highest metrological quality available at a given location or in a given organization, from which measurements made there are derived. Compare *working standard*.

relevant indication: See *indication, relevant*.

repeatability: Ability to reproduce a result. For example, a detectable indication, in separate processings and tests from a constant source.

response factor: Experimentally determined correction of a detector's measurement (that is, area under the curve) to account for its unique sensitivity to a given compound. In leak testing, it may be a halogen leak detector's response to 3×10^{-7} Pa·m³·s⁻¹ (3×10^{-6} std cm³/s) of tracer refrigerant, divided by the response to the same quantity of another tracer gas. Thus, the actual leakage rate of a detected leak will equal the indication of the detector multiplied by the response factor of the specific halogen tracer gas used. The response factor of a mixture of tracer and nontracer gases will be the response factor of the tracer divided by the fraction of tracer gas in the test gas (by volume).

response time: Time required for a leak detector signal to reach a specified value after a step input (O'Hanlon 1989). The signal reaches 63 percent of final value in one time constant.

reynolds number: Experimental number expressing the relative quantity of fluid flow and a means to predict the flow velocity at which turbulence will occur. Estimation is made based on the fluid's viscosity, density, and radius of the pathway. In general, a low reynolds number is associated with laminar flow, a moderate value is associated with transition flow, and a high reynolds number is associated with turbulent flow.

roots blower: Blower that uses two lobed rotors mounted on parallel shafts in conjunction with mechanical pumps to obtain greater pumping speeds and lower pressures. See also *pump, mechanical*.

rotameter: Meter that uses a float and a tapered glass bore to measure flow (O'Hanlon 1989).

S

sampling, partial: Testing of less than one hundred percent of a production lot.

sampling probe: See *detector probe*.

sampling, random partial: Partial sampling that is fully random.

sampling, specified partial: Partial sampling in which a particular frequency or sequence of sample selection is prescribed. An example of specified partial sampling is the testing of every fifth unit.

sensitivity: Ability of a sensor or system to distinguish a signal or indication from background noise. See also *probability of detection*.

SI (International System of Units): International measurement system in which the following seven units are basic: meter, mole, kilogram, second, ampere, kelvin, and candela.

signal: Physical quantity, such as voltage, that contains relevant information.

signal-to-noise ratio: Ratio of signal values (responses that contain relevant information) to baseline noise values (responses that contain nonrelevant information).

sniffer probe: See *detector probe*.

SNT-TC-1A: See *ASNT Recommended Practice No. SNT-TC-1A*.

soak time: In leak testing, the period of time between when the system or component reaches test pressure and either when the leak detector solution is applied to the surface or when the detector probe is used to scan that surface.

solution film: Thin continuous film of bubble solution used in bubble testing (O’Hanlon 1989).

specification: Set of instructions or standards invoked to govern the properties, results, or performance of a specific set of tasks or products. Compare *code*; *recommended practice*; *standard*.

spectrometer: Device used to characterize the emission spectrum of a source of electromagnetic radiation as counts per integration time, as relative irradiance, or as absolute irradiance versus wavelength or frequency. Compare *mass spectrometer*.

standard: (1) Physical object with known material characteristics used as a basis for comparison or calibration. In leak testing, a standard tracer leak may be used to facilitate tuneup and calibration of the leak detector or test system. (2) Concept established by authority, custom, or agreement to serve as a model or rule in the measurement of quantity or the establishment of a practice or procedure. (3) Document to control and govern practices in an industry or application, applied on a national or international basis and usually produced by consensus. See also *acceptance standard*; *working standard*; *reference standard*.

standard atmospheric pressure: At sea level, standard barometric pressure is taken as 101.325 kPa (14.6959 lb_f/in.²). It is also equal to the pressure exerted by a mercury column 760 mm (29.92 in.) high — that is, equal to 760 mm Hg (29.92 in. Hg) or 760 torr. Compare *gauge pressure*.

standard temperature and pressure: Atmospheric pressure of 101.325 kPa (14.6959 lb_f/in.²). Temperature of 0 °C (273 K or 32 °F). The density of dry air at these conditions is 0.12041 kg/m³ (0.07517 lb_f/ft³) at sea level. See also *standard atmospheric pressure*.

static testing: See *accumulation test technique*.

structural integrity test (SIT): Test that demonstrates the capability of a vessel to withstand specified internal pressure loads. See also *pressure proof test*.

surface tension: Characteristic of liquids where the outer surface contracts to the smallest possible area.

T

temperature: Measure of the intensity of particle motion in degrees celsius (°C) or degrees fahrenheit (°F) or, in the absolute scale, kelvin (K), where the increment of 1 K = 1 °C = 1.8 °F.

tesla coil: High voltage spark coil (several thousand volts), which identifies leaks in nonconductive vessels through ionization and avalanche multiplication (the townsend discharge).

thermal: Physical phenomenon of heat involving conduction, convection, or radiation.

thermal conductivity: Material property defining the relative ability to carry heat by conduction in a static temperature gradient. Conductivity varies slightly with temperature in solids and liquids, and with temperature and pressure in gases. It is high for metals (copper has a k of 380 W·m⁻¹·K⁻¹) and low for gases and porous materials (concrete has a k of 1.0 W·m⁻¹·K⁻¹).

thermal conductivity vacuum gauge: Instrument that operates on principle that, as gas molecules are removed from a system, the amount of heat transfer by conduction is reduced. This relationship is used to indicate absolute pressure.

thermal desorption: Release of gases or vapors from the interior wall of a vacuum system by heat (O’Hanlon 1989).

thermal equilibrium: Condition of an object wherein temperatures throughout the object remain constant.

thermistor: Temperature detector, usually a semiconductor, whose electrical resistance decreases predictably and nonlinearly with increasing temperature. The coefficient of electrical resistance with temperature is typically on the order of -4 percent K⁻¹. Compare *thermocouple*.

thermocouple: Device for measuring temperature based on the fact that opposite junctions between certain dissimilar metals develop an electrical potential when placed at different temperatures. Compare *thermistor*.

thermography: In infrared and thermal testing, technique that uses infrared radiation to seek discontinuities in materials, components, and structures. Thermography may be active (pulsed thermography or thermosonics) or passive (thermal wave imaging or infrared thermography).

throughput: Quantity of gas, or total number of molecules at a specific temperature, passing a section of a vacuum system per unit of time. See also *leakage rate; mass flow rate; volumetric flow rate*.

torr: Unit of absolute pressure defined as exactly 1/760 of a standard atmosphere, or exactly 101 325 760 pascals (~133.3 Pa). Historically, one torr was equivalent to one millimeter of mercury in a liquid column manometer.

tracer: In leak testing, a gas that is sensed by a specific leak detector as it escapes from confinement. Also called *search gas*.

tracer probe test: Localized leak test in which a tracer is introduced to portions of the external surface of an evacuated specimen by means of a probe, and simultaneously, a leak detector in line with the vacuum pump enables individual leaks to be located as they admit tracer.

transition flow: Phenomenon that occurs when the mean free path of gas is about equal to the cross sectional dimension of a leak or the tube through which flow is occurring. Compare *laminar flow; turbulent flow*.

trap: See *cold trap*.

turbulent flow: Chaotic flow with eddies, which is unlike a smooth laminar flow. Compare *transition flow*.

U

ultimate pressure: Lowest pressure that can be achieved in a vacuum chamber after cleaning and baking (O'Hanlon 1989).

ultrasonic: Pertaining to acoustic vibration frequencies greater than about 20 kHz.

ultrasonic leak test: Leak test that detects acoustic vibration frequencies approximately in the 40 kHz range, which are produced by gas flowing through the leak path.

ultraviolet radiation: Electromagnetic radiation with wavelengths between 40 and 400 nm. See also *near ultraviolet*.

UV: Ultraviolet.

V

vacuum: Space that is at a pressure below atmospheric pressure.

vacuum box: Device used to create a differential pressure over an isolated area of a weld or of a pressure boundary that cannot be directly pressurized.

vacuum box leak testing: Technique of bubble testing where a vacuum box is used to create a pressure differential across a boundary. A viewing window allows observation of bubble formation within the solution film.

vacuum grease: Substance commonly used to attain a seal and to lubricate devices such as stopcocks and motion feedthrough penetrations.

vacuum pressure testing: Leak testing procedure in which the test object containing a tracer is placed in an evacuated enclosure and the tracer gas is detected after entering the enclosure. Also called *bell jar testing*. Compare *vacuum testing*.

vacuum testing: Method of testing for leaks in which the object under test is evacuated and the tracer gas is applied to the outside surface of the test object. Compare *vacuum pressure testing*.

vapor: Gaseous form of, for instance, water or oil.

vapor pressure: Pressure exerted by the vapor of a liquid when in equilibrium in a closed system at the interface with a condensed phase (solid or liquid) at a specified temperature. These limiting pressures can restrict the levels of pressurization of enclosures with these tracer gases during pressure leak testing and can also limit the vacuum obtainable in presence of these liquids (for example, water or solvents).

vent: Valve in a vacuum system for letting air into a vacuum chamber.

verification test: Tests intended to confirm the capability of leak test technique and equipment to determine leakage rate.

virtual leak: Emission of gas in a vacuum system that results from condensable or trapped gases. They gradually evaporate from surfaces or escape from pockets, raising the absolute pressure in the same manner as a real leak.

viscosity: The resistance of a fluid to deformation by shear or tensile stress. Lower viscosity equates to greater fluidity.

viscous flow: Flow of gas or gas mixtures through a leak or duct under conditions such that the mean free path is smaller than the cross section of the leak or opening. Viscous flow may be either laminar or turbulent and is most likely to occur during leak tests at atmospheric or higher pressures. With vacuum conditions, the flow of tracer gases to the leak detector element is usually by diffusion, resulting in slow response to leaks being probed by a tracer jet.

visible light: Any radiant energy with a wavelength between 380 and 780 nm. Compare *white light*.

volumetric flow rate: Fluid speed expressed in cubic meters per second. Compare *mass flow rate*.

W

white light: Light combining all frequencies of light visible in the electromagnetic spectrum (wavelengths from 380 to 780 nm), in bands (called hues) of roughly equal proportions.

working standard: Standard that is lower in quality and cost than a reference standard against which it is calibrated and that is routinely used to calibrate or check material measures, measuring instruments, or reference materials. Compare *reference standard; standard*.