

13

Glossary

Section Outline	Page
13.1 GLOSSARY	2

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13.1 GLOSSARY

Absorption current: The current which is absorbed by the insulation during dielectric testing as changes are taking place in the molecular structure of the insulation materials. It lasts for a variable time, decaying to zero in a few seconds for small windings, or up to hours for large windings.

Acceleration: A measure of the amplitude of vibration. It is proportional to the amplitude measured in velocity times the frequency. It is also proportional to the amplitude measured in displacement times the frequency squared. The common unit in the US Customary and in the Metric system is “g” peak, (g pk). Acceleration is the rate of change of the velocity and 1 g pk is equivalent to the acceleration resulting from earth’s gravity.

Adjacent pole connection: See short jumper connection.

Aging: An irreversible change in properties of any material (such as lamination steel or insulation) that occurs over time and is accelerated by increases in temperature, applied voltage, or other stresses.

Air gap: An air space interrupting the path of flux within a magnetic structure; e.g., between the stator and rotor of a motor or generator.

Air-gap area: The total area around the bore of an induction machine; computed by multiplying the axial length of the bore by the circumference of the bore. For a DC machine, it is the area of the bore covered by the main poles.

Alternator: A synchronous machine used to convert mechanical power into alternating current electric power.

Aluminum bronze: Copper-base alloys with aluminum as the principal alloying element, normally in the range of 3 to 11%, with or without the additions of other elements.

Ambient temperature: The temperature of the surrounding cooling medium. Commonly known as room temperature when air is the cooling medium in contact with the equipment.

Amortisseur winding: Pole-face bar windings embedded in the cores of the field poles of synchronous machines; used to dampen rotor oscillations, and as a squirrel cage winding for starting synchronous motors. Also termed damper winding.

Anode: The positive pole of an electrode.

Armature: The portion of a rotating machine that carries the AC winding; the rotor of a DC motor or generator and the stator of an induction motor, synchronous motor, or alternator. Also, the movable magnetic structure of a relay or solenoid.

Armature reaction: In a DC machine current that flows through the armature produces a magnetic flux, in addition to that produced by the field current, which reduces the output capability and affects commutation.

AWG: American Wire Gauge.

B-stage: A condition during reaction of a thermosetting resin (e.g., epoxy) when it has converted to the solid stage but is not fully cured. It is flexible or brittle and capable of flow when heated.

Base line: A vibration reading taken when a machine is in good operating condition that is used as a reference for monitoring and analysis.

Black-band test: A test to assess the commutating ability of a DC machine. The interpole ampere turn strength is increased (boost) or decreased (buck) at various levels of load. The amount of boost or buck current required to initiate brush sparking is noted and the results plotted with respect to load. The area between the boost and buck curves is referred to as the “black band.” This information can be used to adjust brush position and interpole strength.

Brazing: A joining process wherein coalescence (growing together into one body) is produced by heating above 800°F (427°C) and by using a nonferrous filler metal having a melting point below that of the base metals. The filler is distributed by capillary action.

Breakdown torque: The maximum torque that an AC motor will develop with rated voltage applied at rated frequency without an abrupt drop in speed. Also termed pull-out torque or maximum torque.

Brinell hardness: A measure of resistance to indentation. It is obtained by applying a load through a ball indenter and measuring the permanent impression in the material. The hardness value is obtained by dividing the applied load in kilograms by the spherical area of the impression in square millimeters. In testing aluminum alloys, a load of 500 kilograms is applied to a ball 10 millimeters in diameter for 30 seconds. This test is seldom used on copper and copper-base alloys.

Brush potential test: A test to characterize the commutation curve of a DC machine by measuring the voltage drop between the brush and revolving commutator at points along the brush face and adjacent to the brush on the commutator.

Buck and boost test: See black-band test.

Capacitance current: During dielectric testing, capacitance current is caused by the capacitance to ground of the insulation system. This current decays to zero much more rapidly than the absorption current.

Cathode: The negative pole of an electrode.

Chord factor: Ratio of the resultant voltage induced in a coil to the arithmetic sum of the magnitudes of the voltage induced in the two coil sides.

Chorded winding: A winding with a span that is not full pitch. The chord factor is less than 1.0.

Circuits: The paths the intended current can flow through. For an AC machine the paths are from one end of a phase to the other end.

Circular mil: The area of a circle one mil (.001") in diameter. The circular mil area of a round wire is found by squaring its diameter in mils.

Circular mil area: The cross-sectional area of wire, expressed in units of circular mils.

Code letter: A letter which appears on the nameplates of AC motors to show their locked-rotor kilovolt-amperes per horsepower at rated voltage and frequency.

Coefficient of thermal expansion: The linear expansion (or contraction) per unit length per degree of temperature between specified lower and upper temperatures.

Cogging: Non-uniform angular velocity (rotation) occurring in jerks or increments rather than smooth motion due to torque variation. The fewer the number of coils in a DC armature, the more noticeable it can be at low speeds. Cogging can occur in induction machines at very low speeds, the cause being variations in the magnetic flux due to alignment of the rotor and stator teeth at various positions of the rotor.

Coil group: A group of series connected coils that make up one pole of a phase winding.

Coil pitch: The slots in which two sides of a coil lie. Usually expressed as 1- __ (number of the slot with the other side of the coil). For example, a coil in slots 1 and 9 would have a pitch of 1-9.

Coil span: Specifically, the number of teeth spanned by a coil. Thus a coil with a pitch of 1-9 would span 8 teeth.

Coil throw: See coil pitch.

Cold forming (working): The process of changing the form or cross-section of a piece of metal at a temperature below the softening or recrystallization point, but commonly at or about room temperature. It results in increased hardness and improved strength. Cold worked metal may be brought back to the original state or workability by proper annealing.

Cold rolling: The process of passing metal between rolls under pressure, below the softening point of the metal, to reduce its cross-section.

Commutating pole: See interpole.

Commutation: The reversal of current in the armature coils of a DC machine as they are repeatedly short-circuited at the commutator by the brushes.

Compensating winding: A winding embedded in the faces of DC machine main poles that is connected in series with the interpoles; also called a pole-face winding. It counteracts the demagnetizing effects of armature reaction and assists the interpoles in commutating the armature coils.

Concentric winding: A winding in which coils of a group have a common center and each coil in a group has a different span. For AC machines, the group polarities are often, though not always, arranged in a consequent pole pattern.

Conductor: Any material that will transmit electric current readily, such as a wire or cable, busbar, liquid electrolyte, etc.

Consequent pole: A winding in which the polarity of all the coil groups are alike.

Constant horsepower motor: A term used to describe a multispeed motor in which the rated horsepower is the same for all operating speeds. When applied to a solid-state drive unit it refers to the ability to deliver constant horsepower over a predetermined speed range.

Constant torque motor: A multispeed motor for which the rated horsepower varies in direct ratio to the synchronous speeds. The output torque is essentially the same at all speeds.

Core loss: That portion of the electrical losses in a machine caused by the magnetization of the core iron.

Core test: A loop test of a magnetic core in which the watts loss is measured. Often performed before and after winding stripping as a means of verifying that core quality has been maintained.

Corona: See partial discharge.

Corrosion: Corrosion is electrochemical in nature. Common steel will corrode and form rust when it is exposed to moisture. Other metals will corrode in varying degrees upon contact with dissimilar metals under conditions that encourage such disintegration.

Cos ϕ (cosine phi): International expression for power factor; see power factor.

Counter electromotive force: The effective electromotive force within a system that opposes the passage of current in a specified direction. Also, the induced voltage in a motor armature, caused by conductors moving through or “cutting” field magnetic flux. This induced voltage opposes armature applied voltage.

Couple unbalance: That condition of weight distribution of a rotating mass which causes the principal inertia axis to intersect the rotating centerline at the center of gravity of the mass. Such a condition is caused by a heavy spot on each end of the rotating mass, but on opposite sides of the centerline, so as to produce two forces acting in opposite directions on opposite ends of the mass.

Critical speed: The speed of a rotating element at which resonance (natural frequency) occurs. It can destroy the rotating mass as the uncontrolled vibration level increases. See also resonance and natural frequency.

Cross connection: See equalizer.

CSI: See current source inverter.

CT: See current transformer.

Current source inverter: A variable (adjustable) frequency drive which controls the current output to an AC motor. The output switching devices are switched at the desired frequency to vary the motor speed.

Current transformer: An instrument transformer with the primary connected to, or sensing, line current. It steps down line current in a specific ratio and normally has a secondary rating of 5 amperes regardless of the primary current rating.

Dahlander connection: European term for a two-speed, single-winding, consequent-pole connection.

Damper winding: See amortisseur winding.

Delta connection: A three-phase winding connection in which the phases are connected in series to form a closed circuit.

Density (mass): The ratio of the mass of a homogeneous portion of matter to its volume.

Design: NEMA design letters A, B, C and D define certain starting and running characteristics of three-phase squirrel cage induction motors. These characteristics include locked-rotor torque, locked-rotor current, pull-up torque, breakdown torque, slip at rated load, and the ability to withstand full voltage starting.

Die-cast rotor winding: A squirrel cage rotor winding manufactured by placing the laminated core in a die. Molten aluminum alloy is then cast under pressure through the die and core slots to form the rotor bars and end rings.

Dielectric strength: Ability to prevent significant current conduction; a measure of insulation quality, expressed as a breakdown value in volts per mil. Values are time- and thickness-dependent.

Displacement: A measure of amplitude of vibration. It is proportional to the amplitude measured in velocity divided by the frequency. It is also proportional to the amplitude measured in acceleration divided by frequency squared. The common unit in the US Customary system is mils peak to peak, (mils pk-pk), where one mil is equal to one thousandth of an inch, (0.001”). Common units in the metric system are millimeters (mm), and micro-meters (μm).

Dissipation factor: Ratio of energy dissipated in watts to quantity of energy stored in insulation. Also called $\tan(\delta)$ or power factor.

Distribution factor: The ratio of the resultant voltage induced in a series-connected group of coils to the arithmetic sum of the magnitudes of the voltages induced in the coils.

Drawing (drawn): The process of pulling flat products, rod, wire, tube, and shapes through a die. This reduces the size or changes the shape of the cross-section and hardens the metal.

Duplex winding: In a DC machine armature, a duplex consists of two separate windings that are insulated from each other. For a duplex lap winding, the coil end connections are two commutator bars apart—i.e., commutator pitch is 1 - 3.

Duty: A continuous or short-time rating of a machine. Continuous-duty machines reach an equilibrium temperature within the temperature limits of the insulation system. Machines which do not, or cannot, reach an equilibrium temperature have a short-time or intermittent-duty rating. Short-time ratings are usually one hour or less for motors.

Dynamic braking: Using a DC motor as a generator, taking it off the supply line and applying an energy dissipating resistor to the armature circuit. Dynamic braking of an AC motor may be done by disconnecting the motor from the line and applying DC to the stator winding.

Dynamic unbalance: For a rotating mass the general term used to describe static unbalance, couple unbalance, or the combination of both static and couple unbalance.

Eddy current: Localized currents induced in an iron core or electrical conductor by variation of magnetic flux. These currents translate into losses which can be reduced by using laminations for cores or multiple strands for conductors. The thinner the lamination or strand, the lower the eddy current loss.

Efficiency: The ratio between useful work performed and the energy expended in producing it. It is the ratio of output power divided by the input power.

Elastic limit: The maximum unit stress to which metal can be put without permanent deformation.

Elongation: The permanent extension of a specimen that has been stretched to rupture in a tension test.

Equalizer: Jumper connections commonly used in lap-wound DC armatures to join winding points that are 360 electrical degrees apart. For a 4 pole armature, these points are diametrically opposite (180 mechanical degrees). Their functions are to reduce circulating currents and equalize the flux under all the poles. Equalizers are also used in slow-speed AC motor windings to connect points of equal potential in different parallel circuits.

Even grouping: A winding in which the coil groups each have the same number of coils.

Extrusion: The pushing of metal, usually at high temperature, through a die to form various shapes.

Fabricated rotor winding: A squirrel cage rotor winding manufactured by installing preformed bars in the rotor slots and welding or brazing them to preformed end rings. The bars and end rings may be copper, aluminum, or alloys of these metals.

Fatigue: The tendency for a metal to fail structurally due to repeated cyclic stress at considerably less than its yield strength.

Field weakening: The reduction of voltage, and therefore current, to a DC motor shunt field to obtain speeds above the base speed. The motor horsepower is usually held constant in the field weakened speed range.

Flux (magnetic): See magnetic flux.

Foot-pound: The amount of work, in the English system, required to raise a one pound weight a distance of one foot.

Form-wound coil: A coil made with rectangular or square wire, usually covered with insulation such that it is essentially self-supporting. It is formed into the required shape prior to insertion into a machine.

Free-machining (free-cutting): The quality of an alloy that enables it to be cut in automatic machines at relatively high speeds yielding short, brittle chips. The standard of 100% machinability is considered to be Free-Cutting Brass (UNS C36000).

Frequency: The number of cycles in a time period (usually one second). Alternating current frequency is expressed in cycles per second, termed Hertz (Hz).

Full-load current: The current required for any electrical machine to produce its rated output or perform its rated function.

Full-load speed: The speed at which any rotating machine produces its rated output.

Full-load torque: The torque required to produce rated power at full-load speed.

Fungus proof: The application of coating to a winding to protect it from fungus and mold; commonly used on windings subjected to a tropical environment.

Generator: A rotating machine that converts mechanical power into electrical power. The electrical power may be either alternating current or direct current.

Hardness: The resistance of metal to plastic deformation by indentation. See Brinell, Rockwell, and Scleroscope Hardness Tests.

Harmonic: A multiple of the fundamental electrical frequency. Harmonics are present whenever the electrical power waveforms (voltage and current) are not pure sine waves.

Hermetic motor: A motor sealed from the environment and cooled with a refrigerant.

Hertz (Hz): The preferred terminology for cycles per second (frequency).

High-potential test: A test which consists of the application of high voltage between windings and metal enclosure, core, supporting conductive structure, or other windings. It is applied for a specified time to determine the adequacy against breakdown of the insulating materials and spacings under normal conditions.

Horsepower: A unit for measuring the power of motors or the rate of doing work. One horsepower equals 33,000 foot-pounds of work per minute (550 ft-lbs per second) or 746 watts.

Hot forging: The shaping of any metal, while hot, by the blow of a hammer.

Hot spot: The hottest winding spot reached during rated operation of a machine.

Hot working: The process of changing the form or cross-section of a piece of metal at an elevated temperature.

Hydrostatic test: A test that uses internal water pressure to prove the soundness and resistance to leakage of any vessel.

Hysteresis: The resistance offered by materials to becoming magnetized, resulting in energy being expended, with corresponding loss. Hysteresis loss in a magnetic circuit is the energy expended to magnetize and demagnetize the iron core.

Hz: See Hertz.

IACS: International Annealed Copper Standard. It is the internationally accepted value for the resistivity of annealed copper of 100% conductivity.

IEC: International Electrotechnical Commission.

IEEE: Institute of Electrical and Electronics Engineers.

IGBT: See insulated gate bipolar transistor.

Induction generator: An induction machine which, when driven above synchronous speed by an external source of mechanical power, is used to convert mechanical power to electric power.

Inrush current: The instantaneous current drawn by an electric machine at the moment the winding is energized. For an AC motor or transformer this can be much higher than any of the currents experienced during operation.

Insulated gate bipolar transistor: A high power capacity, very fast switching, semiconductor device commonly used with pulse-width modulated inverters.

Insulation: Non-conducting materials separating the current carrying parts of an electric machine from each other or from adjacent conducting material at a different potential.

Insulation class: A letter or number that designates the temperature rating of an insulation material or system with respect to thermal endurance.

Interpole: A narrow pole centered on the neutral axis of a DC machine, the winding of which is connected in series with the armature circuit, and which provides a neutralizing effect to aid commutation.

Inverter: A device that converts power from a DC source to AC power at a specified voltage and frequency. The term “inverter” is commonly associated with electronic drives that rectify AC line power into DC, then invert the DC into AC power with variable frequency and voltage.

Kilowatt: A unit of electrical power. Also, the output rating of motors manufactured and used off the North American continent.

Lap winding: A winding in which the coils lay over each other, have the same slot pitch and no common center; that is, they are not concentric. In a DC machine armature, the coil ends are connected to adjacent bars (if simplex) of the commutator.

Leading edge (of a brush): The edge of the brush first met by the commutator bars as they pass under the brush.

Leakage current: During dielectric testing, the current flowing through the insulation as a result of the applied test voltage. In an AC test of insulation, it is the element of the total current that is in phase with the test voltage. In a DC test of insulation, it is the value of steady-state current after the capacitive and absorptive currents have decayed to negligible values.

Locked-rotor current: Steady-state current taken from the line with the rotor of a motor at standstill and at rated voltage and frequency.

Locked-rotor torque: The minimum torque that a motor will develop at standstill for all angular positions of the rotor, with rated voltage applied at rated frequency.

Long jumper connection: A method of internally connecting AC rotating machine coil groups of a phase in series in which every other group is bypassed. Also referred to as “1-7 jumper” or skip-pole connection.

Loop test: A test to detect hot spots due to shorted laminations whereby turns are looped through a core and then energized to induce flux in the core.

Magnetic flux: The magnetic field that is established around an energized conductor or permanent magnet; it is represented by flux lines creating a flux pattern between opposite poles. The density of flux lines is a measure of the strength of the magnetic field.

Maximum torque: See breakdown torque.

Megohmmeter: An instrument for measuring insulation resistance.

Mill finish: Metal sheet material with an uncontrolled finish that may vary from sheet to sheet and within a sheet and that may not be entirely free from stains or oil.

Monomer: A relatively simple compound (usually a liquid) that can react to form a polymer (usually a solid).

Motor: A rotating machine that converts electrical power (either alternating current or direct current) into mechanical power.

Multiplex windings: In a DC machine armature, the multiplex indicates the number of separate windings that are insulated from each other. The most common multiplex windings are duplex (two separate windings) and occasionally triplex (three separate windings).

Multispeed motor: A motor that can be operated at any one of two or more definite speeds, each being practically independent of load (e.g., an induction motor with windings capable of various pole groupings).

Mush-wound coil: See random-wound coil.

Natural frequency: The vibration frequency at which resonance occurs. It is due to the nature (essentially the physical shape and type of material) of a mass or structure. See also resonance and critical speed.

NEC: National Electrical Code.

NEMA: National Electrical Manufacturers Association.

Neutral axis: The mechanical axis, or line, exactly halfway between the adjacent main field pole axes.

Newton-Meter: Unit of torque, in the metric system, that is a force of one newton, applied at a radius of one meter and in a direction perpendicular to the radius arm.

Odd grouping: A winding in which the coil groups do not each have the same number of coils.

Open slot: Any slot in a core that is not completely encircled by core material. Commonly used to refer to a core slot with a wide opening at the air gap to accept a form-wound coil.

Overcommutation: Commutation in which the current changes direction too rapidly, evidenced by sparking at the leading edge of a brush. It can be caused by interpoles that are too strong magnetically.

Overload: Operating a machine at a higher power or current rating than that for which it was designed.

PAM winding: Pole-amplitude modulation of a winding (connection) to produce two operating speeds with a ratio of other than 2:1.

Part-winding starting: A part-winding start three-phase motor is one arranged for starting by first energizing part of its primary winding and, subsequently, energizing the remainder of the primary winding. The leads are normally numbered 1,2,3 (starting) and 7,8,9 (remaining).

Partial discharge: An electrical discharge that only partially bridges the insulation between conductors. Partial discharges can originate at either conductor or within voids or cavities in the insulating material.

Pattern (coil groups): Repeatable manner in which coil groups are inserted in a winding with odd grouping.

Peripheral speed: The speed at which a point on the outside diameter of a rotating part is moving.

Phantom pole: See consequent pole.

Phase voltage: The electric potential difference across one phase in a polyphase electrical system. In a three-phase machine, phase voltage equals line voltage for a delta connection and 58 percent of line voltage for a wye connection.

Pin fire sparking: For a commutator to brush interface, pin fire or pin point sparking is the point where sparking first occurs on one or more brushes. Such sparking may be destructive, and may not be visible if it occurs under (but away from the edges) of the brushes.

Plastic deformation: Permanent change in material dimensions as a result of stress exceeding yield strength.

Plug reversal: See reversing motor.

Plug stopping: Reconnecting a motor's windings so as to reverse its rotation while it is running, to effect dynamic braking. Plug stopping is a severe braking method that should be used with caution.

Pole-amplitude modulation: See PAM winding.

Pole-face winding: See compensating winding and amortisseur winding.

Poles: The magnetic poles set up inside an electric machine by the placement and connection of the windings.

Potential transformer: An instrument transformer with the primary connected directly to the line to measure voltage. It steps down line voltage in a specific ratio and normally has a secondary rating of 120 volts for primary voltage ratings up to kilovolts.

Pound-foot: Unit of torque, in the English system, that is a force of one pound, applied at a radius of one foot and in a direction perpendicular to the radius arm.

Power factor: The ratio of watts to volt-amperes of an AC electric circuit.

Primary winding: The winding of an electric machine which is connected to, or is, the power source.

Progressive connection: A DC armature coil to commutator connection in which the leads do not cross over each other at the commutator if the winding is lap. If the connection is made retrogressive, the armature polarity is reversed.

PT: See potential transformer.

Pull-in torque: The maximum constant torque under which a synchronous motor will pull its connected inertial load into synchronism at rated voltage and frequency when its normal field excitation is applied.

Pull-out torque: The maximum sustained torque that a synchronous motor will develop at synchronous speed with rated voltage applied at rated frequency and with normal excitation. For an induction machine, it is another term for breakdown torque.

Pull-up torque: The minimum external torque developed by an AC motor during the period of acceleration from rest to the speed at which breakdown torque occurs with rated voltage and frequency applied. For motors without a definite breakdown torque, pull-up is the minimum torque developed up to rated speed.

Pulse-width modulation: A method used in variable-speed drives to control the speed of an AC motor. The amplitude or voltage of the pulses to the motor remains essentially constant, but the amount of energy supplied is controlled by varying the width or duration of the pulses.

PWM: See pulse-width modulation.

Radius factor: The amount by which the cross-sectional area of rectangular or square wire is reduced due to the rounding of the corners.

Random-wound coil: A coil in which the individual conductors (usually round wire) of a coil side occupy random positions in the slot.

Rated temperature rise: The permissible rise in temperature above ambient for an electric machine operating under load.

Regeneration: The characteristic of a motor to act as a generator when driven above its normal operating speed by an overhauling load. It is a form of dynamic braking in which the kinetic energy of the motor and driven load is returned to the power system.

Regenerative braking: See regeneration.

Regulation (voltage, speed): The amount of change in voltage or speed resulting from a load change, usually taken from no-load to rated load and the result expressed in percentage of the rated load value.

Residual magnetism: The magnetic field that remains in a magnetic material (e.g., a winding core) after the removal of electric power or the magnetizing force.

Residual stresses: Stresses that are set up within a metal as a result of deformation; caused by cold working or drastic temperature gradients.

Resistance temperature detector (RTD): A device used for temperature sensing consisting of a wire coil or deposited film of pure metal for which the change in resistance is a known function of temperature. The most common type is nickel, with other types being copper, platinum, and nickel-iron.

Resonance: The amplification of the vibration level of a mass or structure at its natural frequency, caused by excitation from an external source. For a rotating mass, this occurs at the critical speed.

Retrogressive connection: A DC armature coil to commutator connection in which the leads cross over each other at the commutator if the winding is lap. If the connection is made progressive, the armature polarity is reversed.

Reversible motor: A motor that is capable of operating in either direction of rotation when started from rest.

Reversing motor: A motor capable of being reversed, even when running at normal speed, by changing electric connections (plug reversal).

Ripple: The AC component of DC power from either an electronic rectifier or rotating generator and arising from sources within the power supply. It is not sinusoidal but consists of the fundamental frequency and an infinite number of harmonics.

Rockwell hardness: A test to measure hardness by determining the depth of penetration into a specimen of a penetrant under predetermined conditions.

Rolling: The process of passing metal between rolls under pressure to reduce its cross-section.

Rotor: The rotating element of any motor or generator.

RPM (or rpm): Revolutions per minute.

RTD: See resistance temperature detector.

Salient pole: That type of field pole which projects toward the armature. Commonly the main poles of a DC machine or the rotating DC field poles of a synchronous machine.

Salient-pole winding: An AC winding in which the polarity of the coil groups alternate.

Scleroscope test: A test to determine the hardness of a metal by dropping a small, standard object onto the surface of a specimen from a fixed height and measuring its rebound.

Season cracking: Spontaneous failure of some metals by cracking under the combined action of corrosion and residual stresses over time.

Secondary winding: The winding of an electric machine which is not connected to the power source, but which carries current (and voltage) induced in it via its magnetic linkage with the primary winding.

Section (winding): The number of coil groups in a winding before the pattern repeats.

Service factor: A multiplier which, when applied to rated power, indicates a permissible power loading that may be carried under the conditions specified for the service factor.

Shaft currents: A circulating current in a rotating machine that can damage bearings. In an electrical machine, the origin may be dissymmetries in the magnetic paths through the stator/field frame and rotor/armature iron.

Shear strength: The maximum shearing stress that a material can develop. In practice, it is considered to be the maximum average stress computed by dividing the ultimate load in the plane of shear by the original area that is subject to shear.

Shore: A measurement of hardness (Durometer) of soft materials. Scale A (soft) and Scale D (hard) are used for specifying hardness of materials such as urethane and rubber.

Short jumper connection: An internal connection of an AC rotating machine winding whereby adjacent poles of a given phase are connected in series. Also referred to as “1-4 jumper” or adjacent-pole connection.

Simplex winding: In a DC machine armature, a simplex is a single winding. A simplex wave winding has two circuits, and a simplex lap winding has as many circuits as poles.

Skein winding: A winding with coils produced by a skein of wires.

Skew: The arrangement of laminations in a rotating machine core to provide a slight diagonal pattern of the slots with respect to the shaft axis. This pattern reduces low-speed cogging effects in armatures and induced vibration in rotors.

Skip pole: See long jumper connection.

Slip: The difference between synchronous and operating speeds, compared to synchronous speed, expressed as a percentage. Also the difference between synchronous and operating speeds, expressed in rpm.

Soldering: Joining metals by fusion of alloys that have relatively low melting points (below 800°F or 427°C), usually lead-base or tin-base alloys.

Space factor: The ratio of the winding space occupied by the bare wire of an insulated conductor to the winding space available. In general, a higher space factor indicates the winding has lower power losses and higher thermal conductivity.

Space heater: An electrically powered device in an electrical machine enclosure which keeps the internal air above the dew point, primarily to prevent condensation from forming on winding insulation.

Specific gravity: The weight of a material divided by the weight of an equal volume of water.

Stabilizing field: A weak cumulative series field in a DC machine, providing enough strength to counteract armature reaction. The machine maintains a shunt characteristic; thus it is termed a “stabilized shunt motor” or “stabilized shunt generator.”

Star connection: See wye connection.

Star-delta starting: See wye-delta starting.

Starting torque: The torque produced by a motor at rest when power is applied. For an AC machine this is the locked-rotor torque.

Static unbalance: That condition of weight distribution of a rotating mass where the center of gravity does not lie on the rotating centerline of the mass.

Stator: The stationary part of a rotating electric machine. Commonly used to describe the stationary part of an AC machine that contains the primary windings.

Strands: The individual wires that make up a conductor—e.g., 5 #14 means 5 strands of #14 wire.

Strain: Deformation caused by stress.

Stress: The intensity of force within a body that resists a change in shape. It is measured in pounds per square inch or kilograms per square meter.

Submersible motor: One so constructed that it will operate successfully when submerged in water under specified conditions of pressure and time.

Surge arrester: A protective device that passes surge voltage above a certain value harmlessly to ground and has continuous insulation for normal voltage to ground.

Surge capacitor: A protective device that reduces the voltage wavefront steepness of a surge by absorbing energy from the surge impulse such that its rise time is extended to a safe value.

Surge suppressor: A protective device which “clips” (limits) voltage transients to a designed level. Common types of protectors are metal oxide variable resistors (MOVs) and resistance-capacitance circuits (RC).

SWG: Standard Wire Gauge (British).

Synchronous speed: The speed of the rotating magnetic field created by the primary winding of a rotating electric machine. When the speed of the rotating element matches the speed of the magnetic field, it is said to be rotating at synchronous speed.

$$\text{Synchronous speed} = \frac{\text{Frequency} \times 120}{\text{Number of Poles}}$$

T-frame: Suffix to frame numbers of rotating machines built to NEMA standards after the mid-1960s.

Tan(gent) delta: See dissipation factor.

Temperature rise: The increase in temperature, above ambient, of a winding or other part of an electrical machine.

Tensile strength: The value obtained by dividing the maximum load observed during tensile straining by the specimen cross-sectional area before straining.

Thermal aging: A thermal stress, usually associated with insulating materials, that describes the deterioration of the materials due to exposure to high temperatures. Insulation breakdown is accelerated when the insulating materials are exposed to above rated temperature for prolonged periods.

Thermal conductivity: The capability of conducting heat; measured by the quantity of heat that passes in unit time through a unit area of plate whose thickness is unity, when its opposite faces differ in temperature by one degree.

Thermal protector: A protective device for assembly as an integral part of the machine, which, when properly applied, protects the machine against dangerous overheating due to overload, and in a motor, failure to start.

Thermistor: A resistive device used for temperature sensing that is composed of metal oxides formed into a bead and encapsulated in epoxy or glass. A typical thermistor has a positive temperature coefficient; that is, resistance increases dramatically and non-linearly with temperature. Though less common, there are negative temperature coefficient thermistors.

Thermocouple: A junction of two dissimilar metals which generates a minute voltage in proportion to temperature. Such devices may be used for temperature detection and thermal protection.

Tolerance: The amount by which any characteristic may vary from that specified.

Torque: The rotating force produced by a motor. The units of torque may be expressed as pound-foot, pound-inch (English system), or newton-meter (metric system).

Tracking: Irreversible degradation of insulation material due to the passage of leakage current over the end turns of a winding as a result of surface contamination and/or carbonization.

Trailing edge (of a brush): The edge of the brush where the commutator bars exit as they pass under the brush.

Trending: Analysis of the change in measured data over at least three data measurement intervals.

U-frame: Suffix to frame numbers of rotating machines built to NEMA standards between the mid-1950s and the mid-1960s.

Unbalanced magnetic pull: Radial magnetic pull of the rotor of a rotating electric machine due to unequal magnetic attraction all the way around the periphery of the rotor. Common causes are shorted or open windings, shorted laminations, and unequal air gap.

Undercommutation: Commutation in which the current changes direction too slowly, evidenced by sparking at the trailing edge of a brush. It can be caused by interpoles that are too weak magnetically.

Variable-torque motor: A multispeed motor in which the rated horsepower varies as the square of the synchronous speeds.

Velocity: A measure of the amplitude of vibration. It is proportional to the amplitude measured in displacement times the frequency. It is also proportional to the amplitude measured in acceleration divided by the frequency. The common unit in the US Customary system is inches/second peak (in/sec pk). The common metric units are millimeters/second peak (mm/sec pk), and millimeters/second rms (mm/sec rms).

Volts per coil: The voltage stress across a single coil of a winding.

Volts per turn: The voltage stress across one turn of a coil.

Wave winding: A series style winding used mostly for DC machine armatures and AC machine wound rotors. It often has more than one coil per winding slot. In a DC machine armature, the coil ends are connected to commutator bars that are two pole pitches apart.

Welding: The process of producing localized coalescence (growing together into one body) of metal by heating to suitable temperatures, with or without the application of pressure, and with or without the use of filler (above 800°F or 427°C melting point) material.

Wet winding: Process by which liquid is applied by brush or other means between the individual layers of insulation at the time of winding.

Work hardness: Condition of hardness and strength developed in metal as a result of plastic deformation or cold working.

Wye connection: A three-phase winding connection formed by joining one end of each phase to make a “Y” point. The other ends of each phase are connected to the line. Also termed a star connection.

Wye-delta starting: Wye-delta is a connection which is used to reduce inrush current and torque of a three-phase motor. A wye (star) start, delta run motor is one arranged for starting by connecting to the line with the winding initially connected wye (star). The winding is then reconnected to run in delta after a predetermined time. The lead numbers for a single run voltage are normally 1,2,3,4,5 and 6.

Yield strength: In many materials a point reached on the stress-strain diagram at which there is a marked increase in strain or elongation without an increase in stress or load. The point at which this occurs is termed the yield point. It is usually quite noticeable in ductile materials but may be scarcely perceptible or possibly not present at all in certain hard-drawn materials such as hard-drawn copper.

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