

**ABSOLUTE LOSSES:** Production deferred or lost due to the specified element or system, as a percentage of the total potential production.

**AC MOTORS:** A Motor operating on AC current that flows in either direction (AC current). There are two general types: Induction, and Synchronous.

**ACCELERATION:** An expression of maximum theoretical acceleration from stall (locked rotor) of an unloaded motor with maximum current ( $I_m$ ) applied, measured in  $\text{rad}/\text{sec}^2$ .

**ACCELEROMETER:** Transducer or pickup that measures acceleration.

**ACOUSTIC EMISSION ANALYSIS:** Like vibration analysis, patterns of acoustic emission spectra are monitored and diagnosed. Acoustic emission analysis technology is applied to study bearing faults, detect flaws and cracks in welding and pipe-work, and to study de-lamination, de-bonding, and fracture in aerospace materials.

**ACTIVE IRON:** The amount of steel (iron) in the stator and rotor of a motor. Usually the amount of active iron is increased or decreased by lengthening or shortening the rotor and stator (they are generally the same length).

**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:** The space between the rotating (rotor) and stationary (stator) member in an electric motor.

**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.

**AIR PRESSURE SWITCH:** Used on motors with blowers to measure the difference in pressure across the filter so as to detect a clogged filter.

**AIR TEMPERATURE SWITCH:** A device used in air hooded motors to detect the temperature of the exhausted air. When used in this manner an air temperature switch will detect blockage in the cooling air system or long-term motor overload.

**AIR-OVER:** Motors for fan or blower service and cooled by the air stream from the fan or blower.

**ALIGNMENT (Precision):** Refers to bringing or placing machine(s) shaft(s) in line. Misaligned shafts often cause problems with machine components (i.e. bearings). Specialized tools and personnel for precision alignment exist. A number of tools are based on laser technologies.

**ALTERNATING CURRENT:** an electrical current which reverses direction repeatedly due to a change in

voltage which occurs at the same frequency. Often abbreviated AC or ac.

**ALTERNATOR:** an electric generator designed to produce alternating current. Usually consists of rotating parts which created the changing magnetic field to produce the alternating current.

**ALTERNATING CURRENT:** Abbreviation AC The commonly available electric power supplied, an AC generator and is distributed in single or three-phase forms. AC current changes its direction of flow (cycles).

**ALTITUDE:** The atmospheric altitude (height above sea level) at which the motor will be operating; NEMA standards call for an altitude not exceeding 3,300 ft. (1,000 meters). As the altitude increases above 3,300 ft. and the air density decreases, the air stability to cool the motor decreases - for higher altitudes higher grades of insulation or a motor de-rating are required. DC motors require special brushes for high altitudes.

**ALUMINUM BRONZE:** copper-based 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.

**AMBIENT:** The temperature of the space around the motor. Most motors are designed to operate in an ambient not over 40 °C

**AMERICAN NATIONAL STANDARDS INSTITUTE:** a private organization that coordinates and/or approves some US standards, particularly those related to the electrical industry. Abbreviated ANSI.

**AMERICAN WIRE GAUGE:** A standard measure which represents the size of wire. The larger the number, the smaller the wire. Abbreviated AWG.

**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.

**AMPACITY:** the maximum continuous current that a conductor can carry without overheating above its temperature rating.

**AMPERE:** electric current produced by one volt applied across a resistance of one ohm. It is also equal to the flow of one coulomb per second.

**AMPERE-HOUR:** the flow of electricity equal to one ampere for one hour. Commonly used to rate the capacity of batteries.

**AMPLITUDE:** The extreme range of a signal, either fluctuating (AC) or static (DC).

**ANALOG:** a measuring or display methodology which uses continuously varying physical parameters. In contrast, digital represents information in discrete binary form using only zeros and ones.

**ANALYSIS:** (1) A step-by-step process of determining the solution to a problem. (2) The collection, viewing, and examination of data and information. (3) The process of determining the composition of a substance or material using chemical or physical methods.

**ANODE:** The positive pole of an electrode.

**ANTI-FRICTION BEARING:** An anti-friction bearing is a bearing utilizing rolling elements between the stationary and rotating assemblies.

**APPARENT POWER:** the mathematical product of voltage and current on ac systems. Since voltage and current may not be in phase on ac systems, the apparent power thus calculated may not equal the real power, but may actually exceed it. Reactive loads (inductance and/or capacitance) on ac systems will cause the apparent power to be larger than the real power.

**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 CURRENT, AMPS:** Rated full load armature circuit current.

**ARMATURE INDUCTANCE:** The apparent inductance of the armature as seen by the brushes.

**ARMATURE INDUCTANCE, MH:** Armature inductance in milli-henries (saturated).

**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 capacity and affects commutation.

**ARMATURE RESISTANCE:** The resistance of the armature winding, commutator connections and the commutator measured on the commutator bars normally spanned by a pair of opposite polarity brushes. It does not include the brush film. The resistance is usually taken at room temperature (25 °C).

**ARMATURE:** The rotating portion of the magnetic structure that is found in machines with commutators.

**AUTONOMOUS MAINTENANCE:** Operators in independent groups carry out routine maintenance and preventive maintenance. These groups, which may include maintenance workers, solve problems without management intervention. The maintenance department is only

called on for bigger problems that require more resources, technology, or downtime.

**AVAILABILITY (Achieved):** In the definition of achieved availability, the mean time between maintenance (MTBM) is used as measure of uptime. This mean time between maintenance includes both unplanned and planned maintenance. The mean (expected) system downtime includes unplanned and planned (preventive/predictive) maintenance, but does not include supply or maintenance resources delays. Achieved (equipment) availability fulfills the need to distinguish availability when planned maintenance shutdowns are included, whereby it assumes zero supply and maintenance resources delay times.

**AVAILABILITY (Inherent):** Inherent availability is defined as  $MTBF / (MTBF + MTTR)$ . Availability increases by increasing reliability (MTBF) and maintainability ( $1/MTTR$ ). For example: MTBF = 1000 hours, MTTR = 48 hours. Then the availability is  $1000 / 1048 = 95\%$ . The inherent availability is solely based on the failure distribution and repair-time distribution, assuming no supply and maintenance delays, and no planned (preventive / corrective) maintenance. It is considered as an equipment design parameter. Inherent availability fulfills the need to distinguish expected performance between planned shutdowns.

**AVAILABILITY (Operational):** Similar to achieved availability, but in the operational availability also the supply and maintenance resource delays are included in the mean system downtime. Operational availability is required to isolate the total effectiveness and efficiency of maintenance operations.

**AVAILABILITY:** Availability is the probability that a system or component is performing its required function at a given point in time, or over a stated period of time when operated and maintained in a prescribed manner. In other words, the proportion of total time that an item of equipment is capable of performing its specified functions. The general observation of availability is:

**AVAILABLE HOURS:** The total number of hours that a piece of equipment is capable of performing its specified functions. It is equal to the total hours in any given period minus all the downtime hours.

**AVERAGE LIFE:** How long, on average, a component lasts before it suffers a failure. Average life is commonly measured by Mean Time Between Failures (MTBF), and is usually expressed in hours.

**AXIAL END PLAY:** The shaft displacement along the motor axis which is due to a reversal of the axial force. It is measured in inches or mm. Free End Play: The displacement measured when the moving force is removed after positioning the shaft axially from one extreme position to the other. Cushioned End Play: The displacement mea-

sured when a force of known value causes the shaft to move axially from one position to another. When specifying cushioned end play, the force and direction of movement must also be specified.

**AXIAL THRUST:** The force or loads that are applied to the motor shaft in a direction parallel to the axis of the shaft. (Such as from a fan or pump)

**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.

**BACK END OF A MOTOR:** The back end of a normal motor is the end which carries the coupling or driving pulley. (NEMA) This is sometimes called the drive end (D.E., pulley end P.E.) etc.

**BALANCE:** The condition where no vibration occurs in a rotating member due to the center of mass being displaced from the center of rotation.

**BALL:** Used where high shaft load (radial or axial thrust load) capacity is required or where periodic lubrication is impractical.

**BALL HEAD:** See "Governor Head"

**BASE SPEED, RPM:** The speed which a DC motor develops at rated armature and field voltage with rated load applied.

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

**BASELINE MEASUREMENTS:** A set of measurements (or metrics) that seeks to establish the current or starting level of performance of a process, function, product, firm, etc. Baseline measurements are usually established before implementing improvement activities and programs.

**BATTERY:** a group of two or more cells connected together to provide electrical current. Sometimes also used to describe a single cell which converts chemical energy to electrical current.

**BATTERY CYCLE LIFE:** the number of discharge and recharge cycles that a battery can undergo before degrading below its capacity rating.

**BATTERY SELF-DISCHARGE:** the gradual loss of chemical energy in a battery that is not connected to any electrical load.

**BEARING DEFECT FREQUENCIES:** Different bearing defects generate specific frequencies: An outer race defect generates a Band Pass Frequency of an outer race defect (BPFO). An inner race defect generates a Band Pass Frequency of an inner race defect (BPFI). A roller/ball defect generates a Ball Spin Frequency (BSF).

**BEARING LIFE:** Rating life, L10 (B10), is the life in hours or revolutions in which 90% of the bearings selected will obtain or exceed. Median life (average life), L50 (B50)

**BEARINGS, SLEEVE:** Preferred where low noise is important as on fan and blower motors. Unless otherwise stated, sleeve bearing motors can be mounted in any position, including shaft-up or shaft-down.

**BEARINGS:** Are used to reduce friction and wear while supporting rotating elements. For a motor it must provide a relatively rigid support for the output shaft. The bearing acts as the connection point between the rotating and stationary elements of a motor. There are various types such as roller, ball, sleeve (journal), and needle. The ball bearing is used in virtually all types and sizes of electric motors. It exhibits low friction loss, is suited for high speed operation and is compatible in a wide range of temperatures. There are various types of ball bearings such as open, single shielded or sealed. Reliance offers a unique PLS bearing system.

**BEARING FAILURES: SEIZURE:** Partial or large-area welding and deep scratches in the lip and roller face areas. Also, lubricant coking in this area. **CORROSION:** Red/brown stains or deposits on rolling elements, raceways, or cages. Increased vibration followed by wear, increase in radial clearance or loss of preload.

**OUTER RING FRACTURE:** Normally a crack spreads evenly in the circumferential direction, with several fractured pieces often originating. With axial load, these fractures occur as a rule a little beyond the middle of the raceway. The outer ring outside surface normally shows an irregular load carrying pattern.

**FLUTING:** Brownish marks parallel to the axis on a large part of the raceway, or covering the entire raceway circumference.

**MISALIGNMENT:** A wear path not parallel to raceway edges on the raceway of the non-rotating ring.

**SLIPPAGE TRACKS:** Spotted smear marks, or roughening of rolling elements or raceways.

**FALSE BRINELLING:** Elliptical wear marks in an axial direction at each ball position with a bright finish and sharp demarcation, often surrounding by a ring of brown debris.

**OVERHEATING:** Discoloration of the rings, rolling elements and cages from gold to blue. Temperatures in excess of 400 °F can anneal ring and rolling element materials, reducing the bearing capacity and causing early failure. In extreme cases, the bearing components will deform. Temperature rise can also degrade or destroy lubricant.

**LIP FRACTURES:** Supporting lips are partly or completely broken off or cracked.

**NORMAL FATIGUE:** Often referred to as spalling, and indicated by the fracture of the running surfaces and subsequent removal of small discrete particles of material from the inner ring, outer ring, or rolling elements. Spalling is progressive, and once initiated will spread with continued operation. It is always accompanied by a noticeable increase in vibration.

**TRUE BRINELLING:** Brinell marks appear as indentations in the raceway, increasing bearing vibration (noise). Severe brinell marks can cause premature fatigue failure.

**EXCESSIVE LOADS:** Heavy rolling element wear paths, evidence of overheating, and widespread fatigue areas (spalling).

**LUBRICANT FAILURE:** Discolored rolling elements (blue/brown) and rolling element tracks. Excessive wear of rolling elements, rings, and cages follow, resulting in overheating and catastrophic failure.

**AXIAL CRACKS:** Inner ring cracked in the axial direction. Slightly rounded fractured edges indicate that fracture originated during operation and was cycled (crack edges may break off after prolonged operation). Sharp edged cracks indicate fracture during dismounting.

**CONTAMINATION:** Denting of rolling elements and raceways, causing vibrations.

**TIGHT FITS:** A heavy rolling element wear path in the bottom of the raceway. Can cause overheating, and in some cases an inner ring axial crack.

**FRETTING:** Fretting, the generation of fine metal particles, which oxidize, leaving a distinctive brown color. Wear at the fitting surfaces causing noise and runout problems, possible fatigue fracture, and possible disturbance of floating bearing function.

**BENCHMARKING (Competitive):** The process of consistently researching new ideas, methods, practices, and processes, and adapting, adopting, and implementing their best features. It is the continuous procedure of measuring one's products, services, and practices against competitive "best in class" companies or organizations for the purpose of seeking improvement.

**BENCHMARKING (External):** The process of consistently researching new ideas, methods, practices, and processes, and adapting, adopting, and implementing their best features. It is the continuous procedure of measuring one's products, services, and practices against external companies or organizations for the purpose of seeking improvement.

**BENCHMARKING (Generic):** The process of consistently researching new ideas, methods, practices, and processes, and adapting, adopting, and implementing their best features. It is the continuous procedure of measuring one's products, services, and practices against companies or

organizations that carry out the same or similar functions (e.g. warehousing) for the purpose of seeking improvement.

**BENCHMARKING (Internal):** The process of consistently researching new ideas, methods, practices, and processes, and adapting, adopting, and implementing their best features. It is the continuous procedure of measuring one's products, services, and practices within the company for the purpose of seeking improvement.

**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.

**BLACK START:** refers to certain electric utility generating units that can start upon demand without any outside source of electric power. These are often combustion turbines that have stationary battery banks to provide backup power to energize all the controls and auxiliaries necessary to get the unit up and running. In the event of an large area-wide blackout, these units are critical to restoring the utility grid. Most utility generating units do not have black start capability.

**BLADES:** Curved members on a propeller type turbine runner that radiate from the hub, deflect the flowing water and transmit the power to the hub. The blades may be angularly adjustable or rigidly fixed to the hub.

**BLOWER WHEEL TYPES:** Single Inlet, Galvanized Steel - Typical applications include fan coil units, room air conditioners, draft inducers, power burners, flue exhaust, furnaces, heaters, condensers and small appliances.

**BONDING:** an electrical conducting path formed by the permanent joining of metallic parts. Intended to assure electrical continuity and the capability to safely conduct any likely current. Similar to bonding jumper or bonding conductor.

**BRAKES:** An external device or accessory that brings a running motor to a standstill and/or holds a load. Can be added to a motor or incorporated.

**BRAKING TORQUE:** The torque required to bring a motor down to a standstill. The term is also used to describe the torque developed by a motor during dynamic braking conditions.

**BRANCH CIRCUIT** - the conductors between the last overcurrent protective device and the outlets or loads.

**BRINELL HARDNESS:** A measure of resistance of 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-based alloys.

**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.

**BREAK DOWN MAINTENANCE (BDM):** “Unplanned” corrective maintenance performed on equipment after the equipment has suffered a failure and has to be corrected during a break down of the equipment. Break down maintenance indicates a lack of planning.

**BREAKAWAY TORQUE:** The value of torque that is required to begin motion of an armature or rotor that is de-energized and has been at rest.

**BREAKDOWN TORQUE:** The maximum torque a motor will develop at rated voltage without a relatively abrupt drop or loss in speed.

**BREAKER:** Short for “Circuit Breaker.” A switch that can be operated from a distance either automatically or by an operator. Usually used for high-voltages and currents. Often set up to open automatically when overloaded or in other emergencies.

**BRUSH:** A piece of current conducting material (usually carbon or graphite) which rides directly on the commutator of a commutated motor and conducts current from the power supply to the armature windings. **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.

**BRUSH RESISTANCE (R<sub>b</sub>):** Circuit resistance created by the brushes and the brush film in a brush type motor (universal, PM, wound field) adding to other power losses in a motor.

**BTU:** British Thermal Unit. The quantity of heat needed to raise the temperature of one pound of water one degree Fahrenheit at sea level; approximately the amount of heat given off by burning one wooden match.

**BUBBLE POINT:** A term used with new refrigerant blends to indicate the refrigerant pressure / temperature relationship at the outlet of the condenser (i.e., liquid pressure). Used when measuring for subcooling on refrigerant blends with temperature glide.

**BUCKETS:** Curved members on the Francis and impulse

turbine runners that deflect the flowing water and transmit the power to the crown or disk.

**BUSES, BUS WORK:** Electrical conductors that are usually rigid copper bars or rods, not insulated and often high-voltage. Bus ducts are specially constructed pipes or tubes that have buses inside.

**CANADIAN STANDARDS ASSOCIATION:** Sets safety standards for motors and other electrical equipment used in Canada. Most all motors in this catalog meet CSA standards and the CSA logo is displayed on the nameplate.

**CANOPY (DRIP COVER):** A protective cover placed on the top of a motor being mounted vertically to protect it from liquids or solids that might drop onto the motor. (It acts similar to an umbrella for the motor.)

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

**CAPACITOR MOTOR:** A single-phase induction motor with a main winding arranged for direct connection to the power source, and auxiliary winding connected in series with a capacitor. There are three types of capacitor motors: capacitor start, in which the capacitor phase is in the circuit only during starting, permanent-split capacitor, which has the same capacitor and capacitor phase in the circuit for both starting and running; two-value capacitor motor, in which there are different values of capacitance for starting and running.

**CAPACITOR START, CAPACITOR RUN:** Performance and applications similar to capacitor-start, induction-run, except higher efficiency. Generally used in higher single-phase HP ratings or energy saver designs.

**CAPACITOR:** A device which, when connected in an alternating-current circuit, causes the current to lead the voltage in time phase. The peak of the current wave is reached ahead of the peak of the voltage wave. This is the result of the successive storage and discharge of electric energy used in 1 phase motors to start or in 3 phase for power factor correction.

**CATHODE:** The negative pole of an electrode.

**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.

**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.

**CAVITATION:** A result of a pump not operating near its best efficiency point or having insufficient net positive suction head.

**C, CENTIGRADE:** A system of temperature measurement, often used for electrical equipment. To change C to Fahrenheit, divide by five, multiply by nine, and add 32.

**CENTRIFUGAL CUTOOUT SWITCH:** A centrifugally operated automatic mechanism used in conjunction with split phase and other types of single phase induction motors. Centrifugal cutout switches will open or disconnect the starting winding when the rotor has reached a predetermined speed, and reconnect it when the motor speed falls below it. Without such a device, the starting winding would be susceptible to rapid overheating and subsequent burnout.

**CFM:** Cubic Feet Per Minute. A standard air flow quantification used to describe air flow across coils and through ducted fan systems.

**CFS:** Cubic Feet per Second. A measurement of water flow. One cubic foot equals 7.5 gallons.

**CHANGE OF STATE:** The change of a substance from one form to another, resulting from the addition or removal of heat. Changes of state due to the addition of heat: liquid to gas (evaporation), solid to gas (sublimation). Changes of state due to the removal of heat: liquid to solid (freezing), gas to liquid (condensation)

**CHARGE RATE:** the rate at which a battery or cell is recharged. Can be expressed as a ratio of battery capacity to current flow.

**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 MILL:** 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.

**CIRCUIT BREAKER:** a device designed to open a circuit either by manual action or by automatic action when current exceeds a value longer than permitted. A circuit breaker can provide overcurrent protection.

**CLUTCH:** A mechanical device for engaging and disengaging a motor often used when many starts and stops are required.

**CODE LETTER:** A letter that 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.

**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.

**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.

**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.

**CORROSION:** Corrosion is electromechanical 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.

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

**COGGING:** A term used to describe non-uniform angular velocity. It refers to rotation occurring in jerks or increments rather than smooth motion. When an armature coil enters the magnetic field produced by the field coils, it tends to speed up and slow down when leaving it. This effect becomes apparent at low speeds. The fewer the number of coils, the more noticeable it can be.

**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 (Stator or Armature):** The electrical conductors wound into the core slot, electrically insulated from the iron core. These coils are connected into circuits or windings which carry independent current. It is these coils that carry and produce the magnetic field when the current passes through them. There are two major types: "Mush" or "random" wound, round wire found in smaller and medium motors where coils are randomly laid in slot of stator core; and formed coils of square wire individually laid in, one on top of the other, to give an evenly stacked layered appearance.

**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.

**COLLECTOR:** A set of smooth, steel rings mounted on an AC generator shaft, with stationary carbon "brushes" sliding on them. The collector carries DC current for the field windings on to the rotating shaft.

**COLLINEAR:** When the rotational centers of two shafts form a single, straight line then the shafts are said to be collinear.

**COMMUTATION ANGLE:** In a brush type D.C. motor, the angle in electrical degrees that a coil or group of coils on an armature rotate while being commutated. In a brushless D.C. motor, the angular difference in electrical degrees between the rotor and stator poles when the current is reversed in the windings.

**COMMUTATION:** In D.C. motors the switching

(either mechanically or electronically) of the direction of the current in a coil or group of coils to cause a change of magnetic polarity.

**COMMUTATOR:** A cylindrical device mounted on the armature shaft and consisting of a number of wedge-shaped copper segments arranged around the shaft (insulated from it and each other. The motor brushes ride on the periphery of the commutator and electrically connect and switch the armature coils to the power source.

**COMPLIANCE TEST:** Test used to show whether or not a characteristic or a property of an asset complies with state requirements.

**COMPONENT:** A system or subsystem piece that has the ability to perform a defined function, and is physically replaceable.

**COMPOUND WOUND DC MOTORS:** Designed with both a series and shunt field winding, the compound motor is used where the primary load requirement is heavy starting torque, and adjustable speed is not required. (See Paralleling) Also used for parallel operation. The load must tolerate a speed variation from full-load to no-load.

**COMPUTER-AIDED DESIGN (CAD):** Computer-based systems for product design that may incorporate analytical and "what if" capabilities to optimize product designs. Many CAD systems capture geometric and other product characteristics for engineering-data-management systems, production and cost analysis, and performance analysis. In many cases, CAD-generated data is used to generate tooling instructions for computer-numerical-control (CNC) systems.

**CONDENSER CAPACITY:** The KVA capability of the generator when operating as a synchronous condenser or "motoring." Under this condition, the turbine may be running in air or with a small amount of water flow to provide for unit losses.

**CONDENSING:** The change of state from a gas to a liquid. Heat is rejected during this process.

**Condition Monitoring:** The use of objective technologies to measure the condition of equipment. Vibration analysis, oil analysis, and thermography are examples of condition monitoring techniques.

**CONDITIONAL PROBABILITY OF FAILURE:** The probability that an item will fail during a particular age interval, assuming that it survives to enter that age.

**CONDUCTOR** - usually a metallic substance capable of transmitting electricity with little resistance. The best conductor at normal temperature ranges is silver. The most common is copper. Some other recently discovered substances called super conductors actually have zero resistance at extremely low temperatures.

**CONDUIT BOX:** The metal container usually on the side of the motor where the stator (winding) leads are attached to leads going to the power supply.

**Conformity:** Fulfillment by a product, process, or service of the specified requirements.

**CONSTANT H.P.:** A designation for variable or adjustable speed motors used for loads requiring the same amount of H.P. regardless of their motor speed during normal operation.

**CONSTANT SPEED:** A DC motor which changes speed only slightly from a no load to a full load condition. In AC motors, these are synchronous motors.

**CONSTANT TORQUE:** Refers to loads whose H.P. requirements change linearly with changing speeds. Horsepower varies with the speed, i.e. - 2/1 HP at 1800/900 RPM. (Seen on some 2-speed motors). Possible applications include conveyors, some crushers, or constant-displacement pumps.

**CONTINUOUS IMPROVEMENT:** Reduction to maintenance input (hours, materials, management time) to provide a given level of maintenance service. Increases in the number of assets, or use of assets with fixed or decreasing inputs.

**CONTINUOUS LOAD:** a sustained electrical load current for three hours or more.

**CONTINUOUS REPLENISHMENT PROGRAMS:** Arrangement with supplier companies in which the supplier monitors the customer's inventory and automatically replaces used materials, eliminating the need for purchase orders and related paperwork.

**CONTROL ENGINEERING:** Control engineering is the area of method and technique to automatically control industrial processes. A commonly used industry method is the PID (Proportional, Integrative and Differential) control algorithm, implemented in PLCs (Programmable Logic Controllers).

**CONTROL SYSTEM:** The system that controls water flow to a turbine to allow stopping, starting, and load control. The governor is part of the control system. The system also usually has an oil supply and pressurizing system. This system also usually has an oil supply and pressurizing system, overspeed protection, and the turbine water flow control mechanism.

**CORE DAMAGE: WHEN A NORMALLY RE-BUILDABLE COMPONENT IS DAMAGED SO badly that it cannot be repaired.**

**CORE:** The iron portion of the stator and rotor; made up of cylindrical laminated electric steel. The stator and rotor cores are concentric separated by an air gap, with the rotor core being the smaller of the two and inside to the stator

core.

**CORRECTIVE MAINTENANCE:** Any planned or unplanned maintenance activity required to correct a failure that has occurred or is in the process of occurring. This activity may consist of repair, restoration, or replacement of components.

**CORROSION (MOISTURE):** Corrosion (rust) is a chemical reaction on metal surfaces. When steel is in contact with moisture, such as water or acid, oxidation takes place, and subsequently, the formation of corrosion pits and flaking occur.

**COULOMB** - the practical unit of electric charge transmitted by a current of one ampere for one second. It is the charge carried by  $6.2418 \times 10^{18}$  electrons. Named for the French physicist Charles A. de Coulomb 1806.

**COUNTER ELECTROMOTIVE FORCE (CEMF):** The induced voltage in a motor armature, caused by conductors moving through or "cutting" field magnetic flux. This induced voltage opposes the armature current and tends to reduce it.

**COUPLINGS:** The mechanical connector joining the motor shaft to the equipment to be driven.

**CREST:** The highest permanent part of a dam that water will normally flow over or up to. It is usually located in feet above sea level.

**CRITICAL SPEED:** The speed of a rotating member that corresponds to a resonant frequency in the member.

**CRITICALITY ANALYSIS:** Criticality analysis is a method for identifying product or process criticality for the purpose of prioritizing activities like design and maintenance. It is a process of decomposing product or process into hierarchical components, followed by study of their failure modes and effects, and (where appropriate) their causes. Criticality is the combined measure of the failure mode probability and the severity of its effects.

**CRITICALITY:** The priority rank of a failure mode, based on some assessment criteria such as operational and HSE (Health, Safety, Environment) consequences, and the likelihood of failure occurrence.

**CURRENT:** The time rate of flow of electrical charge and is measured in amps (amperes).

**CURRENT TRANSFORMER:** A transformer which converts large AC currents to very small currents and also isolates the small current from high-voltage. The small current is used for measurements and signals in meters and relays. Sometimes called a "CT."

**CYCLES PER SECOND (HERTZ):** One complete reverse of flow of alternating current per rate of time. (A measure of frequency.) 60 HZ (cycles per second) A.C. power is common throughout the U.S. and 50 HZ is more

common in some foreign countries.

**D FLANGE:** A special end shield with holes for through bolts in the flange and is primarily used for mounting the motor on gear boxes or bulkheads. Standardized for frames 143T through 445T. "D" flanges are not threaded and the bolt holes extend beyond the motor frame.

**DAMAGE:** Something that reduces the value, effectiveness, or usefulness of the thing affected.

**DAMPING COEFFICIENT:** In a D.C. motor the constant that defines the braking characteristics of the motor with shorted leads.

**DC MOTOR:** A motor using either generated or rectified D.C. power (see Motor definition) . A DC motor is usually used when variable speed operation is required.

**DECIBEL:** a logarithmic measure of the ratio of two quantities. Abbreviated dB. For electrical power,  $1 \text{ dB} = 10 \times \log_{10} P1/P2$ . For electric voltage or current,  $1 \text{ dB} = 20 \times \log_{10} E1/E2$ .

**DEFINITE PURPOSE MOTOR:** A definite purpose motor is any motor design, listed and offered in standard ratings with standard operating characteristics with special mechanical features for use under service conditions other than usual or for use on a particular type of application. (NEMA)

**DEFORMATION (BY OVERLOAD):** Overloading by static or shock loads, which leads to plastic deformations (i.e. the formation of shallow depressions in steel surfaces).

**DEPTH OF DISCHARGE:** the percent of rated capacity of a battery that has been discharged from the battery.

**DE-RATING:** Using an item in a way that applies stresses that are below the recommended stress values.

**DESIGN FOR RELIABILITY:** A four-phase design process to build reliability into a part, component, or system. The phases are concept, design and development, full-scale development, and operational.

**DEWATER:** To drain water from a place normally under water, usually for inspection or repair. Usually the water must be shut or blocked off upstream (and sometimes also downstream), then the water in the place to be dewatered is drained or pumped away.

**DIELECTRIC STRENGTH:** A high voltage test of the motor's insulation ability to withstand an A.C. voltage. The test criterion limits the leakage current to a specified maximum at the test voltage of specified magnitude and frequency, applied between the motor case and windings.

**DIMENSIONS:** NEMA has standard frame sizes and dimensions designating the height of the shaft, the distance between mounting bolt holes and various other measurements. The integral AC motor NEMA sizes run from 143T- 445T, and the center of the shaft height in

inches can be figured by taking the first two digits of the frame number and dividing it by 4. The fractional horsepower motors, for which NEMA spells out dimensions, utilize 42, 48 and 56 frames whose shaft height in inches is figured by dividing the frame number by 16.

**DIODE:** an electronic semiconductor device that predominantly allows current to flow in only one direction.

**DIRECT CURRENT (DC):** Type of power supply available from batteries, generators (not alternators) or a rectified source used for special-purpose applications.

**DISCONNECT:** A very simple kind of hand-operated switch. usually used where there is high voltage and current, to operate equipment from all electrical connections. Disconnects must never be when they are "live."

**DISPLACEMENT:** The change in position of a body measured from the point of rest. Usually expressed in mils (.001 in).

**DISTRIBUTING VALVE:** The distributing valve is a large pilot valve, usually controlled by a smaller pilot valve that controls oil flow to and from the servomotor in a turbine control system.

**DIVISION 11:** Locations in which ignitable concentrations of flammable or combustible material exist but are contained within closed systems or containers and normally would not come in contact with the motor.

**DIVISION I:** Location in which ignitable concentrations of flammable or combustible material exist and come in contact with the motor.

**DO IT NOW (DIN) WORK:** "Do It Now" means non-emergency work that has to be done immediately. An example is moving furniture in the executive wing.

**DOUBLE INLET, TWO HUBS, BELT DRIVE, GALVANIZED STEEL:** Designed to accommodate higher horsepower and temperature requirements. With Two Inlets and Two Hubs.

**DOUBLE INLET,ALUMINUM WITH STEEL HUBS:** Designed to accommodate higher horsepower and temperature requirements.

**DOUBLE INLET,DIRECT DRIVE GALVANIZED:** Designed to accommodate higher horsepower and temperature requirements. With Two Inlets.

**DOWNTIME:** The time that an item of equipment is out of service, for example as a result of equipment failure. The time that an item of equipment is available but not utilized is generally not included in the calculation of downtime. In other words, downtime is the time that the asset is not in a condition to perform its required function. The downtime of an item includes active maintenance time and delays due to awaiting spares, labor, facilities, movement, etc. Unless otherwise stated, downtime due to

failure is considered to commence at the instant the item is deemed to have failed and to persist until the equipment is again available.

**DRAFT TUBE:** A flared passage leading from the water wheel or turbine to the tail race.

**DRAFT TUBE LINER:** A steel lining that protects the draft tube concrete from water erosion.

**DRIP-PROOF GUARDED:** A drip-proof machine with ventilating openings guarded (with screens) as in a guarded motor.

**DRIP-PROOF MOTOR:** An open motor in which the ventilating openings are so constructed that drops of liquid or solid particles falling on it, at any angle not greater than 15 degrees from the vertical, cannot enter either directly or by striking and running along a horizontal or inwardly inclined surface.

**DUAL TORQUE:** Dual speed motor whose torque varies with speed (as the speed changes the horsepower remains constant).

**DUAL VOLTAGE:** Some motors can operate on two different voltages, depending upon how it is built and connected. The voltages are either multiples of two or the 3 of one another.

**DUTY CYCLE:** The relationship between the operating time and the off time of a motor. Both the on time and the repetition rate must be specified.

**DYNAMIC BRAKING:** A control function that brakes the motor by dissipating its stored energy.

**DYNAMOMETER:** A device which loads the motor to measure output torque and speed accurately by providing a calibrated dynamic load. Helpful in testing motors for nameplate information and an effective device in measuring efficiency.

**EDDY CURRENT:** Localized currents induced in an iron core by alternating magnetic flux. These currents translate into losses (heat) and their minimization is an important factor in lamination design.

**EFFECTIVENESS:** A measure of the degree to which an item, system, or person can be expected to achieve a set of specific mission requirements. Performing the correct task efficiently.

**EFFICIENCY:** The efficiency of a motor is the ratio of mechanical output to electrical input. It represents the effectiveness with which the motor converts electrical energy into mechanical energy. NEMA has set up codes which correlate to specific nominal efficiencies. A decrease in losses (the elements keeping the motor from being 100% efficient of 10% constitutes an upward improvement of the motor of one code on the NEMA table. Each nominal efficiency has a corresponding minimum efficien-

cy number. In engineering terms, efficiency is a measure of a machine's energy effectiveness: the ratio of the amount of energy used by a machine to the amount of work done. For example, the measurement of the amount of heat produced per unit of fuel burned is a measure of a heating unit's efficiency.

**ELECTRICAL CURRENT ANALYSIS:** An investigation of the electric current (spectrum) of electric motors or generators. Through this analysis, irregularities (e.g. broken rotor bars, cracked end-rings, high resistance joints) are detected. Specialized tools and personnel exist for doing these investigations.

**ELECTRICAL DEGREE:** A unit of measurement of time as applied to alternating current. One complete cycle = 360 electrical degrees. One cycle in a rotating electric machine is accomplished when the rotating field moves from one pole to the next pole of the same polarity. There are 360 electrical degrees in this time period. Therefore, in a two pole machine there are 360 degrees in one revolution, and the electrical and mechanical degrees are equal. In a machine with more than two poles, the number of electrical degrees per revolution is obtained by multiplying the number of pairs of poles by 360.

**ELECTRICAL UNBALANCE:** In a 3 phase supply, where the voltages of the three different phases are not exactly the same. Measured in % of unbalance.

**ELECTROLYTE:** a nonmetallic conductor of electricity usually consisting of a liquid or paste in which the flow of electricity is by ions.

**ELECTROMAGNETIC INTERFERENCE (EMI):** Electromagnetic interference (EMI), sometimes referred to as Radio Frequency Interference (RFI), is a phenomenon which, either directly or indirectly can contribute to degradation in performance of an electronic receiver or system. EMI consists of undesirable voltages and currents that reach the victim device either by conduction through the power lines or by radiation through the air and causes the device to exhibit undesirable performance. It is usually caused by switching or winding commutation.

**ELECTROMOTIVE FORCE (EMF):** A synonym for voltage, usually restricted to generated voltage.

**EMERGENCY WORK:** Maintenance work that requires immediate response from the maintenance staff. Its urgency is usually associated with safety, operational, health, or environmental effects. Emergency work is often performed without a requisite work order issued in advance.

**ENCAPSULATED WINDING:** A motor which has its winding structure completely coated with an insulating resin (such as epoxy). This construction type is designed for exposure to more severe atmospheric conditions than

the normal varnished winding.

**ENCLOSURE:** The term used to describe the motor housing. Common Types are: Open: Ventilation openings in end shields and /or shell to permit passage of cooling air over and around the windings. Location of openings not restricted, for use indoors, in fairly clean locations.

Totally Enclosed: No openings in the motor housing (but not air-tight). Used in locations which are dirty, oily etc.

Two types are: Totally enclosed fan cooled: Includes an integral fan to blow cooling air over the motor Totally enclosed non-ventilated: Not equipped with a fan for external cooling. Depends on convection air for cooling. Explosion-proof: A special enclosed motor designed to withstand an internal explosion of specified gases or vapors, and not allow the internal flame or explosion to escape. Usually available as non-ventilated (EPNC) in smaller ratings (below 1/3 HP) and fan-cooled (EPFC) in larger ratings. Explosion-proof motors are labeled to meet UL and NEC requirements.

**ENDSHIELD:** The part of the motor housing which supports the bearing and acts as a protective guard to the electrical and rotating parts inside the motor. This part is frequently called the “end bracket” or “end bell.”

**ENERGY** - the capacity for, or the ability to do, mechanical work. Electrical energy is measured in kilowatt-hours for billing purposes.

**EQUIPMENT LIFETIME:** Span of time over which equipment is expected to fulfill its intended purpose.

**EROSION (ELECTRIC):** Electric erosion is damage to contact steel surfaces caused by the passage of electric current. Small current leakage typically results in small craters, and possibly flutes or discoloration. Large craters can result from excessive voltage leaks.

**EVAPORATION:** The change of state from liquid into a gas. Heat is absorbed during this process.

**EXCITER:** A DC electrical generator, usually built into the main turbine generator unit, which generates power for the main generator field windings.

**EXPLOSION-PROOF ENCLOSURE:** A totally enclosed enclosure which is constructed to withstand an explosion of a specified gas, vapor or dust which may occur within it. Should such an explosion occur, the enclosure will prevent the ignition or explosion of the gas or vapor which may surround the motor enclosure. These motors are listed with Underwriter’s Laboratories.

**EXPLOSION-PROOF-U.L. CLASSIFICATIONS**  
**CLASS I** -Those in which flammable gasses or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Group C - Atmospheres containing ethyl or ether vapors. Group D - Atmospheres containing gasoline, hexane, benzene, butane,

propane, alcohols, acetone, benzol, lacquer solvent vapors, natural gas, etc. Class 11- Those which are hazardous because of the presence of combustible dust. Group E - Atmospheres containing metal dust, including aluminum, magnesium, or their commercial alloys. Group F - Atmospheres containing carbon black, charcoal, coal or coke dust. Group G - Atmospheres containing flour, starch, grain or combustible plastics or chemical dusts.

**EXTERNALLY VENTILATED:** A motor using an external cooling system. This is required in applications where the motor’s own fan will not provide sufficient cooling; this is true for certain duty cycle applications, slow speed motors, also in environments with extreme dirt. Often a duct with an external blower is used to bring clean air into the motor’s air-intake. **Efficiency:** A measurement of how effectively a motor turns electrical energy into mechanical energy.

**FAIL SAFE:** When a system or piece of equipment is built so that it will shut down in a safe way if any part breaks or fails in any way, or if it loses power, pressure, fuel, etc. - it is said to “fail safe.”

**FAILURE CAUSE:** The apparent cause of a functional failure, not to be confused with the root cause, which is only determined through a Root Cause Failure Analysis (RCFA). (Used interchangeably with Failure Reason).

**FAILURE CODE:** An alphanumeric code typically entered against a work order in a computerized maintenance management system (CMMS), which indicates the failure cause (e.g. lack of lubrication, metal fatigue, etc.). These codes are employed to facilitate analysis of plant history.

**FAILURE DESCRIPTOR:** The term failure descriptor refers to the apparent observation of a failure. The failure descriptor must answer the question of what caused the equipment to fail to perform or fulfill the required function(s).

**FAILURE EFFECT:** A description of the events that transpire after a failure has occurred as a result of a specific failure mode.

**FAILURE FINDING INTERVAL:** How often a failure finding task is performed. It is determined by the frequency of failure of the protective device, and the desired availability required of that protective device.

**FAILURE FINDING TASK:** A routine maintenance task, normally an inspection or a testing task, designed to determine, for hidden failures, whether an item or component has failed. A failure finding task should not be confused with an on-condition task, which is intended to determine whether an item is about to fail. Failure finding tasks are used in reliability-centered maintenance (RCM), and are sometimes referred to as functional tests.

**FAILURE MODE:** The term failure mode refers to the

observed way or mechanism of failure. For a failure mode to be valid it must answer the question: "What is the primary manner in which the associated failure descriptor becomes evident?" Depending on the application, the definition of failure mode may slightly vary. Failure modes may also be defined according to the effect by which a failure is observed. A high level model system may include the following general failure modes: CRT: General critical failure resulting in 100% production loss. DEG: Degraded equipment performance, resulting in partial production loss while waiting for repair and 100% production loss during repair. INC: Incipient failure. Equipment failure did not result in immediate production loss. The failure was found during other repair / scheduled maintenance activities. 100% production loss during repair. UNK: No impact details are recorded in database. 100% loss of equipment item on repair.

**FAILURE RATE:** Failure rate refers to the overall speed of failures, or the number of failures that occur in a given time frame, usually expressed in years. The total number of failures within an item population is divided by the total time expended by that population during a particular measurement interval under stated conditions. Failure rate is the ratio of the number of failures that occur in an interval to the size of the original population, divided by the length of the time interval. Other formats include the number of failures per year, and in some cases, it is common to express failure rate as the number of failures per hour, or the number of failures of an item per unit time. This can be applied to: Observed failure rate: as computed from a sample Assessed failure rate: as inferred from sample information Extrapolated failure rate: projected to other stress levels

**FAILURE REASON:** Sometimes used to refer to the apparent root cause of a functional failure, but not to be confused with the real root cause obtained from a thorough root cause failure analysis (RCFA). Used interchangeably with Failure Cause.

**FAILURE:** A lack of success in something, or an unsuccessful attempt at doing something. A breakdown or decline in the performance of something, or an occasion when something stops working or stops working adequately. Note that "failure" is an event, as distinguished from "fault" which is a "state."

**FARAD:** a unit of capacitance. One coulomb of charge will produce a potential difference of one volt across a capacitance of one Farad. Named for the English physicist Michael Faraday 1867.

**FATIGUE (SUBSURFACE INITIATED):** Under the influence of repetitive (especially high) loads in any metallic contact, structural changes occur in steel, and cracks are initiated at a certain depth under the surface, due to

volume changes of the altered material. Cracks propagate through the material until they reach the surface. In extreme cases, cracks further propagate until the component completely fractures Fatigue (Surface initiated): Surface initiated fatigue or surface distress refers to the failure of any metal surface contact due to a fatigue process started from the surface. Generally, a surface defect, such as a foreign particle indentation or a corrosion pit, is the initiator. The fatigue process is especially accelerated by a reduced lubrication regime (ISO/CD 15243).

**FAULT TREE ANALYSIS (FTA):** Fault tree analysis is a deductive process by means of which an undesirable event, called the top-event, is postulated, and the possible ways for this event to occur are systematically deduced

**FAULT:** A defect or imperfection. A fault develops when physical degradation has occurred, but the degradation is not severe enough to be termed as failure. A fault is absolute. This means there is a sufficiently high degree of confidence that a detailed physical examination of the component in question will show a fault that is absolutely supported by the symptom(s).

**FEEDBACK:** When used in a maintenance context, feedback means that information from the individual failure history is accounted for in the task list. The list increases when failure history is high, and decreases when failure history is low. In control engineer context, feedback means that measurements are taken from a process and used to take (automated) control actions (i.e., to keep a temperature constant over an operating range).

**FEEDER -** circuit conductors between the service equipment and the last downstream branch circuit overcurrent protective device.

**FIELD COIL RESISTANCE:** The resistance of the wire in the field coil as seen at the field leads or terminals.

**FIELD WEAKENING:** The introduction of resistance in series with the shunt wound field of a DC motor to reduce the voltage and current which weakens the strength of the magnetic field and thereby increases the motor speed.

**FIELD:** A term commonly used to describe the stationary (Stator) member of a DC Motor. The field provides the magnetic field with which the mechanically rotating (Armature or Rotor) member interacts.

**FILTER:** a device made up of circuit elements designed to pass desirable frequencies and block all others. It typically consists of capacitors and inductors.

**FLA:** Full load amperes, also sometimes abbreviated RLA for full load amperes. This is the current in amperes that a motor requires to produce rated nameplate horsepower output when rated nameplate voltage and frequency is provided to its terminals.

**FLANGE:** Mounting endshield with special rabbets and

bolt holes for mounting such equipment as pumps and gear boxes to the motor or for overhanging the motor on the driven machine.

**FLOAT CHARGE:** charging current supplied to a battery which overcomes the battery self-discharge rate. This current, under otherwise normal conditions, will maintain the battery in a fully charged state.

**FLUX:** The magnetic field which is established around an energized conductor or permanent magnet. The field is represented by flux lines creating a flux pattern between opposite poles. The density of the flux lines is a measure of the strength of the magnetic field. For single-phase operation: Shaded pole: Low starting torque, low cost. Usually used in direct-drive fans and blowers.

**FLYBALLS:** The flyballs in a turbine governor are the weights mounted so as to form a rotating pendulum that is sensitive to speed change.

**FLYBALL SPRING:** They flyball spring is arranged to oppose the force of the turbine governor flyballs so as to produce the desired relationship between movement and the change in speed.

**FOREBAY:** The part of the water storage area from which water is taken to run a water wheel or turbine.

**FORM FACTOR:** A figure of merit which indicates how much rectified current departs from pure (non-pulsating) DC. A large departure from unity form factor (pure DC, expressed as 1.0) increases the heating effect of the motor and reduces brush life. Mathematically, form factor is the ratio of the root-mean square (rms) value of the current to the average (av) current or  $I_{rms}/I_{av}$ .

**FORM WOUND:** A type of coil in which each winding is individually formed and placed into the stator slot. A cross sectional view of the winding would be rectangular. Usually form winding is used on high voltage, 2300 volts and above, and large motors (449T and above). Form winding allows for better insulation on high voltage than does random (mush) winding.

**FRACTIONAL-HORSEPOWER MOTOR:** A motor usually built in a frame smaller than that having a continuous rating of one horsepower, open construction, at 1700 -1800 rpm. Within NEMA frame sizes FHP encompasses the 42, 48 and 56 frames. (In some cases the motor rating does exceed 1 HP, but the frame size categorizes the motor as a fractional.) The height in inches from the center of the shaft to the bottom of the base can be calculated by dividing the frame size by 16.

**FRACTURE (FATIGUE):** Fatigue fracture results from frequently exceeding a fatigue strength limit, often under bending condition or excessive compressive loads. Cracks are initiated at little defects and propagate stepwise through the component.

**FRACTURE (FORCED):** Forced fracture is caused by high stress concentration in excess of material tensile strength by local overloading (e.g. by impact).

**FRAME SIZE:** Refers to a set of physical dimensions of motors as established by NEMA. These dimensions include critical mounting dimensions. 48 and 56 frame motors are considered fractional horsepower sizes even though they can exceed 1 horsepower, 143T to 449T are considered integral horsepower AC motors and 5000 series and above are called large motors. (For definition of letters following frame number, see Suffixes.)

**FRAME:** The supporting structure for the stator parts of an AC motor; in a DC motor the frame usually forms a part of the magnetic coil. The frame also determines mounting dimensions (see frame size).

**FREQUENCY:** the number of complete alternations or cycles per second of an alternating current. It is measured in Hertz. The standard frequency in the US is 60 Hz. However, in some other countries the standard is 50 Hz.

**FREQUENCY OF INSPECTION:** The regularity with which inspections are undertaken. Typically these are: Annually (once per year) Bi Annually (twice per year) Quarterly (four times per year) Monthly Weekly Daily Once per shift

**FRETTING:** Fretting corrosion (generally referred to as fretting) consists of a chemical reaction activated by relative (sliding) micro movements between steel surfaces. In case of bearings, this movement leads to oxidation of the bore or outer diameter surfaces and becomes visible as powdery rust and/or loss of material. The surfaces become shiny or discolored (blackish - red). The failure develops as a result of poorly fitting (too loose) components operating in combination with high loads and/or accelerations.

**FRICTIONAL DAMPING COEFFICIENT:** In a D.C. motor or BLDC motor, the constant that defines the braking characteristics of the motor with open leads.

**FRONT END OF A MOTOR:** The front end of a normal motor is the end opposite the coupling or driving pulley. (NEMA) This is sometimes called the opposite pulley end (O.P.E.) or commutator end (C.E.).

**FULL LOAD AMPERES:** Line current (amperage) drawn by a motor when opening at rated load and voltage on motor nameplate. Important for proper wire size selection and motor stator heater selection.

**FULL LOAD TORQUE:** That torque of a motor necessary to produce its rated horsepower at full-load speed, sometimes referred to as running torque.

**FULL-LOAD CURRENT:** The current flowing through the line when the motor is operating at full-load torque and full-load speed with rated frequency and voltage applied to the motor terminals.

**FUNCTIONAL FAILURE:** A specific failure that refers to the termination of, or degradation in the ability of an item to perform any one of the stated required functions.

**FUTURE BENEFIT PM:** Preventive maintenance (PM) tasks that are initiated by a breakdown rather than a schedule. The PM is done on a whole machine, assembly line, or process after a section or subsection breaks down. This is a popular method with manufacturing cells where the individual machines are closely coupled. When one machine breaks, the whole cell undergoes a preventive maintenance activity. Future benefit PM is considered “packaging of opportunistic work” given that an opportunity has arisen to do that work (often due to the failure of an associated piece of equipment).

**GASSING:** gas by-products produced by the chemical reactions that occur when charging a battery. Since one of these gasses is often hydrogen, safety precautions must be taken to ensure proper ventilation to avoid the danger of explosion.

**GATE LEVER:** A lever rigidly attached to the end of a wicket gate stem and that positions the wicket gate.

**Gate mechanism:** The gate mechanism consists of the gate operating ring, the wicket gates, and all the parts between that are used to control the flow of water to the turbine runner.

**GATE OPERATING RING:** The gate operating ring is rotated by servomotors to position the wicket gates. Sometimes called gate shifting ring.

**GATE STEM:** The top or bottom extension of wicket gate that supports the gate in its bearings. The gate lever is connected to one extension

**GATES:** hydro projects are equipped with various types of gates for the purpose of stopping the flow of water into the turbine (known as headgates or stop gates), or of bypassing the flow of water or trash (Tainter gates, sluice gates, flood gates, etc.). The type and use of such gates may be different for each stations.

**GEARHEAD:** The portion of a gearmotor which contains the actual gearing which converts the basic motor speed to the rated output speed.

**GEARMOTOR:** A gearhead and motor combination to reduce the speed of the motor to obtain the desired RPM's.

**GENERAL PURPOSE MOTOR:** A general-purpose motor is any motor having a “B” design, listed and offered in standard ratings with standard operating characteristics and mechanical construction for use under usual service conditions without restriction to a particular application or type of application. (NEMA)

**GENERATING UNIT:** A complete turbine-generator

unit with all the supporting equipment and auxiliaries that are used in the operation of it alone (not with another turbine-generator).

**GENERATOR** - a rotating machine which converts mechanical energy into electrical energy. In the automotive industry traditional terminology uses generator to refer to only those machines designed to produce dc current through brushes and a commutator (as opposed to alternator).

**GOVERNOR:** The part of the turbine control system that receives demand signals, chooses one to be the controlling signal, and uses that signal to control the water flow control mechanism.

**GOVERNOR HEAD:** Part of a turbine control system that measures shaft RPM and converts it to a signal (usually a mechanical movement) that becomes a demand signal to the governor. Sometimes called “Ball Head.”

**GOVERNOR HEAD DRIVE:** That means used to rotate the governor head in proportion to shaft RPM.

**GRID:** in the electrical arena, a term used to refer to the electrical utility distribution network.

**GROUND:** a conducting connection between an electrical circuit or device and the earth. A ground may be intentional, such as in the case of a safety ground, or accidental which may result in high overcurrents.

**GROUNDING MOTOR:** A motor with an electrical connection between the motor frame and ground.

**GUARDED MOTOR:** An open motor in which all openings giving direct access to live or rotating parts (except smooth shafts) are limited in size by the design of the structural parts or by screens, grills, expanded metal, etc., to prevent accidental contact with such parts. Such openings shall not permit the passage of a cylindrical rod 1/2 inch in diameter.

**HAZARD RATE:** Hazard rate is the instantaneous speed of failure. Hazard rate is the ratio of failures that occur in an interval to the size of the population at the start of the interval, divided by the length of time.

**HEAD:** Head is the difference in elevation between the water level in the pond and the level tailrace. The amount of head affects the generation of power. Sometimes used as a unit of pressure measurement, in feet of water. One foot of water equals 0.43 pounds per square inch.

**HEAD COVER:** The head cover spans the top of the runner and wicket gates. It supports the main bearing, the turbine shaft packing box and the upper stems of the wicket gates.

**HEAT EXCHANGER:** A device which will transfer the heat from inside the motor to another medium, through a radiator type heat exchanger.

**HEAT SINK:** This is a piece of metal (usually aluminum) of a specific size and thickness to which a motor is mounted while heat rise tests are conducted. The orientation, such as vertical or horizontal, needs to be stated with the test results.

**HENRY:** the practical unit of inductance. One Henry is equal to the inductance in which the change of one ampere per second results in an induced voltage of one volt. Abbreviated H. Named for the American physicist Joseph Henry 1878.

**HERTZ:** unit of frequency. One Hertz equals one complete cycle per second of an ac source. Abbreviated Hz. Named after the German physicist Heinrich R. Hertz 1894. This unit replaces the former "cycles-per-second." Hz - abbreviation for Hertz.

**HIDDEN FAILURE:** A failure that does not become evident to the operating crew under normal circumstances. This typically applies to protective devices that are not fail safe (examples include standby plant and equipment, emergency systems, etc.).

**HORSEPOWER:** The measure of rate of work. One horsepower is equivalent to lifting 33,000 pounds to a height of one foot in one minute. The horsepower of a motor is expressed as a function of torque and rpm. For motors the following approximate formula may be used:  $HP = T \times RPM$  divided by 5250 where HP = horsepower, T = torque (in. lb.ft.), and RPM = revolutions per minute.

**HVAC:** Heating, Ventilation, and Air Conditioning. harmonic - a sine wave which is an integral multiple of a base frequency. For example, the third harmonic on a 60 Hz system is a frequency of 180 Hz. Certain types of electrical equipment generate harmonics which interfere with the proper functioning of other devices connected to the same system.

**HUB:** The center part of a propeller type turbine runner that supports the blades and has provisions for attachment to the main shaft.

**HYDRAULIC TURBINE:** The complete machine that uses flowing water under a head to create rotational mechanical energy. The rotational energy is usually converted to electrical energy by a generator. The turbine includes all parts that contact water and also bearing(s), gate operating mechanism, coupling, etc. In hydroelectric plants, a hydraulic turbine is sometimes referred to as a "runner" or a "wheel" but this is only one part of the complete turbine.

**HYDRO:** Hydro is short for hydroelectric.

**HYDROELECTRIC:** hydroelectric refers to the production of electricity by water power.

**HYSTERESIS LOSS:** The resistance offered by materials to becoming magnetized (magnetic orientation of molecular structure) results in energy being expended and cor-

responding loss. Hysteresis loss in a magnetic circuit is the energy expended to magnetize and demagnetize the core.

**I<sup>2</sup>R:** Losses due to current flowing in a conductor caused by resistance (equals the current squared times the resistance.)

**IATROGENIC:** Failures that are caused by your own service person(s).

**IDENTIFICATION:** In most instances, the following information will help identify a motor: Frame designation (actual frame size in which the motor is built). Horsepower, speed, design and enclosure. Voltage, frequency and number of phases of power supply. Class of insulation and time rating. Application

**IMPEDANCE:** the total effects of a circuit that oppose the flow of an ac current consisting of inductance, capacitance, and resistance. It can be quantified in the units of ohms.

**IMPEDANCE PROTECTED:** A motor which under stalled conditions will not exceed specified maximum coil temperatures. Implies that the motor can be stalled (maximum temperature condition) without overheating or damage. **INDUCTANCE:** The characteristic of an electric circuit by which varying current in it produces a varying magnetic field which causes voltages in the same circuit or in a nearby circuit.

**IMPREGNATION** to bind all the other components together and fill in the air spaces. (A total impregnation, applied in a fluid form and hardened, provides protection against contaminants.

**IMPROVEMENT:** Combination of all technical, administrative, and managerial actions intended to decrease the dependency of an asset without changing its required function.

**INCREMENTING:** A rapid start, move and stop motion.

**Indentation:** An indentation (dent) is a plastic depression caused by debris being pressed into a contact surface. Indentations can go hand in hand with (abrasive) wear. Depending on the hardness of the particle, sharp (often with raised edges) or smooth indentations result.

**INDUCTION MOTOR:** An induction motor is an alternating current motor in which the primary winding on one member (usually the stator) is connected to the power source and a secondary winding or a squirrel-cage secondary winding on the other member (usually the rotor) carries the induced current. There is no physical electrical connection to the secondary winding, its current is induced.

Industrial machine applications include large planers, boring mills, punch presses, elevators, and small hoists.

**INERTIAL LOAD:** A load (flywheel, fan, etc.) which tends to cause the motor shaft to continue to rotate after the power has been removed (stored kinetic energy). If this continued rotation cannot be tolerated, some mechanical or electrical braking means must normally be applied. This application may require a special motor due to the energy required to accelerate the inertia. Inertia is measured in either lb.ft.<sup>2</sup> or OZ.jn.<sup>2</sup>

**Infant Mortality:** The relatively high conditional probability of failure during the period immediately after an item returns to service.

**INHERENT RELIABILITY:** A measure of the reliability of an item, in its present operating context, assuming adherence to ideal equipment maintenance strategies.

**Inspection:** Any task undertaken to determine the condition of equipment, and/or to determine the tools, labor, materials, and equipment required to repair the item.

**INSPECTORS:** In a maintenance sense the term refers to the nominated person(s) that has primary responsibility for maintenance tasks. Inspectors can be members of the maintenance department or any other department (machine operators, drivers, security officers, custodians, etc).

**INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS:** an independent organization which develops electrical standards and furthers the profession of electrical and electronics engineers. (IEEE)

**INSTRUMENT:** A general name for any device used to measure or record something. More accurate terms are: Dials, indicators, pointers. Measure positions or fluid levels either directly or at a distance. Gauges measure pressure. Meters measure electrical quantities such as volts, amperes, and watts. These quantities are often multiplied by one thousand or a "kilo," so we have kilovolts or KV, etc. Quantities are sometimes multiplied by a million or "mega" so we have megawatts or MW.

**INSULATION CLASS:** Since there are various ambient temperature conditions a motor might see and different temperature ranges within which motors run and insulation is sensitive to temperature; motor insulation is classified by the temperature ranges at which it can operate for a sustained period of time.

**INSULATION SYSTEMS:** Five specialized elements are used, which together constitute the motor's insulation system. The following are typical in an AC motor:

**INSULATOR:** A material which tends to resist the flow of electric current (paper, glass, etc.) In a motor the insulation serves two basic functions: Separates the various electrical components from one another. It protects itself and the electrical components from attack of contaminants and other destructive forces.

**INTERMITTENT DUTY:** A requirement of service

that demands operation for alternate intervals of (1) load and no load; or (2) load and rest; or (3) load, no load and rest; such alternate intervals being definitely specified.

**INTERPOLES:** An auxiliary set of field poles carrying armature current to reduce the field flux caused by armature reaction in a DC motor.

**Intervention (scheduled / planned):** Action taken systematically in a period of time independent of machine condition. The time period may be fixed (calendar based) or measured according to machine utilization (running hours based).

**INTRINSIC SAFETY:** Intrinsic safety is intended for products in which the level of electrical energy circulating or stored in the product is insufficient to ignite a surrounding explosive atmosphere even under fault conditions.

**INVERTER:** An electronic device that converts fixed frequency and fixed voltages to variable frequency and voltage. Enables the user to electrically vary the speed of an AC motor.

**ION:** a positively or negatively charged atom or molecule.

**J SECONDS (DC Motors):** J is the per unit moment of inertia. It is defined as the time in seconds to accelerate the motor armature to rated base speed using rated full load torque.

**JACKSCREW:** A device used for leveling the positioning of a motor. These devices are adjustable screws fitting on the base or motor frame. Also a device for removing endshields from a motor assembly.

**JOULE** - a unit of work or energy equal to one watt for one second. One kilowatt hour equals 3,600,000 Joules. Named after James P. Joule, an English physicist 1889.

**Joule's law** - defines the relationship between current in a wire and the thermal energy produced. In 1841 an English physicist James P. Joule experimentally showed that  $W = I^2 \times R \times t$  where I is the current in the wire in amperes, R is the resistance of the wire in Ohms, t is the length of time that the current flows in seconds, and W is the energy produced in Joules.

**KILOVAR:** unit of ac reactive power equal to 1000 vars. Abbreviated kVAR or KVAR.

**KILOVOLT:** unit of electrical potential equal to 1000 volts. Abbreviated kV or KV.

**KILOWATT-HOUR:** unit of energy or work equal to one kilowatt for one hour. Abbreviated as kwh or KWH. This is the normal quantity used for metering and billing electricity customers. The price for a kwh varies from approximately 4 cents to 15 cents. At a 100% conversion efficiency, one kwh is equivalent to about 4 fluid ounces of gasoline, 3/16 pound LP, 3 cubic feet natural gas, or 1/4

pound coal.

kV: abbreviation for kilovolt and equal to 1000 volts.

kVA: abbreviation for kilovolt amperes.

kVAR: abbreviation for kilovar. A unit of ac reactive power equal to 1000 vars.

kW: abbreviation for kilowatt. A unit of power equal to 1000 watts. KILOWATT: Since the watt is a relatively small unit of power, the kilowatt (kw), 1,000 watts, is used where larger units of power measurements are desirable.

LAMINATIONS: The steel portion of the rotor and stator cores made up of a series of thin laminations (sheets) which are stacked and fastened together by cleats, rivets or welds. Laminations are used instead of a solid piece in order to reduce eddy-current losses.

LARGE MOTORS: Usually refers to AC motors in 5,000 series frames and above and to 500 series frames and larger in DC.

LASER VIBROMETER: State-of-the-art transducer for non-contact vibration analysis.

Latent Fault: An existing fault that has not yet been detected.

LATENT HEAT: Heat energy absorbed in the change of state of a substance (melting, vaporization, fusion) without a change in temperature.

Lean Manufacturing: The systematic identification and elimination of waste to reduce manufacturing or operating costs.

LISTED: an electrical device or material that has been tested by a recognized organization and shown to meet appropriate standards. Many local governmental authorities require that installed electrical products be listed. A well-known listing organization is Underwriters Laboratories (UL).

LOAD: The burden imposed on a motor by the driven machine. It is often stated as the torque required to overcome the resistance of the machine it drives. Sometimes "load" is synonymous with "required power."

LOAD REJECTION: A load rejection is the sudden loss of electrical load on a generator, resulting from the opening of circuit breakers.

LOCKED ROTOR AMPERES: This is the current that a motor would require if the rotor were locked in place and prevented from rotating and rated nameplate voltage and frequency were applied to its terminals. This is also the current that could appear briefly during motor starting. While the motor comes up to speed this current gradually drops off and when the speed approaches running rpm this current rapidly falls to the RLA value. Often the starting current is less than the LRA value because the

voltage at the motor terminals dips during starting. This LRA value is important when sizing a generator because the generator's surge rating must be large enough to handle it.

LOCKED ROTOR CURRENT: Steady state current taken from the line with the rotor at standstill (at rated voltage and frequency). This is the current seen when starting the motor and load.

LOCKED ROTOR TORQUE: The minimum torque that a motor will develop at rest for all angular positions of the rotor (with rated voltage applied at rated frequency).

Locked Rotor: This is a motor test condition in which the rotating element is not allowed to move.

LOG SHEET: A document on which brief details of minor activities and repairs are recorded.

LOSSES: A motor converts electrical energy into a mechanical energy and in so doing, encounters losses. These losses are all the energy that is put into a motor and not transformed to usable power but are converted into heat causing the temperature of the windings and other motor parts to rise.

LOW SIDE: The portion of a refrigeration system which is at evaporating pressure. Typically, from the thermostatic expansion valve (TXV) to compressor piston suction valves.

LUBRICANT: A friction reducing substance. A substance, typically oil or grease, applied to a surface to reduce friction between moving parts.

LUBRICATION: In order to reduce wear and avoid overheating certain motor components require lubricating (application of an oil or grease). The bearings are the major motor component requiring lubrication (as per manufacturer's instructions). Excess greasing can however damage the windings and internal switches, etc.

LUBRICATION MANAGEMENT: Lubrication management at a production facility includes all activities related to the lubrication of machinery. Included, but not limited to, are the following activities: Establishing a lubrication strategy "where to go, in what period". Planning for lubrication improvement "projects". Resource planning: people, tools, software, etc. Establishing lubrication plan: lubrication selection, schedules, routes, intervals, quantities, etc. Establishing recording database and reporting system. Establishing health, environmental, and safety procedures. Optimizing supply and storage. Implementation – ensuring the plan and operating procedures are followed. Lubrication Management is in essence a concentrated effort to evaluate and improve lubrication issues in the plant that will improve returns on plant assets and lower consumption and supply costs.

MAGNETIC FIELD INTENSITY: The vector mag-

netic quantity that determines the ability of an electric current or a magnetic body to induce a magnetic field at a given point. It is measured in oersterds, amps turns/inch or amps/meter.

**MAGNETIC FLUX DENSITY:** This is the measure of concentration of magnetic flux in a given area. It is measured in lines per square inch or tesla.

**Magnetic Flux:** A term used to describe the amount of magnetism there is in a space around a coil or permanent magnet or in the air gap of a motor. It is measured in lines or webers.

**MAGNETIC POLARITY:** It is a fundamental principle of a winding that adjacent poles must be wound to give opposite magnetic polarity. This does not mean that the coils actually have to be wound in this direction before being placed into the stator. It does mean that the winding must be connected so that, if the current proceeds through one pole in a clockwise direction, it must proceed through the next pole in a counterclockwise direction. This principle is used to determine the correctness of connection diagrams.

**MAIN GUIDE BEARING:** The turbine bearing that locates and steadys the turbine shaft radially. Usually mounted on the head cover. Sometimes called “Wheel Bearing” or “Turbine Guide Bearing.” Bearings may be oil, grease, or water lubricated.

**MAINTAINABILITY IMPROVEMENT:** A maintenance engineering activity that looks at the root cause of breakdowns and maintenance problems and designs a repair that prevents future breakdowns. Maintainability improvement places an emphasis on making equipment easier to maintain.

**MAINTAINABILITY:** Maintainability is the probability that a failed component of system will be restored or repaired to a specified condition within a period of time when maintenance is performed according with prescribed procedures. The prescribed maintenance procedures include not only the manner in which repair is to be performed but also the availability of maintenance resources (people, spare parts, tools, and manuals), the preventive maintenance program, skill levels of personnel, and the number of people assigned to the maintenance crew. Restoration times are commonly characterized by the log normal distribution.

**MAINTENANCE:** Management All activities of the management that determine the maintenance objectives, strategies, and responsibilities, and implement them by means, such as maintenance planning, maintenance control and supervision, improvement of methods in the organization, including economical, environmental, and safety aspects.

**MAINTENANCE OBJECTIVES:** Targets assigned and accepted for maintenance activities. Targets may include availability, cost reduction, product quality, environmental preservation, safety, etc.

**MAINTENANCE PLAN:** Structured set of tasks that include the activities, procedures, resources, and time scale required to carry out maintenance.

**MAINTENANCE RECORD:** Part of maintenance documentation that contains all failures, faults, and maintenance information related to an asset. This record may also include maintenance cost, asset availability or uptime, and any other data where relevant.

**MAINTENANCE SCHEDULE:** A list of planned maintenance tasks to be performed during a given time period, together with the expected start times and durations of each task. Schedules apply to different time periods (e.g. daily schedule, weekly schedule, etc.), or to specific plant items (e.g. a machine manufacturer may supply a maintenance schedule with a new machine, related to which is a condition of warranty).

**MAINTENANCE STRATEGY:** Management method that covers all aspects of maintenance activities, including firm action plans for achieving maintenance objectives.

**MAINTENANCE/RELIABILITY ENGINEERS:** Employees with primary functions of analyzing and resolving maintenance problems, preventive and predictive maintenance, inspection and/or equipment reliability support.

**MAINTENANCE:** Combination of all technical, administrative, and managerial actions during the life cycle of an asset intended to retain it in, or restore it to, a state in which it can perform the required function. So, maintenance covers any activity carried out on an asset to repair equipment, or to ensure the asset continues to perform its intended functions. Maintenance includes all actions taken to prevent or reduce the consequences of failure.

**MANUFACTURING CYCLE TIME:** The length of time from the start of production and assembly operations for a particular (finished) product to the completion of all manufacturing, assembly, and testing for that product or specific customer order. (Does not include front-end order-entry time or engineering time spent on customized configuration of non-standard items.)

**MANUFACTURING RESOURCES PLANNING:** Software-based Manufacturing Resources Planning systems that translate forecasts into master production schedules, maintain bills of material (lists of product components), create work orders for each step in the production routing, track inventory levels, coordinate materials purchases with production requirements, generate “exception” reports identifying expected material shortages or other

potential production problems, record shop-floor data, collect data for financial reporting purposes, and other tasks depending on the configuration of the software.

**MAXIMUM CURRENT:** The maximum current limit beyond which demagnetization of the permanent magnet field (in a PM motor) will occur (at 20°C).

**MEDIUM MOTORS:** Motors in NEMA 143T to 449T frames.

**MEGGAR TEST:** A measure of an insulation system's resistance. This is usually measured in megohms and tested by passing a high voltage at low current through the motor windings and measuring the resistance of the various insulation systems.

**MINIMUM CIRCUIT AMPERES:** This is the minimum current rating allowed for the wiring and circuit breaker or fuse protection for the equipment. It is used by the installer and electrician to size the branch circuit to feed the equipment.

**MODAL ANALYSIS:** The analysis of structural bending characteristics.

**MOMENT OF INERTIA:** The property of matter that causes it to resist any change in its rotational or positional state. Normally it is an important property of the armature or rotor.

**MOTOR:** A machine that converts electrical power into mechanical power in a turning shaft. Also, "motor" describes an operational condition in which a generating unit is synchronized to the system with no water flow through the turbine, while maintaining normal no-load excitation. The generator runs as a synchronous motor

**MOTOR CONSTANT:** The ratio of the motor torque to motor input power. It is measured in Nm/W or oz.in./W.

**MOTOR TYPES:** Classified by operating characteristics and or type of power required, the AC induction motor is the most common type. Speed remains relatively constant as load changes. There are several kinds of AC induction motors.

**MOUNTING (DIS-):** Fixing, setting, arranging a component in its intended position. Trained maintenance personnel generally use special, professional equipment for mounting. The mounting tools are based on mechanical, hydraulic, or (induction) heating methods. Dismounting refers to removing the component from its position.

**MULTI-SPEED MOTORS:** A motor wound in such a way that varying connections at the starter can change the speed to a predetermined speed. The most common multi-speed motor is a two speed although three- and four-speeds are sometimes available. Multi-speed motors can be wound with two sets of windings or one winding. They are also available either constant torque, variable torque or

constant horsepower.

**N.E.C. TEMPERATURE CODE ("T" CODE):** An index for describing maximum allowable "skin" (surface) temperature of a motor under any normal or abnormal operating conditions. The "T" codes are applicable to U.L. listed explosion-proof motors. The skin temperature shall not exceed the minimum ignition temperature of the substances to be found in the hazardous location. The "T" code designations apply to motors and other types of electrical equipment subject to hazardous location classification.

**NAMEPLATE:** The plate on the outside of the motor describing the motor, HP, voltage, RPM's, efficiency, design, enclosure, etc.

**NATIONAL ELECTRICAL CODE:** a code for the safeguarding of people and property from hazards related to the use of electricity. Compliance with this code along with proper maintenance will result in an installation essentially free from hazard. Abbreviated NEC. The NEC was first developed in 1897 as a result of the efforts of various insurance, electrical, architectural, and allied interests.

**NATURAL FREQUENCY:** The frequency at which a component or a complete system resonates. Every structure has a natural frequency, which, when excited, can be detrimental to the structure.

**NEMA:** The National Electrical Manufacturers Association is a non-profit organization organized and supported by manufacturers of electric equipment and supplies.

**NEUTRAL:** a conductor of an electrical system which usually operates with minimal voltage to ground. Depending on the type of system, it may carry little current or only unbalance current. Systems that have one conductor grounded use the neutral for this purpose. **NAVY SERVICE "A":** Motors designed to meet requirements of MIL M-17059 or MIL M-17060 for high shock and service and are essential to the combat effectiveness of a ship. These motors are usually made of nodular iron.

**NEUTRAL ZONE:** The angular distance in electrical degrees between magnet poles or field poles. It is the theoretical space in which field flux is zero.

**NO LOAD CURRENT:** The current generated at rated voltage with no load on the motor – a function of rotation losses, both electrical and mechanical.

**NO LOAD SPEED-ACTUAL:** The actual speed the motor will run with no load applied at rated voltage.

**NO LOAD SPEED-TRUE:** A theoretical speed to which the motor will rise when rated voltage is applied with no load. This speed is based on the point where back emf is equal to input voltage.

**NO SCHEDULED MAINTENANCE:** An equipment maintenance strategy, where no routine maintenance tasks are performed on the equipment. The only maintenance performed on the equipment is corrective maintenance after the equipment has suffered a failure in the event that a fault becomes apparent (e.g. oil leak, running hot, etc.). Also related to “throwaway maintenance” and “run-to-failure” strategy.

**NODULAR IRON (DUCTILE IRON):** Special cast iron with a crystalline formation which makes it capable of handling high shock.

**Non-Routine Maintenance:** Any maintenance task not performed at a regular, pre-determined frequency.

**NON-SCHEDULED WORK:** Work that isn't planned or scheduled. Work falls into three categories: 1) emergency, 2) Do It Now (DIN), 3) routine.

**OBSOLETE STORE ITEMS:** Stock keeping units that have not had activity in three or more years and are not designated as safety stock.

**Occupational Safety and Health Administration (OSHA):** A division of the United States Department of Labor. The mission of the Occupational Safety and Health Administration (OSHA) is to save lives, prevent injuries and protect the health of America's workers. To accomplish this, federal and state governments must work in partnership with the more than 100 million working men and women and their six and a half million employers who are covered by the Occupational Safety and Health Act of 1970

**OHM:** a unit of electrical resistance. A circuit resistance of one ohm will pass a current of one ampere with a potential difference of one volt. Named for the German physicist George Simon Ohm 1854.

**OHM'S LAW:** defines the relationship between voltage, resistance, and current. In 1828 the German physicist George Simon Ohm showed by experiment that the current in a conductor is equal to the difference of potential between any two points divided by the resistance between them. This may be written as  $I = E / R$  where E is the potential difference in volts, R is the resistance in Ohms, and I is the current in amperes.

**OIL ANALYSIS:** The process of monitoring the condition of equipment through the analysis of oil properties and other lubricants. Typically, oil analysis is conducted through the measurement of particulates in the oil, or the chemical composition of the oil (spectrographic oil analysis). It is commonly used for monitoring the condition of large gearboxes, engines, and transformers.

**OIL DEBRIS MONITORING:** The analysis of metallic particles that collect in oil to gauge the degree of machine degradation. A variety of techniques may be employed, which include: Laboratory analysis of collected oil sample-

sUse of magnetic plugs to collect debris  
On-line particle analyzers

**OIL MIST LUBRICATION-DRY SUMP:** A method for lubricating anti-friction bearings which utilizes oil dispersed on an air stream. The mist is exhausted from the bearing housing so as not to permit oil to accumulate.

**OIL MIST LUBRICATION-WET SUMP:** Similar to Oil Mist Lubrication - Dry Sump, except that a pool of oil is developed in the bearing chamber. This oil pool will continue to supply oil to the bearing in the event that the oil mist is interrupted and is fed from a source outside the bearing housing such as a constant level oiler.

**OIL MONITORING:** Oil monitoring is the practice of regularly checking oil to assess the level of oil degradation to determine the oil's suitability for continued use as a lubricant, power transmission medium, or coolant. A variety of techniques are typically applied, which include: Subjective inspection  
Use of instrumentation to assess water contamination, viscosity levels, etc.  
Laboratory analysis of collected oil samples

**OIL WHIRL:** Produced when a rotating shaft within a sleeve bearing is forced into an orbital pattern by an oil pressure within the bearing that is greater than the force that the shaft can exert upon the oil.

**ON-SITE MAINTENANCE:** Maintenance carried out at the location where the asset is used.

**OPEN (PROTECTED) MOTOR:** A motor having ventilating openings which permit passage of external cooling air over and around the windings. The term “open machine”, when applied to large apparatus without qualification, designates a machine having no restriction to ventilation other than that necessitated by mechanical construction.

**OPEN BEARING:** A ball bearing that does not have a shield, seal or guard on either of the two sides of the bearing casing.

**OPEN CIRCUIT VOLTAGE:** the maximum voltage produced by a power source with no load connected.

**OPEN EXTERNALLY-VENTILATED MACHINE:** A machine which is ventilated with external air by means of a separate motor-driven blower mounted on machine enclosure.

**OPEN PIPE-VENTILATED MACHINE:** An open machine except that openings for admission of ventilating air are so arranged that inlet ducts or pipes can be connected to them. Air may be circulated by means integral with machine or by means external to and not a part of the machine. In the latter case, this machine is sometimes known as separately- or force-ventilated machine.

**OPERATING HOURS:** The (accumulated) length of

time that an item of equipment is actually operating.

**OPERATIONAL CONSEQUENCES:** A failure has operational consequences if it has a direct adverse impact on operational capability such as lost production, increased production costs, loss of product quality, or reduced customer service.

**OPERATIONAL EFFICIENCY:** Used in the calculation of overall equipment effectiveness. The actual output produced from an asset in a given time period divided by the output that would be produced from that asset in that period, had it produced at its maximum rated capacity. Normally expressed as a percentage.

**OPERATOR BASED MAINTENANCE:** A philosophy derived from TPM, whereby basic maintenance tasks are performed by operations / production personnel. Typically such activities include cleaning and subjective inspection. Sometimes referred to as Operator Maintenance.

**ORIGINAL EQUIPMENT MANUFACTURER (OEM):** An OEM (original equipment manufacturer) is a company that build a product that it sells under its own company name.

**OUTAGE:** A term used in some industries (notably power generation), which is equivalent to a planned shut-down. A period of time during which there is a complete planned production stoppage.

**OVERCURRENT:** any current beyond the continuous rated current of the conductor or equipment. This may be value slightly above the rating as in the case of an overload, or may be far above the rating as in the case of a short circuit.

**OVERHAUL:** A comprehensive examination and restoration of an asset to an acceptable condition.

**OVERLOAD:** operation of electrical equipment above its normal full-load rating or of a conductor above its rated ampacity. An overload condition will eventually cause dangerous overheating and damage.

**OVERSPEED:** A situation where a turbine-generator runs above normal speed usually due to load rejection or some emergency condition.

**Overspeed Trip:** A device that senses shaft RPM and sets off an automatic shut-down sequence if the RPM goes over a set limit. Usually completely separate from the RPM measuring device for the governor.

**P BASE:** A special mounting similar to "D" flange except with a machine fit tenon recessed instead of protruding. Usually found on pumps.

**PACKING BOX:** The packing box surrounds the turbine shaft and forms a seal to prevent water leakage from inside the turbine out around the shaft.

**PARALLELING:** When two or more DC motors are required to operate in parallel - that is, to drive a common load while sharing the load equally among all motors - they should have speed-torque characteristics which are identical. The greater the speed droop with load, the easier it becomes to parallel motors successfully. It follows that series motors will operate in parallel easier than any other type. Compound motors, which also have drooping speed characteristics (high regulation), will generally parallel without special circuits or equalization. It may be difficult to operate shunt or stabilized-shunt motors in parallel because of their nearly constant speed characteristics. Modifications to the motor control must sometimes be made before these motors will parallel within satisfactory limits.

**PART WINDING START MOTOR:** Is arranged for starting by first energizing part of the primary winding and subsequently energizing the remainder of this winding in one or more steps. The purpose is to reduce the initial value of the starting current drawn or the starting torque developed by the motor. A standard part winding start induction motor is arranged so that one-half of its primary winding can be energized initially and subsequently the remaining half can be energized, both halves then carrying the same current.

**PATTERNS OF FAILURE:** Failures manifest in one of four primary patterns. They are described below together with their approximate percentage contribution to the whole shown.

**PEAK TORQUE:** The maximum torque capability of a motor based on the maximum current limit. **PERMANENT MAGNET SYNCHRONOUS (PMR) (HYS-TERESIS SYNCHRONOUS):** A motor with magnets embedded into the rotor assembly, which enable the rotor to align itself with the rotating magnetic field of the stator. These motors have zero slip (constant speed with load) and provide higher torque, efficiency and draw less current than comparable reluctance synchronous motors.

**PENSTOCK:** A pipe conducting water from the forebay to the scroll case of the turbine.

**PERMANENT SPLIT CAPACITOR:** Performance and applications similar to shaded pole but more efficient, with lower line current and higher horsepower rating.

**P-F INTERVAL:** A term used in reliability-centered maintenance. The time from when a potential failure (P) is first detected on an asset or component using a selected predictive maintenance task, until the asset or component has failed (F). Reliability-centered maintenance principles state that the frequency with which a predictive maintenance task should be performed is determined by the P-F Interval.

**PHASE:** Indicates the space relationships of windings and changing values of the recurring cycles of A.C. volt-

ages and currents. Due to the positioning (or the phase relationship) of the windings, the various voltages and currents will not be similar in all aspects at any given instant. Each winding will lead or lag another, in position. Each voltage will lead or lag another voltage, in time. Each current will lead or lag another current, in time. The most common power supplies are either single (10) or three phase (with 120 electrical degrees between the 3 phases).

**PHASE-TO-GROUND INSULATION** between windings as a whole and the “ground” or metal part of the motor. (A sheet material, such as the liner used in stator slots, provides both di-electric and mechanical protection.)

**PHASE-TO-PHASE INSULATION** between adjacent coils in different phase groups. (A separate sheet material on smaller motors - not required on form wound coils because the tape also performs this function.)

**PILOT EXCITER:** A small DC generator, usually built into the main turbine-generator unit, that generates power for the exciter field windings, thus “exciting the exciter.” The pilot exciter is self-contained and does not need any electrical power from outside in order to start generating. The main exciter needs the pilot exciter and the main generator needs the main exciter.

**PILOT VALVE:** Part of turbine control system or other hydraulic system that converts a mechanical motion into a flow of hydraulic fluid that is in accurate proportion to the mechanical motion.

**PLANNED DOWNTIME:** The amount of time officially scheduled in the production plan, which includes, no orders, changeovers and planned maintenance. Planning and scheduling technologies. A variety of software-based advanced planning, scheduling, and optimization systems.

**PLANNED MAINTENANCE:** Any maintenance activity for which a pre-determined job procedure is documented, for which all labor, materials, tools, and equipment required to carry out the task are estimated, and their availability assured before commencement of the task.

**PLANNED REPAIR SCHEDULE COMPLIANCE:** The number of planned repair work orders completed from the daily/weekly schedule divided by the total number of work orders on the schedule.

**PLANNING:** The process of determining the resources, methods, and processes needed to perform maintenance work efficiently and effectively.

**PLANT:** As in “power plant,” “generating plant,” hydroelectric plant, etc. All structures, equipment and machinery in a station that is used for the production and transmission of power. Includes dam, headworks, water transport system, powerhouse, and everything in it.

**PLANT/PROJECT ENGINEERS:** Employees with

primary function of planning and executing on-site plant projects (capital and expense).

**PLS:** An exclusive Reliance bearing and lubricating system which permits complete lubrication of the bearing whether the motor is mounted vertically or horizontally. This system also helps prevent over lubrication which would shorten motor life. An additional benefit to PLS lubrication is cooler running bearings.

**PLUG REVERSAL:** Reconnecting a motor’s winding in reverse to apply a reverse braking torque to its normal direction of rotation while running. Although it is an effective dynamic braking means in many applications, plugging produces more heat than other methods and should be used with caution .

**PM:** A term variously used as an acronym for Planned Maintenance or Preventative Maintenance. Sometimes used to describe the Work Order (documentation) associated with a routine maintenance task. This term has different meanings depending upon its context.

**POLARIZATION TEST:** A ratio of a one-minute meggar test (see Meggar Test) to ten-minute meggar test. Used to detect contaminants in winding insulation done typically on high voltage, V.P.I. motors which are tested by water immersion.

**POLES:** In an AC motor, refers to the number of magnetic poles in the stator winding. The number of poles is a determinant of the motor’s speed. (See Synchronous Speed) In a DC motor, refers to the number of magnetic poles in the motor. Creates the magnetic field in which the armature operates. (Speed is not determined by the number of poles).

**POLYPHASE MOTOR:** Two or three-phase induction motors have their windings, one for each phase, evenly divided by the same number of electrical degrees. Reversal of the two-phase motor is accomplished by reversing the current through either winding. Reversal of a three-phase motor is accomplished by interchanging any two of its connections to the line. Polyphase motors are used where a polyphase (3-phase) power supply is available and is limited primarily to industrial applications. Starting and reversing torque characteristics of polyphase motors are exceptionally good. This is due to the fact that the different windings are identical and, unlike the capacitor motor, the currents are balanced. They have an ideal phase relation which results in a true rotating field over the full range of operation from locked rotor to full speed.

**POND:** A body of water, usually smaller than the reservoir, artificially formed by a dam for the production of power. The water in the pond is called pondage.

**POTENTIAL FAILURE:** A term used in Reliability-centered Maintenance. An identifiable condition that

indicates a functional failure is about to occur, or in the process of occurring.

**POTENTIAL TRANSFORMER:** A transformer that converts high AC voltages to low voltages and also isolates the low voltage circuit from the high. The low voltage is used for measurements and signals in meters and relays. Sometimes called a P.T.

**POWER:** the rate at which work is performed or that energy is transferred. Electric power is commonly measured in watts or kilowatts. A power of 746 watts is equivalent to 1 horsepower.

**POWERHOUSE:** The building(s) within a generating station that have the generating units inside.

**POWER CODE:** Identifies the type of power supply providing power to a DC motor. Frequency, voltage, and type of rectifier configuration.

**POWER FACTOR:** the ratio of real power to apparent power delivered in an ac electrical system or load. Its value is always in the range of 0.0 to 1.0 or 0% to 100%. A unity power factor (1.0) indicates that the current is in phase with the voltage and that reactive power is zero.

**POWER IN:** Input power as a function of volts times amps in D.C. motors and volts times amps times power factor (Pf) in A.C. motors and expresses watts.

**POWER OUT:** The output power computed by multiplying torque times speed times a constant. Power out is equal to the power in minus all of the losses.

**PREDICTIVE MAINTENANCE:** A maintenance process based on machinery inspection, monitoring, and prediction. Machine stops for maintenance are planned depending on the predictions (condition-based). The terms Condition Based Maintenance, On-Condition Maintenance and Predictive Maintenance are often used interchangeably.

**PREVENTIVE MAINTENANCE SCHEDULE COMPLIANCE:** The number of preventive maintenance work orders completed from the daily/weekly schedule divided by the total number of preventive maintenance work orders on the schedule.

**PREVENTIVE MAINTENANCE:** A maintenance process based on preventing unexpected events from occurring by employing proper maintenance procedures, clean environment, etc. Maintenance is mostly done during planned machine stops (fixed intervals). Emphasis is placed on replacing, overhauling, or remanufacturing an item at a fixed interval, regardless of its condition at the time. Scheduled restoration tasks and scheduled discard tasks are both examples of Preventive Maintenance tasks.

**PREVENTIVE/PREDICTIVE WORK:** Scheduled, preplanned preventive and predictive (condition-based)

inspections and work orders.

**PRIMARY FAILURE:** A failure not caused either directly or indirectly by another failure or fault.

**PRIMARY WINDING:** That winding of a motor, transformer or other electrical device which is connected to the power source.

**PRIORITY:** The relative importance of a job. A safety problem has a higher priority than an energy improvement job.

**PROACTIVE:** Action before a stimulus (opposite of reactive). A proactive maintenance department acts before a breakdown.

**PRODUCTIVITY:** The primary definition here is annual dollar value of shipments per employee.

**PROGRAMMABLE LOGIC CONTROLLER:** A Programmable Logic Controller (PLC) is a piece of hardware and embedded software used to control any process machinery. The software needs to be adjusted by a control engineer after applying any control method (e.g., PID control).

**PROTECTIVE RELAY:** A relay, the principal function of which is to protect service from interruption, or to prevent or limit damage to apparatus.

**PROXIMITY PROBE:** An electronic measuring device. The probe is mounted in a fixed position close to but not touching a turning shaft. It measures the size of the gap between probe and shaft very accurately so can be used to measure shaft vibration, alignment changes, etc.

**PSIG:** Pounds per square inch, gauge, A unit of pressure measurement. "Gauge" means, the measure in the pressure above the atmospheric pressure.

**PULL-IN TORQUE:** (synchronous motors) Pull-in torque is obtained by starting the motor from rest at a pre-set torque value and specified motor terminal voltage. The maximum torque setting which the motor will accelerate to synchronous speed is the pull-in torque. Since the inertia of the connected load greatly affects the pull-in torque, this test should be run with minimum external inertia.

**PULL-OUT TORQUE:** (synchronous motors) Pull-out torque is obtained by steadily increasing the load torque from the normal operating range of a synchronous motor while maintaining specified terminal voltage. The maximum torque reading obtained without having caused the speed to drop from synchronous speed is the pull-out torque.

**PULL-UP TORQUE:** (induction motors) Pull-up torque is obtained by starting the motor from rest at a pre-set torque value and specified motor terminal voltage. The maximum torque setting which the motor will accelerate to a speed higher than the speed at which breakdown

torque occurs is the pull-up torque.

**QUALITY RATE:** A term used in Total Productive Maintenance (TPM) to indicate the rate of approved product(s) with respect to products that do not comply with the relevant quality standards. Quality rate is expressed as a percentage.

**QUALITY:** Degree to which product characteristics conform to the requirements placed upon that product. This includes reliability, maintainability, and safety. The totality of features and characteristics of a product or service that bear on its ability to satisfy given needs; fitness for use; degree of variation from the target (nominal) value; and conformance to requirements.

**R.P.M.:** (Revolutions Per Minute): The number of times per minute the shaft of the motor (machine) rotates. This is a function of design and the power supply.

**RANDOM WOUND:** The standard type of stator winding used in motors under 1,000 volts. The coils are random wound with round wire as opposed to flat form wound coils.

**REACTANCE (INDUCTIVE):** The characteristic of a coil, when connected to alternating current, which causes the current to lag the voltage in time phase. The current wave reaches its peak later than the voltage wave reaches its peak.

**REACTIVE MAINTENANCE:** Maintenance Strategy to equipment malfunctions or break downs after they occur. Maintenance is mainly performed during irregular non-planned stops. It may be undertaken where equipment is knowingly assigned a Run-To-Failure (RTF) strategy, or No Scheduled Maintenance strategy.

**REACTIVE POWER:** the mathematical product of voltage and current consumed by reactive loads. Examples of reactive loads include capacitors and inductors. These types of loads when connected to an ac voltage source will draw current, but since the current is 90° out of phase with the applied voltage they actually consume no real power in the ideal sense.

**REAL POWER:** the rate at which work is performed or that energy is transferred. Electric power is commonly measured in watts or kilowatts. The term real power is often used in place of the term power alone to differentiate from reactive power. Also called active power.

**REAL TIME ANALYZER:** Possesses superior analytical capabilities. Main Advantages: Greater resolution Low frequency capabilities

**REDUNDANCY:** The existence of one or more means (though not necessarily identical) for accomplishing a given function. Active redundancy has all items operating simultaneously, while standby redundancy has alternate means activated upon failure.

**REENGINEERING:** A one time fundamental rethinking and business process redesign to achieve dramatic improvements in performance and/or maintainability.

**RELATIVE LOSSES:** The production deferred or lost due to the specified element or system, as a percentage of the total deferment or losses.

**RELAY:** A device that is operative by a variation in the conditions of one electric circuit to effect the operation of other devices in the same or another electric circuit.

**RELIABILITY:** The probability that equipment, machinery or systems will perform their required functions satisfactorily under specific conditions within a certain time period. This can be measured by mean time between failure (MTBF) - the duration or probability of failure-free performance under stated conditions. The term reliability may also be used to denote the probability of success or success ratio.

**RELUCTANCE SYNCHRONOUS MOTOR:** A synchronous motor with a special rotor design which directly lines the rotor up with the rotating magnetic field of the stator, allowing for no slip under load. The reluctance motors have lower efficiencies, power factors and torques than their permanent magnet counterparts.

**RELUCTANCE:** The characteristic of a magnetic material which resists the flow of magnetic lines of force through it.

**REMOTE MAINTENANCE:** Maintenance carried out without physical access of the personnel to the asset.

**REPLACEMENT MAINTENANCE:** Replacement / Rehabilitation / Remodel Maintenance. All activity designed to bring an asset back into good shape, upgrade an asset to current technology, or make an asset more productive.

**RESERVOIR:** The entire body of water behind a dam. It includes the pond and may also include water that cannot be used for power production and water that would be there even if there were no dam.

**RESILIENT MOUNTING:** A suspension system or cushioned mounting designed to reduce the transmission of normal motor noise and vibration to the mounting surface. This type of mounting is typically used in fractional motors for fans and blowers.

**RESISTANCE:** The degree of obstacle presented by a material to the flow of electric current is known as resistance and is measured in ohms.

**RESISTANCE THERMAL DETECTORS WINDING:** A resistance device used to measure temperature change in the motor windings to detect a possible over heating condition. These detectors would be embedded into the winding slot and their resistance varies with the

temperature. **Bearing RTD:** A probe used to measure bearing temperature to detect an overheating condition. The RTD's resistance varies with the temperature of the bearings.

**RESONANCE:** The natural frequency of a system. When an unbalanced system is running at its resonance or one of its resonances, the vibration reaches a peak. Any change in speed from this point will decrease the amplitude of vibration.

**RESONANT FREQUENCY:** That speed at which a system resonates, see Resonance.

**RESTORING MECHANISM:** That part of a turbine control system that carries the feedback signal from the control system's output back into the control system. Usually the linkage between the gate operating ring and the pilot valve or distributing valve.

**REVEALED (OVERT) FAILURE:** A component or system failure that is automatically brought to light on occurrence.

**REVERSING:** Unless otherwise specified, a general-purpose DC motor is reversible. A DC motor can be reversed by changing the polarity of the field or the armature, but not both. When rapid reversing is necessary, the armature circuit is reversed. In some cases, it is frequently more advantageous to reverse the field connections of shunt motors, since the controls have to handle much less current, especially on large motors, than do armature-circuit contactors. An AC motor is reversed by reversing the connections of one leg on three-phase power or by reversing the leads on single phase.

**RISK-BASED INSPECTION:** Risk Based Inspection (RBI), as the name suggests, employs similar RBM risk assessment techniques, but differs significantly from RBM in terms of its basis and scope. Risk Based Inspection is concerned primarily with pressure and containment systems including (but not restricted to):

**RISK-BASED MAINTENANCE:** A maintenance improvement program whereby the maintenance processes and procedures are planned based on (failure) risks, effects, and calculated cost. This is a financially based analysis technique which focuses on establishing the relative worth of maintenance. It was originally developed as a means of reviewing existing maintenance programs, and in this mode it works well as a continuous improvement tool. RBM defines opportunities for incremental improvement through the elimination of tasks of low value and the introduction of tasks which address high commercial risk areas. As such, RBM is also valuable in transferring knowledge from existing installations to provide a baseline for new builds.

**ROLLER BEARING:** A special bearing system with

cylindrical rollers capable of handling belted applications, too large for standard ball bearings.

**ROOT CAUSE FAILURE ANALYSIS:** Generally stands for a systematic procedure to investigate the root causes of asset failures (failure diagnosis). The diagnosis results are used in maintenance tasks as a proactive way to prevent repetitive failures.

**ROTATING MAGNETIC FIELD:** The force created by the stator once power is applied to it that causes the rotor to turn.

**ROTOR:** The rotating member of an induction motor made up of stacked laminations. A shaft running through the center and a squirrel cage made in most cases of aluminum which holds the laminations together and act as a conductor for the induced magnetic field. The squirrel cage is made by casting molten aluminum into the slots cut into each lamination.

**ROUTE MAINTENANCE:** A mechanic's established route through a facility to fix the small problems. The route mechanic is usually very well equipped so he/she can deal with most small problems. Route maintenance and preventive maintenance activity are sometimes combined.

**ROUTINE MAINTENANCE TASK:** Any maintenance task performed at a regular, predefined interval.

**ROUTINE WORK:** Work done on a routine basis where the work and material content is well known and understood (for example, daily or weekly line start-ups).

**RUNNING LOAD AMPERES:** This is the current in amperes that a motor requires to produce rated nameplate horsepower output when rated nameplate voltage and frequency is provided to its terminals.

**RUNAWAY SPEED:** The maximum speed obtained by the turbine at full water flow, maximum head, and with no load on the generator.

**RUNNER:** The rotating element of a turbine that converts the energy of the water into mechanical power. Sometimes called "wheel" from the old "waterwheel."

**RUNNER CONE:** The conical extension below the crown or hub on Francis and propeller turbine runners that guides the water as it leaves the runner.

**RUN OF RIVER:** A hydro generation station that has little or no useable water storage. Also, a control system that adjusts generating unit power output to water level conditions.

**RUN-TO-FAILURE:** An equipment maintenance strategy, where no routine maintenance tasks are performed on the equipment. The only "planned" maintenance performed on the equipment is corrective maintenance after the equipment has suffered a failure. Run-To-Failure is a conscious decision as opposed to break down maintenance.

**SAFETY INSTRUMENTED SYSTEM:** Safety Instrumented System (SIS) is a function to be implemented by a SIF, or other technology safety related system, or external risk reduction facilities, which is intended to achieve or maintain a safe state for the process, with respect to a specific hazardous event. The terms SIS and SIF are often used almost interchangeably. It should be noted, though, that a Safety Instrumented System is a combination of one or more Safety Instrumented Functions.

**SAFETY INTEGRITY LEVEL:** The Safety Integrity Level (SIL) of a process is a measure of its safety, in terms of the extent to which a user may expect that process to perform safely, and in the case of failure to fail in a safe manner.

**SCADA:** Supervisory Control And Data Acquisition - SCADA system refers to the combination of telemetry and data acquisition. It consists of collecting information, transferring it back to a central site, carrying out necessary analysis and control, and then displaying this data on a number of operator screens. The SCADA system is used to monitor and control a plant or equipment. Control may be automatic or can be initiated by operator commands. SCADA system incorporates both hardware and software and provides central monitoring and control of plant and facilities. SCADA typically consist of a "master" terminal unit (MTU) and one or more "remote" terminal units (RTU).

**SCHEDULED DOWNTIME:** A period of time when the equipment is not available to perform its intended function due to planned downtime events. These include maintenance delay (delay after an interrupt is reported, but before anyone arrives to repair it); production test; preventive maintenance; change of consumables; setup; and facilities-related downtime.

**SCHEDULED MAINTENANCE:** Any maintenance work that is planned and included on an approved maintenance schedule.

**SECONDARY FAILURE:** A failure caused either directly or indirectly by another failure or fault.

**SECONDARY WINDING:** Winding which is not connected to the power source, but which carries current induced in it through its magnetic linkage with the primary winding.

**SEPARATELY DERIVED SYSTEM:** an electrical system whose power is provided by a stand-alone generator, transformer, or converter and which has no direct electrical connection or ground connection to another source (such as the utility). The NEC contains special grounding and bonding requirements for such systems.

**SERIES DC MOTORS:** Where high starting torques are required for a DC motor, the series motor is used. The

load must be solidly connected to the motor and never decrease to zero to prevent excessive motor speeds. The load must tolerate wide speed variations from full load to light load. Typical areas of application are industrial trucks, hoists, cranes, and traction duty.

**SERVICE:** the equipment and conductors that transmit electricity from the utility supply system to the building being served.

**SERVICE EQUIPMENT:** the circuit breaker or fused switch located near where the service conductors enter the building which is intended as the primary means of disconnecting the supply.

**SERVICE FACTOR:** 1. When used on a motor nameplate, a number which indicates how much above the nameplate rating a motor can be loaded without causing serious degradation, (i.e., a 1.15 S-F can produce 15% greater torque than the 1.0 S-F rating of the same motor). When used in applying motors or gearmotors, a figure of merit which is used to "adjust" measured loads in an attempt to compensate for conditions which are difficult to measure or define. Typically, measured loads are multiplied by service factors (experience factors) and the result in an "equivalent required torque" rating of a motor or gearmotor.

**SETUP TIME:** The time that is needed for resetting the channel (production line) from one product type to another. It is measured as the lost production between the start of the reset and running normal production rate for the new type. It is expressed in % of manned hours.

**SHAFT:** The rotating member of the motor which protrudes past the bearings for attachment to the driven apparatus.

**SHORT REPAIRS:** Repairs that a preventive maintenance or route person can complete in less than 30 minutes with the tools and materials that he/she carries.

**SHORT-CIRCUIT:** A defect in a winding which causes part of the normal electrical circuit to be bypassed. This frequently results in reducing the resistance or impedance to such an extent as to cause overheating of the winding, and subsequent burnout.

**SHUNT WOUND DC MOTORS:** Integral-horsepower shunt motors, are used where the primary load requirements are for minimum speed variation from full-load to no-load and/or constant horsepower over an adjustable speed range at constant potential. Shunt motors are suitable for average starting torque loads. Typical applications include individual drives for machine tools, such as drills and lathes, and centrifugal fans and blowers which are regulated by means of the discharge opening.

**SHUTDOWN:** Outage scheduled in advance for maintenance or other services. Sometimes called planned outage.

**SHUTDOWN MAINTENANCE:** Maintenance that is only performed while equipment is shutdown.

**SINGLE PLANE BALANCING:** Addition of balancing weight in a single plane to achieve coincidence of the mass center with the rotational center line.

**SINGLE-PHASE:** an AC electric system or load consisting of at least one pair of conductors energized by a single alternating voltage. This type of system is simpler than three-phase but has substantial disadvantages when large amounts of power have to be delivered.

**SKEW:** Arrangement of laminations on a rotor or armature to provide a slight angular pattern of their slots with respect to the shaft axis. This pattern helps to eliminate low speed cogging effects in an armature and minimize induced vibration in a rotor as well as reduce associated noise. Also can help to increase starting torque.

**SLEEVE BEARINGS:** A type of bearing with no rolling elements, where the motor shaft rides on a film of oil.

**SLIP:** The difference between the speed of the rotating magnetic field (which is always synchronous) and the rotor in a non-synchronous induction motor is known as slip and is expressed as a percentage of a synchronous speed. Slip generally increases with an increase in torque.

**SLOT WEDGE** to hold conductors firmly in the slot.

**SOFT FOOT:** Soft foot is a condition in which one of the machine feet does not sit flat on the base. The foot or the base may have been damaged, worn or warped. When you tighten the bolt on the foot, the machinery will distort.

**SOLENOID:** An on-off type of device that uses a magnetic coil to move a metal armature inside the coil. The armature may be mechanically arranged to move a valve stem, open a latch, etc, when the electric current in the coil goes on or off.

**SPACE HEATER:** Small resistance heater units mounted in a motor, that are energized, during motor shutdown, to prevent condensation of moisture on the motor windings.

**SPECIAL PURPOSE MOTOR:** Motor with special operating characteristics or special mechanical construction, or both, designed for a particular application and not falling within the definition of a general purpose or definite purpose motor.

**SPECTRUM (SIGNATURE):** A machine has many moving parts, such as shafts, gears, bearings, etc., each of which has its own vibration characteristics. These characteristics combine to form a vibration pattern (signature) for this machine. The vibration signature consists of multiple vibration frequencies that differ in amplitude and phase.

**SPEED:** The speed of the motor refers to the RPM's

(revolutions per minute) of the shaft.

**SPEED LOAD:** The actual motor speed in RPM with a specified external load and specified terminal voltage and frequency.

**SPEED NO LOAD:** Actual motor speed in rpm with no external load and specified terminal voltage.

**SPEED REGULATION CONSTANT:** The slope of the speed-torque curve in rpm/oz.in. or rpm/Nm.  $R_m = R/KeKt$ .

**SPEED SYNCHRONOUS:** The speed of the rotating field of an induction or synchronous motor. It may be calculated by multiplying 120 times the frequency of the power supply divided by the number of poles.

**SPIRAL CASE:** The spiral shaped water passage that completely surrounds the turbine providing a uniform distribution of water flow to the turbine. The upstream end of the spiral case connects with the penstock.

**SPLASH-PROOF MOTOR:** An open motor in which the ventilating openings are so constructed that drops of liquid or solid particles falling on it or coming toward it in a straight line at any angle not greater than 100 degrees from the vertical, cannot enter either directly or by striking and running along a surface of the motor.

**SPLIT-PHASE START, INDUCTION RUN (OR SPLIT PHASE):** Moderate starting torque, high breakdown torque. Used on easy-starting equipment, such as belt-driven fans and blowers, grinders, centrifugal pumps, etc.

**STABILIZED SHUNT-WOUND MOTOR:** A stabilized shunt-wound motor is a direct-current motor in which the shunt field circuit is connected either in parallel with the armature circuit or to a separate source of excitation voltage and which also has a light series winding added to prevent a rise in speed or to obtain a slight reduction in speed with increase in load.

**STALL CURRENT:** This is the current at stall (locked rotor) with rated voltage applied.

**STALL TORQUE:** This is the actual torque at the output shaft under stall (locked rotor) conditions.  $T_s = (KtI_s) - T_f$ .

**STANDARD INDUSTRIAL CLASSIFICATION (SIC) CODE:** A coding system of the U.S. government used to identify specific economic sectors. Coding for manufacturers encompasses the two-digit numbers of 20 through 39.

**STANDARD JOB PLAN:** A standard job plan is a generic template for a job that will be done repetitively. Their purpose is to facilitate speedy production of job plans for specific maintenance jobs. The Standard Job Plans approach is in particular applied in the maintenance environment.

**STANDARD OPERATING PROCEDURE:** Established or prescribed methods to be followed routinely for the performance of designated operations or in designated situations. Standard Operating Procedures widely used in the production / operations environment.

**STANDBY TIME:** A period of time, other than non-scheduled time, when the equipment is in a condition to perform its intended function, facilities are available, but it is not operated. This includes time when no operator is available, time when no product is available (no boards or components), and waiting on upstream or downstream equipment.

**STANDING/BLANKET WORK:** Small and/or routine and repetitive tasks covered on standing or blanket work orders. Work orders used to cover routine tasks that typically require less than 60 minutes to complete.

**STARTING CURRENT:** Amount of current drawn at the instant a motor is energized - in most cases much higher than that required for running. Same as locked rotor current.

**STARTING TORQUE:** The torque or twisting force delivered by a motor at the instant it is energized. Starting torque is often higher than rated running or full load torque.

**STATIC BALANCING:** Method of balancing without rotating the item to be balanced at full running speed. sine wave - in ideal electric systems, the characteristic shape of the alternating voltage or current wave. This shape matches the trigonometric sine function of the acute angle in a right triangle and equals the ratio of the side opposite the angle to the hypotenuse.

**STATIC FRICTION TORQUE:** A measure of the resistance to angular motion. It is due to bearing friction and cog friction. Cog friction is the magnetic drag between the permanent magnet and rotor laminations in a PM motor. It may be taken as the average of four readings taken 90° apart with a torque watch.

**STATOR:** That part of an AC induction motor's magnetic structure which does not rotate. It usually contains the primary winding. The stator is made up of laminations with a large hole in the center in which the rotor can turn; there are slots in the stator in which the windings for the coils are inserted.

**STAY RING:** The turbine stay ring has a top and bottom flange with stay vanes in between them. The vanes guide the water as it enters the spiral case and provides a rigid connection for top and bottom of the turbine.

**STRESS CONES:** A physical protection placed over the external connections point on medium and high voltage motor leads. Stress cones are used to avoid dielectric breakdown of motor leads in the vicinity of the external

connection. Stress cones generally require an oversized conduit box on large motors.

**STRING-BASED PREVENTIVE MAINTENANCE:** Usually, this refers to simple preventive maintenance tasks that are strung together on several machines. Examples of string PM's include lubrication, filter change, or vibration routes.

**SUBSYSTEM CRITICALITY:** A list of all the subsystems within a model, ranked according to the severity of their individual effect on the performance of the system. Each subsystem contains several events, grouped into a common system.

**SUDDEN FAILURE:** A failure that could not be anticipated by previous examination or monitoring.

**SUFFIXES TO NEMA FRAMES:** Letter suffixes sometimes follow the NEMA frame size. Some of these suffixes, according to NEMA standards, have the following meanings:  
**FRACTIONAL HORSEPOWER MOTOR**  
SC Face mounting  
G Gasoline pump motor  
H Indicates a frame having a larger "F" dimension  
J Jet pump motor  
Y Special mounting dimensions (see manufacturer)  
Z All mounting dimensions are standard except the shaft extension  
**INTEGRAL HORSEPOWER MOTORS**  
SA DC motor or generator  
C Face mounting on drive end  
S Flange mounting on drive end  
P Vertical hollow and solid shaft motors with P-Base flange.  
HP Vertical solid shaft motors with P-Base flange (normal thrust).  
JM Close-coupled pump motor with C-Face mounting and special shaft extensions.  
JJP Close-coupled pump motor with C-Face mounting and special long shaft extension.  
LP Vertical solid shaft motors with P-Base flange (medium thrust).  
S Standard short shaft for direct connection  
T Standardized shaft - "T" frame  
V Vertical mounting  
Y Special mounting dimensions  
Z All mounting dimensions standard except shaft extension.

**SURGE CAPACITY:** the ability of an electrical supply to tolerate a momentary current surge or inrush imposed by the starting of motors or the energizing of transformers.

**SURGE PROTECTION:** A capacitor device usually mounted in the conduit box to flatten the voltage surges that may occur as a result of lighting or a power supply surge (short-period peak). These surges could result in more than twice the rated voltage going to the windings and in turn cause winding damage.

**SURGE TANK:** A vertical chamber located in or just ahead of the penstock. It has a free water surface and serves as a reservoir to decrease and dampen pressure surges during changes in water flow to the turbine.

**SURVEY:** A formal look around. All of the aspects of the

facility are recorded and defined. The survey looks at every machine, room, and throughout the grounds. The surveyor notes anything that looks like it needs work.

**SYMPTOM:** A qualitative or quantitative measure that shows a particular equipment anomaly, directly or indirectly.

**SYNCHRONOUS MOTOR:** A motor which operates at a constant speed up to full load. The rotor speed is equal to the speed of the rotating magnetic field of the stator; there is no slip. There are two (2) major types reluctance and permanent magnet on synchronous motors. A synchronous motor is often used where the exact speed of a motor must be maintained.

**SYNCHRONOUS SPEED:** The speed of the rotating magnetic field set up by the stator winding of an induction motor. In a synchronous motor the rotor locks into step with the rotating magnetic field, and the motor is said to run at synchronous speed. Approximately the speed of the motor with no load on it.

**SYSTEMATIC PREVENTIVE MAINTENANCE:** Maintenance that is planned and programmed in a fixed period of time independent of equipment condition.

**SCREENS:** Are protection which can be placed over openings in the fan cover on a fan-cooled motor or ventilation openings of a protected motor to help keep out large particles and/or animals, but not block ventilation.

**T FRAME:** Current NEMA designation identifying AC induction motor frames. (NEMA has dimension tables which offer standard frame measurements) Replaced the previous standard "U" frame in 1965.

**TACHOMETER:** A small generator normally used as a rotational speed sensing device. Tachometers are typically attached to the output shaft of DC or AC inverter motors requiring close speed regulation. The tachometer feeds its signal to a control which adjusts its output to the DC motor or AC inverter motors accordingly (called "closed loop feedback" control).

**TAIL RACE:** A channel leading water away from the draft tube.

**TAINTER:** A type of water control gate named after the inventor.

**TASK:** One line on a task list that gives the inspector specific instruction to do one thing.

**TASK LIST:** In a maintenance inspection context, a task list provides directions about what to look for during an inspection. Tasks include inspecting, cleaning, tightening, adjusting, lubricating, replacing, etc. Tasks are specific, complete, and have a performance standard. Avoid 'ticks' as the only feedback that a task is completed.

**TEMPERATURE:** Has direct bearing on the life of a

given motor and when considering life expectancy, the following application considerations that affect the motor's operating temperature, should be taken into account

**TEMPERATURE RISE:** Some of the electrical energy losses inherent in motors are converted to heat causing some of the motor parts to heat up when the motor is running. The heated parts are at a higher temperature than the air surrounding them thereby causing a rise above room (ambient) temperature. It is important to match the proper motor and insulation system (NEMA temp. codes) to the appropriate ambient temperature. If a motor has been built with greater than 1.0 service factor then it can run at a temperature some what higher than the motor's rated operating temperature. In all cases, the actual insulation thermal capability usually is higher than the motor's operating temperature to allow for any excessive heat areas. This is called hot spot allowance. (See Insulation Systems for NEMA standard temperature codes.) Each temperature code has an associated temperature rise which when added to the ambient and hot spot should not exceed the temperature handling of the insulation system.

**TEMPERATURE TESTS:** Tests conducted to determine the temperature rise of certain parts of a motor above the ambient temperature, when operating under specific conditions.

**TERMINAL RESISTANCE:** The resistance of a motor as seen by the power supply. It is measured at the motor power leads or terminals.

**Terotechnology:** The application of managerial, financial, engineering, and other skills to extend the operational life of, and increase the efficiency of, equipment and machinery.

**TESTS:** A variety of tests are conducted to ensure motor performance, efficiency, and manufacturing integrity:

**COMPLETE:** A complete test is a test which meets the requirements of IEEE-112-1978. It includes the tests conducted in a Routine Test as well as. full-load heat run; no-load current and watts' determination of torques; efficiencies at 125, 100, 75, 50 and 25 percent of full load; power factor at 125, 100, 75, 50, and 25 percent of full load.  
**NOISE:** A test performed to verify the motor sound level, conducted in accordance with IEEE-85. The tests are performed under no-load conditions in sound room.  
**ROUTINE:** A routine test is a basic test done in the factory to the requirements of NEMA MG1, paragraph 12.51 and IEEE-112-1978 and includes the following measurements: no load current/watts; winding resistance; and high potential test.  
**WITNESS:** A witness test is a test performed with a customer representative present.

**THERMAL CAPACITY:** The ability of a motor to dissipate changing amounts of power.

**THERMAL PROTECTOR (inherent):** An inherent

overheating protective device which is responsive to motor temperature and which, when properly applied to a motor, protects the motor against dangerous overheating due to overload or failure to start. This protection is available with either manual or automatic reset.

**THERMISTOR**-Thermally Sensitive Resistor A semiconductor used to measure temperature; can be attached to an alarm or meter to detect motor overheating.

**THERMOCOUPLE**-Thermal Detection Device: A temperature detecting device made of two dissimilar metals which generate a voltage as a function of temperature. Thermocouples can be attached to a meter or alarm to detect overheating of motor windings or bearings.

**THERMOGRAPHY**: The process of monitoring the condition of equipment through the measurement and analysis of heat. Thermography is typically conducted through the use of infrared cameras and associated software. It is commonly used for monitoring the condition of high voltage insulators and electrical connections, which includes refractory in furnaces and boilers, and other applications.

**THERMOSTAT**: Units applied directly to the motor's windings which senses winding temperature and may automatically break the circuit in an overheating situation.

**THREE-PHASE**: an AC electric system or load consisting of three conductors energized by alternating voltages that are out of phase by one third of a cycle. This type of system has advantages over single-phase including the ability to deliver greater power using the same ampacity conductors and the fact that it provides a constant power throughout each cycle rather than a pulsating power, as in single-phase. Large power installations are three-phase.

**THROWAWAY MAINTENANCE**: This represents a variation on the Run-to-Failure approach. It differs in that the decision is made in advance that the corrective action on failure will always be replacement rather than repair. This is a very common approach to maintenance of electronic components, which often exhibit random failure rates, and for which no repair is feasible.

**THRUST BEARINGS**: Special bearings used to handle higher than normal axial forces exerted on the shaft of the motor as is the case with some fan or pump blade mountings.

**TIME CONSTANT, ELECTRICAL**: This is the time required for the armature or winding current to reach 63.2% of its steady state conditions.

**TIME CONSTANT, MECHANICAL**: The time required for an unloaded motor to reach 63.2% of its final velocity after applying the armature or winding voltage.

**TIME CONSTANT, THERMAL**: The time required for a motor to reach 63.2% of its final temperature under

known input and load conditions. It is measured in minutes. (The value depends on mounting and motor speed).

**TIME TO RE-INSTATE**: Time required to re-instate equipment back into production at full speed.

**TORQUE**: A property which produced, or tends to produce, rotation. A force of one pound applied to the handle of a crank, the center of which is displaced one foot from the center of the shaft produces a torque of one pound-foot, provided the force is applied perpendicular to, and not along, the crank.

**TORQUE CONSTANT**: In a D.C. motor the torque produced per unit armature current.

**TORQUE RIPPLE**: This refers to the cyclical variation of generating torque within one revolution. The torque variation superimposed on the D.C. torque component. The torque variation is a result of the permeance variation which occurs as the rotating member moves with respect to the stationary member.

**TORSIONAL RESISTANCE**: The instantaneous change velocities in a motor-load system caused by the elasticity or compliance of the shaft. In certain driving modes, the frequencies of the various parts of the motor-load system or motor-tachometer load system are in opposite directions.

**TOTALLY -ENCLOSED AIR-TO-AIR-COOLED MACHINE**: A totally enclosed machine cooled by circulating internal air through a heat exchanger which, in turn, is cooled by circulating external air. Provided with an air-to-air heat exchanger for cooling ventilating air and fan or fans integral with rotor shaft or separate, for circulating external air.

**TOTALLY -ENCLOSED ENCLOSURE**: A motor enclosure which prevents free exchange of air between the inside and the outside of the enclosure but is not airtight. Different methods of cooling can be used with this enclosure.

**TOTALLY -ENCLOSED FAN-COOLED ENCLOSURE**: Provides for exterior cooling by means of a fan(s) integral with the machine, but external to the enclosed parts.

**TOTALLY- ENCLOSED NON-VENTILATED ENCLOSURE**:: Has no provisions for external cooling to the enclosing parts. The motor is cooled by heat radiation from the exterior surfaces to the surrounding atmosphere.

**TOTALLY-ENCLOSED PIPE VENTILATED MACHINE**: A totally-enclosed machine except for openings so arranged that inlet and outlet ducts or pipes may be connected to them for the admission and discharge of ventilating air. Air may be circulated by means integral with the machine or by means external to and not a part of the machine. In latter case, these machines shall be

known as separately-forced-ventilated machines.

**TOTALLY-ENCLOSED WATER AIR-COOLED MACHINE:** A totally-enclosed machine cooled by circulating air which, in turn, is cooled by circulating water. Provided with water-cooled heat exchanger for cooling ventilating air and fan or fans, integral with rotor shaft or separate, for circulating ventilating air.

**TRANSDUCER:** A device that converts a physical (mechanical) force to an electrical signal such as a velocity transducer, accelerometer or strain gauge.

**TRANSFORMER:** A device which converts electrical power (alternating current) to electrical power of a different voltage. In this device both primary and secondary windings are usually stationary, and are wound on a common magnetic core.

**TRASH RACKS:** A steel grating arrangement in front of the intake to prevent trash from entering the penstock and turbine.

**TRENDING:** Displaying the value of measurements against time is an easy and accurate method of detecting gradual changes that might otherwise be overlooked.

**TRIBOLOGY:** The science and technology of interacting surfaces in relative motion and related practices. Friction, lubrication, and wear sciences and technology (American Society of Engineers).

**TRIP:** An automatic event that stops, shuts down, or disconnects a piece of equipment. Usually means that a relay has acted to open a breaker or shut down a generating unit. The term to "trip out" is sometimes used.

**TRUE DOWNTIME COST:** A method of recording and analyzing all significant cost metrics associated with equipment downtime in a building or manufacturing facility. TDC provides a way to assign time and/or monetary value to previously considered "non-tangible" cost of downtime. Also TDC includes downtime factors commonly overlooked to arrive at a more true value for the cost of downtime.

**TUBE COOLED:** A motor in which heat is dissipated by air-to-air heat exchange.

**TURBINE PIT:** The turbine pit on a vertical unit is the open space between the top of the turbine and the bottom of the generator. It allows access to the gate mechanism, the main guide bearing, and the packing box.

**TURBINE PIT LINER:** A steel plate lining in the turbine pit. It serves as a protective liner for the surrounding concrete. Not always used.

**TURBINE WALKWAY:** A platform in the turbine pit that provides for inspection and servicing of the gate mechanism, the turbine guide bearing, and the packing box.

**TURNAROUND:** A stop, or full or substantial interruption of plant production. Generally turnaround is considered to be a period longer than 24 hours.

**TURN-TO-TURN INSULATION** between separate wires in each coil. (Usually enamel on random wound coils of smaller motors - tape on "form wound" coils of larger motors.)

**TWO PLANE BALANCING:** The required addition of balance weight in two planes to affect the coincidence of mass and the rotational center line of a rotor. Usually required or specified when the diameter is less than twice the length of the rotor.

**U FRAME:** A previously used NEMA designation indicating frame size and dimension (prior to 1965 the standard frame sizes per horsepower rating).

**ULTRASONIC INSPECTION:** A high frequency signal is sent and reflected by the component to be analyzed. Ultrasonic inspection is especially meant to detect early, small fatigue cracks or material structure defects / changes. Also generally applied for leak detection. See Fatigue.

**UNBALANCE:** According to the International Organization for Standardization (ISO) unbalance or imbalance is defined by "that condition which exists in a rotor when a vibratory force or motion is imparted to its bearings as a result of centrifugal force". The effect occurs when a rotor's mass is unevenly distributed about the axis of rotation. This may be envisaged as a "heavy spot" on the rotor.

**UNDERWRITER'S LABORATORY(U.L.):** An independent testing organization which examines and tests devices, systems and materials with particular reference to life, fire and casualty hazards. It develops standards for motor and control for hazardous locations through cooperation with manufacturers. U.L. has standards and tests for explosion-proof and dust ignition proof motors which must be met and passed before application of the U.L. label.

**UNINTERRUPTIBLE POWER SUPPLY: (UPS)** a device that provides a constant regulated voltage output in spite of interruptions of the normal power supply. It includes filtering circuits and is usually used to feed computers or related equipment which would otherwise shutdown on brief power interruptions.

**UNIT:** The asset the task list is written for in a preventive maintenance system. The unit is a machine, system, or component of a large machine.

**UNPLANNED MAINTENANCE:** Any maintenance activity for which a pre-determined job procedure is not documented, or for which all labor, materials, tools, and equipment required to carry out the task are not estimated, and their availability assured before commencement of the task.

**UNREVEALED (COVERT) FAILURE:** A failure of a component or system that remains undetected until revealed by either proof testing or, more critically, once a demand is placed on the item to function as intended.

**UNSCHEDULED DOWNTIME:** A period of time when the equipment is not available to perform its intended function due to unplanned downtime events. These include maintenance delay, repair, change of consumables, out-of-spec input, and facilities-related downtime.

**UNSCHEDULED MAINTENANCE:** Any maintenance work not included on an approved maintenance schedule prior to its commencement. Note: this is not necessarily a breakdown, rather a break in the schedule of maintenance.

**UPTIME:** The time that an item of equipment is in service and can perform its intended function, assuming that the external resources, if required, are provided. Notice that uptime may not be the same as operating time, which is the time that the equipment is performing its intended function.

**USEFUL LIFE:** The maximum length of time that a component is left in service before it starts to experience a rapidly increasing probability of failure. The Useful Life determines the frequency with which a Scheduled Restoration or a Scheduled Discard task should be performed. For Useful Life to hold true, components must, at some consistent point in time, experience a rapidly increasing probability of failure. Research in the airline industry shows that this is only true for 11% of the components in modern aircraft.

**USER MAINTENANCE:** This is any maintenance request primarily driven by a user. It includes breakdown, routine requests, and DIN jobs.

Usually, a maximum vibration occurs at this point. A member may have several critical speeds. cell - a single device which converts chemical energy into electrical current. Sometimes also referred to as a battery.

**UTILIZATION:** The proportion of available time that an item of equipment is operating. Utilization is calculated by dividing equipment operating hours by equipment available hours, and is generally expressed as a percentage.

**VA** - abbreviation for volt ampere. Unit of apparent power.

**VACUUM DEGASSED BEARINGS:** Vacuum degassing is a process used in the purifying of steel for ball bearings assuring a very dense and consistent bearing surface. This results in a longer lasting superior bearing. All Reliance ball bearings are vacuum degassed bearings.

**VAR** - abbreviation for volt ampere reactive. Unit of AC reactive power.

**VARIABLE FREQUENCY DRIVE (VFD):** A method

of controlling the rotating speed of an electric motor.

**VARIABLE TORQUE:** A multi-speed motor used on loads whose torque requirements vary with speed as in some centrifugal pumps and blowers. The HP varies as the square of the speed.

**VELOCITY:** A measure of speed or rate of motion. It is measured in revolutions per minute (RPM) or radians per second.

**VERTICAL "P" BASE MOTOR:** A vertical motor with a special mounting face conforming to NEMA's "P" design and with a ring groove on the shaft.

**VERTICAL MOTOR:** A motor being mounted vertically (shaft up or down) as in many pump applications.

Vessels and boilers Pressurized and refrigerated storage tanks Compressors and pumps Associated pipe work and valves. Protective devices associated with such systems are also usually included. Risk Based Inspection has an integrity focus. It therefore concerns itself primarily with mitigation of safety and environmental risks.

**VIBRATION ANALYSIS:** A detailed study of the individual characteristics of a machine's vibrations, with the intention of diagnosing specific machinery faults, usually at an early stage of development. This is typically achieved by studying vibration data in the frequency domain (see FFT) and may also include the study of time domain (time waveform) data. Such analysis may be undertaken routinely as an integral part of a vibration based Predictive Maintenance program. It may also be undertaken for ad-hoc analysis of suspect rotating machinery, irrespective of the machine's inclusion in a formal monitoring program.

**VIBRATION MONITORING:** Regular monitoring of machinery vibrations undertaken as part of a Predictive Maintenance Program. Readings are compared with past levels, with significant change as an indicator of developing machinery faults. The objective is to provide valuable lead-time for maintenance planning. A comprehensive monitoring program usually includes vibration analysis.

**VISUAL INSPECTION:** Visual inspection refers to subjective inspection of machinery, and employs only the human senses. Sometimes it is referred to as "look-listen-feel" checks.

**VOLT:** The electrical potential difference or pressure across a one ohm resistance carrying a current of one ampere. Named after Italian physicist Count Alessandro Volta 1745-1827.

**VOLT AMPERE:** a unit of apparent power equal to the mathematical product of a circuit voltage and amperes. Here, apparent power is in contrast to real power. On ac systems the voltage and current will not be in phase if reactive power is being transmitted. Usually abbreviated VA.

**VOLTAGE DROP:** Loss encountered across a circuit impedance from power source to applicable point (motor) caused by the resistance in conductor. Voltage drop across a resistor takes the form of heat released into the air at the point of resistance.

**VOLTAGE:** The force that causes a current to flow in an electrical circuit. Analogous to pressure in hydraulics, voltage is often referred to as electrical pressure. The voltage of a motor is usually determined by the supply to which it is being attached. NEMA requires that the motor be able to carry their rated horsepower at nameplate voltage plus or minus 10% although not necessarily at the rated temperature rise.

**WATERSHED:** The region drained by a river or stream and all its branches. Watershed is also known as drainage area.

**WATT:** The amount of power required to maintain a current of one ampere at a pressure of one volt. Most motors are rated in Kwatt equal to 1,000 watts. One horsepower is equal to 746 watts.

**WEAR (ABRASIVE):** Abrasive wear (often referred to as wear) is the progressive removal of material, which results from the ingress, and presence of (foreign) particles (three-body wear). The surfaces become dull to varying degrees. In the case of very fine particles (dust), the surface may become shiny (polished).

**WEAR (ADHESIVE):** Adhesive wear (also referred to as smearing, skidding, galling) is defined as the transfer of component surface material from a location on one contacting surface to a location on the other contacting surface. The process requires surface-parallel motion (sliding) in the contact, and is often accompanied with high friction heat. Little, or bad lubrication, increases the probability of adhesive wear.

**WEATHER-PROTECTED MACHINE: Type I (WPI)** weather-protected machine is an open machine with its ventilating passages so constructed as to minimize the entrance of rain, snow and airborne particles to the electric parts and having its ventilating openings so constructed as to prevent the passage of a cylindrical rod 3/4 inch in diameter.

**WEATHER-PROTECTED MACHINE: Type II (WPII)** shall have, in addition to the enclosure defined for a Type 1 weather-protected machine, its ventilating passages at both intake and discharge so arranged that high velocity air and airborne particles blown into the machine by storms or high winds can be discharged without entering the internal ventilating passages leading directly to the electric parts of the machine itself. The normal path of the ventilating air which enters the electric parts of the machines shall be so arranged by baffling or separate housing as to provide at least three abrupt changes in direction,

none of which shall be less than 90 feet . In addition, an area of low velocity not exceeding 600 feet per minute shall be provided in the intake air path to minimize the possibility of moisture or dirt being carried into the electric parts of the machine.

**WICKET GATES:** Wicket gates control the flow of water through the turbine thus controlling the speed or power generated.

**WOUND ROTOR INDUCTION MOTOR:** A wound rotor induction motor is an induction motor in which the secondary circuit consists of polyphase winding or coils whose terminals are either short circuited or closed through suitable circuits. A wound rotor motor is sometimes used when high breakdown torque and a soft start or variable speed are required.

**WYE-DELTA STARTING:** A method of starting a motor at rated voltage but drawing locked rotor current and producing reduced stocked rotor torque but it provides lower starting torque than a straight delta connection. Once the load and motor have been started the wiring will switch from the WYE connection to a delta connection in which mode it must run and deliver full torque.

**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 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 rings.

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

**disribtion 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, te coil end connec-

tions are two commutator bars apart.

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

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

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

**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.

**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.

**Hardness:** The resistance of metal to plastic deformation by indentation.

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

**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 adequacy against breakdown of the insulating materials and spacings under normal conditions.

**Hot forging:** The shaping of any metal, white 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.

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

**IEC: International Electrotechnical Commission**

**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.

**Kilowatt:** A unit of electrical power. Also, the output rating of motor 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 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.

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.

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.

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).

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

Newton-Meter: Unit in 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 the interpoles that are too strong magnetically.

Overload: Operating a machine at a higher power or current rating 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.

Partial discharge: an electrical discharge that only partially bridges the insulation between conductors. Partial dis-

charges 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.

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% 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 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.

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.

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.

Pulse-width modulation: A method used in variable-speed drives to control the speed of an AC motor. The amplitude of 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.

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 station.

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: 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.

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.

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.

RPM: Revolutions per minute.

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.

Sciroscope 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.

Section (Winding): The number of coil groups in a wind-

ing before the pattern repeats.

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.

Soldering: Joining metals by fusion of alloys that have relatively low melting points (below 800F or 427C). 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.

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."

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.

Strands: The individual wires that make up a conductor.

Strain: Deformation caused by stress.

Stress: The intensity of force within a body 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 Arrestor:** 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

**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 the high temperatures. Insulation breakdown is accelerated when the insulation 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.

**Tracking:** Irreversible degradation of insulated 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.

**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.

**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 800F or 427C 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.





























