

# GLOSSARY

## A

ABNORMAL OR ASSIGNABLE VARIATION	Assigned to a specific cause or problem. Process may be unstable, or it may be out of statistical control.
A-251 INHIBITOR	Used with Vertan™ in the chemical cleaning process to coat (protect) the insides of the tubes.
ABSOLUTE HUMIDITY	The actual weight of water vapor in grains or pounds per cubic foot of a mixture of air and water vapor. Often measured as ounces of water per cubic foot of air.
ABSOLUTE PRESSURE (PSIA)	Total of all exerted pressure, including atmospheric. Uses the complete lack of any pressure as its zero point reference. Begins at theoretical zero pressure, which is a condition of no pressure and a total absence of air. Difference between absolute pressure and gauge pressure is atmospheric pressure. PSIA - PSIG = 14.7 PSI. Zero pressure is equal to 30" Hg.
ABSOLUTE ZERO	The point at which molecular motion stops, objects contain no heat, and temperature is at its lowest possible measurement.
AC MOTOR	Alternating Current Motor. Operates through the interaction between the magnetic fields of its rotor (magnet) and its stator. In most AC motors, alternating current flow causes the magnetic fields around the stator windings to increase, decrease, and change polarity.
AC TURNING GEAR OIL PUMP	A small motor driven centrifugal oil pump in the turbine lubricating oil system. Provided to supply bearing oil for operating the unit on turning gear and to serve as a backup to the auxiliary oil pump. See Turning Gear.
ACCELERATION	The rate of change in velocity in a given unit of time. A measure of how fast an object changes speed.
ACCUMULATOR	A pressure vessel divided into two chambers by means of a rubber diaphragm, having a liquid stored under pressure in one chamber and high pressure nitrogen gas in the other.
ACID	Any of a large class of substances, the aqueous solutions of which are capable of turning litmus indicators red, of reacting with and dissolving certain metals to form salts, of reacting with bases or alkalis to form salts, or have a sour taste. A substance that ionizes in solution to give up a proton. Any molecule or ion that can

	combine with another by forming a covalent bond with two electrons of the other. A liquid that contains a relatively high concentration of hydrogen ions and has a pH of less than 7.
ACIDIC	Pertaining to an acid, generally of a solution or environment having an excess of hydrogen ions of pH less than 7.0.
ACTUAL CAPACITY	Takes into account the condition of the equipment and the process variables that influence how much product a system can actually produce.
ACTUATOR	A mechanism that moves or controls a device such as a valve. Operates and positions valves in response to signals from controllers. Commonly used with valves that are designed for throttling, or regulating, flow. Actuators reduce the need for operators to go to every valve that needs repositioning and operate the valve by hand. Valves can be repositioned from a central, remote location such as a control room. Three basic types are: pneumatic, hydraulic, and electric.
ACW	Auxiliary Cooling Water
ACWP	Auxiliary Cooling Water Pump
ADDITIVES	Substances that are mixed with oils and greases to improve their lubricating abilities.
ADHESION	The physical attraction or joining of two substances, especially the macroscopically observable attraction of dissimilar substances.
ADHESIVE FORCE	A molecular force that exists between unlike molecules.
ADSORPTION	A phenomenon in which a thin layer of molecules adhere to the surface of a material. A catalyst that works through adsorption attracts and holds reactant molecules on its surface.
ADSORPTION-TYPE CATALYST	Attracts and holds reactant molecules onto it surface.
AES	Allied Energy Services; coal fired; 2 boilers; 1 turbine; 180 MW. Selected for "less largest unit" on the generating schedule because of the single turbine.
AFTER CONDENSER	The second stage air ejector condenser.
AFTERCooler (COMPRESSOR)	A shell and tube heat exchanger that cools the air at the outlet of an air compressor to reduce the volume and decrease the temperature of air after it leaves the compressor. As the compressed air passes through the tubes in the aftercooler, it is cooled by water flowing around the tubes. During the cooling process, any water vapor that is in the air condenses. As a result,

AIR	there may be moisture in the compressed air. Moisture must be removed to prevent it from damaging equipment that uses the compressed air. Second stage air pressure is approx. 120 psi.
AIR BINDING	A colorless, odorless, tasteless gaseous mixture, mainly nitrogen (approx. 78%) and oxygen (approx. 21%) with lesser amounts of argon, carbon dioxide, neon, helium, and other gases.
AIR CIRCUIT BREAKER (ACB)	Air trapped in either the water side or the shell side of a feedwater heater as result of improper venting; causes the terminal temperature difference (TTD) to increase while the drain cooler approach (DCA) remains normal.
AIR CIRCUIT BREAKER (ACB)	A circuit breaker in which the interruption of the circuit occurs in air. The simplest type of an air circuit breaker is the common light switch as used in the home. Although frequently referred to as a switch, it is really a circuit breaker since it opens and closes a circuit under load. These devices use the principle of rapid movement to minimize the arc. A snap acting mechanism is used to insure fast operation regardless of the speed with which the handle is operated. In power plants low voltage ACB's are usually applied to 230 volt and 480 volt circuits. Medium voltage ACB's are usually applied to breakers that service 2400 or 4160 volt circuits.
AIR COOLER SECTION	A section of tubes, located above the air exit lane in a condenser that condenses nearly all of the steam in the steam-air mixture flowing through the air exit lane.
AIR EJECTOR	Jet pumps that use high velocity fluid flow to create a vacuum. Use steam to remove air and other non-condensable gases from the condenser.
AIR EXIT LANE	A low pressure area in the center of the tube sections of a condenser. The low pressure causes the steam-air mixture to flow into the low pressure region and through the tubes in the air cooler section.
AIR HEATER	A boiler efficiency device which reclaims low temperature heat energy from the stack gas by transferring it to the incoming combustion air before it reaches the furnace. This is reflected in fuel savings and an increase in boiler efficiency. Consists essentially of slightly separated metal plates arranged parallel to the gas-air flow. These plates are supported in a frame attached to a slowly rotating shaft. As these plates pass progressively through the gas stream they are heated and then, in passing through the air stream, give up heat to the air before again entering the gas

	stream, thus maintaining the regenerative cycle. The support-bearing assemblies of the air heater are provided with their own lube oil system, consisting of a pump, filter, and cooler (W5&6). Power to turn the rotor is supplied by an electric motor through a speed reducer. An auxiliary air motor is provided for operation in the event the electric motor fails. The heating element is equipped with three types of seals. The radial seals prevent intermingling of combustion air and flue gases. The circumferential seals at the inlet and outlet rotor shell restrict the flow of air or gas from bypassing the heating elements. The seal at the inlet and outlet of the rotor shaft prevents the escape of gases to the atmosphere.
AIR HEATER SOOT BLOWER	A device that cleans the air heater by sweeping across the gas outlet surface of the heating elements. An air-driven motor, with reduction gears, drives a gear and cam to operate the blower.
AIR PREHEATER	A device normally used to control the cold end metal temperature of an air heater by preheating the air before it reaches the air heater.
AIR RECEIVER	Purpose is to dampen pulsation or pressure waves in compressor discharge. It also acts as a reservoir and precipitates any moisture that may have carried over from the aftercooler.
AIR REMOVAL SYSTEM	A system that removes air and non-condensable gases and maintains the vacuum created by the volume reduction of condensing steam; also used to establish a normal vacuum in a condenser prior to turbine startup. The complete air removal system consists of a single-stage high-capacity hogger jet and two sets of primary and secondary ejectors, with associated inter and after condenser and drains.
AIR SWITCH	A switch in which the interruption of the circuit occurs in air.
ALARM	Designed to alert the operator when a process variable changes beyond an acceptable range. Can be visible, audible, or both visible and audible. Usually activated by electrical switches, which are operated by sensing devices connected to the process. Some sensing devices are mechanical, such as a pressure switch that uses a Bourdon tube to respond directly to the pressure in a tank. Other sensing devices are electrical, such as a thermocouple, which generates a voltage proportional to the temperature that it measures.
ALARM RELAY (ALARM SIGNAL)	A relay which operates an audible or visible signal to call attention to some action automatically performed or to some condition that requires operator attention.
ALGAE	A microorganism that builds up in condenser cooling water

ALGEBRA	systems and is very difficult to remove mechanically. Chlorine or bromine are usually utilized to prevent algae buildup.
ALGEBRAIC OPERATION	A branch of mathematics that uses letters or symbols to represent relationship between mathematical and physical concepts.
ALKALI (OR A BASE)	Includes numbers, letters, and symbols.
ALKALINITY	A liquid that contains a relatively high concentration of hydroxyl ions and has a pH of more than 7.
ALKALINITY	Having a pH greater than 7. The alkali concentration or alkaline quality of an alkali-containing substance.
ALLOY	A man-made substance composed of two or more metals combined by heating.
ALTERNATING CURRENT	An electric current that reverses direction in a circuit at regular intervals.
ALTERNATOR	An electric generator that produces alternating current.
AMBIENT AIR	The air surrounding or encompassing an object. 23% oxygen, 77% nitrogen
AMMETER	An electrical device that measures current flow. The unit of measure for current flow is usually amperes, or amps.
AMMONIA	A chemical used in a steam plant for pH control of condensate and feedwater systems. Also contribute to maintaining proper steam PH to prevent acid attack (corrosion) in the superheat and turbine sections. A by-product of hydrazine.
AMPERE or AMP (I)	The basic unit of measure of an electric current. It is proportional to the quantity of electrons flowing through a conductor past a given point in one second. It is the unit current produced in a circuit by one volt acting across a resistance of one ohm.
AMPERE HOUR (Ah)	Unit of electric current over time, equal to the charge transferred by a steady current of one ampere flowing for one hour.
AMPERE-TURN	The magnetizing force produced by a current of one ampere flowing through a coil of one turn. A turn is one wrap or complete loop of wire around the core. Determined by multiplying the number of turns by the amount of electrical current in the coils.
AMPLITUDE	The maximum instantaneous value of an alternating voltage or current, measured in either the positive or negative direction.
ANALOG CONTROL SYSTEM	Does not use a computer. An analog control loop contains an analog controller that uses mechanical devices to control the value

	of a process variable. For example, an analog controller might use a pressure-sensing element, levers, and mechanical linkages. An analog controller can control the value of only one process variable at a time, so it can be part of only one control loop at a time. An analog signal can take on any value between two extreme values. In a process system, it is common to see analog signals in the form of physical properties such as pressure, current, and voltage.
ANALOG INDICATOR	Indicators that use a pointer and a scale.
ANALOG SIGNAL	A type of signal that can take on any value between two extreme values.
ANALYTICAL VARIABLE	A process variable that is based on the physical or chemical composition of materials.
ANALYZER	An instrument that measures and indicates physical or chemical characteristics that are based on the composition of a material.
ANGLE VALVE	A type of globe valve used to change the direction of fluid flow. Easy to identify because of its globe-shaped body with piping connections at a right angle.
ANION(S)	A negatively charged ion resulting from the dissociation of salts, minerals or acids in water. The negatively charged ions in a water solution such as the chloride of sodium chloride.
ANION EXCHANGER UNITS	The exchanger step in the demineralizing system in which OH (hydroxyl) ions are substituted for all the anions in the water except the bicarbonates and the silicates. PH values exiting this bank should be close to neutral (6.0 - 8.5). Conductivities can range between 1.0 and 20, depending on how well the unit is performing.
ANION MEMBRANE (EDR)	An anion exchange resin cast in sheet form through which only anions will transfer.
ANION RESIN BEADS	Resin beads in an ion exchanger that attract negatively charged ions.
ANNUNCIATOR	Audible or visible alarm or signal initiated electrically. A lighted panel that flashes when an alarm sounds to indicate the specific problem or condition.
ANODE	The electrode in a cell (voltaic or electrolytic) that attracts the negative ions and repels the positive; the positive pole.
APPARENT POWER	The amount of power that a generator would produce if inductive reactance or capacitive reactance were not present. The total power in a circuit. It results from both resistance and reactance

	and is measured in VA (volt-amperes). The result obtained from multiplying current and voltage indicated values.
APS	Automatic Pump Start. Commonly used to categorize pressure switches that will automatically start a pump or fan that is in the standby component on a high or low, pressure or flow condition.
ARCING	The flow of current through air. The discharge of electricity across a gap in a circuit. Breaking down of insulation could cause arcing.
ARCING CONTACTS	The contacts on which the arc is drawn after the main contacts of a switch or circuit breaker have parted.
AREA CONTROL ERROR (ACE)	The increase or decrease in total system MW generation.
ARMATURE	The stationary part of the generator, also known as the stator.
ARRAY	Stage; a section of a Reverse Osmosis system made up of one or more tubes. Usually an RO Bank consists of two or three Arrays.
ASH	A noncombustible form of solid waste that is essentially the residue of burned coal.
ASI	Analog Slave Input.
ASME	American Society of Mechanical Engineers
ASME POWER TEST CODE 6	A method of determining turbine heat rate that considers all turbine-related energy flows; used for acceptance testing and for establishing a benchmark for future testing.
ASO	Analog Slave Output.
ASPIRATING AIR	Supplied only when used, is normally compressed air from the station air system. A back-up to the sealing air.
ATMOSPHERIC BLOWOFF TANK	Serves as a collection point for water and steam from the several water wall header drains and the continuous blowdown line from the boiler. The water entering the tank partially flashes into steam which is exhausted to the atmosphere. The remaining impurities and water are drained to waste.
ATMOSPHERIC PRESSURE	The atmosphere, or air, is a mixture of gases that surrounds the earth to a depth of several miles. The air has weight because gravity pulls the air towards the earth. The weight of the air exerts a pressure on the earth's surface. That pressure is called atmospheric pressure. Atmospheric pressure is related to height or depth. This means that the pressure of the atmosphere varies with the height of the air above the earth's surface. Has a value of about 14.7 psi at sea level.

ATOM	Smallest division of an element that can be made while still retaining the chemical properties of an element. Made up of small particles which include electrons (neg. charge) that revolves around a nucleus. The nucleus are made up of protons (pos. charge), and neutrons (no charge). When atoms combine with other atoms, they form molecules. An atom has the same number of electrons as it has protons. When an atom has the same number of electrons as protons, the positive and negative charges are balanced. The atom is said to be electrically neutral. Many forces in nature can upset the balance of electrically neutral atoms.
ATOMIC NUMBER	The number of protons in one atom of an element.
ATOMIC WEIGHT, OR ATOMIC MASS	The weight of an element with respect to the weight of carbon. Atomic weights are expressed in atomic mass units (AMU). One AMU is approximately the weight of one proton or one neutron. Can be found in a periodic table of the elements.
ATOMIZATION	The process of dispersing fuel oil into the furnace as a mist, so that a larger surface area of the oil is exposed to the combustion air.
ATOMIZER BURNER	The atomizer steam and the fuel oil enter the gun through the upper and lower ports respectively of the stationary union, then pass through the removable union and are carried separately through the entire length of the gun by means of two concentric oil gun pipes. Steam passes through the outer pipe, oil through the inner pipe. Mixing and atomization takes place in the mixing chamber of the nozzle. The atomized oil is discharged into the furnace, in the form of a fine spray, through the holes in the spray plate.
ATTEMPERATOR	A device that sprays water into the steam flowing through a superheater or re heater to prevent the final outlet steam temperature from exceeding established limits. Spray water is taken from a point in the discharge line from the boiler feed pumps. Flow of spray water is controlled by the air flow load index readjusted by steam temperature, and with spray water flow tie-back.
ATTRIBUTE DATA (SPC)	Data that can be counted. Based on the number of items that fail to conform to some standard. An example, is the number of products that either pass or fail a standard test. Four types of chart that use these attributes as data are C charts, U charts, NP charts, and P charts. C charts and U charts deal with the number of defects in a product.
AUTOMATIC CHEMICAL	A system providing for the feeding of chemicals automatically

FEED SYSTEM	into the feed water system of a boiler in proportion to the flow and pH.
AUTOMATIC LOAD FREQUENCY CONTROLLER	A device that automatically increases or decreases generator load within a specified band to meet system demands for power.
AUTOMATIC PUMP START (APS)	An instrument which senses abnormal pressure levels in a line carrying fluids or gases and will automatically start a pump or pumps to restore the line pressure to normal level. Pressure switches monitor the bearing oil pressure. The normal bearing oil pressures is 12 to 15 psi. The auxiliary oil pump is set to start at 9 to 10 psi, the AC turning gear pump starts at 6 to 8 psi, and the DC emergency pump starts at 5 psi. The pump will start automatically, but must be manually stopped. The control switch for the pumps should have three positions; Stop, Automatic, and Run.
AUTOMATIC TAP CHANGER	A device that automatically adjusts the voltage output of a transformer to compensate for variations in the transformer's voltage; accomplished by modifying the ratio of turns in the transformer's windings.
AUTOSTOP TRIP VALVE	Designed that when it opens, the autostop oil is dumped to drain, causing the throttle valves, the interceptor valves and reheat stop valves to close. At the same time, it also causes the governing emergency trip valve to operate. The autostop pressure is connected to an emergency trip relay which directs high pressure oil into the control oil header, thus creating a high control oil pressure. Therefore, all valves capable of admitting steam into the turbine will close. An air pilot valve used to monitor the extraction non-return valves is also triggered from the autostop pressure. The autostop valve is also tripped when any one of the protective devices, such as the low bearing oil, low vacuum, solenoid, thrust bearing trip, etc., are actuated.
AUTO-TRANSFORMER	A transformer in which the primary and secondary have a common winding.
AUXILIARY CONTACTS (MCC)	An additional set of contacts usually attached to the armature and operated by it. Used to control auxiliary control functions. For example, they may provide current for indicating lights such as the lights used to indicate whether a motor is on or off.
AUXILIARY GOVERNOR	Mounted on the control block with the main governor. Hydraulically connected to the governing control oil system through a check valve and has no speed changer or speed setting. It is a hydraulically balanced governor which produces a control pressure of approx. 8 psi when the unit is operating at normal

speed. If the turbine should accelerate due to loss of load at a rate of 120 rpm per second or faster, the auxiliary governor will assume control of the turbine. The governor run-back switch will close and run the main governor back to approx. rated speed. When the speed of the turbine levels off, the control automatically returns to the main governor. In the event of the complete or partial loss of electrical load the speed will rise sharply since the main governor speed changer is in such a position that no load speed is higher than 3600 rpm. This sudden speed rise will cause the acceleration response feature of the auxiliary governor to momentarily assume control of the turbine by increasing the control oil pressure causing the governing and interceptor valves to close rapidly. With the governing and interceptor valves closed, the speed of the unit will decrease at a rate depending upon the residual load left on the generators. As the unit reaches a speed which will be determined by the setting of the speed changer, the interceptor valves will regulate the flow of steam, holding the speed of the unit at this value. As the pressure in the reheater circuit decreases, the interceptor valves will continue to open. The speed will then tend to drop and the governing valves open to control speed at the no load speed corresponding to the setting of the speed changer.

**AUXILIARY LOAD**

The total amount of electrical power needed to run auxiliary components such as pumps and fans.

**AUXILIARY OIL PUMP**

A pump in a turbine lubricating oil system used to provide hydraulic and lubricating oil during startups and shutdowns, when turbine speed is too slow for the main oil pump to be effective. A steam driven pump (W3&4), or electrically powered motor. Under control of a separate regulator which is actuated by the pressure in the oil system and automatically starts the auxiliary oil pump if, for any reason, the bearing oil pressure in the system drops below a predetermined point ( 8-10 psig ). The discharge from this pump provides the high pressure oil required to operate the control mechanisms and regulators, primes the main pump through a regulating check valve, and provides the bearing oil through an adjustable orifice. The regulating check valve and bearing oil orifice are adjusted on the initial start to give the desired pump inlet pressure and bearing pressure. The main oil pump suction adjustable check valve should be adjusted to maintain a pressure of 30 to 35 psig. The main oil pump will overtake the auxiliary oil pump at about 90%.

**AUXILIARY POWER SUPPLY**

The power required for operation of generating station auxiliary equipment.

AUXILIARY RELAY	A relay which operates in response to the opening or closing of its operating circuit to assist another relay or device in the performance of its function.
AUXILIARY STEAM	Steam used for purposes other than driving a main turbine or heating feedwater. During normal operation the auxiliary steam is taken directly from the boiler drum and a valve pressure controller reduces the pressure to 200 psi. Used in makeup water purification systems, steam tracing lines, reboilers, turbine-driven boiler feed pumps, burner front, and burner cleaning stations.
AVOIDED COST	The incremental or additional costs to an electric utility of electric energy, or firm capacity, or both, which costs the utility would avoid by.
AXIAL FLOW COMPRESSOR	An air compressor that accelerates air along the compressor shaft, causing the air to be compressed. During operation, the rotating blades spin like the blades of a fan. They draw gas in and accelerates the gas to increase its velocity. The rotating blades then push the gas towards the stationary blades. When the gas contacts the stationary blades, they cause the gas to change direction as it flows toward the compressor's discharge. This causes the gas to slow down. As the gas slows down, its pressure increases. Main parts include a shaft, bearings, seals, rotating blades, stationary blades, a suction line, and a discharge line.
AXIAL FLOW PUMP	Liquid moves along or parallel to the axis of rotation or the shaft. Main parts include a shaft, bearings, seals, rotating blades, stationary blades, a suction port, and a discharge port. May consists of a single runner in a cylindrical case, or it may consist of a runner with one or two sets of fixed guide vanes. This type of pump develops pressure by having the runner blades shaped as air foil sections like an airplane propeller. The shape or inclined angle of the rotating blades produces a force on the liquid thereby raising its pressure. Discharge pressure lower than radial flow pump, but may be able to move large quantities of liquid. This type of pump is seldom used in a power plant.
AXIAL SEAL	A type of seal used to prevent air from leaking into the gas along the shaft of an air heater.
AXIAL THRUST	A force created along the shaft of a pump that tries to push the shaft in the direction of lower pressure. End to end movement; movement that is along the axis of the shaft.

**B**

BABBITT METAL	A soft, silvery, antifriction alloy composed of tin with small
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	amounts of copper and antimony. Used on the turbine journal bearings. Melts at approx. 200°F.
BACK PRESSURE	The difference between atmospheric pressure and condenser vacuum. Condenser vacuum measured in inches of mercury absolute. One way to view back pressure is as the <u>resistance</u> to flow into the condenser from the turbine. It is the amount of absolute pressure the turbine is exhausting into. This should always be as little as possible when the turbine is on-line. When you deal with back pressure, barometric pressure must be taken into account. To determine back pressure we must use the vacuum reading in the condenser. This is the reading that will be in inches of mercury. If the condenser vacuum is 25" Hg, we must subtract this reading from the barometer. Therefore, if the barometric (atmospheric) pressure is 29.09" Hg, and the condenser vacuum is 25" Hg, the back pressure (condenser absolute pressure) will be 4.09" Hg.
BACK WASHING	A process of reversing the flow of water through a component such as a filter or an ion exchanger to remove trapped material. A means of removing any blockage from condenser tube sheets by reversing the flow of circulating water through the sheets.
BAFFLES	Metal plates that change the direction of the flow of exhaust gases in a silencer. Partitions that help support the tubes and increase the efficiency of heat transfer in a shell and tube heat exchanger by directing shell-side flow.
BAGHOUSE	Uses a series of porous bags installed in the gas flow path to physically filter particulates from the combustion gases. As the combustion gases are drawn through the baghouse, particulates are trapped on the surface of the bags, while the rest of the combustion gases pass through.
BALANCE LINE	A pressure equalizing line.
BALANCED DRAFT BOILER	A boiler that uses a forced draft fan, and an induced draft fan, to create a negative furnace draft.
BALANCED EQUATION (CHEMICAL REACTION)	Indicates the proportions in which the reactants will react and the proportions in which the products will be formed. The proportions of reactants and products are expressed in terms of molecules.
BALANCING DRUM LEAKOFF	A flow created by a pressure differential in a balancing line; insures that the pressure across the balancing drum will not equalize.
BALANCING PISTON, OR	A device that helps to compensate for axial thrust by creating

**BALANCING DRUM**

another force that opposes the axial thrust. A piston mounted on the shaft inside a chamber at one end of a multi-stage pump and used to reduce axial thrust created by the spinning impellers. Used at the high pressure end of the high pressure turbine rotor, designed so as to partially balance the thrust toward the coupling end. This piston serves a dual purpose of balancing the thrust and serving as the high pressure gland. Leakage past this piston is reduced to a minimum by labyrinth and water seals.

**BALL CHECK VALVE**

Consists of a valve body, a seat, and a ball. When fluid flows through the valve, the ball is pushed out of the seat. As the ball is lifted, it rotates in the fluid flow. It is difficult for solid materials in a fluid to stick to the spinning ball, so these valves are useful for handling liquids containing solid particles. This self-cleaning effect helps ensure that the valve will close properly. When flow stops, gravity pulls the ball onto the seat. Backflow will then hold the ball firmly on the seat. Ball check valves can be used in either horizontal or vertical piping runs.

**BALL VALVE**

A type of plug valve in which a ball with a hole pivots to allow fluid flow. Commonly used for on/off purposes requiring fast valve positioning in process systems. Consists of a valve body, a stem with a handle attached to it, a ball that has an opening straight through it, a seal around the stem that prevents leakage along the stem, and two-part, ring shaped seats, which are commonly called wipers. A ball valve can be opened or closed by turning the handle one quarter turn. The handle is usually aligned with the opening in the ball, so that valve position can be determined by the handle position. The body of a ball valve may be either cylindrical or round in shape. Used in lines less than 3 inches in diameter, and less than 300 psig pressure. Chemical systems application.

**BAR GRAPH**

A graph consisting of columns, or bars, that may be arranged either vertically or horizontally, to provide information such as process variable values.

**BAROMETER**

An instrument which measures atmospheric pressure. Consists of a sealed tube filled with mercury, and a bowl. When the bottom of the tube is unsealed, mercury flows from the tube into the bowl. The weight of the column of mercury exerts pressure, and the atmosphere also exerts pressure. As a result, the flow from the tube into the bowl stops when the pressure exerted by the weight of the mercury in the tube equals the opposing pressure exerted by the atmosphere on the mercury in the bowl. In other words, the mercury will flow until the pressure exerted by the mercury column is equal to atmospheric pressure. The amount of pressure

	exerted by the atmosphere can be determined by measuring the height of the mercury column. At sea level, atmospheric pressure can support the weight of a column of mercury that is about 30" high. Atmospheric pressure can support a column of water about 34 feet high. Standard atmospheric pressure equals 30" of mercury, or 14.7 psi.
BARREL (OF OIL)	A unit of measure equal to 42 gallons.
BASKET STRAINER	A strainer used to filter out large amounts of impurities from fluid in a piping system that is subject to large buildups of impurities.
BATTERY	A group of several cells connected together as a unit for furnishing electric current.
	A device for generating an electric current by chemical reaction (electrolytes). Before the chemical reaction begins, both electrodes are electrically neutral, that is, they have an equal number of protons and electrons. The chemical reaction that takes place in a battery causes electrons to leave one of the electrodes. When this occurs, that electrode becomes positively charged. At the same time, the electrons build up on the other electrode, which becomes negatively charged. The oppositely charged electrons in a battery create an electrical potential. If the electrodes are connected as part of a complete flow path, the electrical potential will cause a flow of electrons, or current. A group of several cells connected together as a unit for furnishing electric current.
BATTERY CHARGERS	Consist of motor-generator sets, the motor operating at 440 AC. Control of the DC output is by means of a hand-operated field rheostat.
BEARING	Turbine components designed to support the rotor and allow it to rotate while preventing metal-to-metal contact between stationary and moving parts. A bushing, sleeve, box, or shell within which the shaft rotates. Performs three functions: they carry loads, they reduce friction, and they position moving parts.
BEARING OIL PRESSURE RELIEF VALVE	Provided in the bearing oil line to compensate for moderate changes in oil requirements. Maintains the bearing oil pressure to within 12-15 lbs. If the input oil pressure to the bearings change, the output changes dramatically.
BEARING PEDESTALS (STANDARDS)	Supports for turbine bearings and turbine casings.
BELLOWS	Pressure element; basically a movable, accordion-shaped tube that converts changes in pressure to mechanical motion. A thin-walled, corrugated metal tube that expands and contracts in

	responds to changes in pressure.
BELLOWS TRAP	A thermostatic trap in which a bellows expands or compresses to open or close the outlet valve.
BENCHBOARD (CONTROL DESK)	A switchboard having a horizontal or slightly inclined section for mounting control switches, indicating lamps and instrument switches, and constructed with or without vertical instrument sections.
BENTONITE	A common additive that is a type of dried clay, used to thicken grease. Far more heat resistant than some other grease thickeners. Resist high temperatures, so it keeps grease from melting.
BERM	A structure (concrete, hollow tile, or earthen) used to retain leakage from tanks, ponds, and/or sumps.
BHP	Broken Hill Proprietaries Refinery (sold to new owner)
BIAS	A loading pressure adjustment made by the operator to balance or unbalance two or more control pressures.
BIAS	A loading pressure adjustment made to balance or unbalance two or more control pressures.
BIMETALLIC DEVICE (MCC)	A type of thermal overload device. One part of the bimetallic device is a heater, which is in the motor controller's power circuit. The bimetallic device also contains a bimetallic strip, which is a strip made up of two different metals that are bonded together; a spring-loaded mechanical linkage; contacts; which are in the motor controller's control circuit; and a reset button. The two metals in the bimetallic strip expand at different rates when the strip is heated by the heater. Under normal circumstances, the bimetallic strip holds the mechanical linkage in place, which keeps the contacts closed so that there is a complete path for current to flow to the motor controller's "M" coil. When the current level in the power circuit exceeds the rated value of the bimetallic device, enough heat is generated by the current flow through the heater to cause the bimetallic strip to bend. The strip bends because the two metals in the strip expand at different rates. When it bends, it releases the mechanical linkage. When the mechanical linkage is released, the force of the spring pulls the contacts open. Opening the contacts interrupts the current flow in the control circuit to the controller's "M" coil. The interruption of current flow in the control circuit opens contacts in the motor controller. As a result, current flow in the power circuit to the motor is interrupted, and the motor stops.
BIMETALLIC	A temperature measuring device that operates on the principle that

THERMOMETER	different metals expand and contract at different rates in response to changes in temperature. Has a bimetallic element, which is a strip that is made of different metals and formed into a coil. An increase in temperature causes the metals to expand at different rates. The unequal expansion causes the element to rotate slightly. The rotation turns a rod, which, in turn, moves a pointer. The pointer movement indicates the change in temperature. If the temperature decreases, the opposite effect occurs. Overheating, or overranging a fluid or bimetallic thermometer can damage it.
BIOCIDE	A chemical, such as chlorine, used to prevent biological organisms in water from growing into slime deposits.
BLACK START	A startup of the plant when all station power has been lost and no outside source of electricity is available.
BLADE	A rotating or fixed part of a turbine. Rotating blades convert energy in steam into mechanical energy, which causes rotation of the turbine shaft. Fixed blades direct the steam into the rotating blades.
BLEEDER TRIP VALVE	Extraction check valves (or non-return valves) are provided in most of the extraction lines from a steam turbine. Their primary function is to prevent steam from entering the turbine on loss of load and thus they comprise an important element in the control which <u>protects the turbine against excessive destructive overspeed</u> . Also provide some protection against water induction. Power closed on heater level. When the bleed trip is energized, a spring opens the non-return valves about 10%, with steam pressure from the heaters slamming it closed the rest of the way. Two reasons for testing are: to be sure they work properly, and to remove any binding caused by scale.
BLIND TRANSMITTER	A transmitter that does not provide a local visual indication of the value of the process variable that is being monitored.
BLOCK DIAGRAM	A drawing that uses squares or rectangles to represent major systems or components in a system. Blocks may represent the energy source, devices that perform a control function, and the load, or demand, in a system. The lines represent the transmission paths for material or energy through the system.
BLOCK VALVE	Isolation valves. On boiler bottom blowdown, valve downstream of root valve. Opened after root valve is opened, and closed before root valve is closed.
BLOCKED LOAD	Load held steadily at a fixed point.
BLOWBACK	The difference between the pressure needed to open a safety valve

	and the pressure at which the valve snaps shut; also called blowdown.
BLOWDOWN	A type of drain that may be opened during boiler operation for specific purposes, such as to remove contamination that has built up in the drum. Boiler blowdowns are used as a means of controlling boiler water concentrations (alkalinity) and to remove sludge formation. In extreme cases of sludge formation, or in cases of poorly treated feedwater with high solids contents resulting in carry-over, the boiler may be blown down intermittently through the downtake drain valves or the waterwall supply drum drains. <u>In no case should the waterwall header drains be used for blowing down the boiler while the unit is steaming.</u>
BLOWDOWN VALVE	A valve, usually found in a drain line, used to remove unwanted moisture or solids from a system.
BMP	Better Management Practice.
BOILER	The component in a power plant that burns fuel to produce heat and uses that heat to convert water into steam. Supplies steam at design pressure and temperature, on demand, to drive the turbine.
BOILER DRUM	Functions to separate the water from the steam generated in the furnace walls and to reduce the dissolved solids contents of the steam to below the prescribed limits. Wet steam entering the drum from the riser tubes and furnace walls is collected in a compartment, formed by internal baffles. From this compartment the steam is first led through two rows of turbo separators. Each turbo separator consists of a primary stage and a secondary stage. The primary stage is formed by two concentric cans. Spinner blades impart a centrifugal motion to the mixture of steam and water, flowing upward through the inner can, thereby throwing the water to the outside and forcing the steam to the inside. The water is arrested by a skim-off lip above the spinner blades and returned to the lower part of the drum through the annulus between the two cans. The steam proceeds up to the secondary separator stage. The secondary stage consists of two opposed banks of closely spaced thin corrugated sheets which directs the steam through a tortuous path and force remaining entrained water against the corrugated plates. Since the velocity is relatively low, this water does not get picked up again, but runs down the plates and off the second stage lips at the two steam outlets. From the secondary separators the steam flow uniformly and with relatively low velocity upward to the series of screen dryers, extending in layers across the length of the drum. These screens perform the final stage of separation. The boiler drum is equipped with three safety

valves, two on the drum itself and one is on the superheater outlet. In addition, a fourth combination safety and electromagnetic relief valve is located on the superheater outlet line. The boiler drum is fitted with two water level gauges, one for normal level and one for high level. The high level gauge is for use only during shutting down and fast cooling operations. This gauge should be shut at pressures above 750 psig with its block valves. The drum is also provided with a water level recorder indicator (Bailey), two normal remote level indicators and one high level remote level indicator (Yarway) mounted on a panel outside the control room door but visible from within the control room.

**BOILER ENVELOPE**

A boundary that energy crosses when it enters or leaves the boiler.

**BOILER FEED PUMP**

Takes suction from the #3 heater (deaerator at W3&4), and discharges above boiler pressure into a common header, through a feedwater regulating valve, then through the #4 and #5 high-pressure heaters, the economizer, and finally into the boiler drum. The feedwater pumps also supply water for main steam temperature control. Contains approx. 12 stages. Lubrication for the pumps, when in service, is provided by a screw-gear type pump attached to the outboard end of the main shaft. The complete lubricating oil system consists of the main oil pump, related coolers, and a reservoir with internal strainers. A motor-driven gear-type auxiliary pump will supply oil to the feed pump bearings for starting, until the main oil pump discharge pressure exceeds the auxiliary oil pump pressure. The motors are 2,300-volt line start.

**BOILER MASTER**

A hand/auto station that can control several other hand/auto stations for boiler fuel flow control.

**BOILING**

The process of changing the state of water from a liquid to a vapor. The condition at which the molecules of a heated liquid become active enough to escape the liquid. When pressure is reduced, water boils at a lower temperature. When pressure is increased water boils at a higher temperature.

**BONNET (VALVES)**

Seals the top of the valve body.

**BOOST**

Raise or attempt to raise voltage.

**BOOST FIELD**

A field designed into the exciter to raise voltage. In service only when the voltage regulator is in the "regulate", or "automatic" position. One part of the voltage regulator keeps constant watch on the generator output voltage. If the generator voltage drops the regulator pushes a little current through the "boost" field which aids the main shunt field and causes the exciter output to increase.

	When you increase the voltage to your rotating field, you will make your current lag your voltage. This will add reactive power to the power system, which will tend to raise system voltage. <u>Current lags</u> , voltage high. VARs will be created and exported out of the generator.
BOOSTER PUMP	A pump used in some systems to supply oil to the suction of the main lube oil pump and to the turbine bearings.
BORON	A chemical used in steam plants in cooling water systems to prevent corrosion of metal surfaces.
BOURDON TUBE	A pressure sensing element. Basically a curved hollow tube that converts changes in pressure to mechanical motion. A thin-walled tube, closed at one end, that responds to changes in pressure by attempting to curl up or straighten out.
BOWSER	The trade name of a lubricating oil conditioner. Removes water and solid impurities from a portion of the oil while in service. This system employs a precipitation or settling compartment, a filter bag compartment, and in some cases, a polishing cartridge filter is included.
BOYLE'S LAW	A theory explaining the relationship between volume and pressure of gases during compression or expansion. At a given temperature, the pressure of a gas varies inversely with its volume. When the volume of gas decreases, its pressure increases. If the volume increases, the pressure decreases.
BREAK POINT	The point at which operation changes from constant drum to constant throttle.
BREAKABLE DIAPHRAGM	Mounted on the turbine exhaust cylinder cover for the purpose of providing automatic emergency relief should the internal pressure rise beyond the maximum safe value for which the cylinder is designed. It consists of a thin lead diaphragm supported against the external atmospheric pressure by a round thin diaphragm pressure disc. This pressure disc is in turn carried on a grid type support. The thin lead diaphragm is clamped between the diaphragm pressure disc and the diaphragm retaining ring. If the exhaust pressure rises above the predetermined point, the diaphragm pressure disc is forced outward causing the lead diaphragm to be sheared off between the inner edge of the retaining ring and the edge of the diaphragm pressure disc. Rupturing of this diaphragm relieves the pressure in the turbine exhaust. The turbine cylinder directs the rush of steam upward and the guard prevents scattering of the diaphragm and disc. This diaphragm is used in conjunction with an automatic low vacuum

	trip mechanism, which will normally shut the turbine down, when the exhaust pressure rises to a predetermined point, usually about 17 inches of Hg. The pressure at which the lead diaphragm will rupture is usually 5 psig. when mounted on the turbine cylinder.
BRITISH THERMAL UNIT (BTU)	The unit of thermal energy equal to the amount of heat required to raise the temperature of one pound of water at standard conditions one degree Fahrenheit. Defined as 1/180 of the amount of heat required to raise the temperature of 1 lb. of water from 32°F to 212°F, (a temperature rise of 180°F). This means that 1 lb. of water at 212°F will contain 180° BTU. This heat in the water is known as the "Heat Of The Liquid".
BRUSH	The conducting material, usually made of carbon, bearing against the commutator or slip rings through which the current flows in or out of the rotor of the machine.
BRUSH HOLDER	A device which holds the brush in position.
BRUSHLESS EXCITER	An exciter that does not have brushes or slip rings.
BT	Batch Tank
BUBBLER SYSTEM	An indirect level measurement system that measures the level in a tank based on the air pressure needed to force all of the liquid from a vertically mounted pipe. Utilized for level measurement in inaccessible areas, and where the vessel or tank is below ground level. This device balances the pressure with either a manometer or a pressure gauge.
BUCK	Lower or attempt to lower voltage.
BUCK FIELD	A field designed into the exciter to lower voltage. In service only when the voltage regulator is in the "regulate", or "automatic" position. One part of the voltage regulator keeps constant watch on the generator output voltage. If the voltage rises, the regulator pushes a little current through the "buck" field, which is so constructed that its field opposes the main shunt field and thus decreases the exciter output. When you make your current lead your voltage sine waves by reducing field voltage, you will draw reactive power from the power system, and will lower system voltage. <u>Current leads, voltage low, VARS could be drawn into the generator.</u>
BUMP	A shift at a control station between manual and automatic signals with a difference between the signals resulting in a fluctuation in the process variable. A rapid shift in a control action caused by suddenly changing instrument settings.
BURNER	A boiler component that directs the combustion air from the

BURNER REGISTERS	windbox and the fuel into the furnace, where combustion takes place.
BURNER THROAT	Components located between the windbox and the burners that regulate the amount of air flow to each burner.
BUS	The opening between the wind box and the furnace, usually lined with refractory material.
BUSHING (BEARING)	A conductor or an assembly of conductors that receives electric current and distributes it to equipment. A bus conductor, or group of conductors, is a switchgear assembly which serves as a common connection for three or more circuits. The conductors of a bus are usually in the form of a bar. Distributes power in an electrical distribution system, and it operates at a specific voltage.
BUSHING (ELECTRICAL)	A special type of sleeve bearing. A thin-walled bearing that can be removed in one piece. The grooves in a typical bushing collect oil and keep the shaft lubricated.
BUTTERFLY VALVE	A device that connects electrical equipment to electrical lines.
	A type of valve used for isolation and flow control; use is generally limited to low pressure applications. Have round, relatively thin valve bodies, and they take up less space in piping than many other types of valves. Consists of a valve body, a seating area, or seat, a disc, a stem, a stuffing box, packing, and a packing gland, with gland nuts. A handle may be attached to the stem for manual positioning of the valve. The disc of a butterfly valve is just slightly smaller in diameter than the inside of the piping in which the valve is installed. The disc is also relatively thin, and it offers little obstruction to flow when the valve is fully open. The disc is attached to the stem. The stem is used to rotate the disc when the handle is moved. The flow rate through the valve is adjusted by changing the angle of the disc. The butterfly valve requires only a ninety-degree movement, or one quarter turn, of its handle to go from the fully open position to the fully closed position. The handle is usually aligned with the disc. When the handle is in line with the valve's inlet and outlet, the valve is fully open. When the handle is perpendicular to the piping, the valve is fully closed. Used in lines with large flow volume such as circulating water/condenser flow reversing systems.
C	
C CHART (Control Chart)	Used to display the actual number of defects per item. The horizontal axis represent time, and the vertical axis represents the

	number of defects per sample. The sampling size is based on the number or amount of product sample needed to determine a data point for the chart. The sampling size is constant for a particular application. Part of Statistical Process Control (SPC) charts.
CAGE (BEARING)	A metal retainer that holds the rolling elements in position and keeps them from rubbing against each other.
CAID	Customer Average Interruption Duration. Measures the average length of time, in minutes, that service was interrupted.
CALCIUM HYDROXIDE	A strong alkali commonly sold in water solution and as an ingredient of bleaching powder.
CALORIE	The amount of energy needed to make the temperature of one gram of water one degree Celsius.
CAPABILITY	The maximum load which a machine, apparatus, station or system can carry under specified conditions for a given time interval.
CAPABILITY CURVE	A chart that can be used to calculate a generator's ability to produce power safely under specific operating conditions.
CAPACITANCE	A physical property of AC circuits that opposes changes in voltage. The property of two or more bodies which enables them to store electrical energy in an electrostatic field between the bodies, which resists or opposes any change in the voltage of the associated circuit. When the applied AC voltage increases, capacitance opposes the change and delays the voltage increase across the circuit. When the voltage decreases, capacitance tends to maintain the original voltage across the circuit and delays the decrease in voltage. Measured in farads. Causes current to lead voltage.
CAPACITANCE (PROCESS SYSTEMS)	The ability to store energy. A water tank has the ability to store energy. Capacitance is determined by the size or capacity of the container.
CAPACITIVE REACTANCE	The opposition offered to the flow of an alternating current (AC) by capacitance, expressed in ohms. The frequency dependent impedance of a capacitor.
CAPACITOR	A component used to control or increase the amount of capacitive reactance in an AC circuit. Two electrodes or sets of electrodes in the form of plates, separated from each other by an insulating material called the dielectric.
CAPACITY (PUMP)	The volume of water that is moved by a pump, as measured at its discharge.
CAPILLARY ACTION	When a tube is placed into a container of liquid, the liquid tends to

	rise in the tube because of the adhesive forces between the liquid and the tube. These forces actually pull the liquid molecules up into the tube. Capillary action stops when the weight of the liquid in the tube is equal to the adhesive forces pulling the liquid into the tubes.
CARBON DIOXIDE (CO <sub>2</sub> )	A colorless, odorless, incombustible gas formed during proper combustion in flue gas; inert gas. Non-condensable gases formed in varying amounts due to chemical action taking place in the boiler water during the boiling process. These gases also tend to form in layers that act as insulating blankets. When mixed with steam, the gas lowers the temperature of the resulting mixture. A heavy colorless gas that does not support combustion, dissolves in water to form carbonic acid, is formed esp. in animal respiration and in the decay or combustion of animal and vegetable matter, is absorbed from the air by plants in photosynthesis, and is used in the carbonation of beverages.
CARBON MONOXIDE (CO)	A colorless, odorless, highly poisonous gas that burns to carbon dioxide with a blue flame and is formed by incomplete combustion of carbon or any carbonaceous material. Non-condensable gases formed in varying amounts due to chemical action taking place in the boiler water during the boiling process. These gases also tend to form in layers that act as insulating blankets. When mixed with steam, the gas lowers the temperature of the resulting mixture.
CARBON SEAL	A seal consisting of carbon rings that are held against the turbine shaft by springs.
CARDOX	Manufacturer's name for the Combustion Turbine CO <sub>2</sub> system.
CARNOT EFFICIENCY	The ideal or highest efficiency theoretically possible from a particular cycle.
CARRYOVER	A condition existing in a steam generator in which actual droplets of boiler water containing dissolved solids are carried along with the steam leaving the boiler drum up into the steam tubes and from there into the turbine. This condition is very dangerous, the prevention of which is vital in order to have uninterrupted plant service. This condition is usually detected by checking the conductivity of the saturated and superheated steam. The main causes of carryover are: high dissolved solids in the water, high alkalinity and the presence of oil in the boiler water. Total dissolved solids in the water are controlled by blowing down the boiler whenever the concentration gets too high. Excess alkalinity usually results from improper treatment and can only be corrected by blowing down the boiler.

	Oil in the boiler water reacts with the caustic to form soap which will create foam or soap suds and cause carryover. Oil should never be allowed to enter the boiler water supply.
CASCADING DRAIN SYSTEM	A drain system associated with feedwater heaters in a string arrangement. The pressure differential from one heater to the next causes the drips to flow from one heater to another.
CATALYST	A material that can increase the rate of a reaction without becoming part of the final product.
CATHODE	A negative electrode.
CATHODIC PROTECTION	A system that induces a counter current on the piping with sacrificial anodes to maintain ionic balance in condensers.
CATION	A positively charged ion resulting from the dissociation of salts, minerals or acids in water. Positive ions in a water solution such as the sodium of sodium chloride.
CATION EXCHANGER (Water Softener)	The first exchange step in the demineralizing system, which substitutes hydrogen ions for all the cations in the water. Cation exchanger beds contain cation resin which exchanges hydrogen ion, H+, for calcium, magnesium, sodium, and other positively charged ions from the raw water as it enters the top of the bed. The water exiting this bed contains H+ and negatively charged ions. Acid Regeneration. pH values should be between 2.5 and 3.0, and conductivities between 400 and 750 $\mu\text{mhos}$ .
CATION MEMBRANE (EDR)	A cation exchange resin cast in sheet form through which only cations will transfer.
CATION RESIN BEADS	Resin beads in an ion exchanger that attract positively charged ions.
CATIONS	Positive ions in a water solution such as the sodium of sodium chloride.
CAUSTIC ATTACK	Corrosion caused by an alkali.
CAUSTIC EMBRITTLEMENT	A condition caused by a combination of excessively alkaline boiler water and leaks in a boiler tube; changes the molecular structure of boiler tube metal so that the metal becomes brittle.
CAUSTIC SODA (NaOH)	Sodium Hydroxide; used to raise the PH and alkalinity of boiler water.
CAVITATION	A condition that may occur in pumps if the fluid they contain begins to boil. Vaporization of fluids due to pressure loss forms vapor pockets, and upon collapse, produces shock waves,

	vibration, noise, and destruction of the impeller and surrounding walls.
CAVITATION (PUMPS)	Usually violent, and can damage a pump. Directly related to the amount of head, or pressure, at the suction of a pump. If the suction drops below its designed value for the system, the liquid being pumped can flash to vapor. This is when cavitation occurs. Cavitation is the formation and subsequent collapse of vapor bubbles. Cavitation normally begins in the suction of a pump, where liquid is drawn into the pump and pressure is lowest. If the pressure of the liquid decreases too much, the liquid will vaporize, or boil. When the liquid boils, bubbles form and travel with the liquid in the pump. As thousands of bubbles travel towards the higher pressure areas in the pump, they are compressed until they can no longer withstand the pressure. Then they collapse, or implode, violently. As liquid rushes in to fill the spaces left by the collapsing bubbles, it strikes the inside surfaces of the pump and gradually wears away pump material. The result is a sandblasting effect on internal pump components such as the impeller. This kind of damage decreases the pump's performance. The temperature of a liquid could also be a cause of cavitation.
CEIP	Campbell Estate Industrial Park (aka CIP or Campbell Industrial Park)
CELLULOSE ACETATE	Reverse Osmosis membrane. Operates at higher pressures and are susceptible to damage from pH variances, (especially pH above 7.0). Require low levels of chlorine to reduce bacterial growth within the elements.
CEMS	Continuous Emission Monitoring System. Continuous monitoring direct to the DOH.
CENTIGRADE (CELSIUS)	Pertaining to a temperature scale that registers the freezing point of water as 0° C. and the boiling point as 100° C. under normal atmospheric pressure. °C = (°F-32) x 5/9; °C = (°F-32) ÷ 1.8
CENTIMETER	One hundredth of a meter
CENTRALIZED DIGITAL CONTROL SYSTEM	A type of process unit digital control system in which all of the system's process control functions are performed in a single location. Commonly called direct digital control, or DDC.
CENTRIFUGAL COMPRESSOR	Main internal components are an impeller and a volute. Gas that enters the compressor at the center of the impeller is swept up by vanes on the impeller and moved outward by centrifugal force. This action increases the velocity of the gas. When the gas leaves the impeller, it enters the volute. In the volute, the gas expands and gradually slows down as the chamber widens. As the gas

	slows down, its velocity, or kinetic energy, is converted into pressure. The gas reaches its maximum pressure as it is discharged from the compressor through the gas discharge line.
CENTRIFUGAL FORCE	The force that exists when an object or material moves in a circular motion. This force causes the object or material to move outward, away from the center of rotation.
CENTRIFUGAL PUMP	Uses an impeller, which creates a centrifugal force to move the liquid. This force pushes the liquid away from the center of rotation and out of the pump.
CENTRIFUGE	A centrifugal separating machine used to remove water and solids from lubricating oils. Two principal makes are De Laval and Sharples.
CGS	Centimeter Gram Second
CHARLES LAW	The relationship between the temperature and volume of gas. At a given pressure, the volume of gas varies directly with its temperature. As temperature increases, volume increases, and as temperature decreases, volume decreases.
CHECK VALVE	Automatic operating valves which allow flow in one direction only. Most check valves consist of a body containing a seat and a hinged disc balanced in such a way that the disc swings open allowing flow in one direction and swings closed preventing flow in the opposite direction. Check valves are normally installed where several pumps discharge into a common line or header. This prevents flow in the reverse direction through an idle pump. Scale, rust or other foreign material may collect above the disc preventing it from opening or under the seat preventing it from closing. The cover must be removed and the obstruction cleared whenever this occurs. Three types of check valves commonly found in industrial facilities are swing check valves, lift check valves, and ball check valves.
CHELATE	Relating to, or having a ring structure that usually contains a metal ion held by coordination bonds.
CHEMICAL ENERGY	When a substance is able to undergo a chemical reaction and release energy.
CHEMICAL EQUATION	Basically a description of a chemical reaction in the form of letters, symbols and numbers. The starting materials, or reactants, and the products are separated by a yield sign. The yield sign is an arrow. It indicates that a reaction is taking place. The arrow points toward the products of the reaction. The numbers to the right of some of the element symbols in a chemical equation

	indicates how many atoms of that element are present. The absence of a number means that there is only one atom. Chemical equations must balance. In other words, whatever is represented on the left side of the equation must also be represented on the right side. The idea of a balanced equation is based on a simple principle that atoms are neither created nor destroyed in a chemical reaction. What goes in must come out.
CHEMICAL REACTION	A reaction that forms a chemical bond, breaks a chemical bond, or simultaneously forms and breaks chemical bonds. The materials that produce a chemical reaction can be called reactants, because they will react together. An interaction between the atoms of substances. Valence electrons are either transferred from one atom to another or shared between two or more atoms. By transferring or sharing valence electrons, atoms of certain elements combine, or bond, with each other to form molecules. When atoms combine, they often transfer or share valence electrons so that each atom ends up with eight electrons in its outermost shell. A smaller atom may end up with two electrons in its outermost shell.
CHEMICAL RESIDUAL	A predetermined desirable quantity of chemical remaining in a system during operation.
CHLORINATOR	A piece of equipment in a chlorine injection system that regulates the pressure of chlorine gas and controls its flow rate so that it is mixed with water in the correct proportions.
CHLORINE DIOXIDE	This chemical is generated at the point of application by mixing chlorine gas and a solution of sodium chlorite in a chlorinator. The gas is dissolved in a moving stream of water which is injected into the inlet of the condenser. Introduced to condenser cooling water in very low concentrations, controls fouling of the heat exchanger tubes. This aids in maintaining optimum heat exchange efficiency. Chlorine Dioxide effectively prevents or discourages the establishment of marine plants and animals in the condensers.
CHLORINE INJECTION SYSTEM	A system that adds chlorine to the circulating water system to retard the growth of contaminants such as algae and bacteria.
CHROMATOGRAPH	An on-line analyzer that provides the data used to plot control charts. A type of gas analyzer often used to measure the concentrations of various gases in a complex gas mixture, which is a mixture of more than two gases.
CIRCUIT	Any closed path followed or capable of being followed by an electric current. A configuration of electrically or electromagnetically connected components or devices. A

	complete flow path. The means for connecting a source of electricity to devices that use electricity to operate. A basic circuit consists of: Energy Source (battery) - Transmission Path (wires) - Control device (switch) - Load (motor)
CIRCUIT (ELECTRIC)	A conductor or a system of conductors through which an electric current flows or is intended to flow.
CIRCUIT BREAKER	A protective device for opening or closing a circuit which is carrying load to interrupt the flow of current at that particular point.
	A device used to open or close circuits which are carrying load. In order to do this safely, the circuit breaker must have some special provisions for handling the arc. There are four basic methods used for minimizing the arc and its effect on the equipment.
	<ol style="list-style-type: none"><li>1) The contacts are moved very rapidly so that they quickly reach a distance or separation across which the arc is present and thereby reduces the amount of burning that takes place.</li><li>2) A fluid is used to either cool the arc or force it away from the contacts into a special area which resists burning. In this manner the arc and its effect are reduced.</li><li>3) Multiple contacts are used and are adjusted to operate sequentially. The main current carrying contacts are the first to open and the last to close. In this way the auxiliary or arcing contacts handle all the arcing and burning while the main contacts are preserved for their main job of carrying the circuit load. The auxiliary contacts are designed so that they can be readily replaced.</li><li>4) A coil is installed around the contacts. The coil is energized and produces a magnetic field which forces the arc away from the contacts. In this application the ionized air acts as a conductor and is the magnetic field produced by the coil. A force is exerted on the conductor which in this case is the ionized air.</li></ol>
	Circuit breakers protect loads from potentially damaging conditions by automatically tripping, that is, interrupting current flow. Also isolates equipment.
CIRCUIT BREAKER MECHANISM	An assembly of levers and other parts which actuates the moving contacts of the circuit breaker.
CIRCUIT RECLOSER	A line protective device usually associated with the lower voltages of a distribution system which interrupts momentary line faults.

	The circuit recloser is designed to automatically reclose after a short period of time.
CIRCULAR MIL	An area equal to that of a circle with the diameter of 0.001 inch. It is used for measuring the cross sectional area of wire.
CIRCULATING WATER PUMP	Usually, a large centrifugal pump that is capable of pumping thousands of gallons of water per minute through the circulating water system.
CIRCULATING WATER SYSTEM	Supplies sea water for condensing the turbine exhaust steam.
CIRCULATOR	Condenser circulating water pump.
CIRCUMFERENTIAL SEAL	A type of seal used to prevent air from leaking into the gas around the circumference of an air heater.
CIS	Control Interface Slave.
CIU	Computer Interface Unit
CLARIFICATION	Process of removing suspended solids by settling. A water treatment process in which chemicals are used to cause charged particles in raw water to come together in heavier clumps and settle out.
CLARITY	The measure of how clear, or transparent, a substance is.
CLEARANCE POCKETS	Small air chambers in the walls of some air compressor cylinders; used to reduce the flow of air from the compressor to the air receiver when the air receiver pressure is too high.
CLOSED CONTROL LOOP	A control loop that has a sensing element, a measuring element, a controlling element, and a final control element.
CLOSED HEATER	A shell and tube feedwater heater that does not allow extraction steam and feedwater to come into contact and mix.
CLOSED IMPELLER	Can be classified as single-suction or double-suction impeller. Has vanes that are enclosed by shrouds on both sides. The shrouds direct the flow of liquid between the vanes. Often used with low viscosity, or thin, liquids.
CLOSING COIL (Circuit Breaker)	A coil used in the electromagnet which supplies power for closing a circuit breaker.
COAGULANT	A chemical added to raw water in a clarifier to form a positively charged precipitate that attracts negatively charged particles suspended in the water.
COAGULATION	The first stage of the clarification process, in which a chemical coagulant is rapidly mixed into raw water.

COCK VALVE	See plug valve.
COGENERATION	The simultaneous production of electric energy and useful thermal energy for industrial, commercial, heating or cooling purposes.
COHESION	The mutual attraction by which the elements of a body are held together.
COHESIVE FORCE	A molecular force that exists between like molecules.
COLD END	The end of an air heater where gas exits and air enters.
COLD END METAL TEMPERATURE	The temperature of the air heater plates at the cold end of the air heater.
COLD PLUG	A restriction in a fuel oil line caused by cold fuel oil.
COLD REHEAT STEAM	Steam that flows from the exhaust of the high pressure turbine to the boiler reheater.
COLLECTOR RINGS (SLIP RINGS)	Metal rings suitably mounted on the rotor of an electric machine which conduct current into or out of the rotor by the use of stationary brushes bearing upon the rings.
COLORIMETER	An analyzer that measures the color intensity of a solution.
COMBINED CYCLE	A combustion turbine installation using waste heat boilers to capture the turbine exhaust heat energy for steam generation which is usually used to drive a steam turbine generator unit.
COMBINED CYCLE PLANT	Exhaust gases from a gas turbine are used to produce steam to drive a steam turbine. The hot exhaust gases that leave the gas turbine are routed to a heat recovery steam generator, or HRSG. In the HRSG, the exhaust gases transfer heat to water to produce steam. The steam that is produced is sent to the steam turbine, where some of the energy in the steam is converted into mechanical energy. The mechanical energy is then converted into electricity by a second generator. This process increases the efficiency of the plant, since more of the energy in the gas turbine exhaust gases is used before the gases are released.
COMBUSTIBLES	The amount of incomplete burning of fuel oil.
COMBUSTION	A chemical reaction between carbon and hydrogen contained in fuel, and oxygen contained in combustion air. Product is hot flue gas.
COMBUSTION AIR MOISTURE LOSS	Loss due to heat absorption by the moisture that enters the boiler in the combustion air supply. Most of this heat leaves the boiler in the exhaust gas.
COMBUSTION AIR	A method used to control the cold end metal temperature of an air

RECIRCULATION	heater by recirculating some of the combustion air from the discharge of the air heater back to the air inlet.
COMBUSTION AIR SYSTEM	The system that supplies the air necessary for the proper combustion of fuel in a boiler.
COMBUSTION CONTROL	Purpose is to regulate the correct ratio of fuel and air flow to the furnace throughout the boiler load range. The function of an automatic combustion control system is to maintain fuel and air input to the furnace in accordance with the demand for steam, and to proportion the fuel and air for maximum combustion efficiency. The demand for fuel and air flow is from the steam flow signal which is corrected by drum pressure. Steam flow is directly proportional to the required fuel and air flow, therefore, this signal is used as an index of boiler load. First stage pressure is proportional to the turbine steam flow, so, it is used as an indication of steam flow. The first stage pressure is calibrated to equal the feedwater flow at each division of load. But, the condition of the turbine blading will effect the relationship of 1st stage pressure to steam flow. Thus, indicating a higher steam flow per generator MW output as the turbine blading deposits increase. <u>The basic concept of the control system is for the air flow to increase first on a load increase. Air flow increasing will increase the fuel flow.</u> To prevent fuel enrichment, the rate of combustion is limited to the actual air available for firing. The fuel demand signal is compared to the total air flow metered. A low signal selector chooses the lesser for the fuel demand signal. Whereby, <u>on a load reduction, the fuel and air flows are reduced together.</u> The fuel and air flow meter feedback signals provide a method of informing the fuel and air flow controllers when the required flow conditions exist. The O2 control system corrects the air flow meter feedback signal to increase or decrease the excess air. The O2 set point adjustment biases the O2 set point which is required by steam flow. The boiler is provided with high and low speed forced draft fan motors. The fan motor speed which is selected depends upon the air flow requirement.
COMBUSTION GASES	The gases produced when fuel burns in a boiler furnace.
COMBUSTION REACTION	A exothermic reaction. A reaction between oxygen and fuel. One place that a combustion reaction occurs is in a boiler. Requires fuel, oxygen, and heat to get started. After it is started, it produces heat, which sustains the reaction as long as there is an adequate supply of fuel and oxygen. When a combustion reaction occurs, oxygen reacts with the fuel so rapidly that a fire is created.
COMBUSTION TURBINE	An electric generating unit in which the prime mover is a gas

	turbine engine.
COMBUSTOR	A chamber in a gas turbine in which combustion occurs. Where compressed air is mixed with fuel, and the mixture is ignited and burned. The burning creates gases that expand rapidly.
COMMAND KEYS (COMPUTER)	Used for operations such as changing process variable set points.
COMMUNICATION INTERFACE	A circuit in a control system that connects the equipment in the system to a communication network.
COMMUTATOR	A device in a DC exciter that changes alternating current to direct current. That part of the rotor of a motor or generator which is used to conduct electrical energy to the rotor windings from the stationary brushes with which the commutator is in contact. The conducting ring is mounted on the end of the armature. It is not a solid ring. Consists of conducting segments that are separated from each other. During operation, the commutator makes sliding contact with the brushes. Current flows from the negative side of the DC power source through one brush to a commutator segment. The current then flows through the armature, through the other commutator segment and the other brush, and to the positive side of the power source. The current flow through the armature creates a magnetic field with a north pole and a south pole. The poles are perpendicular to the armature.
COMMUTATOR AND BRUSHES	The parts of a DC motor that cause the poles on the rotor to switch. Constantly changes the direction of current flow to the rotor, which is what changes the polarity of the rotor. The change in polarity keeps the rotor rotating in the same direction. It continually moves toward opposite poles. The continuous process of switching polarity causes the magnetic fields in a DC motor to change positions. This is what causes a DC motor to operate.
COMPARATOR	An instrument that receives two different signals, compares them, and sends out a signal that is proportional to the difference between the two signals.
COMPONENT EFFICIENCY	The amount of useful energy leaving a component divided by the energy entering the component.
COMPOUND	A definite combination of the atoms of two or more elements in simple numerical proportions, resulting in the formation of the basic particle of the compound called the molecule. A product of chemical reaction. Formed when two or more elements are combined, or bonded, chemically. Each molecule of a compound consists of specific numbers of specific atoms.

COMPOUND GAUGE	A gauge that can measure both pressure and vacuum.
COMPRESSION	Occurs when external forces try to push particles of a body together.
COMPRESSOR	A mechanical device that compacts air or other gases into a smaller volume to increase pressure. Rated for discharge pressure (pounds per square inch, psi) and flow rate (units of cubic feet per minute, cfm). Drive mechanisms include electric motors, gasoline engines, and steam or gas turbines.
CONCENTRATION	Refers to the amount of solute present in the solution. The amount of one solution dissolved in another solution.
CONDENSATE	Water formed in a condenser by condensation of turbine exhaust steam. The condensate system includes all equipment from the condenser hotwell to the boiler feed pump.
CONDENSATE POLISHING MIXED-BED ION EXCHANGER	A specially designed mixed-bed ion exchanger used to remove dissolved solids from condensate; usually contains 2-3 times as much cation resin as anion resin.
CONDENSATE PUMP	Multistage vertical pit type. Its purpose is to remove the accumulated condensate from the condenser hot well and discharge it to the suction of the boiler feed pump through the air ejector and low-pressure feedwater heaters and/or deaerator.
CONDENSATE SYSTEM	A system of heat exchangers, pumps, storage tanks, valves, and piping that are usually located between the condenser and the suction of the boiler feed pumps; also includes instruments that measure flow rates, pressures, and temperatures.
CONDENSER	A shell and tube heat exchanger that condenses vapor into liquid. The purpose of a condenser is to decrease the exhaust pressure of the turbine, thereby increasing thermal efficiency, and to condense the exhaust steam from the low-pressure turbine for return to the condensate and feedwater systems. Also functions to remove air and other non-condensable gases from the steam. The exhaust steam from the turbine flows down and around the condenser tubes where its latent heat is given up through the tube walls to the circulating water. The condensed steam collects in the hot well. Make-up condensate enters near the top of the condenser and is deaerated before added to the system. Condensers used in HECO power plants are surface condensers and are so named because steam is cooled and condensed by contact with the surface of metal tubes through which the cooling water is circulated.
CONDENSER LEAKAGE	Leakage of the circulating water through the condenser tubes into the condensed steam and from there carried into the boiler. This

CONDENSING	condition is usually detected by the checking of the conductivity of the hotwell condensate.
CONDUCTANCE	The process of changing the state of water from a vapor to a liquid.
CONDUCTION	The measure of a material's ability to conduct an electric charge. The reciprocal of electrical resistance.
CONDUCTIVITY	A method of heat transfer in which heat is transferred from a warmer object to a cooler object when the two objects touch. The transfer of heat from one part of a body to another part or to another body by short range interaction of molecules and/or electrons.  The ease with which a substance transmits electricity. A measure of a solution's ability to conduct electrical current. A means of measuring the total ionizable (dissolved) solids in the water.  An electrical method of measuring the resistance of a water solution by the passage of electricity through it. The quantity of dissolved solids usually is in direct proportion to the conductivity. The greater the dissolved solids, the higher the conductivity. Certain gases, namely carbon dioxide and ammonia, also increase the conductivity. High conductivity causes foaming and priming in the steam drum, thus causing carry-over. Measured in micromhos.
CONDUCTIVITY CELL	A device that passes an electrical current through a solution to measure the solution's conductivity.
CONDUCTIVITY PROBES	Electrical probes that initiate an action, such as activating an alarm, in response to changes in the level of a liquid.
CONDUCTOR	A body so constructed from conducting material that it may be used as a carrier of electric current. A material that offers very little resistance to current flow.
CONDUIT	A protective pipe or tubing that carry power cables. Most of the cables and wires are insulated.
CONSTANT	Unchanging in nature, value, or extent; invariable. A quantity taken to have a fixed value in a specified mathematical context.
CONSTANT DIFFERENTIAL PUMP, OR BOOSTER PUMP	maintains a fixed pressure difference between the suction and discharge, irrespective of the supply pressure.
CONSTANT SPEED MOTOR	A motor that receives a constant supply of energy and operates at a constant speed.

CONTACT PYROMETER	A portable temperature-measuring instrument that uses a probe in direct contact with the surface of the object being measured.
CONTACT SEAL	Seals the opening where the shaft leaves the housing to keep lubricants from escaping and contaminants from getting in. Usually made of a relatively soft material, such as felt, synthetic rubber, cork, or a synthetic material such as silicone. The outer ring fits tightly in a bearing housing while the inner ring or lip, presses against the spinning shaft.
CONTACTOR	An electrically operated device for energizing and de-energizing electrical equipment, usually low voltage.
CONTACTOR, OR MOTOR STARTER (M)	An electromagnetic switch that is a part of a motor controller. When the contactor is operated (energized), it allows current to pass through the controller to the motor.
CONTINUITY EQUATION	Consider the condition where water is flowing through a length of pipe. As long as there are no leaks and no water is added to or removed from the system, the amount of water flowing past any one point is equal to that flowing past any other point. This holds true regardless of any changes in pipe size or shape. The flow rate at any point in a pipe depends on the area available for flow and the velocity of the flow.
CONTROL BLOCK	A preprogrammed function, or algorithm, that a control program can use to help achieve control of a process variable. Commonly referred to as control slots or computational slots.
CONTROL BUS	A bus mounted in the rear of a switchboard or in the circuit breaker structure to distribute power for operating electrically controlled devices.
CONTROL CIRCUIT	A circuit carrying a low voltage used to operate various pieces of equipment such as circuit breakers, contactors, valves, etc., usually from a remote location.
CONTROL DEVIATION, OR ERROR	Difference between the set-point and the process variable.
CONTROL FIELD	Direct current applied to magnetic coils to cause variation of output voltage.
CONTROL LOGIC PROGRAM	A set of instructions programmed into a programmable controller that determines the actions to be taken and their sequence.
CONTROL LOOP	A control scheme or logic for control system operation. A single part of a control system that uses some form of mechanical or electronic automation to balance supply against demand. A collection of devices whose function is to maintain the value of a

	process variable at or near set-point.
CONTROL POINT	The value at which a process variable returns to steady state.
CONTROL PRESSURE	The operating air pressure to the final control element which in turn regulates the measured variable.
CONTROL STAGE	The first stage of a turbine, consisting of a nozzle block and a row of moving blading.
CONTROL SWITCH	A switch for controlling electrically operated devices.
CONTROL VALVES	Valves that are used to automatically throttle flow. Work basically the same way as manually operated valves. Can be either linear or rotary. A linear control valve, such as a globe valve, has a stem that moves the valve disc up and down. A rotary control valve is positioned by rotation. Butterfly valves, which open or close with a 90-degree turn, are examples of rotary control valves. A globe-type control valve has the same basic parts as a manually operated globe valve. These parts include a valve body, a disc, a seat, a bonnet, a stem, and a packing assembly. Control valves can also have parts that may not be found in manually operated valves. For example, some control valves have guides that align the valve stem and disc with the valve seat. These guides help ensure precise control when the valve is opened and closed. The upper stem guide is housed above the packing, inside part of the packing assembly. The lower stem guide is held in place by a hollow cylinder with openings, called a cage. When the valve disc is moved away from the seat, fluid flows up through the seat, through the cage openings, and out of the valve.
CONTROL VALVES (TURBINE)	Steam valves leading to a turbine's inlet that regulate the amount of steam supplied to the turbine and consequently the amount of energy that the turbine receives; valves designed to regulate the flow of steam into the HP turbine during normal operation, and to serve as a backup to the main stop valves during shutdowns, to shut off the flow of steam into the HP turbine; sometimes called governor valves.
CONTROLLED CIRCULATION	A process that uses boiler water circulation pumps to move steam and water through boiler tubes.
CONTROLLER	A device or group of devices that serves to automatically regulate, in some predetermined manner, the electric or pneumatic signal delivered to the apparatus to which it is connected. Controlling element. Part of the instrumentation systems that monitor plant process and respond to variations in the processes. A controller receives a signal from a transmitter, that represents the value of a process variable such as temperature, pressure,

	level, or flow; compares that signal to a set-point, which is the desired value for the process variable; and sends out a corrective signal to regulate the value of the process variable.
CONVECTION	A method of heat transfer in which a fluid is heated and then moved away from the heat source, carrying heat with it as it moves. The transfer of heat by the combined mechanisms of fluid mixing and conduction. The method in which heat is transferred by the motion of a heated medium. Transfer of heat by convection can only take place in moving fluids (liquids or gases). The primary mode of heat transfer within or between fluids.
CONVERSIONS	Equivalencies between units used to measure the same quantity.
CONVERTER	A device used to change one type of signal (such as an electronic signal) to another type of signal (such as a pneumatic signal).
COOLDOWN RATES	Rates provided by the turbine manufacturer to be used when shutting down the turbine; designed to minimize turbine damage and efficiency losses during the shutdown.
COOLING FINS	The parts on air-cooled compressors that provide additional surface area for the dissipation of heat.
COORDINATE POINT	The point on a graph at which the grid lines for an x value and a y value cross.
CORE	A mass of iron placed inside a coil to decrease the reluctance to magnetic lines of force.
CORE MONITOR	A device used to measure the amount of particulate matter in the hydrogen, inside a hydrogen-cooled generator.
CORONA	An electrical discharge into space caused by an excessive electrostatic stress surrounding an electrical conductor.
CORROSION	Destruction of metal by a chemical or electrochemical attack. Electrochemical is electrons flowing from the anode to the cathode. Corrosion due to dissolved gases results in pitting and deterioration of the boiler drum and the tube metal.
CORROSION INHIBITOR	A chemical, such as hydrazine, chromates, or nitrites, that protects metal surfaces from corrosion by forming a protective coating on the surfaces or by neutralizing corrosion-causing impurities in water.
COSINE OF THETA	The ratio of the adjacent side of a right triangle to the hypotenuse.
COUNTER ELECTROMOTIVE FORCE (CEMF)	Counter electromotive force; an EMF induced in a coil or armature by self-induction that opposes the applied voltage. Voltage induced in an operating circuit that opposes the existing

	applied voltage. Also called self-induction.
COUNTERFLOW	A flow pattern in a surface heat exchanger in which two fluids flow in opposite directions; also called reverse flow. A turbine cylinder arrangement in which steam flows through one cylinder in one direction and through another cylinder in the opposite direction, or from the center of one cylinder to each end.
COUPLING	A device that connects the shaft of a driver to the shaft of the driven equipment. Pump couplings are divided into two categories: fixed and variable couplings. When a fixed coupling is used, the speed of the pump is fixed by the speed of the driver. To change the speed of the pump, the speed of the driver has to be changed. When a variable coupling is used, the speed of the pump can be changed without changing the speed of the driver.
COVALENT BOND	A bond in which the atoms involved complete their outer shells by sharing electrons between them to form molecules.
CPR	Cardiopulmonary Resuscitation
CRACKING POINT	The point at which a turbine control valve is nearly closed, and frictional loss in the valve is high. Partially open governor valves have a potential of up to 3% efficiency loss. Pressure and temperature drop across the valves.
CRITICAL MASS FLOW (TURBINE)	The point at which the steam flow through the turbine, is where it was designed for at full load. Where the steam flow is most efficient; Mach .9; just before Mach 1, which is supersonic. It takes 1/10 of a second for steam to pass through the turbine. Approx. 1100 feet per second.
CRITICAL POINT	The point at which the density of water and the density of steam are the same; 705 degrees Fahrenheit and 3206 psi.
CRITICAL PRESSURE POINT	A pressure of 3206.2 psia of which there is no longer any change in volume between liquid and vapor. Saturation temperature is 705.34°F. A point at which the latent heat of vaporization is zero BTU'S per pound. Above the critical point, water flashes to steam, but there is no latent heat transfer. Above this point, water exists as a superheated vapor.
CRITICAL SPEED (COMPRESSOR)	Rotational speeds that may cause severe vibration. This vibration is caused by the physical characteristics of the compressor's rotating parts. Serious damage may occur. Critical speeds occur when the compressor is at less than full operating speed.
CRITICAL SPEED (TURBINE)	A speed at which the rotor will vibrate excessively.
CROSS FLOW	A flow pattern in a surface heat exchanger in which one fluid

	flows at right angles to another fluid.
CROSS-CONNECT VALVE	A valve used to continue flow through both halves of a condenser if one of the circulating water pumps is shut down. This permits the turbine to continue to operate, even though load may have to be reduced. Sometimes referred to as a tie valve.
CUNO FILTER	A metal multidisc liquid filter which is cleaned by rotating an external handle which turns the inner discs. Mounted on the lube oil reservoir to filter high pressure oil to the turbine control system.
CURRENT	A flow of electric charge, measured in amps. The movement of electrons, or electrical charges, from one place to another. Substance of electricity as to water in piping.
CURRENT TRANSFORMER (CT)	A small transformer for instrumentation, measuring heavy currents in power leads. A component that typically steps line current down to a lower current that is in direct proportion to the amount of line current. All current transformers are designed so that the output of current will be 5 amperes when maximum current flows in the input circuit. Used to supply current at a reduced value to devices such as ammeters and relays that are used to monitor and control the power in the system. The current transformer does not affect the current flowing from the main transformer to the rest of the system, but it does allow the current to be measured. Connected in series with the main circuit. Frequently the CT is made in the form of a torus or donut and is installed around the conductor whose current is to be measured. In these cases, the main conductor acts as an input circuit of one turn. The output circuit then contains sufficient turns to produce an output current of 5 amperes when rated current flows through the main conductor.
CURTIS, OR IMPULSE STAGE	An impulse stage in the high pressure turbine using two rows of moving blades with a stationary row of blades between the two rows of moving blades. Steam flows from the nozzle block to the curtis stage, then to the impulse section.
CURVE	A line used to connect points plotted on a graph, regardless of whether it is actually curved or straight. Represents the relationship between the variables on the two axis.
CUSUM (SPC)	Cumulative summation; a method of using Statistical Process Control (SPC) that typically involves a computer. The difference between the average value of the variable that is being monitored and its desired value, or "aim". When cusum detects an out-of-control condition, it may automatically adjust the process, or it

	may simply recommend an adjustment. If a cusum system experiences problems, or if it is provided with inaccurate information, an off-aim condition can occur. Two causes of an off-aim condition are overreaction and underreaction.
CYCLE (SINE WAVE)	One complete positive and one complete negative alternation of a current or voltage wave-shape; one complete sine wave. See Hertz.
CYCLE (SPC)	A pattern that forms when data points fall above or below the process centerline in an alternating pattern. Could mean the process is being adjusted too frequently, which is called over-control. Could also mean the amount of adjustment made is too great.
CYCLING UNITS	Units which operate with rapid load changes, frequent starts and stops but generally at somewhat lower efficiencies and higher operating costs than base load units.

**D**

DAMPER (LOUVERS)	A device used to regulate the flow of air through a fan. A type of final control element that uses a number of adjustable parallel vanes, or blades, to control the flow of air and other gases.
DC MOTOR	Direct current from a battery source flows through a conductor (rotor, or armature) and creates a magnetic field around the conductor. This magnetic field interacts with another magnetic field (stator) to produce motion. Utilizes commutator and brushes to change the polarity of the rotor. The stator is the electromagnet.
DC TURNING GEAR OIL PUMP	This pump is identical to the AC turning gear oil pump but is driven by a DC motor. This is the final back up to the bearing oil system. This pump protects the turbine in case of loss of AC power. It should have sufficient DC storage battery capacity to operate for approx. 30 minutes which is the approx. time required for a unit to coast down from 90% to 0 speed.
DCS	Distributed Control System. The DCS is the computer system (often a large computer system) which controls and monitors many aspects of a large plant's operation. The DCS often communicates with several PLC systems and is capable of providing operator control, or monitoring of these PLC systems.
DEAD TIME	The amount of time required to transfer energy from one point to another. The amount of time between an operating change and a process's initial response to the change.

DEAD ZONE	The amount of change that can occur in a process without triggering a control action.
DEAERATE	To remove dissolved gases.
DEAERATOR	A direct contact low pressure heater in the condensate-feedwater system that heats water, and also removes corrosive, non-condensable gases which are entrapped or dissolved in the condensate make-up. The main gases to be removed are oxygen (O <sub>2</sub> ) and carbon dioxide (CO <sub>2</sub> ). Condensate entering the deaerator flows through a spray bar at the top of the deaerator and is mixed with the steam where it receives its heating and deaerating. A type of open feedwater heater in which the steam and feedwater mix together.
DEFECT (SPC)	A product characteristic, such as color, size, or shape, that does not match design specifications.
DEFECTIVE PRODUCT (SPC)	A product that is unusable because it has one or more defects. The quality standards set by the company or by the end user determine how many defects are allowed before a product becomes unusable and is considered defective.
DEFOAMING TANK	Oil returning from the hydrogen side of the glands goes to two de-foaming tanks which are designed to remain half full so that foam will have an opportunity to come out of the oil. The oil level in the de-foaming tanks is maintained by a float valve which is located inside one of the tanks and an equalizing line between the two tanks keeps the oil in both at the same level. This float valve prevents gas escaping from the generator housing through the drain line. Separate tanks are used for each so that any slight difference in the fan suction at the two ends will not cause a circulation of oil vapor through the machine. The oil in these tanks serves as a buffer in case of an explosion and protects the main oil system in such an event.
DEGASIFIER	A component that removes carbon dioxide and other gases from water. Contains baffles that water passes over to liberate undesired gases, which is then removed by the vacuum pump.
DEGREES OF SUPERHEAT	Difference between the actual temperature of the superheated steam and the saturation temperature for the existing pressure.
DELTA CONNECTION	A type of electrical connection used in three phase circuits that is formed by connecting the three phases of a component at three separate points.
DEMAND	The amount of power needed by a power system's customers. The load at the terminals of an installation or system averaged

	over a specified interval of time. Demand is expressed in kilowatts, kilovolt amperes or other suitable units.
DEMAND-SIDE MANAGEMENT (DSM)	The planning, implementation, and monitoring of utility activities designed to reduce customer use of electricity in ways to obtain a desired change in shape of the utility's daily load curve or offset/delay the need for increased power generating capacity.
DEMINERALIZED WATER	Water from which most of the solids and gases have been removed, in order to make it chemically pure for boiler feed water purposes.
DEMINERALIZER	Takes minerals from the water using an ion exchange method to remove impurities and solids.
DEMING, W. EDWARDS	Researcher from the Census Bureau; strong supporter of SPC. Taught Japanese managers, engineers, and scientists how to use statistics to improve quality.
DEMISTER (COMPRESSOR)	Removes moisture from compressed air, sent from the aftercooler. Compressed air is swirled around inside a cylinder. The swirling action causes the heavier moisture to separate from the lighter air and collect in the bottom of the cylinder. The moisture is then drained from the system, and the dry compressed air is sent on to other components in the system.
DEMULSIBILITY	A measure of the oil's ability to separate readily from water and is the property that guards against the formation of permanent emulsions.
DENSITY	A comparison between the weight of a material and its volume. The weight per unit of volume of any material. Total mass (weight) divided by its total volume. Commonly expressed in units such as pounds per cubic foot, or grams per cubic centimeters.
DENSITY BUBLER SYSTEM	A system that measures the density of a liquid by using different pressures. The density indication is expressed as a percent concentration of a particular substance in the liquid.
DENSITY METER	Purity of the gas in the generator is determined by use of the density meter and density meter blower. The density meter is a differential pressure gauge measuring the pressure developed by the density meter blower. An induction motor, loaded very lightly so as to run practically at constant speed, drives the density meter blower and circulates gas from the generator housing. Thus the pressure developed by the blower varies directly with the density of the machine gas. The scale of the density meter is graduated in percent with 100% corresponding to the density of air at

	atmospheric pressure.
DERATING EXTENSION (DE)	An extension of a Planned Derating (PD) or a Maintenance Derating (MD) beyond its estimated completion date.
DERATINGS	Exists whenever a unit is limited to some power level less than the unit's Net Maximum Capacity.
DESICCANT	A moisture-absorbing chemical.
DESICCANT DRYER (COMPRESSOR)	Removes moisture that may be present in the compressed air, using chemicals called desiccants. Two commonly used desiccants are silica gel and activated alumina. Located just before the air receiver.
DESUPERHEATER	A component that controls steam temperature by spraying a fine mist of water into steam pipes; also called an attemperator.
DETRAINING TANKS	Tanks in a seal oil system that remove hydrogen and air trapped in oil.
DEVIATION	The difference between the set point of a process variable and the existing value of the process variable.
DEW POINT	The temperature at which air with any given moisture content must be cooled to produce saturation of the air and begin condensation of its vapor. Air at its dew point temperature has 100% relative humidity.
DIAL THERMOMETERS	Have a round face very similar to a pressure gauge except that it is calibrated in temperature units rather than pressure units. A movable pointer indicates the temperature on the dial.
DIAPHRAGM	A stationary part of a turbine; a diaphragm contains blades or nozzles that direct steam from one set of rotating blades to the next. A row of fixed blading that consists of an inner ring, which surrounds the shaft, and an outer ring, which attaches the row to the turbine casing.
DIAPHRAGM ACTUATOR	One of the most common types of pneumatic actuators. Air pressure acts on a flexible diaphragm to position a valve.
DIAPHRAGM PRESSURE ELEMENT	A type of pressure element that has a plate, or diaphragm, that flexes in response to changes in pressure and moves a pointer through a mechanical linkage.
DIAPHRAGM VALVE	A valve in which a flexible membrane is used. Has a bell-shaped bonnet. Uses a flexible diaphragm that is positioned on or near a weir, or dam-shaped seat, to control or stop fluid flow. A stud connects the diaphragm to a plunger that is moved by the valve stem. A handwheel is sometimes used to raise and lower the stem.

When the handwheel is turned clockwise, the stem and the plunger lower the diaphragm, which presses against the seat to stop flow through the valve. When the handwheel is turned counterclockwise, the diaphragm is moved upward, and flow through the valve can begin. A diaphragm valve can be used for both on/off and throttling purposes. The diaphragm in this type of valve also serves as a seal that keeps fluid from coming in contact with the rest of the operating parts of the valve. This design makes the diaphragm valves well suited for use in systems carrying corrosive materials such as acids and caustics. Some diaphragm valves also contain a plastic cover to help protect the body of the valve from corrosive fluids. Excessive force should never be used to close a diaphragm valve. Excessive force can cause the plunger to jam the diaphragm against the seating area, which could cut the diaphragm. If the diaphragm is cut, the valve may leak through from the valve inlet to the valve outlet, around the stem or at the body-to-bonnet joint.

**DIELECTRIC**

An insulator; a term applied to the insulating material that separates the parallel plates inside a capacitor.

**DIESEL**

An internal combustion engine that burns diesel fuel and uses the compression of air to initiate combustion.

**DIFFERENTIAL EXPANSION**

Difference in growth between the rotor, and turbine casing, caused by uneven heating between the rotor and casing. The difference between the rates at which a turbine rotor and a turbine shell expand or contract in response to temperature changes.

**DIFFERENTIAL PRESSURE  
(DELTA P)**

The difference in the pressure of a fluid, such as circulating water, from one point of measurement to another.

**DIFFERENTIAL PRESSURE  
(DP) CELL**

A device that measures the pressure difference across an orifice or other flow restrictor. The output of a DP cell is often used to measure flow through a flow restrictor. Measures the differential between two pressures and provides a corresponding flow rate signal. An indirect measurement.

**DIFFERENTIAL RELAY**

A protective relay that operates whenever there is a difference between the currents going into and coming out of electrical equipment. A relay that compares the power produced by a generator and the power leaving a transformer. If there is a significant difference, the relay opens a circuit breaker.

**DIFFERENTIAL  
TEMPERATURE**

The change, or difference, in the temperature of a substance across a system or an object.

**DIFFUSER (CENTRIFUGAL  
PUMP)**

Consists of a series of stationary vanes that surround the impeller. The distance between the outer tips of the vanes is greater than the

	distance between the inner tips. As a result, the vanes create a series of small volutes all around the impeller. This arrangement of vanes balance the radial thrust around the impeller.
DIFFUSER VANES (COMPRESSOR)	A series of plates, or vanes, designed to minimize radial thrust in centrifugal compressors.
DIGITAL CONTROL SYSTEM (DCS)	Contains one or more computers. Process control computers use data to provide the user with information, and also provide process control action. They do this either by directing the actions of controllers that control the values of process variables or by controlling the values of process variables themselves. Process computers can work with other devices to start up or shut down process systems. A digital control loop contains a digital controller. A digital controller uses a built-in computer to control the value of a process variable. The computer performs the control function by executing a set of instructions called a control program. The control program is stored in the computer's memory. Along with the control program, the computer's memory can store information associated with several control loops. The digital controller can be part of more than one control loop at a time. This means one digital controller can control the values of more than one process variable at a time. A digital signal consists of electrical pulses that, when taken in groups, represent information. An advantage of digital control systems is that they can efficiently organize large quantities of data into readily understandable information displays. These displays provide information such as the values of process variables, the status of equipment in a system, and the overall condition of a facility. Magnetic tapes and discs are used for processes that produce two or more different products. The tape or disc is used to put new values into the control systems to change from one product to another.
DIGITAL INDICATOR	Indicators that display only the number that represents the value of a process variable. The numbers are typically either electronically lighted or on rotating wheels.
DIGITAL SIGNAL	A type of signal that consists of electrical pulses, that, when taken in groups, represents information.
DIODE	A two-terminal semi-conductor device used chiefly as a rectifier.
DIRECT CONTACT HEAT EXCHANGER	A heat exchanger in which two fluids come in contact and mix with each other.
DIRECT CURRENT	Current that always flow in the same direction.
DIRECT DIGITAL CONTROL	Main component is a DDC computer. A DDC computer often has

(DDC)	a built-in control panel and display screen. The computer directly inputs and outputs data that it needs to control all of the control loops in the process. During the operation of a DDC system, input signals are sent from the process to the computer. The computer stores the input signal values in memory. Each input value is compared to the appropriate set-point value to determine a corresponding output value. The computer uses the output values to generate output signals. The output signals are sent directly to control devices that adjusts parameters within the process to keep it under control.
DIRECT FLOW MEASUREMENT DEVICE	Measures the actual flow of the fluid that passes through them.
DIRECT LEVEL MEASUREMENT DEVICE	A device that indicates level based on the position of the surface of the substance being measured. Gauge glass; plumb bob; float and tape.
DIRECT PROPORTION	A proportionality in which when one variable increases by a specific multiple, another variable increases by the same multiple; when the first variable decreases by a specific multiple, the second variable decreases by the same multiple.
DISC	A movable part of a valve that presses against a seat to stop fluid flow.
DISC TRAP	Thermodynamic trap. Consists of a round flat disc positioned over a center inlet orifice and an annular discharge leading off through a discharge port. All are enclosed within a bonnet mounted on the body of the trap. When operation starts, pressure in the inlet orifice pushes the disc up vertically off the two concentric seating surfaces surrounding the inlet and outlet ports. This allows discharge to flow out through the discharge port. When very hot condensate and steam come to the trap, the high velocity flow outward past the rim of the disc up into the chamber and tends to reduce the pressure on the under side of the disc causing some of the condensate to turn to flash steam. At the same time the flashing condensate flowing outward at high velocity strikes the side wall of the chamber causing a build up of pressure in the chamber snapping the disc shut. The disc remains in the closed position until the pressure in the bonnet falls due to the condensing of the steam in the bonnet. When pressure in the bonnet falls sufficiently the disc rises, condensate flows out and the cycle is repeated.
DISCHARGE HEAD (PUMPS)	The head at the outlet of a pump.
DISCONNECT SWITCH	A switch that can isolate a circuit from its power source by

	interrupting current flow; generally used in conjunction with a circuit breaker.
DISODIUM PHOSPHATE (DSP)	Raises PO <sub>4</sub> levels in the boiler water. Will not contribute to raising pH, in fact it may suppress it a little. Ties up calcium and magnesium as a flocculent phosphate precipitate which can be removed through boiler blowdown. Elevates the total dissolved solids levels, therefore causing conductivity to rise. Prevention of scaling on tubes and drums.
DISPATCHING	The control of an integrated electric system to assign generation to specific generating stations, and control operation and maintenance of high voltage lines and substations.
DISPERSANTS AND DETERGENTS	Chemical additives added to oils and greases to reduce the formation of carbon deposits and sludge. These additives keep particles in the lubricant suspended, so that deposits and sludge do not form.
DISPLACER	A device used to measure level in fluid systems. The operation is based on the principle of buoyancy. This principle states that when a body is immersed in a fluid, it is lifted, or buoyed up, by a force that is equal to the weight of the displaced fluid.
DISPLAY KEYS (COMPUTER)	Used along with number and letter keys to call up information displays.
DISSOLVED SOLID	A solid that is dissolved in a solvent, usually water.
DISTILLATE	The liquid that is condensed from process vapors other than steam.
DISTILLATION	A method of separating liquid products and reactants.
DISTRIBUTED CONTROL SYSTEM (DCS)	A type of process unit digital control system in which control of a process is divided among and coordinated between various control units. Uses numerous digital controllers to control different parts of a process. These controllers can act independently.
DISTRIBUTION (MATH)	An operation in which the quantity that is outside of a grouping symbol is multiplied by each term that is inside the grouping symbol.
DOUBLE-ACTING DIAPHRAGM ACTUATOR	Called double acting because air pressure acts on both sides of a flexible diaphragm to position a valve. Consists of a casing, a flexible diaphragm, an upper air supply port, a lower air supply port, a stem, and a valve position indicator, which shows the position of the valve. The center of the diaphragm is supported by metal plates, and the outer edge is sandwiched between the rims of the upper and lower halves of the casing to form an airtight seal.

This arrangement divides the casing into two chambers: an upper chamber and a lower chamber. The upper end of the actuator stem is connected to the metal plates and the diaphragm. The lower end is connected to the valve stem. When air pressure is applied to the upper chamber, the diaphragm and the actuator stem are pushed downward, and the valve closes. Air in the lower chamber is exhausted through the lower air supply port. When air pressure is applied to the lower chamber, the diaphragm and the stem are pushed upward, and the valve opens. Air in the upper chamber is exhausted through the upper air supply port. Stem movement and valve position are proportional to the difference between the two air pressures applied to the chambers of the actuators. Controlling the applied pressures enables the actuator to position the valve anywhere within the limits of travel for the actuator. In most applications, accurate positioning is achieved by using a device such as a positioner to add air to one side of the diaphragm and bleed it off the other side.

**DOUBLE-ACTING  
HYDRAULIC ACTUATOR**

Uses hydraulic fluid pressure to both open and close a valve. Consists of a cylinder, a fluid port at the base of the cylinder, a second fluid port at the top of the cylinder, a piston, and a piston rod, which is connected to the valve disc. Fluid can enter the cylinder through either of the two ports to move the piston to either open or close the valve. If fluid enters through the top port, it pushes the piston and piston rod and closes the valve. An equal volume of fluid is bled through the port at the base of the cylinder. When fluid flow is directed into the other port, it causes the piston and piston rod to move in the opposite direction, opening the valve. At the same time, an equal volume of fluid flows out of the top port. When the flow of fluid is stopped, fluid is trapped on both sides of the piston, and the piston is held in place by the trapped fluid. The piston can be positioned anywhere in the cylinder by controlling the amount of fluid entering the cylinder through one port and bled from the cylinder through the other port.

**DOUBLE-ACTING PISTON  
ACTUATOR**

Similar to those of a single-acting piston actuator. However, a double-acting piston actuator may not have a spring, and it may have an air supply port on each end of the cylinder. When air pressure is fed into one of the supply ports, it pushes against that side of the piston. The force of the air pressure moves the piston to open or close the valve, depending on which port supplies the air. Air on the other side of the piston is bled off through the other air supply port. When air is fed in through the supply port in the opposite end, the piston and valve disc are pushed in the other direction. Air is bled off through the other supply port. Filling

	the cylinder with air and bleeding air from the cylinder can be controlled by a device called a positioner.
DOWNCOMERS	Large diameter tubes connecting the main steam drum to the lower headers, ensuring positive water circulation. Located outside of the boiler.
DRAFT	The amount of pressure or vacuum inside a furnace, or the flow rate through the furnace. Normally expressed as "inches of water."
DRAIN COOLER APPROACH (DCA)	The difference between the temperature of the drips leaving the drain cooler section of a feedwater heater and the temperature of the feedwater entering the tubes from the inlet water box.
DRIP PUMP	The pumps, handling heater drips are of the centrifugal type and, except for low pressure drip pumps, are multistage to handle high volumes and discharge heads necessary to overcome condensate line pressure. Drip pumps on heaters that drop below atmospheric pressure at low loads are treated in much the same manner as condensate pumps. Venting, suction head, recirculation and gland sealing must be considered to prevent air leakage at the pump glands and flashing in the pump suction.
DRIPS	Condensate formed on the shell side in a feedwater heater as steam transfers its energy to the feedwater and gives up its latent heat of condensation.
DRIVER (PUMP)	Purpose is to supply the power needed to produce the pumping action. Electric motors, gasoline engines, steam or gas turbines.
DROOP	The reduction in speed of a generating unit as load increases.
DRUM-TYPE BOILER	A type of boiler that has a large steam drum located on top to collect the steam produced by the boiler.
DRY BULB TEMPERATURE	The air temperature as indicated by any sort of thermometer which is not affected by the moisture in the air.
DRY CELL	A type of battery in which the electrolyte is a paste; typically, a primary cell.
DRY GAS LOSS	Heat contained in the exhaust gas that goes up the stack.
DRY SCRUBBER	Mixes the combustion gases with a powder to remove sulfur oxides. The powder, often called sorbent powder, absorbs the sulfur oxides, removing them from the combustion gases. The combustion gas and powder mixture is then passed on to a gas collector, where the powder, along with other particulates in the combustion gases, is removed. The dust collector is often either a electrostatic precipitator, or a baghouse.

DSI	Digital Input Slave
DSO	Digital Output Slave
DUMMY BALANCE PISTON	Turbine spindle accessory for balancing axial end thrust. One located before the HP section (HP dummy piston), which connects to an equalizing line, then to the end of the IP section (LP dummy piston). Is actually a rotating blade with a solid center, and small blades on the outside. The pistons are different in size to equalize thrust.
DUPLEX STRAINER	A two-basket strainer that allows one strainer element to remain in operation while the other element is shut down.
DYNAMIC COMPRESSOR	A compressor that compresses air by accelerating it.
DYNAMIC HEAD (PUMPS)	The head that exists when a liquid is in motion.
DYNAMIC RESPONSE CURVE	Illustrates a basic fact about a system's response to operating changes. The response is gradual, not immediate.

**E**

EAF	Equivalent Availability Factor
ECCENTRICITY	The degree of deviation from absolute roundness; the amount that the rotor deviates from its normal center of rotation. A condition associated with a bowed turbine shaft. Measured under 600 rpm.
E-CELL STACK	The basic module of the E-Cell System. Capable of producing 12.5 gpm of deionized water (GLEGG).
E-CELL SYSTEM	Any combination of E-Cell Stacks connected together to produce deionized water.
ECONOMIZER	Preheats the boiler feedwater before it is introduced into the steam drum, by recovering some of the heat of the flue gases leaving the boiler. Located in the boiler gas pass, below the primary superheater. It is composed of a number of parallel tube circuits, arranged in horizontal rows in such a manner that each row is staggered in relation to the row above and below. The economizer tubes are provided with fins, to increase the amount of effective heating service. The fins also strengthen the economizer tube construction while their stream-lined shape prevent accumulation of fly-ash on top or bottom. Feed water is supplied to the economizer inlet header via feed stop and check valves. The feed water flow is upward through the economizer, that is, in counter flow to the hot flue gases. Most efficient heat transfer is hereby accomplished, while the possibility of steam generation within the economizer is eliminated by the upward water flow. From the

	outlet header the feed water is led to the steam drum through the economizer outlet links.
ED (ELECTRODIALYSIS)	An electrochemical separation process in which ions are transferred through membranes from a less concentrated to a more concentrated solution as a result of the flow of direct electric current.
EDR	Electrodialysis Reversal. An electrochemical separation process in which ions are transferred through membranes from a less concentrated to a more concentrated solution as a result of the flow of direct electric current.
EDR (ELECTRODIALYSIS REVERSAL PROCESS)	This method employs electrochemical and membrane cell technologies to perform separations of ionic materials in aqueous solutions. An electrodialysis process in which the polarity of the electrodes is reversed on a prescribed time cycle thus reversing the direction of ion movement in a membrane stack.
EFFECTIVE VALUE	The equivalent heating value of an alternating current or voltage, as compared to a direct current or voltage. It is 0.707 times the peak value of the alternating current or voltage sine wave. It is also called the RMS or root mean square value.
EFFICIENCY	The amount of energy expended to do work divided by the amount of energy supplied. The relationship between work and energy. The ratio of input to output power, generally expressed as a percentage.
EFFICIENCY CURVE (PUMPS)	Used to examine a pump's efficiency. The vertical axis is usually marked to indicate efficiency, from 0 to 100%. The horizontal axis indicates flow rate.
EFOR	Equivalent Forced Outage Rate. Measures the percentage of time the generating units were not available due to unplanned outages. Unscheduled unit trips (forced outages), inability to synchronize (startup failures), and unscheduled unit blocks (forced deratings) affects the EFOR. If the derating or outage can wait beyond the next weekend, it does not count against us in terms of our EFOR goal. The term "risk", as we use it, has no impact on EFOR. "Risk" has no impact on a unit's ability to make full load. The availability of blackstart generators, although critical for us, does not impact EFOR, as blackstarts are not "official" generating units.
EHC	Electro-Hydraulic Control System (electronic governor)
ELASTIC LIMIT	The point at which the force applied to a solid exceeds the ability of the solid to return to its original shape. The point at which the

	solid will remain deformed.
ELASTICITY	The ability to return to their original shape after being deformed by stress.
ELECTRIC ACTUATOR	Use electricity to produce motion. They usually fall into one of two general classifications: solenoid or motor-operated. A motor-operated actuator is often referred to as a motor operator.
ELECTRIC BOLT HEATER	Alloy steel bolt and studs in the high pressure and/or high temperature flanges, should be tightened sufficiently to produce a definite amount of stretch. The purpose of the electric bolt heater is to expand cylinder bolts by internally heating them so that they may be tightened (stretched) a specified amount, without resorting to heavy wrenching or the use of a "tensioner".
ELECTRIC FIELD	A space in which an electric charge will experience a force exerted upon it.
ELECTRIC GENERATOR	A machine which converts mechanical energy into electrical energy.
ELECTRIC MOTOR	A machine which converts electric energy into mechanical energy.
ELECTRICAL DIAGRAM	A drawing that generally uses letters, numbers, symbols and lines to identify components and show how they are connected electrically in a system. Use lines to represent flow paths for electric current, and symbols to represent equipment in the system.
ELECTRICAL ENERGY	Produced when electrons, each of which possess a unit negative charge of electricity, are made to flow in a circuit. Units are kilowatt-hours (K W-HR) or megawatt-hours (MW-HR).
ELECTRICAL POTENTIAL	Any occurrence that causes an electrical charge imbalance, or, in other words, anything that causes the number of electrons to be different from the number of protons. An electrical potential is a situation that can lead to an electrical discharge. When an electrical discharge occurs, electrons, or electrical charges, move from one place to another. One example of an electrical potential is static electricity. Three of the many sources of electrical potential are chemical action, heat, and light.
ELECTRICITY	Pumping of electrons, called current, in a conductor caused by a force called voltage.
ELECTRODE	A solid electric conductor (terminal) through which an electric current enters or leaves a medium or through which current leaves or enters an electrolytic cell, such as a battery. Generally some type of metallic material that becomes charged as a result of a

	chemical reaction.
ELECTRO-HYDRAULIC CONTROL SYSTEM	A turbine control system that uses an electronic governor and oil from an independent oil supply to monitor and control turbine speed.
ELECTROLYSIS	Chemical decomposition that results from the action of electrical current through a solution.
ELECTROLYTE	A solution which is capable of conducting electricity. An electrolyte may be in the form of either a liquid or a paste.
ELECTROLYTES	Dissolved solids that are normally present in water and are capable of conducting electricity through the water. A substance that dissociates into ions in solution or when fused, thereby becoming electrically conducting.
ELECTROLYTIC CELL	Made up of electrodes and the beaker of solution, which produces a voltage in relation to the PH of the solution.
ELECTROMAGNET	A magnet made by winding a coil of wire around a soft iron core. Current passing through this coil produces magnetic lines of force in the core. Magnets created using DC currents. The strength of the magnetic field around an electromagnet is proportional to the flow of current through the coils.
ELECTROMAGNETIC FIELD	A field around a conductor or instrument, traversed by the electromagnetic waves set up by current in the conductor.
ELECTROMAGNETISM	Magnetism that is created by current flowing through a conductor.
ELECTROMATIC RELIEF VALVE	Normally closed. Operated to open by an electrical impulse which is triggered when the pressure in a line or vessel reaches a predetermined set-point. Installed on the superheater outlet with a shut-off valve. Can be operated automatically or manually. Set to "pop" first, ahead of all other safety valves on the boiler, thus saving the need for constant overhaul of the safety valves, which would require a shutdown of the unit.
ELECTROMOTIVE FORCE	The electrical pressure that moves or tends to move electrons. Voltage; potential difference. Unit of measurement is the volt.
ELECTRON	The negatively charged particles of matter. A negatively charged particle that orbits around the nucleus of an atom.
ELECTRONIC TRANSMITTER	A device that senses and measures a process variable and produces an electronic output signal that is proportional to the value of the process variable.
ELECTROSTATIC	The movement, or flow of electrons from one place to another,

DISCHARGE	resulting from a high electrical potential. One of the most dramatic examples of an electrostatic discharge is lightning. Lightning occurs when atmospheric conditions cause a huge electrical potential to be built up between clouds and the earth. When the charge imbalance is great enough, a tremendous arc forms that we call lightning. Electrostatic discharges are situations in which there is a momentary flow of current.
ELECTROSTATIC FIELD	The field of influence between two charged bodies.
ELECTROSTATIC PRECIPITATOR	Remove particulates using an electrical charge. Has several power sources that create a positive charge on a series of metal plates, and a negative charge on a series of wires located between the plates. As the combustion gases pass through the precipitator, the particulates pick up a negative charge from the wires and are attracted to the positively charged metal plates. Devices called rappers are used to physically jar the collected particulates loose from the plates. The particulates slide into a collection hopper in the bottom of the precipitator. From there, they can be removed from the system.
ELEMENT	A basic substance consisting of atoms of only one kind. Pure substances which cannot be broken down into simpler substances by any chemical reaction or change. Made up of tiny particles called atoms which can not be divided by any chemical means. Basic building blocks of all materials. Characterized by the number of protons in their atoms. This number is called the element's atomic number.
ELEVATION DRAWING	Shows where equipment is located on different levels in a plant. Looking at an elevation drawing is like removing a wall and seeing a side view of the equipment on different levels.
EMERGENCY DRAIN VALVE	A high level dump valve in an emergency drain line from a feedwater heater to the condenser.
EMERGENCY OIL PUMP (DC)	A battery-powered pump that supplies oil to the turbine bearings while the turbine coasts down following a loss of AC power. Provided as a back-up in case all AC power is lost. Can be started by its own pressure switch that is connected to the bearing oil line when the pressure decays to somewhere between 3 to 4 psig.
EMF	Electric & Magnetic Field or Electromagnetic Field
EMS	Energy Management System. A system-wide computerized control that controls speed (frequency) and loading of all units within the range of the individual unit's set limits and efficiencies, when those units are connected thereto.

EMS INHIBITOR	Will stop EMS "raise" pulses to the governor when the throttle pressure decreases to the set-point. Pressure switches are set at 85-95% of rated throttle pressure. When the throttle pressure rises to the reset pressure, normal EMS pulsing will resume.
ENCLOSED BUS	A bus having its conductors enclosed in an insulating or metal enclosure.
END BELLS (MOTOR)	House the bearings that support the motor's shaft.
ENDOTHERMIC REACTION	Chemical reactions that must be continually provided with energy from outside in order to keep going.
ENERGY	Implies that a capacity for action is present; broadly defined as the ability to produce a change from the existing conditions. The capacity of a body to do work. Can neither be created nor destroyed, but only altered in form. That which does or is capable of doing work; electrical energy is usually measured in kilowatt-hours.
ENERGY MANAGEMENT SYSTEM (EMS)	Controls frequency and provides for economic load dispatch of generating units. Pulses the individual generating unit governor to change the generator output in response to system frequency deviation (Load/Frequency Control). Calculates the increase or decrease in total system MW generation to correct the frequency deviation.
ENTHALPY	Thermal energy or heat content of one pound of a substance. The amount of heat or energy contained in a fluid. The amount of energy that is contained in each pound of steam. Enthalpy can only be used with fluids because it is the sum of the flow energy and internal energy expressed in heat units.
ENTRAINMENT	The process by which water containing impurities is picked up and pushed along by steam.
ENTROPY	An indication of the energy in a material that is not available for doing useful mechanical work; unrecoverable energy; typically expressed in BTU's per pound per degree. A calculated property used to evaluate the efficiency of a process.
EP ADDITIVES	Chemicals added to gear oils to protect metal surfaces against wear from rubbing. The letters "EP" stand for extreme pressure. Used in greases or oils to form a protective coating on the exposed metal. The coating stays in place and prevents metal-to-metal contact even if the lubricant is rubbed away.
EPM (EQUIVALENTS PER MILLION)	A method of expressing ionic concentrations in terms of equivalent electrical charges.

EPRI	Electric Power Research Institute
EQUATION	A way to show how two mathematical expressions are equal even though they may seem to be different.
EQUILIBRIUM	A state of balance between two different concentrations.
EQUILIBRIUM REACTION	A reversible reaction; a reaction in which reactants form products and products revert back into reactants. As reactants are forming products, the products are reverting back into reactants. There is never a time when all of the reactants are gone, because some of the products are always reverting back into reactants. Equilibrium reaction reach a state of balance when the reactants are forming products at the same rate that the products are reverting back into reactants. This state of balance is called the equilibrium point. The proportions of reactants and products do not change once the equilibrium point is reached. Equilibrium reaction is both exothermic and endothermic reactions.
EQUIPMENT ARRANGEMENT DIAGRAM	Show the locations for pieces of equipment in a plant. Each type of equipment is represented by a symbol. Equipment shown on diagrams is usually labeled with its name, its equipment number, or both. For example, a pump may be labeled "P-31-A", for pump 31-A. Some diagrams may also show the distances between equipment.
EQUIPMENT CAPACITY	A system's actual production capacity.
EROSION	The wearing away of metal surfaces caused by the flow of a substance. To wear away by abrasion.
ERROR (CONTROL SYSTEMS)	The difference between set-point (requested value) and the actual value. This forms the basis of all control systems, including our governor.
EVAPORATED WATER OR DISTILLATE	Water obtained from an evaporator and used for boiler feed water purposes.
EVAPORATOR	A piece of equipment that removes suspended solids and dissolved solids from water by heating the water to produce steam. Makes distilled water through the distillation process; boiling. The boiler has to be at a high pressure in order for the proper distillation to occur. Evaporators usually do not make enough distilled water to accommodate make-up water supply.
EXCESS AIR	Air supplied to the boiler in excess of the theoretical amount required for complete combustion of the fuel. This excess amount of air is necessary to ensure complete combustion on a practical basis. Excess air, to satisfy percentage O <sub>2</sub> versus load signals, are shaped during start-up field testing. The measured O <sub>2</sub> value us

	compared to the desired O <sub>2</sub> set point for each load index. Deviation from this comparison causes an integrated signal to correct the air demand feed forward signal to satisfy the pre-designed O <sub>2</sub> curve versus load. Departure from the normal O <sub>2</sub> calibrated set point may be biased to correct for any operational desired condition. The bias correction merely raises or lowers the calibrated curve to a new parameter position.
EXCESS OXYGEN	The term used to describe the oxygen going up the stack.
EXCITATION	Current flow that causes the field magnetic flux in motors and generators.
EXCITER	A device that produces and supplies direct current to a generator's rotor windings. A DC generator which supplies energy for the field excitation of another electric machine. Balances the flux on the generator. Matches the torque.
EXHAUST HOOD	The exhaust section of the outer casing in the LP turbine.
EXHAUST TRUNK	Turbine exhaust connection to the condenser.
EXOTHERMIC REACTION	Chemical reactions that produce energy once they are started. After an exothermic reaction is started, it continues by using the energy it produces.
EXPANSION JOINTS	Joints in steam piping that allow for movement that may result from the flow of a large volume of water or from temperature variations in a system. A joint in a piping system that takes up movement from thermal expansion and from equipment vibration.
EXPANSION LOOPS AND BENDS	Loops and bends that allow for expansion and contraction in piping due to temperature changes.
EXPONENT	A number that indicates how many times another number is to be multiplied by itself; also, the power of a number.
EXTRACTION BLOCK VALVE	A valve that isolates a feedwater heater from the turbine.
EXTRACTION NON-RETURN VALVE	A fast acting swing check valve that prevents extraction steam or water from flowing back into the turbine.
EXTRACTION STEAM	Steam that is extracted from the turbine and used by the feedwater heaters to heat the feedwater that is being sent to the boiler.
<b>F</b>	
FACTORING	An operation used to separate a common factor from items in an expression.

FAHRENHEIT	Pertaining to a temperature scale that registers the freezing point of water as 32° F, and the boiling point as 212° F, under standard atmospheric pressure. $^{\circ}\text{F} = (\text{ }^{\circ}\text{C} \times 9/5) + 32$ ; $^{\circ}\text{F} = (\text{ }^{\circ}\text{C} \times 1.8) + 32$
FAILURE COST (SPC)	The cost associated with producing defective products. Includes the cost of replacing defective products, the cost of scrap material from the production process, the cost resulting from returned products, and the cost associated with lost sales and customers.
FAN	A mechanical device used to move large volumes of gas.
FAN PRESSURE GAUGE	A second differential pressure gauge is furnished on the gauge panel to show the pressure developed by the generator fans. This pressure can be used as a check on the density meter, or can be used to indicate hydrogen purity if the density meter is taken out of service while the generator is running.
FARAD (F)	Unit of capacitance.
FATT	Future Appearance Transition Temperature
FAULT (Wire or Cable)	An open, ground, or short in an electrical device or system. A partial or total local failure in the insulation or continuity of a conductor.
FBS	Field Bus Slave.
FEEDBACK	Verification of information. Information updating the condition of a process variable that is fed into a control loop.
FEEDBACK CONTROL	A method of process control in which corrective action occurs after a disturbance has affected the process.
FEEDER	A conductor or group of conductors connecting (a) two generating stations, (b) two substations, (c) a generating station and a substation or feeding point, or (d) a substation and a feeding point.
FEEDER BREAKER	An overcurrent protective device that interrupts power to a distribution panel or group of smaller breakers.
FEEDFORWARD CONTROL	A method of process control that attempts to correct for a disturbance before the disturbance affects the process.
FEEDWATER	The water that is pumped into the boiler to replace the water that leaves the boiler as steam. The feedwater system includes all equipment from the boiler feed pump to the boiler economizer inlet.
FEEDWATER HEATER	A type of heat exchanger that uses turbine extraction steam to heat condensate and feedwater. Potential of up to 14% efficiency loss, 14% more fuel burned when out of service. The heaters were designed to maintain the temperature of the feedwater, even if

	another heater were to be removed from service. In other words, one heater is capable of doing two or three heaters work, (D. Miller).
FERROMAGNETIC MATERIALS	Natural magnetic materials. Ferrous stands for iron and each of the materials acts like iron with respect to magnetism.
FIELD	The region around magnet or electric charge in which the magnet or field is capable of exerting its influence.
FIELD COIL	A suitably insulated winding to be mounted on a field pole to magnetize it.
FIELD FLASHING	Since our generator and exciter both use electromagnetic fields, and not permanent magnet fields, we must have an "outside" source of power to initially "flash" or energize the field so that the entire process can be started. This is usually done by a field flashing circuit that converts AC station service from the power system to DC for an initial "blast" or "flash" of DC to the generator field. This is a momentary supply during start-up of the generator that provides the field with excitation long enough for the generator to begin producing power to sustain the excitation process.
FIELD MAGNET	A magnet used to produce a magnetic field.
FILM BOILING	Steam is formed faster than it can be removed from the surface. This results in the heat transfer surface becoming blanketed with a film of steam. This should be avoided since the layer of steam acts as an insulator and restricts heat transfer.
FILM LUBRICATION	A process that maintains a wedge of oil between a bearing and a shaft.
FILTER	A device that allows liquid to pass through it while it traps solids. The outlet pressures in a filter system.
FILTERS (COMPRESSOR)	Used in the intake line to remove foreign material from the air before the air is compressed. The filtering devices are often paper or cloth filters.
FILTRATION	Removal of suspended matter by passing the water through a filter medium.
FINAL CONTROL ELEMENT	A device that adjusts or regulates the value of a process variable; valves, dampers, motors. The element of a control system that converts a signal from a controlling element into a corrective action.
FINNED-TUBE HEAT EXCHANGER	A heat exchanger, such as an air preheater, in which steam flows through tubes inside the exchanger to heat air. The tubes are

FIRM POWER	finned on the outside to provide a greater surface area to increase the heat transfer rate.
FIXED BLADING (STATIONARY BLADING)	Power intended to have assured availability to the customer to meet the customer's load requirement.
FLAMMABILITY	Turbine blading that is fixed to the casing; consists of nozzle-shaped blades that direct steam flow through the turbine and supply high velocity steam to the moving blading.
FLASH STEAM	The degree of difficulty of a substance to drive off the combustible gases.
FLASH TANK	The vapor that forms when hot water at steam temperature is discharged to the atmosphere (or from a higher pressure to a lower pressure). An example of this is the cloud of vapor that rises when a kettle of boiling water is poured into the kitchen sink. Flash steam expands many times the volume it had when it was water. Actually, nearly 1600 times the volume it had before it turned to flash steam. When a trap is discharging to the atmosphere it is usually quite easy to tell whether the steam formed is flash steam or live steam. If a strong jet or blast issues from the trap discharge and is colorless at first some live steam is present, but if it is all white with no clear jet it is flash steam mixed with condensate. Also when steam issues from the trap in a lazy drift or cloud it is flash steam rather than live steam.
FLASHING	A tank used to "flash" high pressure/temperature water into steam and water at a lower pressure. It is used to recover heat from drips and drains and to recover heat and water.
FLEXIBLE DIAPHRAGM RECIPROCATING PUMP	A rapid change of state from water to steam. The process whereby water is converted to steam by reducing the pressure.
	Uses a flexible diaphragm to create the reciprocating motion that displaces the liquid. The flexible diaphragm is installed across the pumping area, or cavity. The diaphragm is attached to a connecting rod, which, on some pumps, is connected to a motor driven device called an eccentric. The eccentric and the connecting rod convert the rotation of the motor into a reciprocating motion. The suction and discharge valves are located underneath the pump cavity. At the start of the suction stroke, the connecting rod is in its lowest position, and the diaphragm is flexed to its maximum downward position. As the eccentric rotates, it pulls the diaphragm upward, creating a reduced pressure below the diaphragm. The reduced pressure closes the discharge valve, opens the suction valve, and draws a specific amount of liquid into the pump. As the eccentric

	continues its rotation, it forces the diaphragm downward to start the discharge stroke. The downward motion of the diaphragm exerts a force on the liquid in the cavity, which increases the pressure. The increased pressure closes the suction valve, opens the discharge valve, and pushes the liquid out of the pump. An important characteristic of all diaphragm pumps is that they do not have mechanical seals or packing. For this reason, they are often used on applications where little or no leakage can be tolerated.
FLOAT	A level sensing device that moves up or down on the surface of a liquid in response to changes in level.
FLOAT AND THERMOSTATIC TRAP	A float trap with a thermostatic bellows arrangement inside its casing.
FLOAT TRAP	A type of mechanical trap containing a float and a valve within its casing.
FLOCCULATION	Adding a flocculent to waste water which forms large, heavy clumps with particles in the water. These clumps are allowed to settle out of the water, and later removed. The second stage of the clarification process, in which a slow mixing action causes negatively charged suspended particles to come together with the positively charged precipitate formed during coagulation.
FLOCCULENT	A chemical that attracts suspended and dissolved solids and causes them to stick together.
FLOW DIAGRAM	Piping diagram. Uses lines to represent process flows, and symbols to represent process equipment in the system, including tanks, pumps, and valves. Does not show the devices used to monitor the process, and it does not show all of the devices used to control the process.
FLOW ENERGY	The term given to a specific kind of energy that exists when a fluid is in motion or has the ability to be put into motion. This is not the same as the kinetic energy of the fluid. Flow energy results from the fact that some force must have been exerted on the fluid in order to make it flow.
FLOW RATE	The amount of fluid that passes a particular point of a system at a particular time. Mass is pounds per hour; volume is gals per minute. Area x velocity = cubic feet/sec,
FLOW TRANSMITTER	A transmitter that senses and measures the rate of fluid flow.
FLUE GAS	A mixture of gases resulting from combustion and other reactions in a combustion device (boilers, combustion turbines), which is channeled through a chimney or stack into the outdoor air.

FLUE GAS RECIRCULATION	A combustion zone control system in which flue gas that is low in oxygen is added to the combustion air to expand the combustion zone and reduce the overall combustion temperature. A method of steam temperature control that involves rerouting flue gas from the outlet of the economizer to the bottom of the furnace.  Provided as a means of maintaining design reheat steam temperature. The gas recirculating system should not be used for the purpose of obtaining <u>design</u> steam temperature below the specified control range as this may lead to overheating of superheater elements and unstable furnace conditions. Gas recirculation may be used at boiler loads below the control point to maintain a specified rate of temperature increase. However, at ratings below the control point, care must be exercised not to overheat element metal temperatures. When the boiler load decreases below the control range, the system will automatically limit the gas recirculation so that it will not exceed 30% of total gas flow. <u>Gas recirculation must not be employed at boiler ratings below 25% of full load rating as it will lead to unstable furnace conditions.</u> The gas recirculation fan must not be started until this boiler load is exceeded.
FLUID	A general term that is applied to substances which flow or tend to take the shape of the particular container they are in. Fluids may be of three general types: <u>Liquids</u> such as water, <u>gases</u> such as air, and <u>vapors</u> such as steam.
FLUID SYSTEMS BASIC STRUCTURE	Energy (source) - transmission path (pipes) - control devices (regulators, valves) - demand or load (actuators)
FLUME FLOW MEASURING DEVICE	An open channel flow measuring device that has a restriction with a downward sloping throat. The liquid level behind the restriction is converted to a flow rate.
FLUX	The magnetic lines of force existing between two opposite magnetic poles.
FLY ASH	Light, fine particles of ash that are carried out of a boiler furnace by flue gas.
FLYWEIGHT GOVERNOR	A device used to control turbine speed. It is connected to the turbine shaft and senses the speed of the turbine shaft.
FLYWEIGHTS	Parts of some mechanical governors; consisting of a set of weighted arms connected together by a spring.
FLYWHEEL	A heavy wheel of opposing and moderating by its inertia any fluctuation of speed in the machinery with which it revolves.
FOOT POUND	The English unit of work and energy.

FOOT VALVE	Holds pump priming water up in a pump.
FORCE	The total weight applied to a surface by a solid, liquid, or gas; also, any influence capable of producing movement or a change in movement. Force = Mass x Acceleration.
FORCED DERATINGS	Anything that blocks load on the unit, that isn't scheduled. Counts against our EFOR outages. The difference between "scheduled" and "unscheduled" is if the derating or outage can wait beyond the next weekend, it does not count against us in terms of our EFOR goal.
FORMULA	A mathematical expression made up of known and unknown values. An algebraic equation for a typical problem or situation. A method for describing relationships between quantities in a physical system. The relationships are usually described by words or symbols and expressed as mathematical equations.
FOULING	The buildup of deposits on the internal surfaces of a heat exchanger.
FOUR-WAY VALVE	A multiport valve commonly used to change flow through a piping system. Has two L-shaped openings in its plug.
FRAME	The supporting structure for the stator parts.
FREE ELECTRONS	Electrons which are loosely held and consequently tend to move at random among the atoms of a material.
FREQUENCY (F)	The number of cycles completed each second by a given AC voltage. The number of complete cycles per second existing in any form of wave motion; such as the number of cycles per second of an alternating current. Generator frequency is 60 cycles per second.
FREQUENCY CONTROL UNIT (FCU)	Rapid pulse frequency control. System frequency will control individual unit load.
FRICITION	A force that always acts to oppose motion. The resistance to relative motion between two bodies in contact. Produces heat and wears away surfaces.
FRICITION HEAD	Related to the level of a liquid. The difference between static head and velocity head that results from friction.
FRICITIONAL LOSS	The loss of energy due to friction that occurs when steam passes through a valve, such as a turbine control valve.
FUEL INJECTION SYSTEM	A system that delivers fuel to engine cylinders at the right time and in the proper amount to ensure smooth and efficient combustion of fuel.

FUEL INJECTOR	A device, such as a nozzle, used to spray fuel into an engine cylinder so that combustion can occur.
FULL ARC ADMISSION	A method of starting a turbine in which steam is distributed equally through the control valves to each section of the nozzle block so that the turbine is heated evenly. During start-up, when the turbine-generator unit is being brought up to speed, the governing valves are all open with the speed controlled by the throttle valve's inner plug valve. It allows steam to be admitted to all of the nozzle chambers situated around a 360 degree arc before the turbine control stage blading. This start-up method results in even heating and expansion of the nozzle chambers and reduces thermal shocking. Upon reaching a certain speed point (approx. 3400 rpm), the governing valves are positioned to take control, the throttle valves are opened wide, and then the turbine is controlled by either governor single valve or sequential valve operation. Potential of up to 7% efficiency loss. Prevents thermal stress.
FUNDAMENTAL UNITS	Length, Mass, Time
FURNACE	The open area in a boiler where fuel is burned; combustion area.
FURNACE DRAFT	The amount of pressure or vacuum inside a furnace.
FURNACE PRESSURE TRANSMITTER	Mechanically measures the furnace pressure and then converts this measurement to an electrical signal. 4 milliamp is the minimum signal, while 20 milliamp is the maximum.
FUSE	A part of a circuit made of low melting point material so that it will melt and break the circuit when a specified current is exceeded.

**G**

GAIN	A proportional control adjustment. Gain is the inverse of proportional band, and it is expressed as a quantity, rather than as a percent value.
GAS CIRCUIT BREAKERS (GCB)	Very high voltage level circuits, notably the 500 KV system. In these breakers a special gas, under pressure is used to extinguish the arc. The gas used must have excellent stability and dielectric properties. The gas used at the present time is a compound of sulfur and fluorine known as sulfur hexafluorine (SF6).
GAS RECIRCULATION FANS	Fans found in some generating units that are designed to recirculate furnace gas so that the boiler can be warmed more efficiently during unit startups.
GAS TEMPERING	A method of steam temperature control that involves rerouting

	flue gas from the outlet of the economizer to the top of the furnace, above the fire and below the secondary superheater.
GATE VALVE	Primarily for open and closed service; flow isolator. Used in situations where the valve position seldom changes, such as a drain valve on a tank, which would be closed most of the time. Consists of a body containing two inclined seats mounted in a plane nearly perpendicular to the line of flow and a wedge which has the same angle as exists between the two seats. The wedge is moved up and down by the stem to which it is attached. Gate valves offer very little opposition to flow when they are wide open. The wear on the seats and wedge of a gate valve is uneven when the valve is not fully open. For this reason they should not be used to throttle the flow. Gate valves are used as stop or shutoff valves where they can be either fully open or closed. Gate valves are fairly easy to identify because they have relatively long bodies and long valve stems.
GAUGE	An indicating instrument that uses a pointer and scale to display information about a measured variable.
GAUGE GLASS	A type of direct level measurement device whose use is based on the principle that liquid levels equalize in containers that are connected together. Permit visual observation of the level in the vessel. Consists of a small diameter glass tube which is connected to the top and bottom of the vessel. The liquid level inside the glass changes directly with any change in level inside the vessel. Special types of glass and construction make this device usable for practically any type of service.
GAUGE PRESSURE (PSIG)	Pressure measured from a zero reference point of atmospheric pressure. Since atmospheric pressure serves as the starting point, it is given a value of zero on the gauge scale. PSIG OR PSI; PSIG = PSIA -14.7 PSI
GEAR PUMP	Rotary pump. Consists of a casing with a suction port and a discharge port. Inside the casing are two gears. One gear is rotated by the pump's driver. This gear is often referred to as the driver, or driving, gear. The other gear moves because its teeth are meshed with the teeth of the driver. This gear is called the idler gear. During operation, liquid enters the pump through the suction port. As the gears turn and un-mesh, liquid is trapped in the spaces between the casing and the gear teeth. This liquid is moved along until it reaches the discharge port, where it is forced out of the pump. On this type of pump, each space between the gear teeth positively displaces a given amount of liquid. Therefore, on each revolution that the gear makes, a specific

	amount of liquid is pumped.
GEGWT	GE Glegg Water Technologies Inc.
GENERAL ENERGY EQUATION	A law governing fluid flow based on the principle that energy cannot be created or destroyed but can only be transformed from one form to another. The general energy equation states that the total energy contained in the fluid at one point in the system must be equal to the total energy contained at any other point in the system providing there is no energy added or removed between the two points.
GENERAL GAS LAW, OR IDEAL GAS LAW	The relationship between gas temperature, pressure, and volume. Pressure times volume, divided by temperature equals a constant value. Whenever there is a change in one of the three variables, the remaining two variables will change so that the value of the constant does not change.
GENERATING STATION	A plant wherein electric energy is produced from some form of energy (e.g. chemical, mechanical, or hydraulic) by means of suitable apparatus.
GENERATOR	A machine that converts mechanical energy into electrical energy. A generator does not produce or make electricity any more than a pump produces or makes water. The generator produces a voltage or potential difference which causes current to flow just as the pump produces a pressure difference which causes water to flow. Whenever a conductor which has no current flow is moved through a magnetic field, a potential difference or voltage will be developed in the conductor. The motion must be such that the conductor cuts across the lines of force of the magnetic field. The magnitude of the voltage produced in this manner depends on the strength of the magnetic field, the length of conductor in the field and the speed with which the conductor cuts across the lines of force. It does not matter whether the magnetic field is stationary and the conductor moves, or the magnetic field moves and the conductor is stationary. The principle is the same as long as there is relative motion between the two. In all large generators, the magnetic field moves and the conductors are stationary. The mechanical power required to produce this motion is supplied by the steam or gas turbine. The magnetic field is produced by passing a direct current through a circuit known as the generator field. This direct current is supplied by a small DC generator which is known as the exciter. The rotating member is frequently called the field, or rotor. The stationary part of the machine is known as the stator although the term armature may also be used. The armature is the part of the generator which contains the

conductors and since in all our machines this is the stator, the two terms may be used interchangeably. The generator rotor bearings, the hydrogen shaft seals, and the oil passages for supplying oil to these parts are contained in and supported by the outer generator end shields. The end shields are split on the horizontal center line to facilitate their removal. Finned-tube coolers are provided in the stator frame to cool the hydrogen gas as it is circulated inside of the generator. They may be mounted in either a vertical or a horizontal position. External connections are provided for cooling water supply and return piping. The cooling medium is treated water known as auxiliary cooling water. All main generators produce three phase power and all large electrical equipment utilizes three phase power. For small low voltage applications in the plant, office or home, single phase power is used. For this use, just one of the three separate circuits or phases is used.

**GENERATOR BEARING DRAIN LOOP SEAL**

A loop seal is provided in the combined generator bearing oil drain line before it enters the turbine bearing oil drain system. The purpose of this loop seal is to prevent the hydrogen in the generator from escaping into the main oil reservoir in the event of failure of the generator hydrogen shaft seals which might result in a sudden surge of hydrogen through the drain line. The generator shaft seals are especially designed to prevent the possibility of this type of failure occurring, and the service record of Westinghouse hydrogen-cooled turbine generators has proved the adequacy of this design. The loop seal, however, will provide protection against the remote possibility of shaft seal failure from any cause whatsoever, and as such represents an additional safety feature beyond normal or anticipated requirements. A vent to the atmosphere is provided on the upstream or inlet side of this loop seal so that any hydrogen flowing through the bearing drain line will be carried out of the system before sufficient pressure can be built up to blow the oil out of the loop seal and allow the hydrogen to reach the main oil reservoir. Since this loop seal presents an obstruction to uninterrupted flow in the bearing drain system, the vapor extractor on the main oil reservoir is not able to ventilate that part of the generator bearing oil drain system on the upstream side of the trap. Therefore, an additional vapor extractor assembly consisting of extractor, control by-pass, and check valve is provided as a part of the loop seal assembly to provide the negative pressure in the generator drain system on the upstream side of the loop seal required for normal operation.

**GENERATOR SEAL OIL SYSTEM**

The seal oil system prevents hydrogen gas from escaping from the generator at the shaft seals. Entrained hydrogen carried in the seal oil is removed and the oil is cooled before it is returned to the

seals. Since the rotor shaft ends of a hydrogen-cooled generator must be brought out of the gas-tight enclosure, means must be provided to prevent escape of gas along the shaft. Gland seals supplied with oil under pressure are used for this purpose. Oil is pumped to a feed groove between the gland rings and flows both ways along the shaft through the clearance space between the gland rings and the shaft. As long as oil pressure in the feed groove exceeds the gas pressure in the machine, oil will flow toward the hydrogen side of the seal and prevent escape of hydrogen from the machine. The gland rings are provided to restrict the flow of oil through the seal. These rings can move radially with the shaft, but are restrained from rotating by dowels in the supporting structure. The function of the gland oil system is to provide oil under pressure to the seals as free as possible from air and moisture. The same oil is used in the turbine bearing system and the gland system. This oil in contact with air or hydrogen absorbs an appreciable volume of gas and will also absorb moisture if water vapor is present. When oil with air and water absorbed in it is pumped into the hydrogen compartment, some of the air and moisture will come out of the oil and contaminate the hydrogen in the machine. The hydrogen purity must be kept up to the required value by adding fresh gas. In the gland oil system a large part of the absorbed gas and moisture is removed from the oil before it is pumped to the seals. The gland oil system is isolated from the bearing oil system. However, there is a slight amount of oil interchange between the seals and the bearings, so it is necessary to have a makeup and overflow arrangement between the gland oil and the main bearing oil systems so as to maintain the proper amount of oil in the gland oil system. The seal oil makeup consists of a float valve in the seal oil vacuum tank which opens when the level drops and adds oil from the generator bearing oil system. If the quantity of oil in the gland oil system tends to increase, a float valve in the hydrogen side seal oil drain chamber opens and the excess oil is returned to the generator bearing oil system.

**GENERATOR VOLTAGE REGULATOR**

A regulator which functions to maintain the voltage of a generator, at a predetermined value.

**GENEVA RULES**

A system for naming organic chemicals. Uses different word endings, such as "ane" and "ol", to identify different groups of molecules. For example, the letters "ane" at the end of a chemical name indicate that the molecule is part of what is called the alkane group of hydrocarbons. A hydrocarbon is a compound that contains only hydrogen and carbon. The difference between alkanes and other hydrocarbons is in the way that the carbon and

hydrogen are bonded together. Three of the most common alkanes are methane, ethane, and propane. The first part of the name also has meaning. Within the alkane group, there is a connection between the first part of the name and the number of carbon atoms a molecule contains. Methane has one carbon atom, ethane has two, and propane has three. Another group of organic chemicals that has the same connection between the name and the number of carbon atoms is the alcohol group. Alcohols are formed by removing it with a hydrogen (OH) group. Methyl alcohol, which is also called methanol, has one carbon atom. Ethyl alcohol, which is also called ethanol, has two carbon atoms. The "ol" ending indicates that methanol and ethanol are part of the alcohol group.

GLAND	The collective term for the gland seals used at a particular sealing point. A component of the gland seal system made of grooves and ridges designed to help seal the turbine; usually supplied with steam or water, which provides sealing.
GLAND NUTS (VALVES)	Used to tighten down on the packing gland.
GLAND SEAL	A seal, usually composed of several labyrinth seals, designed to prevent leakage of air or steam around a turbine shaft. Water, steam, or oil used to prevent leakage of gases or liquids along rotating shafts.
GLAND SEAL SYSTEM	A turbine support system designed to prevent air from leaking into the turbine and prevent steam from leaking out; sealing is accomplished by supplying steam to a series of glands located along the turbine shaft. Also prevents thermal stress.
GLAND STEAM CONDENSER	Purpose is to maintain in the gland leakoff system a pressure slightly below that of sub-atmosphere, to prevent the escape of steam from the ends of the glands, and to remove and condense the vapor. Eliminates dropping and accumulation of moisture caused by slight gland leakage to atmosphere. Steam that leaks past the labyrinth seal toward atmosphere is piped to the shell side of the gland steam condenser. The shell side of the condenser is provided with an air exhauster which maintains a slight vacuum in the shell. The cooling medium, which passes through the tubes of the condenser, is supplied by the condensate pumps. The gland steam that is condensed is usually returned to a drip tank and from there to the condenser hotwell.
GLAND STEAM EXHAUSTER	A vacuum pump that draws air and steam from the turbine glands to the gland steam condenser.
GLOBE VALVE	A valve that may be used wide open, fully closed, or in an

	intermediate position for regulating flow; throttling valve.
	Consists of a body containing a seat ring usually placed in a horizontal position parallel to the line of flow and a valve disc which is made to bear against the seat ring. The disc is raised and lowered by the handwheel and stem. The globe valve, because of its construction offers a considerable restriction to flow even when it is wide open. Normally arranged in a piping system so that the higher pressure side of the piping system is acting under the valve's disc. This makes it easier for an operator to open the valve.
GLYCERINE	Glycerol; a sweet syrupy hygroscopic trihydroxy alcohol usually obtained by the saponification of fats and used especially as a solvent and plasticizer.
GOVERNING TRANSFORMER	A pressure transformer which, magnifies the relatively small pressure changes delivered by the governing impeller into large pressure changes which are utilized to actuate the relay of the servomotor.
GOVERNING VALVE	Valves located in the steam chest that control the steam flow to meet changing load demands. Westinghouse turbines utilize the bar lift mechanism for governing valve control. The bar-lift mechanism opens the valves in desired sequence. Valve stems pass through holes in a bar raised and lowered by the control mechanism. Collars on each valve stem are set at different heights; as the bar rises, valves lift in a sequence determined by the collar settings. Turbines with separate steam chests have flexible inlet piping which connects the chests to separate nozzle chambers in the turbine casing. Another application of the bar-lift operation is the external hinged lever lift. The valve stems are connected to the operating lever by links. The point at which each valve starts to open is determined by the length of the slot in the links. The valves are equipped with compression springs which act downward on the spring seat to provide a positive closing force.
GOVERNING VALVE EMERGENCY TRIP	Designed to admit high pressure oil to the governing control system and close the governing valves.
GOVERNOR	A device used to maintain the speed of a turbine at a desired value. Consists of a speed sensitive oil impeller mounted on the turbine shaft and an oil operated servo-motor that positions the governing valves, with oil pressure used for transmitting the speed impulse to the servo-motor element. See Main Governor.
GOVERNOR IMPELLER	Mounted on the turbine shaft and supplied with a limited amount of high pressure oil from the main oil pump, maintains a pressure

	which varies as the square of the speed thus giving a governing medium.
GOVERNOR VALVES	See control valves.
GPM	Gallons Per Minute.
GRAM	A metric unit of weight equal to approximately 0.035 ounces.
GRAPH	A diagram that represents the variations of one variable in comparison with one or more other variables. Pictorial representations of numbers and various relationships between numbers.
GRAPHIC DISPLAY	A type of display that uses symbols and lines to provide information about the present condition of a process or part of a process.
GRAPHITE	A solid lubricant; a very slippery mineral form of carbon. Because it is not sticky, it does not attract dirt. It can also resist heat and pressure.
GREASE	A mixture of oil and a thickener. Grease is measured on a scale from 0, for very soft grease, to 6, for very hard grease. There are also extra-soft 00 and 000 grades.
GRID	A network of power stations, power lines, and power users.
GROSS HEAT RATE	The heat rate of a generating unit calculated by using the total electrical output of the generator.
GROSS POWER	The total amount of power produced by a generator, measured at the generator leads.
GROUND	An electrical fault that occurs when electricity takes an undesirable path to earth or ground, usually as a result of a breakdown in insulation.
GROUND CURRENT	Any current flowing to a grounded body.
GROUND DETECTOR	An instrument used for indicating the presence of a ground on an ungrounded system.
GROUND PROTECTIVE RELAY	A protective relay that can detect excessive ground current and actuate an alarm.
GROUND RELAY	A relay that initiates an alarm if it detects abnormal current flow to ground.
GROUND RESISTOR	A protective device that provides resistance to limit the amount of fault current flowing to ground.
GROUNDED (EARTHED)	Connected to earth or to some conducting body which serves in place of the earth.

GROUNDED SYSTEM	A system of conductors in which at least one conductor or point (usually the middle wire or neutral point of a transformer or generator windings) is intentionally grounded.
GROUNDING SWITCH	A form of air switch by means of which a circuit or a piece of apparatus may be connected to ground.
GROUNDING TRANSFORMER	A transformer intended primarily for the purpose of providing a neutral point for ground.
GUIDE VANES	Devices located on the inside of a windbox that help to distribute air flow evenly.

**H**

H2500	See Sodium Chloride.
HAND/AUTO STATION	A control in a control loop that passes the control loop's automatic signal to a final control element, or allows an operator to assume manual control; also called a control station.
HARD WATER	Water containing a relatively high concentration of those dissolved solids that have a soap consuming property; calcium and magnesium. In the steam plant these materials correspond to the scale forming solids, which are to be avoided as much as possible.
HARDNESS	A quality of water defined by the amount of calcium and magnesium present.
HARDNESS SALTS	Compounds made of calcium or magnesium.
HAZARDOUS WASTE	Waste material which by their nature are dangerous to handle or dispose of, such as chemicals, solid materials containing heavy metals (copper, chrome, iron, etc.), or other wastes produced by industrial operations. A waste is considered hazardous if it exhibits characteristics of ignitability (ignites or burns easily), corrosivity (acid, caustics), reactivity (oxidizers), and toxicity (heavy metals).
HEAD (HEAT EXCHANGER)	The ends of the heat exchanger. The fluids that flows through the tubes enters and exits through the heads.
HEAD (PUMPS)	The pressure caused by the weight of a column of liquid as a result of its height; usually given in feet. Another way of looking at head is by relating it to pressure. For example, the amount of pressure at the discharge of a pump that's running can be viewed as the height of a column of liquid that the pump's discharge pressure will support. This imaginary column of liquid represents head.

HEAD CURVE (PUMPS)	Indicates how much head, or pressure, the pump should produce for various flow rates. The horizontal axis is often marked to indicate flow rate in units such as gallon per minute (GPM). Flow rate can also be referred to as the pump's capacity. The vertical axis is usually marked to indicate head, in feet.
HEAD PRESSURE	The pressure exerted by a column of liquid as a result of its height, or level. The amount of pressure exerted also depends on the liquid's density. Denser liquids exert more pressure for a given height than less dense liquids. Positive pressure at a given point in a liquid system, normally expressed in feet of water.
HEADER	A pipe or drum, that serves as a central connection for two or more smaller pipes.
HEAT	A form of energy called thermal energy; amount of thermal energy. A form of energy capable of raising the temperature of a substance.
HEAT EXCHANGER	A device designed to transfer heat from one fluid to another. Components used to heat, cool, condense, or evaporate fluids.
HEAT LOSS METHOD	A method of determining boiler efficiency expressed as a relationship between individual heat losses and inputs to the boiler.
HEAT OF VAPORIZATION	See Latent heat of Vaporization.
HEAT RATE	A measurement of generating station thermal efficiency. The amount of fuel, in BTU, put into the process that is required to produce 1 kilowatt-hr of electrical energy. Measured in BTU per Kilowatt-hour (BTU/Kilowatt-hr). Chemical energy is divided by electrical energy out.
HEAT SOAK	A procedure in which the speed of a turbine is held constant for a specified length of time; a method used to bring steam-to-metal temperature mismatches back to normal.
HEAT TRANSFER	Thermal energy that is moving from one substance to another, or from one part of an object to another, by means of radiation, convection, or conduction. This movement is a result of a temperature difference. Mass x specific heat x (Tf-Ti). The formula states that the amount of heat transferred equals M, the mass, or amount, of substance involved, times its specific heat, which relates to the type of substance involved, times the difference between the final temperature of the substance, Tf, and the initial temperature, Ti.
HEAT TRANSFER RATE	The amount of heat transferred from one body to another in a specific time period; often expressed in BTU's per hour.

HEATING VALUE	The BTU content of a fuel.
HEATUP RAMP RATE	The rate at which a boiler is taken from startup to normal operating temperature; generally expressed as a number of degrees or watts per unit of time.
HEAVY METALS	Metallic elements like mercury, chromium, cadmium, arsenic, and lead, with high molecular weights.
HELIUM	Inert and nonflammable, would be an ideal medium for ventilation and cooling purposes for the generator. Because of its scarcity and high cost, it could not be considered feasible as a cooling medium.
HENRY (H)	Basic unit of inductance.
HERTZ (Hz)	Basic unit of frequency, one cycle per second.
HICKEY	A tool used on valve hand wheels to increase mechanical advantage when opening valves. Also referred to as a valve wrench.
HIGH BLOCK	An adjustable turbine control device used to limit the maximum load the machine will pick up or carry.
HIGH POT	High potential applied to electrical machine or equipment normally during testing of insulation.
HIGH PRESSURE HEATER	A heater, usually located after the discharge of the boiler feed pumps, where the pressure of the water is relatively high, that uses the latent heat of extraction steam to heat the water that passes through it. Provides suitably heated water to the boiler to prevent thermal shock.
HIGH SIDE	The higher voltage electrical system of two systems connected by a transformer.
HIGH VOLTAGE	Above 600 volts.
HIGH VOLUME WASTE (HVW)	Classified waste that contains items found in the Federal Code of Regulations; metal cleaning waste. Waste that needs treatment before overboarding.
HISTOGRAM	A bar chart used to graphically display sample data. Data is plotted in the form of bars, or rectangles. The bars are called cells. A cell's height is related to the number of readings for the cell. The distance between the starting point and the ending point of a cell is called the cell range.
HOG JET	A high capacity steam air ejector utilized to assist the normal air ejectors.

HOLDING COIL	A device that, when energized, holds contacts either open or closed. When the holding coil is de-energized, the contact position changes: for example, if a contact is open, it closes.
HOLDOFF REQUEST	Purpose is to protect personnel working on a generator from injury caused by the accidental energizing of the main generator leads from the switchyard. Clarifies and communicates the isolation of equipment between Production and System Operation Department personnel and provides an electrical "clearance" on the equipment or position of the system.
HORSEPOWER	A rating of how much mechanical power a motor can be expected to produce. A unit of power in the US Customary System, equal to 745.7 watts or 33,000 foot-pounds per minute. ( $1.34 \times \text{KW}$ )
HOT	Energized electrically - referring to pieces of electrical equipment, buses or lines.
HOT REHEAT STEAM	Steam that flows from the boiler reheater to the intermediate pressure turbine.
HOT REHEAT STEAM TEMPERATURE SET-POINT	The design temperature value for hot reheat steam; intended to provide as much energy as possible to the IP and LP turbines, while preventing over-heating.
HOT WELL	Condensate drain reservoir.
HRRV (H-POWER)	Honolulu Recovery Resource Venture; refuse; 2 boilers; 46 MW
HUMIDITY	The measure of how much water vapor is in the air.
HYDRAULIC ACTUATOR	A device, consisting of a casing, a piston, and a spring, that is commonly used to operate a control valve. Powered by a pressurized liquid, such as hydraulic fluid. Compared to pneumatic actuators, hydraulic actuators of the same size are usually more powerful.
HYDRAULIC COUPLING	A coupling that uses hydraulic fluid to vary pump speed while the driver speed remains constant. Uses centrifugal force to transfer the torque of a driver to the shaft of driven equipment.
HYDRAULIC GOVERNOR	A governor that typically consists of a centrifugal pump mounted on, and driven by, the shaft of a turbine. A relay connected to the hydraulic governor converts the discharge pressure of the hydraulic governor to a mechanical action.
HYDRAZINE	A chemical deoxygenating agent used to eliminate dissolved oxygen in boiler water. A chemical used in a steam plant for oxygen scavenging of boiler water.

HYDROCARBON	An almost innumerable combination of hydrogen and carbon atoms that produce combustion under proper conditions.
HYDROGEN (H)	A colorless, highly flammable gaseous element, the lightest of all gases and the most abundant element in the universe. Low density and high thermal characteristics. Has the degree of purity desired and required for cooling purposes. Hydrogen is the most desirable gas that can be used as the cooling medium for rotating electrical machines. A mixture of hydrogen and air is explosive over a wide range of proportions (from about 5% to 70% hydrogen by volume). In a generator, carbon dioxide is used as the intermediate gas when changing either from air to hydrogen or from hydrogen to air.
HYDROGEN DRYER	A device that removes moisture from the hydrogen circulating inside a hydrogen-cooled generator.
HYDROGEN EMBRITTLEMENT	A condition caused by the interaction of dissolved hydrogen and the carbon in boiler metals; loss of carbon causes the metal to become brittle.
HYDROGEN GAS COOLERS	The hydrogen is cooled by passing it through two coolers where the gas gives up its heat to the cooling water in the finned tubes of the cooler. At the water piping connections to the coolers, the nozzle end is bolted solidly to the generator frame, while the rear end is permitted to move freely with temperature changes. The rear end is covered with a protective steel cover which must be removed to clean the cooler tubes. A flexible diaphragm between the cooler and the frame at the rear end permits this movement, yet prevents the escape of gas at this point.
HYDROGEN ION ( $H^+$ )	A positively charged hydrogen particle. Makes a solution acidic.
HYDROMETER	A device used to measure the specific gravity of a substance. Works on the principle that a floating object displaces an amount of liquid that is equal to its own weight. Based on the principle, the depth at which a hydrometer floats in a liquid is an indication of the liquid's specific gravity. Many hydrometers are calibrated for a standard temperature of 77°F. For temperatures above 77°F, the correction factor is added to the hydrometer readings. For temperatures below 77°F, the correction factor is subtracted. Some hydrometers are used with a thermometer, so that temperature compensations can be made.
HYDROSTATIC PRESSURE	The pressure related to the height of a column of liquid. The pressure exerted by a static, or non-moving liquid. Related to the depth and the density of the liquid. Every inch of water above a measurement point corresponds to a pressure of .0361 psi. Every

	foot of water corresponds to a pressure of .433 psi.
HYDROXYL ION (OH-)	A negatively charged particle made up of hydrogen and oxygen. Makes a solution alkaline.
HYGROMETER	A device that uses the expansion and contraction of a material, such as hair, to measure humidity.
HYPOTENUSE	The longest side of a right triangle.

**I**

IGNITOR	Fuel burner igniting device.
IK SOOT BLOWERS	Insertable Kinetic soot blower The air motor driven IK blower is a retracting, rotating, long lance tube type blower provided with one and often two venturi type openings near the end of the lance. They clean a wide area by moving the lance in and out along the tube banks while turning in a 360° arc. Inserted more than half the width of the boiler. Used to remove soot from superheaters and reheaters. The air motor type of power drive is provided with a sheave wheel or square lug for emergency use in case of power failure. When power air is applied to the motor, the blower is projected into the furnace, automatically reversed, and retracted to the "rest" position. The air driven motor is mounted beneath the unit carriage and travels with the assembly. Provided with a mechanically operated poppet valve which is applicable to either air or steam as the blowing medium.
IMPEDANCE (Z)	The total opposition offered to the flow of alternating current. It may consist of a combination of resistance, inductive reactance, and capacitive reactance. The combined effect of resistance and reactance. Measured in ohms. This term is very useful for making calculations but is not normally encountered in power plant operation.
IMPELLER (PUMPS)	The part of the pump that creates the centrifugal force, or pressure, to move liquid through all centrifugal pumps. Three categories: closed, open, and semi-open.
IMPULSE	An impelling force on the motion it produces; a thrust; a push; momentum. Impact reaction.
IMPULSE BLADES	Turbine blades that are shaped so that steam actually strikes the blades, causing the turbine rotor to turn. Impulse blading is more predominant in the higher pressure stages of a turbine, where the blades are shorter. Moving blading in which the space between

	blades is the same size at the blading inlet and the blading outlet. Energy transfer in impulse blading results in a decrease in steam velocity. Buckets; curve rotating blades used in HP and IP sections; 76% efficient. The temperature and pressure drop, which is fairly large, is across the stationary nozzle and not the blades. Most efficient at low loads.
IMPULSE STAGE	First stage chamber of turbine. The area between the curtis wheel and the rateau stages.
IMPULSE TRAP	Thermodynamic trap. Consists of a piston type valve operating within a control cylinder. The lower end of the valve has a tapered seating surface which opens and closes the orifice. When steam is turned on in the system ahead of the trap, pressure is exerted on the underside of the piston disc, on the valve, pushing it upward to open the orifice, so the condensate and air can flow out at full capacity. The valve opens wide on start-up for full discharge of condensate and to quickly get rid of any air that may have accumulated in the system. The valve stays wide open until condensate nears steam temperature. Opening and closing of this trap is regulated by the slight condensate flow termed the control flow, which goes up past the piston disc into the control chamber and out the small control orifice in the hollow stem of the valve. When condensate nears steam temperature it flashes in the control chamber and in the control orifice. This chokes the flow through the control orifice which increases the pressure in the control chamber snapping the valve shut to prevent the loss of live steam. As long as the condensate remains hot enough to continue the flashing the valve remains closed. When it cools slightly the flashing decreases. This reduces pressure in the control chamber allowing the valve to reopen and the cycle is repeated. The control flow continuously samples the flow coming to the trap and causes the valve to open and close quickly at the proper time, to open wide on condensate but close when steam reaches the trap. The control flow consists of only a slight percentage of the full flow through the main orifice. This means that only an amount of condensate equal to this small percentage is required to completely fill the control orifice at all times. When the main valve is closed and as long as this slight amount of condensate flow is maintained there can be no measurable flow of steam through the control orifice.
IMPULSE TURBINE	A turbine in which the force of high-pressure steam causes the rotating blades to turn.
IMPURITY	A suspended solid, dissolved solid, or dissolved gas that must be removed from water in order to make it pure.

IN PHASE	Applied to the condition that exists when two or more waves of the same frequency pass through their maximum and minimum values of like polarity at the same instant.
INDICATOR	An instrument that gives a visual indication of the current value of a process variable.
INDIRECT CONTACT HEAT EXCHANGER	A heat exchanger in which the two fluids are separated by a solid surface; also called a surface heat exchanger.
INDIRECT FLOW MEASUREMENT DEVICE	Measures process conditions that are related to flow, such as pressure. They then convert those measurements to flow indications.
INDIRECT LEVEL MEASUREMENT DEVICE	A device that measures a physical aspect of a fluid that varies in proportion to level and uses that information to provide a level measurement.
INDIVIDUAL X CHART	Plotted using single samples from a process. The actual value of each sample is plotted directly onto the chart. Used to monitor processes for which single measurements are taken some time apart. Centerline is the average value around which the process should operate.
INDUCE	To produce a force in a body by exposing it to an influence such as a magnetic force, electric force, or changing current.
INDUCED VOLTAGE (INDUCTION)	Produced by providing relative motion between a conductor and a magnetic field. The motion must be such that the conductor actually cuts across the magnetic lines of force. The magnitude and direction of this induced voltage depends on the direction and strength of the field, the speed and direction of motion, and the length of the conductor in the field.
INDUCTANCE (L)	A physical property of AC circuits that opposes changes in current flow. Measured in units known as Henrys. Causes current to lag voltage.
INDUCTION	The act or process of producing voltage by the relative motion of a magnetic field across a conductor.
INDUCTION COIL	An arrangement of two coils such that a changing current in the first produces a voltage in the second.
INDUCTION MOTOR	An AC motor whose rotor field is produced by induction. Consists of a stationary part called the stator and a revolving part called the rotor. The induction motor derives its name from the fact that the rotor is not connected electrically to the source of power supply. Current flow in the rotor conductors is not produced directly by the voltage of the power supply but result from voltages induced

in the rotor by the action of the magnetic field set up by the stator. The motor depends, for its operation, upon the production of a rotating magnetic field. This is necessary since the relative motion is required to induce voltage in the rotor conductors. Current flow in the rotor conductors, in turn, produces the rotor field. The rotors of induction motors turn at a speed slower than the speed of alternation, or rotation, of the stator fields. The rotating magnetic field is produced by using a three-phase power supply. Three groups or sets of coils are embedded in slots in the stator. The three sets of coils are spaced 120 degrees apart. These sets of coils constitute the three phases of the winding to which the three-phase voltages, 120 degrees apart, are applied. The applied voltages will produce currents in each phase winding that are 120 degrees apart. The current in each phase will produce its own magnetic field. The three individual magnetic fields can be combined to form a single composite field.

**INDUCTIVE REACTANCE  
( $X_L$ )**

The effect of inductance on an AC circuit. The opposition to the flow of alternating or pulsating current caused by the inductance of a circuit. Because inductive reactance opposes changes to current, it tends to cause the current in a circuit to lag the voltage. Measured in ohms.

**INDUCTOR**

A circuit element designed so that its inductance is its most important electrical property; a coil.

**INERTIA**

A property of matter by which it remains at rest or in uniform motion in the same straight line unless acted upon by some external force. A property of matter that resist changes of motion.

**INFRARED MOISTURE  
ANALYZER**

Based on the fact that water absorbs certain infrared waves. Used to measure the moisture content of a solid material.

**INLET GUIDE VANES**

A set of movable triangular-shaped sections, pivoted at a central hub, that control the amount of air entering some dynamic compressors or fans.

**INLET VALVE UNLOADER  
(COMPRESSOR)**

A device used to prevent overpressurizing the receiver. The unloader consists of a piston and a connecting rod. The rod is connected to the inlet valve on the compressor. A pressure sensing line is connected from the unloader to the receiver. Air from the receiver fills the pressure sensing line. As the pressure in the receiver increases, it moves the piston and the connecting rod, and opens the compressor's inlet valve. With the inlet valve open, the air that enters the compressor is pushed back out again and is not compressed.. When the pressure in the receiver decreases, the pressure in the unloader piston also decreases, allowing the inlet valve to move back and forth normally, and the compressor

	resumes normal operation.
INPUT/OUTPUT METHOD	A method of determining the heat rate for a turbine generator set by comparing the net energy supplied to the set with the amount of useful work that is produced; also called heat balance method.
INSTABILITY (SPC)	Process values remain within the control limits even though abnormal variations are present. Causes could include changes in process materials, changes in sampling techniques, and changes in process variables such as temperature, pressure, and flow.
INSTANTANEOUS OVERCURRENT RELAY	A protective relay that initiates a circuit breaker trip immediately after detecting an overcurrent condition.
INSTANTANEOUS VALUE	The magnitude at any particular instant when a value is continually varying with respect to time.
INSTRUMENT	Any device used to measure, indicate, control, or transmit information about a process or system.
INSTRUMENT AIR	Air suitable for the operation of pneumatic instruments and controls; must be very clean, cool, and dry.
INSTRUMENT AIR COMPRESSOR	<p>Supplies air needed for controlling and regulating the different systems within the power plant. Air at atmospheric pressure enters the compressor through intake filters and is compressed and passed through the aftercooler and separator. From there it goes to the air receiver. The aftercooler and air receiver are equipped with a Y strainer and air trap. Back-up source of air is supplied from the service air system through a filtering system and reducing valve which is set to open at 80 psi.</p> <p>Air compressor accessories: See Service Air Compressor</p> <p>Instrument air from the air receiver is supplied to the following:</p> <ol style="list-style-type: none"><li>1. The 100 psig air is supplied directly from the receiver to:<ol style="list-style-type: none"><li>a. Soot blower panel (controls)</li><li>b. Turbine bleeder trip system</li><li>c. Demineralizer</li><li>d. Chemical lab and instrument rooms</li></ol></li><li>2. The 40 psig air is supplied from the Bailey reducing station to:<ol style="list-style-type: none"><li>a. Fan damper operators</li><li>b. Feedwater and by-pass regulators</li><li>c. Positioners on the reheat attemperator trip valves</li><li>d. Instruments in the circulating water pump area and fuel tank areas.</li></ol></li><li>3. The 30 psig air is supplied from the Bailey reducing station to:<ol style="list-style-type: none"><li>a. Control room panels and all transmitters</li></ol></li></ol>

- b. Controllers and control valves throughout the plant that operate on the 3-27 psig air system.

INSTRUMENT IDENTIFICATION CHART	Defines the letters on a diagram, which designate the type of instrument, and its functions.
INSTRUMENT SWITCH	A switch used to disconnect an instrument or to transfer it from one circuit or phase to another. EXAMPLES: Ammeter switch; voltmeter switch.
INSTRUMENT SYSTEM	A group of instruments and associated devices that work together to monitor and/or control the value of a process.
INSTRUMENT TRANSFORMER	A single phase transformer that steps down high voltage or current to a value low enough to be used by instruments. A potential or current transformer.
INSULATOR	A material that offers a great deal of resistance to current flow.
INTAKE FILTER	A device that removes impurities from air before it enters a compressor.
INTER CONDENSER	The first stage air ejector condenser.
INTERCEPTOR VALVES	Controls the steam flow from the reheater to the intermediate and low pressure turbines. These valves are monitored by control oil pressure and will normally open wide when the autostop trip valve is latched. The interceptor valves remain open during normal operation, being held open by a supply of high pressure oil fed through an orifice. In case the speed rises suddenly, the auxiliary governing control oil pressure will increase rapidly and open the interceptor valve trip valve, releasing the oil pressure beneath the interceptor valve servomotor piston to drain, thus closing the interceptor valves rapidly. When the speed rise stops, the auxiliary governing control oil pressure will decrease to its steady state value and when the speed decreases the interceptor will close permitting the oil pressure to be again established beneath the interceptor valves servomotor, thus opening the interceptor valves. A handwheel is provided for manual closing to test reheat safety valves
INTERCOOLER	A cooler used to cool air leaving one compression cylinder before it enters another compression cylinder; only found in multistage compressors. A shell and tube heat exchanger located between stages. As the air passes through the tube in the intercooler, it is cooled by water flowing around the tubes. The cooled air is then routed to the second stage of the compressor. First stage air pressure is approx. 25 psi.

INTERLOCK	An electrical or mechanical arrangement that prevents one operation or sequence of operations from taking place until another prerequisite operation or condition has been satisfied.
INTERNAL BYPASS VALVE	A turbine valve that is part of the main stop valve; designed to regulate the control of steam flow into the turbine during startups.
INTERNAL ENERGY	Due to the rotation, vibration, and movement among the molecules of a substance. Two specific types; chemical energy and nuclear energy.
INTERRUPTER	A device to quickly open an electrical circuit in air.
INVERSE PROPORTION	A proportionality in which when one variable increases by a specific multiple, another variable decreases by the same multiple; if the first variable decreases by a specific multiple, the second variable increases by the same multiple.
INVERTED BUCKET TRAP	A type of mechanical trap that contains an inverted bucket connected to a valve. When the bucket is at rest, it hangs downward with the valve open. Condensate enters the trap either from the side, flowing down the passage in the side of the trap and then upward under the open end of the bucket, or if the trap has a bottom inlet the condensate will enter directly under the bottom of the bucket. As long as condensate is flowing to the trap, the bucket stays down and flow continues out the orifice and passage. When steam reaches the trap it fills the bucket, the bucket floats and rises to close the valve. The steam in the bucket slowly condenses and also bleeds off through the small vent in the top of the bucket. Thus the bucket loses its buoyancy and finally sinks, opening the valve again to discharge more condensate. While the vent allows some of the steam in the bucket to bubble up into the body of the trap and condense, another important purpose of the vent is to permit passage of the air and non-condensable gases. If it were not for this vent the bucket would soon become filled with air and keep the valve closed all the time, or in other words, the trap would become air-bound and inoperative.
INVERTER	A device that converts DC power to AC power.
ION	Atom or group of atoms which have an electrical charge due to gaining or losing one or more electrons. An atom that has too many or too few electrons, causing it to be chemically active; an electron that is not associated (in orbit) with a nucleus. Ions that are positively charged are known as cations while those that are negatively charged are known as anions. A charged particle formed when a solid dissolves in water.
ION EXCHANGE	A method of removing dissolved solids from water by exchanging

	the ions of the solids for ions that will not cause problems in the systems using the water; an example of such ions are those that combine to form pure water.
ION EXCHANGE RESIN	The medium in an ion exchanger where the ion exchange takes place; small, porous, plastic beads that contain areas called sites, which are occupied by ions.
ION EXCHANGER	A component that uses the principles of ion exchange to remove dissolved solids from water; also called a demineralizer.
IONIC BOND	The bond that holds ions together.
IPP	Independent Power Producer
IR (Soot Blower)	Insertable Rotating soot blower, aka Wall Blower
IRON HORSE	The generator hydrogen seal oil supply and purification apparatus. (Westinghouse)
ISAC	Individual System/Station Automatic Control
ISO	International Organization for Standardization; independent, non-governmental organization which develops and publishes International Standards
ISO VISCOSITY GRADING SYSTEM	The higher the ISO number, the higher the viscosity.
ISOCHRONOUS	Equal in length of time. Occurring at equal intervals of time.
ISOLATED-PHASE BUS	Conductors that connect a generator to a main transformer.
ISOTOPES	Forms of a specific atom that have varying numbers of neutrons.
<b>J</b>	
JACKET (COMPRESSOR)	A chamber that surrounds the compressor. Water is circulated through the jacket to cool both the compressor and the gas inside it.
JET PUMP	The pressure of a fluid is increased as it flows through an arrangement of fixed channels. The jet pump has no moving parts. A so-called motive fluid is used to pump some other fluid. These pumps are frequently called by other names such as injector, ejector, evacuator, or aspirator. A simplified jet pump consists of a nozzle, inlet line, mixing chamber and diffuser. The motive or actuating fluid enters the nozzle at a high pressure. The nozzle converts the pressure energy of the motive fluid to velocity. The motive fluid then leaves the nozzle with a very high velocity and low pressure. The low pressure in the mixing

chamber causes the liquid being pumped to flow into the mixing chamber through the inlet line. This entering liquid is then entrained and mixed with the high velocity motive fluid. An exchange of energy takes place which in effect slows down the motive fluid and speeds up the incoming liquid. The mixture still has quite a high velocity as it enters the diffuser section. In this section, the velocity energy of the mixture is converted to pressure energy by slowing down. The discharge consists of a mixture of the two fluids at a pressure that is higher than the liquid inlet pressure but lower than the motive fluid inlet pressure. Different fluids may be used to supply the motive power and they can pump different fluids. For example, in the steam jet air ejector, steam is the motive fluid used to pump air from the condenser. In some main turbine hydraulic systems, oil is used as both the motive fluid and the pumped fluid.

**JOCKEY PUMP**

A pump used to maintain a constant water pressure in a fire protection system and to keep the system filled with water.

**JOURNAL (TURBINE)**

The part of the shaft that rides inside of a bearing. Normally rotates on a lubricating film of oil or grease. The lubricating film separates the journal from the bearing surface.

**JOURNAL BEARING,  
SLEEVE BEARING, OR  
SHAFT BEARING**

Generally made in upper and lower halves lined with high-grade babbitt metal and assembled in a bearing housing. Oil supply passages are provided in the housing and in the bearing shells through which a supply of oil is furnished to the bearing from the circulation-oil system. This oil is delivered to passageways and grooves which distribute the oil along the length of the bearing which is designed in a manner to assist the formation of the oil wedge on which the journal floats. The passageways and grooves are proportioned and arranged so that considerably more oil flows to the bearing that is required for lubrication. This additional oil flow is required to remove frictional heat and the heat that is conducted to the bearing from the hot parts of the turbine.

Bearings use a high-tin babbitt as the inner lining and it is cast on bronze, steel or cast-iron backs. Most journal bearings are of the spherical-seat, self aligning type and are mounted in bearing rings which have an internal spherical surface to fit the ball seat on the bearing. This feature provides for self alignment. The tilting pad bearing is also of the self aligning type consisting of four babbitt lined steel pads. Each pad is supported in the inner bearing ring and is located and pivoted on a spherical button with its spherical end contacting the inner liner located in the center of each bearing pad. This permits the bearing to pivot and align itself to the rotor. The oil wedge on which the journal (shaft) floats is formed by the

working hydrodynamic oil film which involves bearing clearance, bearing grooving, point of oil application, speed, load and viscosity of the lubricant. As the journal starts turning, it rolls uphill on the bearing surface, and since the journal is then slightly off center, the clearance becomes crescent shaped, with the wedge end of the crescent tucked into the load area. As speed increases, oil is dragged from the crescent to form a thin oil film in the bearing load area. Since the shaft and bearing converge, in effect, oil will leave the high load area at a higher average velocity than it had when it entered. There is a tendency for the fluid to back up in the wedge shaped load area, and since oil cannot be squeezed into a smaller volume, its pressure builds up instead to support the journal load. As the turbine speed decreases the thickness of the oil film is reduced. However, as previously stated, higher oil viscosity permits heavier bearing loading. This is one of the reasons why it is necessary to reduce lube oil temperature when a turbine generator is shut down and placed on the turning gear. Another reason is that lower oil temperature assists in removing the heat from the turbine-generator shaft.

**JUMP (SPC)**

Level change; when the plotted points on a control chart that are randomly falling around the process centerline suddenly shift towards the upper or lower control limit. May be a change in the materials entering a process or a change in conditions upstream.

**K****KILO**

A prefix used to indicate one thousand; for example, one kilowatt is equal to one thousand watts.

**KILOWATT HOUR**

A unit of energy equal to 1000 watthours.

**KINETIC ENERGY**

Energy possessed by a body due to its motion.

**KPLP**

Kalaeloa Partners Limited Partnership; oil fired; combined cycle; 2 combustion turbines; 1 boiler; 1 heat recovery generator; 180 MW.

**L****LABYRINTH SEAL (lab-ee-rinth)**

A device for restricting steam leakage along the turbine shaft. The seal must keep steam from leaking out when the pressure inside the casing is above atmospheric, and it must keep air from leaking in when the internal pressure is below atmospheric. The shaft usually has grooves in it, with matching high and low teeth on the packing rings. This forms a more zigzag path for the steam flow.

	increasing the restriction. The packing rings are usually made of a rather soft bronze alloy that will wear away without damaging the shaft in case there is rubbing. They are made in segments; two, three, or more in both the upper and lower half of the packing casing. Flat leaf-type springs that press the segments radially inward, will "give" in case the rotor should rub the packing. Controls thermal stress by maintaining a gradual temperature change on that section of the rotor, from in to out of the seal.
LAG (ELECTRICAL)	The amount one wave is behind another in time. Expressed in electrical degrees or phase angle.
LAG (LAG TIME)	The total delay in a system's response to an operating change; caused by the combined effects of factors such as resistance, capacitance, and dead time. The total amount of time from when the steam temperature changed until the water temperature reaches its maximum amount of change.
LANTERN RING	An open metal ring between rings of packing in a stuffing box used to admit a sealing or lubricating fluid.
LATENT HEAT OF CONDENSATION	The amount of heat that has to be removed from a substance to condense it without producing a change in temperature or pressure.
LATENT HEAT OF FREEZING	The amount of heat that has to be removed from a substance to freeze it without producing a change in temperature or pressure.
LATENT HEAT OF FUSION	The amount of heat required to melt a substance without a change in temperature or pressure.
LATENT HEAT OF VAPORIZATION	The amount of heat required to turn a quantity of saturated water completely into steam. The amount of heat required to vaporize a substance without a change in temperature or pressure. At atmospheric pressure or 0 pounds per square inch gauge (PSIG), 970 BTU must be added to each pound of water to turn it to steam at 0 PSIG.
LATENT HEAT TRANSFER	Heat transfer that does not cause a temperature change.
LE CHATELIER'S PRINCIPLE	If pressure is applied to a gas equilibrium system, the equilibrium will shift to lessen the pressure.
LEAD	The opposite of lag. Also, a wire or connection.
LEADS	Conductors to or from a piece of electrical equipment.
LECTRODRYER	A unit used for removing moisture from hydrogen. It contains activated alumina as the drying agent which is regenerated by heating and blowing with air.

LEFT-HAND RULE	A method for determining the direction of the magnetic field around a conductor when current is flowing through that conductor. The rule states that if the fingers of the left hand could be wrapped around a conductor with the thumb pointing in the direction of current flow, the fingers would be curled in the direction of flow of the magnetic flux lines.
LEGEND	chart on a diagram containing information about components and symbols used in the diagram.
LENZ'S LAW	The induced EMF in any circuit is always in a direction to oppose the effect that produced it.
LESS LARGEST UNIT	The sum of the capabilities of the operating units less the capability of the largest operating unit must be greater than or equal to the estimated peak load.
LEVEL	The position of a surface above or below a reference point. Measured in feet.
LEVEL CONTROLLERS	Devices that monitor level in heaters and control level by sending a signal to valve actuators to open or close valves, as necessary.
LEVEL TRANSMITTER	A transmitter that senses and measures fluid level.
LEVELTROL	Fisher Governor Company controlling device.
LIFT CHECK VALVE	A relatively small check valve that is used when a very tight seal is essential. Consists of a body, a disc, a seat, and a guide. The guide keeps the disc lined up with the seat as the valve operates. This ensures that the disc will align with the seat as the valve closes. When fluid flows through a lift check valve, the disc lifts. When flow stops, gravity pulls the disc back onto the seat. Fluid backflow will push the disc tight against the seat. Lift check valves can be used in either horizontal or vertical piping runs.
LIGHTNING ARRESTER	A device that protects equipment from high voltage surges that can occur when lightning strikes equipment, or lines or buses connected to equipment. A device which has the property of reducing the voltage of a surge applied to its terminals.
LIME	A dry white powder consisting essentially of calcium hydroxide that is made by treating caustic lime with water. Used when treating Vertan® waste to speed up the sludge forming process.
LIME SOFTENING	A process in which lime is added to water to remove hardness impurities such as calcium and magnesium by creating a precipitate that is removed from water as sludge.
LIMIT SWITCH	A simple on/off device which allows remote, electronic indication of the position of a valve, damper drive, or any moving device

	whose position needs to be known for control system purposes. A switch in an electric motor actuator that cuts off current when the final control element has reached a specific position.
LINE OF FORCE	A line in a field of force that indicates the direction of the force.
LINEAR EQUATION	Any equation whose points on a graph fall on a straight line.
LINES OF FORCE	A line in a field of force that indicates the direction of the force.
LINK	Means of opening an electrical conductor. Not used in normal switching procedures.
LIQUID RING VACUUM PUMP	A rotary vacuum pump in which a flow of liquid, usually water, forms a ring around the rotor of the pump and forms a compression chamber. A pump used to create a vacuum in a system.
LITHIUM	An oil thickener used in grease. Lithium greases are multipurpose greases. They are water resistance, and they are able to withstand high temperatures, so they can be used in applications where both heat and water are factors.
LIVE ZERO	Any minimum signal value that is greater than zero.
LJUNGSTROM AIR HEATER	Absorbs waste heat from flue gas, then transfers this heat to incoming cold air by means of continuously rotating heat transfer elements of specially formed metal plates. Protected from dew point corrosion by the recirculation of warm air from the air heater outlet to the inlet of the forced draft fan. The amount of recirculation is controlled by the average impulse of the temperature of the air entering and temperature of the flue gas leaving the air heater.
LOAD	The amount of electrical usage in a power system. A circuit or piece of equipment that uses electric power. The impedance to which electrical energy is being supplied. Can be a device, such as a motor, that uses power, or a device, such as a transformer on a motor control center, that supplies power to other circuits. The amount of electrical power being supplied by a generator to an electrical distribution system.
LOAD BLOCK	An adjustable turbine control device used to limit the minimum amount of load the machine will carry.
LOAD DISPATCHER	The individual who predicts the demand for power, monitors the condition of a power system, and coordinates the outputs of the plants in the system so that supply always equals demand.
LOAD DROP ANTICIPATOR	A device used to sense sudden loss of load above 50%. It will initiate a signal to close the interceptor and steam chest valves

hence arresting the steam flow to the turbine, thus preventing overspeed. It consists of a pressure switch responsive to IP turbine inlet chamber pressure in series with a solenoid type current relay. The pressure switch contacts are closed above 50% and the current relay contacts are open above 20% load. These contact functions are reversed at loads below 20% and both contacts are open between 20 and 40% load. If the load is rejected above 50%, the current will drop closing the current relay contacts. However, the IP turbine inlet pressure will remain high until the interceptor valves close and the pressure dissipates. A solenoid valve will be energized to increase the control oil pressure, thereby closing the steam chest and interceptor valves. The anticipator energizes the solenoid valve until the interceptor valves are closed and the IP turbine inlet pressure decays after which time the control of the unit reverts back to the main governor.

**LOAD FACTOR**

The ratio of the average load over a designated period to the peak load occurring in that period.

**LOAD LIMIT VALVE**

A sensitive spring loaded relief valve which can be set to limit the control oil pressure in the control oil header to any value corresponding to the desired maximum load. Hydraulically connected to the governing control oil system through a ball check valve. This valve can be adjusted to maintain a control pressure corresponding to any governing control oil pressure between no load and full load. Whenever the governing control oil pressure drops below the load limit control oil pressure, the ball check valve moves off its seat permitting the load limit valve control pressure to replace the governing control oil pressure and prevent the governing valves from opening further.

**LOAD REJECTION**

A sudden reduction in the amount of electrical usage in the power system, which may cause a turbine to overspeed.

**LOAD SHEDDING**

The cutting off of electricity to specific consumers in a power system in response to load demands in excess of generating capacity; done to prevent damage to generating units. Intentional interruption of power being supplied to a utility's customer(s) for the purpose of reducing system demands as to avoid a power failure during a period of reduced generating capability.

**LOADING PRESSURE**

A modulated air pressure which is an index of one or more control variables.

**LOBE COMPRESSOR**

A positive displacement compressor. Works by trapping gas and then forcing it out of the compressor. Has two figure-eight shaped

lobes inside of a casing, an inlet port, and a outlet discharge port. The lobes rotate in opposite directions inside the compressor and are spaced to prevent gas flow from leaking back to the compressor's inlet port. During operation, the tips of the lobes alternately sweep across the inlet port. When one of the tips moves beyond the port, a volume of gas is trapped between the lobe and the casing. The trapped gas is transferred to the upper area of the casing, and then through the discharge port and into the discharge piping. As the rotation continues, each lobe packs successive volumes of gas into the discharge. Each additional volume of gas that is packed into the discharge raises the pressure of the gas at the discharge.

**LOBE PUMP**

A rotary pump using lobes mounted on parallel shafts that rotate in opposite directions. A pair of timing gears, located at one end of the shafts, maintains the proper relation between the lobes throughout the rotation. Liquid is drawn into the space between the lobe and the case and is pushed from inlet to outlet.

**LOGIC**

Control scheme. Provides the permissive and the interlocks for safe operation.

**LOGIC DIAGRAM**

A drawing of an electrical system that uses logic circuits. A diagram that uses symbols to represent actions in a control system.

**LOUVERS**

Vanes for directing and controlling air or gas flow.

**LOW BEARING OIL PRESSURE TRIP**

Consists of a spring loaded diaphragm exposed to bearing oil pressure. The diaphragm is connected to a dump relay through linkage. If the bearing pressure falls below a pre-set value of 5 to 6 psi it will release the oil from the overspeed trip valve through an intermediate relay.

**LOW PRESSURE HEATER**

A heater, usually located before the suction of the boiler feed pump, where the pressure of the water is relatively low, that uses the latent heat of extraction steam to heat the water that passes through the tubes.

**LOW VACUUM TRIP**

This device utilizes a pressure responsive bellows which is exposed to exhaust vacuum. When the exhaust pressure drops below a preset value, adjustable between 18 and 25 inches of mercury, a spring loaded lever is actuated which in turn causes the trip relay to release the overspeed trip valve. A means of latching the vacuum trip is provided, which when engaged prevents the device from operating during starting when the exhaust vacuum is less than the normal trip setting. However, it will function with the latch engaged should the exhaust pressure increase to 2-1/2 to 3-1/2 psig during the starting cycle. The latch will fall out of

	engagement when the exhaust vacuum has reached a value of 20 to 28 inches of mercury, and will thereafter trip at the normal value of 18 to 25 inches of mercury, unless relatched.
LOW VOLTAGE	600 volts and lower.
LOW VOLUME WASTE	Classified waste that does not exceed the limits of our NPDES permit. Does not contain items found in the Code of Regulations.
LP SECTION KEY	Secures the turbine to the foundation. Located just about in the middle of the outer LP casing. The turbine expands towards the governor pedestal (front standard).
LUBE OIL COOLERS	Heat exchangers that use a flow of water to cool turbine lube oil.
LUBE OIL TRIP	A circuit designed to activate a solenoid trip when the lubrication oil pressure falls below a certain value.
LUBRICANT	A substance used to reduce friction.
LUBRICANT OXIDATION	Occurs when a lubricant combines with oxygen. Produces acids that can cause corrosion of metal. Tends to occur more rapidly in equipment that operates at high temperatures. Can also form harmful deposits on metal surfaces, such as varnish or carbon deposits. These deposits can greatly increase friction on bearings and other machine parts and keep them from operating freely.
LUBRICATING OIL SYSTEM	A turbine support system designed to provide lubricating oil to the turbine. Lubrication prevents metal-to-metal contact between stationary and rotating parts and abnormal wear due to friction. The oil supplied to the lubrication system is taken from the main oil pump discharge, passes through the oil cooler and thence to the main bearings, thrust bearing and turning gear. A relief valve is provided in the bearing oil line to compensate for moderate changes in oil requirements. A check valve between the bearing oil header and the main oil pump discharge assures isolation of the high pressure oil system for maintenance when unit is on turning gear. A relief valve in the bearing oil line is set to maintain a pressure of 10 to 12 psig, while the orifice supplying oil to the bearing oil header is set to maintain 12 to 13 psig with no flow through the relief valve. The relief is then backed off to maintain the 10 to 12 psig bearing oil pressure required. A Cuno Filter consisting of two filter elements in parallel is mounted on the oil reservoir to filter the high pressure oil to the control system. An additional Cuno Filter is installed in the high pressure oil line to the control devices. Three other oil pumps are located in the main oil reservoir for the following purposes:

1. Auxiliary Oil Pump - 75 HP, AC 440 V, is used during

starting and stopping periods. This pump will automatically start when bearing oil pressure drops to about 8 to 10 psig.

2. Turning Gear Oil Pump - 10 HP, AC 440 V, is used for supplying bearing oil pressure when unit is on turning gear. This pump will automatically start when bearing oil pressure drops to about 5 to 8 psig.
3. Emergency Oil Pump - 10 HP, DC 125 V, is used for back-up in case all AC power is lost. This pump will automatically start when bearing oil pressure decays to about 3 to 4 psig.

The switches controlling each of these pumps will start the pump on falling pressure but will not stop the pump on rising pressure. To stop any of these pumps after the oil pressure has risen to a point at which the pressure switch closes it is necessary to turn the switch to off position. The pump will stop but the switch will automatically return to the "auto" position and in so doing will remain under the control of the pressure switch in case of a drop in pressure. These switches are provided with a "Test" valve which can bleed off pressure on the test header to actuate the pump start for testing purposes. These tests can be carried out during normal operation without affecting the system. Another pressure switch, also connected to the bearing oil header prevents the turning gear motor from starting until bearing oil pressure has risen to somewhere above 2 to 4 psig. High and low level alarm switches are provided in the reservoir to give indications when either of these two levels has been reached. Two oil coolers are provided, and are connected by a tandem-operated three-way valve to switch from one cooler to the other. An interchange valve and sight are provided to assure that the coolers are full of oil before changing over. The interchange valve should always be open to the idle cooler except for periods during maintenance.

**LVW**

Low Volume Waste

**M**

M-268	Used in the Vertan® treating process to isolate copper from the Vertan® waste, which is then removed along with the sludge.
MACH .9	Speed just before supersonic.
MACHINE	Any system, usually of rigid bodies, formed and connected to alter, transmit, and direct applied forces in a predetermined manner to accomplish a specific objective, such as the performance of useful work. A device that uses applied forces

	advantageously.
MAGNETIC AMPLIFIER (MAGAMP)	A reactor of which the output is varied by changes in saturation caused by small changes from a control current coil.
MAGNETIC COUPLING	A variable speed coupling that uses magnetic force to transfer torque from the shaft of a driver to the shaft of driven equipment.
MAGNETIC FIELD (H)	The space in which a magnetic force exists. Composed of the area through which the magnetic lines of force pass. The total number of lines of force issuing from a pole.
MAGNETIC FLUX	The total number of lines of force issuing from a pole; Number of magnetic lines in a magnetic circuit. More lines → more strength.
MAGNETIC OVERLOAD DEVICE, OR MAGNETIC OVERLOAD RELAY (MCC)	Operates on the magnetic field generated by current. Consists of a coil around a metal core and a set of contacts. The contacts are held together by a spring. The overload device's coil is in the motor controller's power circuit. When the power circuit is energized, current flows through the coil, creating an electromagnetic field. The strength of the electromagnetic field increases as the current flowing through the coil increases. When the current level gets too high, the strength of the electromagnetic field increases enough to overcome the force of the spring. As a result, the contacts are pulled apart, which interrupts current flow through the control circuit. The interruption of current flow through the control circuit opens contacts in the motor controller. This interrupts current flow to the motor through the power circuit, and the motor stops.
MAGNETITE	A natural magnet.
MAGNETO	An alternating current generator in which the field is supplied by a permanent magnet.
MAIN GOVERNOR	The main governor produces a governing control oil pressure which varies in accordance with the turbine speed with a fixed setting of the speed changer. When operating in parallel with a utility system or with large units in the same plant, the turbine speed is controlled by the electrical tie of the generators. Under such operating conditions the speed changer actually becomes a load changer. This is true because changing the steam flow can only change the torque while the speed of the turbine is scarcely affected. Accordingly then, there is a different load for every position of the speed changer. The main and auxiliary governors are mounted on a common housing base to the side of the thrust bearing pedestal. These two governors are similar in operation, except that the auxiliary governor is not provided with a motor driven speed changer.

**MAIN GOVERNOR  
TRANSFORMER**

The governor transformer, magnifies the relatively small pressure changes delivered by the governor impeller into larger pressure changes which are used to actuate the relay of the servomotor.

**MAIN OIL PUMP**

A component of the turbine's lubricating oil system. An oil pump that is attached to and driven by the turbine rotor, and whose discharge pressure is dependent on rotor speed. It is a volute type centrifugal pump with a large capacity range with very little change in discharge head. All operating mechanisms are single acting, that is, they open hydraulically, and are closed by springs. Thus there is no extra load imposed on the pump when the valve operating mechanisms are suddenly closed following a trip out or load rejection. The pump is not self-priming, and must have a positive suction pressure at all times during operation. This positive suction pressure is provided either by the auxiliary lube oil pump on startup, or by the main oil pump's ejector when the shaft is up to speed. Actually a lousy pump, because the seals are very loose. Wide clearances provide for rotor long and rotor short during startup. The main oil pump supplies all of the oil required for the control and lubrication systems during normal operation and in addition provides two sources of back up oil for the hydrogen seal oil system of the generator. Oil is supplied to the pump at about 25 psi. Oil discharge by the pump is at about 150 psi, and is used for the following purposes:

1. To operate the oil ejector which supplies the main oil pump suction. The ejector picks up a quantity of oil from the reservoir approx. equal to the amount of HP oil supplied to the ejector.
2. To operate the two steam chest servomotors which position the governing valves.
3. To provide a source of filtered HP oil to operate all the control devices and operating mechanisms.
4. To supply lubrication. An adjustable orifice is used to reduce the flow to the proper amount. The bearing oil flows through a 3 way tandem valve, and to one of two identical oil coolers. A relief valve compensates for small changes in requirements.

**MAIN STEAM PRESSURE  
SET-POINT**

The design pressure value for steam entering the HP turbine.

**MAIN STEAM STOP VALVE**

A specially designed, hydraulic cylinder operated valve that stops the flow of steam to the turbine to prevent possible damage.

**MAIN STEAM SYSTEM**

A system of pipes and valves that directs and controls the flow of steam from the boiler to the turbine.

MAIN STEAM TEMPERATURE SET-POINT	The design temperature value for main steam; intended to provide as much energy as possible to the HP turbine, while preventing over-heating.
MAIN STOP VALVES	Turbine steam valves designed to admit steam to the HP turbine during normal operation, shut off the flow of steam during shutdowns, and regulate the flow of steam during startups; also called throttle valves.
MAINTAINING CONTACTS (Ma)	Auxiliary contacts that are operated by the "M" coil.
MAINTENANCE DERATING (D4)	A derating that can be deferred beyond the end of the next weekend but requires a reduction in capacity before the next Planned Outage (PO). A D4 can have a flexible start date and may or may not have a predetermined duration.
MAINTENANCE OUTAGE (MO)	An outage that can be deferred beyond the end of the next weekend, but requires that the unit be removed from service, another outage state, or Reserve Shutdown state before the next Planned Outage. Characteristically, a MO can occur any time during the year, has a flexible start date, may or may not have a predetermined duration, and is usually much shorter than a PO.
MAKEUP WATER SYSTEM	A system connected to the condenser that adds pure water to the condensate system to compensate for water losses that may occur as a result of condensate sampling or steam and water leaks in the system.
MANIPULATED VARIABLE	The variable that is adjusted, or regulated, to maintain a controlled variable set-point. Example: make-up water into a tank to maintain the tank's water level.
MANOMETER	A liquid filled U-tube used to measure pressures. A measuring device that uses columns of liquids to measure pressure. Compares pressure inside of sealed containers to that of the atmospheric pressure outside of the container. The pressure applied is determined by adding the travel in the two legs. Used to measure condenser vacuum, windbox pressure.
MANUAL OPERATION	Operation of a switch or circuit breaker by hand without using any other source of power.
MASS	Anything that has weight and takes up space. The amount of matter that a body possesses. Proportional to the weight of a substance. Flow units are pounds per hour.
MASS FLOW RATE	Measured as a unit of mass, such as pounds, per a unit of time, such as hours.

MATERIAL BALANCING	A method of calculating the amounts of substances, called reactants, that must be put into a process in order to produce the desired amounts of products. Involves the use of chemical equations, and it can be divided into two steps. The first step is to make sure the equation is balanced. Both sides having the same number of the same types of atoms. The second step is to use the balanced equation to determine the relative amounts of substances that will react with each other. For example, in the reaction between hydrogen ions and hydroxyl ions, one hydrogen ion reacts with one hydroxyl ion to form one molecule of water. This means that, in principle, 100 hydrogen ions will react with 100 hydroxyl ions to form exactly 100 molecules of water. There will be no hydrogen ions or hydroxyl ions left over.
MATTER	Anything that has weight and takes up space. Can be visible, like steel and water, or invisible, like air. Exist in three forms: solid, liquid, and gas. All matter is made up of atoms.
MCC	MOTOR CONTROL CENTER. A MCC is an assembly of one or more enclosed sections having a common power bus and principally containing motor control units. Motor control centers are in modern practice a factory assembly of several motor starters.
MCE	Motor Circuit Evaluation
MCW	Metal Cleaning Waste
MEASURING ELEMENT	The element of a control system that converts the input from the primary element into a signal representing the actual value of a process variable; transmitter.
MECHANICAL ADVANTAGE	The ratio of the output force of a machine to the input force. The ratio between the resistance force (weight) and the applied force. $\text{Resistance Force} \div \text{Applied Force}$
MECHANICAL BURNER	The fuel oil enters the gun through the lower port of the stationary and removable unions, and passes through the inner oil gun to the nozzle. The oil passes through the back plate and tangential slots in the whirl plate to the whirl chamber. The action of the tangential slots imparts a rotary motion to the oil. From the space between the whirl plate and spray plate, part of the oil is sprayed into the furnace through the orifice in the spray plate and the remainder is returned through the outer holes in the spray plate and back plate to the outer oil gun pipe. The return oil leaves the gun through the upper ports of the unions.

MECHANICAL DRAFT COOLING TOWER	A type of cooling tower that uses large fans to create air flow through the tower to cool circulating water.
MECHANICAL ENERGY	Energy in transition, sometimes called work. Usually measured in foot-pounds. Two types; potential and kinetic energy.
MECHANICAL SEAL	Seals the area between the shaft and the casing. Does the same job as packing, but provide a more complete seal. Consists of two basic parts: a stationary element that is attached to the pump casing, and a rotating element that is attached to the pump shaft. Each element has its own seal ring. The two rings are positioned close together to form a nearly perfect seal that <u>has virtually no leakoff</u> . To prevent the seal rings from drying out, overheating, and becoming damaged, some type of lubricant must be supplied to them. In some applications, the process liquid being pumped is used as the lubricant. However, when the liquid being pumped could be hazardous if the seal fails, or if the liquid contains abrasives or other solids, such as in a slurry, an external liquid may be used to lubricate the seal rings.
MECHANICAL TRAP	A trap whose operation is sensitive to the difference between the density of steam and the density of condensate. Operate on change of state of the fluid coming to the trap, whether water or steam. They open to water or condensate, but close on steam. Float trap; open bucket trap; inverted bucket trap.
MECHANICAL-HYDRAULIC CONTROL SYSTEM	A turbine control system that uses a mechanical governor and oil from the turbine lube oil system to monitor and control turbine speed.
MEGA	A prefix used to indicate one million; for example, one megawatt is equal to one million watts.
MEGAVAR	One million vars.
MEGAWATT	One million watts.
MEGGER	Electrician's term for checking electrical insulation.
MEGOHM	One million ohms.
MEMBRANE (ED)	An ion exchange resin cast in sheet form which is essentially water-tight and electrically conductive.
MENISCUS	The curved upper surface of a nonturbulent liquid in a container. It is concave if the liquid wets the container walls and convex if it does not. The free surface of a column of liquid. Water and oil both form a concave meniscus, which means that the center of the column is lower than the outer edges. The level of any meniscus should be read at its center, so the level of a concave meniscus is

	read at the lowest point. Mercury forms a convex meniscus, which means that the center of the column is higher than the outer edges. The level of a convex meniscus is read at the highest point.
MERCURY (Hg)	A silvery-white poisonous metallic element, liquid at room temperature. 13.6 times as heavy as water.
METAL CLEANING WASTE	This type waste includes wastewater resulting from cleaning any metal process equipment. Wastewater produced by boiler fireside and air preheater washes, condenser foam cleaning, and boiler tube chemical cleanings are generally characterized by very high suspended solids and dissolved metal concentrations. In addition to the limitation for low volume waste discharges, metal cleaning wastes must also contain less than one part per million of iron and copper.
METER ORIFICE	A primary device used for establishing pressure differentials in the measurement of flow through pipes.
MFP	Multi-function processor
MHC	Manual Hydraulic Control System
MHO	A basic unit of electrical conductivity that is used to describe a substance's ability to conduct current. A mho is the reciprocal of an ohm. An ohm is used to describe a substance's resistance to current flow.
MICROFARAD	One millionth of a farad.
MICROMHOS ( $\mu$ mhos)	A unit of measurement of water conductivity.
MID-SPAN SEAL	A seal between the HP and IP sections of the turbine; prevents steam from leaking between the two sections during normal operation.
MIL	One thousandth, usually of an inch or an ampere.
MILLI	A prefix used to indicate one one-thousandth; for example, one milliamp is equal to one one-thousandth of an amp.
MINIMUM NET POSITIVE SUCTION HEAD (PUMPS)	The minimum predetermined value of the amount of suction head that must be met to prevent cavitation. The pressure just above the pressure at which the liquid will boil for a given flow and temperature. Factors that influence values for minimum net positive suction head are liquid temperature and type of liquid.
MIXED BED DEMINERALIZER	These contain both cation and anion exchange resins in the same vessel, intimately mixed. The alternating cation and anion resin beads provide an infinite series of cation/anion exchange pairs. This produces the best quality water possible. Mixed bed units are

	also referred to as polishers as they remove any ions which passed through the other beds.
MIXED FLOW PUMP	Pumps that combine the radial flow of centrifugal pumps with axial flow. The liquid enters the impeller in an axial direction and discharge in both an axial and radial direction usually into a volute type casing. The discharge pressure is developed partly by centrifugal action and partly by the dynamic lift of the impeller on the liquid. This type of pump is frequently used for circulating water pump service in power plants. In this application the pump is installed vertically with the suction submerged in the water at all times. These pumps deliver large flow rates at medium head with a low rotational speed.
MIXED-BED ION EXCHANGER	An ion exchanger in which the resin bed consists of anion and cation resin beads mixed together.
MIXTURE	Consists of two or more materials that are not joined together chemically. The properties of the materials that produce the mixture do not change. The proportions of the materials in a mixture can vary. Formed mechanically, and can be separated mechanically.
MKS	Meter (length) Kilogram (mass) Second (time)
MOISTURE	Diffuse wetness that can be felt as vapor in the atmosphere or as condensed liquid on the surfaces of objects; dampness. The measurement of the amount of water in a solid material.
MOISTURE SEPARATOR	A device used to remove moisture from compressed air.
MOLECULAR WEIGHT	The weight of one molecule of a compound; can be determined by adding the atomic weights of the elements that make up the compound.
MOLECULE	The smallest particle of a chemical element or compound that retains all the properties of that element or compound. Made up of a group of atoms held together by a chemical bond. Bond is created when atoms transfer or share valence electrons.
MOLLIER DIAGRAM	A graph of entropy vs. enthalpy that indicates most of the properties of wet steam and superheated steam.
MOLYBDENUM DISULFIDE, OR MOLYSULFIDE	A solid lubricant; a powder typically blended with grease, such as lithium grease. Molysulfide powder is used because it has the ability to withstand extreme pressure.
MONOSODIUM PHOSPHATE	A chemical used for pH control.
MORPHOLINE	pH control of condensate and feedwater system. Also contribute to maintaining proper steam pH to prevent acid attack (corrosion)

	in the superheat and turbine sections.
MOTION	A body changing position.
MOTOR	A device that uses electrical energy to produce mechanical energy. The motion between the stator's magnetic field and the rotor's magnetic field results from the interaction between two magnetic fields, causing the rotor to rotate. Provides the driving force to move, operate, or position components. Used in some process systems as final control elements.
MOTOR ACTION	The movement of an object, such as the rotating part of a motor, that results from the interaction between magnetic fields. All motors work because of the interaction of two or more separate magnetic fields.
MOTOR CONTROL CENTER (MCC)	A common housing for motor controllers. An MCC houses the controllers for the motors in a particular process. Basically a bus that supplies power only to motors. It may also contain other electrical devices, such as circuit breakers and switches.
MOTOR CONTROLLER	A device or a group of devices whose purpose is to control and protect a motor. Has a motor circuit, or power circuit, that provides power to the motor. It also has a control circuit that can open or close the power circuit.
MOTOR-GENERATOR SET	A machine which consists of one or more motors mechanically coupled to one or more generators, usually DC.
MOTORING	This usually refers to a generator with the driving energy removed from the prime mover but still connected to system electrically. The generator is then acting as a motor and continues to rotate.
MOTOR-OPERATED ACTUATOR, OR MOTOR-OPERATOR	Used when a valve has to be throttled or when a large amount of force is needed to position a valve. Consists of a motor and a set of gears that turn a valve stem to open or close the valve. Also has a handwheel, a lever, and switches. Two types of switches are commonly connected to the gears of a motor operator: a limit switch and a torque switch. When the motor operator is energized, the motor drives the gears. The gears move the valve stem to position the valve. The lever is used with the handwheel to position the valve manually if there is a problem with some other part of the motor operator. Depressing the lever disengages the motor from the gearing and connects the handwheel to the valve stem through part of the gearing. The limit switch and the torque switch in the motor operator ensure that the valve is positioned without damaging the valve or the motor operator. The torque switch cuts off the current to the motor when the torque, or turning force, produced by the motor operator reaches a preset

amount. Ideally, the torque switch limits the force on the valve stem to prevent damage, while, at the same time, ensuring a tight seal between the valve disc and seat. If an obstruction blocks stem movement in a valve, a properly set torque switch can cut off the motor before damage occurs. While a torque switch cuts off current to the motor when the turning force reaches a preset amount, a limit switch cuts off current to the motor when a valve reaches a preset position. The limit switch allows the actuator to move the valve stem only within a certain desired range. For example, the limit switch on a motor operator may shut off the current to the motor when the valve is fully open.

**MOVING BLADING  
(BUCKETS)**

Turbine blading that is attached to the shaft and converts the thermal energy in steam into mechanical energy.

**MOVING R CHART**

Used together with other charts to give a more complete picture of what is happening in a process. Centerline sometimes called R bar. Each moving range value that is plotted on a moving R chart is determined by looking at the most recent sample reading and a specified number of previous readings, and then subtracting the lowest value from the highest value.

**MOVING X BAR CHART**

Used to monitor continuous processes. Centerline is sometimes called X-double-bar. Plotted using moving averages. A moving average is an average that is calculated using the most recent sample value and a specific number of previous sample values.

**MULTIPLE ORIFICE AND  
CHECK VALVE**

Control oil to each of the throttle valves, interceptor valves and the reheat stop valves is supplied from orifices in the high pressure line. These orifices and a check valve are encased in a single body.

**MULTIPORT PLUG VALVE**

Has additional piping connections and a different type of plug than a regular plug valve. Instead of a plug with an opening that allows fluid to pass straight through the plug, a multiport plug has an L-shaped opening. Has L-shaped markings on their handles to indicate the position that the valve is in. The "L" on the handle is aligned to the shape of the opening through the plug.

**MULTISTAGE  
CENTRIFUGAL  
COMPRESSOR**

A compressor in which the air is compressed in several steps. Higher discharge pressure than a single-stage centrifugal compressor. The number of stages indicates the number of times the gas is compressed. It also indicates the number of impellers and volutes that the compressor contains. For example, a multistage compressor using three impellers and three volutes is called a three-stage compressor.

**MULTISTAGE PUMP**

A pump that has more than one impeller mounted on its shaft; the

	fluid's pressure is increased in steps; generally used in condensate and feedwater systems.
MULTIWEIGHT OIL	Combine the properties of a lower viscosity oil for low temperature with those of a higher viscosity oil for high temperature. For example, 10W-40 oil. At higher temperatures, this oil has the properties of a 40-weight oil. At lower temperatures, it has the properties of a 10-weight oil.
MUTUAL INDUCTANCE	A circuit property existing when the relative position of two inductors causes the magnetic lines of force from one to link with the turns of the other.
MUTUAL INDUCTION	The inducing of an electromotive force in a circuit by a changing current in a nearby circuit.
MVA	Megawatt-Voltage-Amps. $MVA = MW + MVAR$ . $MW = MVA \div PF$ . Refer to the generator capability curve.
<b>N</b>	
NAAQS	National Ambient Air Quality Standards. Protects the public health and welfare from the effects of air pollution.
NAMEPLATE RATING	The full-load continuous rating of a generator, prime mover or other electrical equipment under specific conditions as designated by the manufacturers.
NARROW PROPORTIONAL BAND	A proportional band that is less than 100%. A small change in input to the controller produces a larger change in output. Control action is rapid, and the value of the controlled variable stays close to set-point.
NATURAL CIRCULATION	The process by which water and steam move through some drum-type boilers; based on the fact that cold water is heavier than hot water or steam, so colder water in downcomers pushes hot water and steam upward through boiler tubes.
NATURAL DRAFT TOWER	A cooling tower in which the air used to cool the circulating water is forced through the tower by the difference in the temperature of the air from the bottom of the tower to the top of the tower.
NEEDLE VALVE	A type of globe valve. Usually smaller than other globe valves and are designed to give fine control of flow in small-diameter piping.
NET GENERATION	The amount of electrical energy produced per hour; also called net electrical output.
NET HEAT RATE	The heat rate of a generating unit calculated by using the electrical

	power that is fed to the grid.
NET POSITIVE SUCTION HEAD	The actual pressure at the suction eye of a pump.
NET POWER	The total amount of power that is produced by the generator (gross power), minus the auxiliary power used to run plant components.
NETWORK	Any electrical circuit containing two or more interconnected elements.
NEUTRALIZATION REACTION	A reaction in which hydrogen ions or hydroxyl ions are removed from a liquid.
NEUTRON	A particle having no charge; found in the nucleus of an atom. A neutral particle.
NIPPLE (PIPING)	Used to join two pieces of pipe. Basically a short piece of pipe with male threads, that is, it is threaded on the outside. The nipple screws into the components that it connects.
NIS	Network Interface Station.
NITROGEN OXIDES (NOX)	Pollutant gases that are produced from atmospheric nitrogen and excess oxygen when combustion takes place under conditions of high temperature and high pressure environment of the boiler furnace. NOX symbolically represents the composition of NO (nitric oxide, colorless) and NO <sub>2</sub> (nitrogen dioxide, orange color) molecules. In the combustion process, nitrogen originates from the air (where it is molecularly stable as N <sub>2</sub> at ambient temperatures), and from the fuel, where it is bound to the hydrogen molecules. At the high flame temperatures in the furnace (>2500°F), a small portion of the molecular nitrogen dissociates and reacts with oxygen to form NO. Similarly, as the hydrocarbon molecules react, the bound nitrogen atoms are freed to react with oxygen to form NO. NO formation increases as: <ol style="list-style-type: none"><li>1. gas temperature,</li><li>2. oxygen availability, or</li><li>3. fuel nitrogen are increased.</li></ol> NOX in utility boiler flue gas streams is typically comprised of 97-99% NO, with the remainder present as NO <sub>2</sub> . After being emitted to the atmosphere for several hours, the NO reacts with atmospheric oxygen (O <sub>2</sub> ) and ozone (O <sub>3</sub> ) to form NO <sub>2</sub> . Scrubbers and other external pollution control devices do very little to reduce the amounts of nitrogen oxides that are released from a boiler. Considered a major air pollutant, NOX is harmful

	to the environment, causes health problems, and attacks the ozone.
NIU	Network Interface Unit
NOMOGRAPH	A graph that uses three or more different scales to represent the values of three or more variables that are related.
NON-RETURN VALVES	Valves that operate like swing check valves and function to protect the turbine from possible back flow in case the flow of steam to the turbine stops. See Bleeder trip Valve.
NORMAL DISTRIBUTION CURVE, OR BELL CURVE	Represents the natural variation that occurs in all processes, and it is the basis for SPC control charts. The center of this curve represents the mean value, or the average of the data being plotted. The downward slope is the same on each side of the mean value line. This means that there are basically as many data points to the left of the average as there are to the right of it.
NORMAL, OR RANDOM VARIATION	Occurs randomly and naturally in a process. Statistical control.
NOX CONTROL	NOX formation in utility boilers may be limited in several ways: <ol style="list-style-type: none"><li>1. Low Excess Air - will reduce<ol style="list-style-type: none"><li>a. the quantity of oxygen available for reaction with nitrogen in the burner flame zone, and</li><li>b. flame temperature.</li></ol></li><li>2. Staged Combustion - produces fuel-rich and air-rich combustion zones. Consequently, the overall combustion zone is larger in size, peak temperatures are lower, and localized oxygen deficient regions exist. The result is lower overall NOX formation.</li><li>3. Flue Gas Recirculation to the Windbox (FGR) - provides for an added amount of inert gas in the flame zone to absorb heat, thereby reducing peak flame temperature and reducing NOX formation.</li><li>4. Fuel Nitrogen Limits - NOX formation from fuel-bound nitrogen is directly proportional to fuel nitrogen concentration.</li></ol>
NOZZLE	A set of fixed blades.
NOZZLE BLOCK	A component located at the inlet to the HP turbine section and used to increase the velocity of the steam flow so that the proper relationship between blade velocity and steam velocity can be established. The first row of fixed blading in the control stage of a turbine. The blades are usually separated into groups so that each group can be supplied with steam from an individual control valve.

NP CHART (SPC)	Used to display the actual number of defective products produced by a process. The vertical axis represents the number of defective products, and the horizontal axis represent a percentage of the products produced, such as every tenth product.
NPDES (NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM (1972))	Regulates the discharge of pollutants from waste streams directly into our waterways. The EPA has the authority to issue the discharge permits and to enforce the discharge limitations of the permit. Failure to comply with the permit conditions can result in fines of up to \$25,000 per violation per day. Our three generating stations have their own NPDES permits which set limits on the condenser cooling volumes and temperatures for each generating unit. The iron, copper, undissolved solids, and the oil and grease content of the wastewaters are also limited. The pH of the wastewaters must be adjusted between 6 to 9. The copper and iron levels must be below 1 ppm.
NPM	Network Processing Module.
NUCLEAR ENERGY	Energy produced from Uranium. Can be released from the nuclei of atoms in certain substances by causing them to split.
NUCLEAR FISSION	The process of breaking down uranium (fuel) in a nuclear reactor.
NUCLEAR PLANT	A power plant that uses energy from uranium to produce electric power.
NUCLEATE BOILING	Steam bubbles form slowly and are removed from the surface as quickly as they form.
NUCLEUS	The central core of an atom; contains protons and neutrons.
NUTATING DISC METER	A device that measures flow directly. Gets its name from the action of a disc located in the meter. The word "nutate" means to wobble or roll about an axis of rotation. A type of flow meter with a disc that wobbles about an axis to trap and measure specific quantities of fluid.
<b>O</b>	
O2 ANALYZER	A device, located in the flue gas flow path, used to measure the percentage of oxygen in the gas. The measurement provided by the device is an indicator of excess air.
OFF-PEAK ENERGY	Electric energy supplied during periods of relatively low system demands as specified by the supplier.
OFFSET	The amount of difference between the control point of a process

	variable and set-point.
OHM	The unit of electrical resistance.
OHM (R)	Unit used to measure electrical resistance. The electrical resistance opposes the flow or movement of electricity, and the energy dissipated in overcoming this opposition appears as heat.
OHM'S LAW	A statement of the relationship between current, voltage, and resistance in an electrical circuit. The current in an electric circuit is directly proportional to the electromotive force in the circuit. 1 volt of magnetism will push 1 amp of current, through 1 ohm of resistance. $E(\text{volts}) = I(\text{amps}) \times R(\text{ohms})$ ; current equals voltage divided by resistance.
OHMMETER	A device used to measure resistance in an electrical circuit.
OHM'S LAW	The current in an electric circuit is directly proportional to the electromotive force in the circuit.
OIL CIRCUIT BREAKER (OCB)	A circuit breaker in which the interruption occurs in oil. Used for practically all high voltage circuits, ranging from 12KV to 230 KV. These breakers are very large and are constructed so that a tank completely surrounds the mechanism. This tank is filled with oil. All contact opening and closing operations are performed in this oil bath. As the contacts open under load, an arc forms. This arc vaporizes a small amount of oil into a gas and ionizes the gas. This gas bubble is quickly replaced by fresh oil which cools and extinguishes the arc. The oil also acts as an insulating media between current carrying contacts and earthed parts of the breaker. Due to their large size, these breakers are always operated electrically.
OIL RESERVOIR	Contains screens for removing all foreign matter from the oil drained back to the reservoir. The ejectors, orifices, check valves, etc. are all enclosed in the reservoir. Two identical oil coolers are provided and connected by a tandem operated three way valve which permits either oil cooler to be used. The cooler not in use can be drained and cleaned or replaced with the unit in operation. Before switching coolers, it is important that the spare cooler be filled with oil. An interchange valve is provided for this with a sight flow in the vent to observe when the spare cooler is full. The interchange valve is normally left open. A vapor extractor maintains a slight negative pressure in the oil system.
OIL SEPARATOR (COMPRESSOR)	Used to remove oil from compressed air, which could damage pneumatic instruments. The oil that is removed collects in the bottom of the separator and is drained to a waste system. Has an inlet, a series of baffle plates, a wire mesh screen, a sump, and a

	air outlet. Compressed air that enters the oil separator passes around the baffle plates. As the air travels around the plates, it is forced to make rapid changes in direction. The oil, which is heavier than the air, is not able to change directions as easily. As a result, the oil droplets separate from the air, collect on the baffle, and then drip down into the sump. After the last baffle, it flows through the wire mesh screen, which traps most of the small amounts of remaining oil, and also drip into the sump.
OIL WHIP	If the turbine lube oil is allowed to get too cool (less than approximately 105°F) when the turbine is rolling, the oil will build too much of a film, or wedge under the rotor. This wedge will not remain because of the spinning action of the rotor hydraulically pushing it out. Since the oil is thicker and slower moving at lower temperatures, the void under the rotor will not be replaced with oil quickly enough. The rotor "falls" due to no oil wedge, and then re-climbs the journal, creating another thick wedge. This cycle repeats itself rapidly, violently shaking the turbine. This is called oil whip.
OILER (COMPRESSOR)	An oil injector which supplies a small amount of oil to the compressor cylinder. In the cylinder, piston rings are used to maintain a seal between the piston and the cylinder. The oil lubricates the piston rings and helps seal the space between the cylinder wall and the rings.
OIS	Operator Interface Station
OIT	Operator Interface Terminal. Usually a CRT (Cathode Ray Tube) which displays graphic and text type data for the operator. Also provides the operator push buttons (membrane keys, mouse, or touch screen) to allow equipment operation selections. Also known as HMI (Human Machine Interface) or MMI (Man Machine Interface).
ON GOVERNOR	Indicates turbo-generator is at approximately synchronous speed and is under control of the turbine governor.
ON THE LINE	Synchronized and connected electrically with the system, usually referring to the main generator.
ONAN	A LPG (propane) operated DC generator providing 125 volt power to the preferred bus. Onan (aka Cummins Onan) brand of generators are built by Cummins Power Generation.
ONE MINUTE PER REPEAT (1 MPR)	When the reset part of the control action increases, or repeats, the proportional action one time in one minute.
ON-PEAK ENERGY	Electric energy supplied during periods of relatively high system

	demands as specified by the supplier.
OPACITY	Used to describe the visibility of the stack plume, and is defined as the percentage of incident light removed by a gas stream or plume due to scattering and absorption by suspended particles. Typically measured by instruments (transmissometers) that direct a light beam across the duct through the gas stream. These measurements yield real-time, continuous emissions data that can be related to stack plume visibility. Opacity is determined by four quantities: mass concentration (mass of particles per unit volume of gas), particle density, path length that the light beam travels, and light scattering characteristics of the particles (e.g., size distribution of the particles). For a given mass concentration, smaller particles will scatter more light than larger particles, and thus the gas stream with the smaller particles will be more visible (higher opacity).
OPACITY METER	An instrument that measures the concentration of suspended particles in a gas.
OPEN (CIRCUIT)	A circuit in which the resistance is so great that there is no current flow.
OPEN BUCKET TRAP	A type of mechanical trap that contains a bucket or float, open at the top, connected to a valve. When condensate comes to this trap, it gradually fills up the body and floats the bucket, causing the latter to rise and close the valve. Finally condensate spills over the top of the bucket and the bucket sinks. This opens the valve and the pressure inside the trap forces the water up through the discharge tube and out the orifice. As soon as the bucket is emptied sufficiently it floats again closing the valve and the cycle is repeated.
OPEN BUS	A bus without an enclosure.
OPEN HEATER	A heater that is classified as a direct contact heater because extraction steam and feedwater come into direct contact and mix.
OPEN IMPELLER (CENTRIFUGAL PUMP)	Has no shrouds to direct the flow of liquid. Where this design helps prevent clogging, it is less efficient at moving liquids than a closed impeller, since the flow of liquid is not directed between the vanes. Used to pump thick liquids or liquids with solids, such as slurries.
OPERATING CAPACITY	The maximum volume of fluid that is moved by a pump under normal conditions.
OPERATING COIL, OR "M" COIL	The coil inside the contactor through which current is supplied. When the "M" coil is energized, it produces a magnetic field. An

	iron core inside the "M" coil concentrates the magnetic field. When the "M" coil is energized, it becomes an electromagnet and attracts an armature. This moves a set of movable contacts against a set of stationary contacts. The armature is connected to a pack of springs, which are compressed as the armature is pulled down. When the contacts close, a complete path for current flow through the controller to the motor is established. When the "M" coil is de-energized, the electromagnetic field is removed. The springs then push the armature back to its original position, separating the two contacts.
OPERATING POINT	The specific combination of pressure and flow that is used to determine if a pump is suited for a particular application.
OPERATION	As applied to a switch or circuit breaker, is the method provided for its normal functioning.
OPERATIONS KEYS (COMPUTER)	Used to run printers and other devices.
OPERATOR CONSOLE	A component in a digital control system that allows operators to monitor and direct the activities in the system, primarily using a keyboard and a display.
ORGANIC CHEMISTRY	The study of carbon, and the chemicals that contain carbon. Inorganic is the study of everything else.
ORIFICE	A device that creates a differential pressure by restricting the flow of a liquid; often used as a component in a flow sensing element. Device for restricting flow or reducing pressure. Pressure decreases, velocity increases.
ORIGIN	Coordinate point (0,0) on a graph.
OUTAGES	Exists whenever a unit is not synchronized to the grid system and not in a Reserve Shutdown state.
OVAL GEAR METER	A type of flow meter that uses gears to trap and measure specific quantities of fluid.
OVERCURRENT RELAY	A relay that provides protection from excessive current conditions. A protective device that opens a circuit when it detects excess current flow.
OVERLOAD	A load greater than the rated load of an electrical device.
OVERLOAD RELAY	A relay that operates on excessive current.
OVER-PRESSURE (OP)	Purpose is to boost spinning reserve generation during peak hours, and meet quick load pick-up capabilities. Unit condition at maximum load with maximum throttle pressure. Off EMS, boiler

	master off cascade/on automatic.
OVERSPEED	A mechanical condition that occurs when rotating machinery exceeds its designed operating speed.
OVERSPEED TRIP (OVERSPEED GOVERNOR, AUTOMATIC STOP GOVERNOR)	An automatic device that protects a turbine from overspeed conditions; energizes the turbine trip circuits, stopping the flow of steam to the turbine. This mechanism consists of an eccentric weight transversely mounted in the end of the turbine shaft, which is balanced in position by a spring until the speed reaches 111%. Its centrifugal force then overcomes the spring and the weight flies out striking a trigger which trips the overspeed trip valve releasing the autostop pressure to drain. Operation of the overspeed governor automatically trips the throttle valve and shuts down the turbine. Set by pulling the <u>autostop trip handle</u> on the governor pedestal to latch position. When latched, the governing valves, reheat stop valves, and interceptor valves will open wide; the oil operated air pilot valve should operate to allow the extraction non-return valves to open. Provision is made for testing the overspeed trip mechanism without actually overspeeding the turbine. If the overspeed trip mechanism hand lever is held to prevent the trip valve from opening, it can be tested without taking the unit off line or removing load. This is accomplished by admitting oil under pressure to the chamber beneath the trip weight and noting the pressure required to move the weight outward.
OVERSPEED TRIP TEST	Set at 111% of rated speed (4000 rpm). During the test an operator should stand by prepared to trip the unit with the hand trip lever in the event that the mechanism fails to function before reaching 4100 rpm. Unit must be on a minimum of 4 hours, with a minimum of 10% rated load, to ensure equipment temperatures are normal; centrifugal stress.
OVERSPEED TRIP VALVE	Produces the auto stop oil pressure when latched.
OXIDATION	Combustion that does not produce heat or light.
OXIDATION INHIBITOR, OR ANTI-OXIDANT	Additives blended with lubricants to help control oxidation.

**P**

P CHART (SPC)	Similar to an NP chart, except that it indicates the percentage of defective products. The vertical axis represents percent defective, and the horizontal axis represent time. The total number of defective samples is divided by the number of samples collected. The result is then multiplied by 100 to produce a percentage
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figure.

**PACKING (PUMP)**

Seals the area between the shaft and the casing. A flexible material that fits into the space between the shaft and casing. A small amount of process liquid is allowed to leak through. This leakoff acts as a cooling mechanism to remove heat from the packing. If too much leakoff is allowed, the efficiency of the pump may be affected. If too little leakoff is allowed, the packing will overheat, dry out, and possibly burn. The packing on a pump is held in place by a packing gland. The gland is in turn held in place by studs with adjusting nuts. As the adjusting nuts are tightened, they move the gland in and compress the packing. This in effect squeezes the packing out radially making a tight seal between the rotating shaft and the inside wall of the stuffing box.

**PACKING (VALVE)**

A rope-like material soaked with a lubricant such as oil, grease, or powdered graphite. The lubricant reduces friction between the packing and the valve stem. The packing fits snugly around the valve stem.

**PACKING GLAND (PUMP)**

Holds the packing in place. Bolted to the pump's casing, and can be adjusted to maintain the proper amount of leakoff.

**PACKING GLAND (VALVE)**

Fits into the top of the stuffing box, holding the packing in place.

**PACKING RINGS**

Seals located between the stationary blades and the rotor.

**PARADIGM**

model or pattern.

**PARALLAX ERROR**

An error that results in incorrect gauge readings; caused by reading the gauge from any position other than straight on.

**PARALLEL CIRCUIT**

A circuit containing two or more parallel paths through which current can flow.

**PARALLEL FLOW**

A flow pattern in surface heat exchangers in which two fluids flow in the same direction.

**PARAMAGNETIC OXYGEN ANALYZER**

An analyzer that measures the oxygen concentration of a gas mixture based on the principle that oxygen is attracted to a magnetic field.

**PARAMETER**

A physical property such as temperature, pressure, or flow.

**PARTIAL ARC**

Sequential valve control. Throttle valves wide open, with governing valves regulating. Temperature and pressure drops across the valves that are not wide open. A condition that occurs after the transfer point in a turbine startup; a state in which steam is admitted through only part of the nozzle block at a time, as a result of the sequential opening and closing of the control valves. Each governor valve will open wide, sequentially, before steam

PARTICULATES	flow goes to critical flow (supersonic), until all valves are open. Efficiency up to 7%.
PARTS PER MILLION (PPM)	Pollutants; very fine unburned solid particles of material that are left in glue gas after combustion. Contains ash (non-combustible mineral matter), inorganic compounds (sulfates, salts, sediments), and carbonaceous organic compounds (coke residue, soot, acid smut).
PCB or PCBs	Measurements that express the amount of a material per million parts of total solution. Used for measuring very low concentrations of materials. One pound of salt in one million pounds of water is one part per million of salt. Equals one ten-thousandth of one percent (0.0001%).
PCU	Polychlorinated Biphenyls. A group of toxic, persistent chemicals used in transformers and capacitors. Further sale or use was banned in 1979 by law.
PCV	Process Control Unit
PEAK LOAD	Process Control View.
PEAK VALUE	The maximum load consumed or produced by a unit or group of units in a stated period of time. It may be the maximum instantaneous load or the maximum average load over a designated interval of time.
PEAKING CAPABILITY	The amount of voltage or current at the maximum positive or negative point on a sine wave. The maximum instantaneous value of a varying current, voltage, or power. It is equal to 1.414 times the effective value of a sine wave.
PEAK-TO-PEAK VALUE	Generating capability available to assist in meeting that portion of peak load which is above base load.
PEENING	The amount of voltage or current represented by the distance between the positive peak and the negative peak on a sine wave.
PERCENT MEASUREMENT	The process in which shrouding is attached to a row of moving blading by hammering tenons on the blades through holes in the shrouding to rivet the shrouding to the blading.
	A fractional value expressed in terms on the number of parts per one hundred. Percent measurement express the amount of a material per 100 parts of total solution, either by weight or by volume. For example, if a solution of water and dye contains 10 ounces of dye and the total volume of the solution is 100 ounces, then the concentration of dye is 10 parts per 100 parts of solution. Ten divided by 100 is .10, or 10%, so the concentration of dye is

	10% by volume.
PERCENT-BY-WEIGHT	Refers to the concentration of solute in a solution expressed as a percentage of the weight of the solution. Basically, the percentage is based on the weight of the solute in relation to the weight of the solution as a whole. Helpful in understanding how solutions with different concentrations relate to each other.
PERIODIC TABLE OF THE ELEMENTS	A listing of all known elements in an arrangement designed to show some of the specific characteristics of each element. Shows the atomic weight of all atoms. The atomic weight is shown just below the element's symbol. The atomic weight is expressed in atomic mass units (AMU). Each element is represented by a block that includes the element's atomic number, chemical symbol, and atomic weight.
PERMEABILITY	A property of matter that indicates the ease with which it is magnetized. The ability to deflect lines of force or concentrate them.
PERMEATE	The portion of feedwater which penetrates (permeates) the membrane. The term product and permeates are synonymous in pure water applications.
PERMISSIVE	Usually affecting the start-up of the equipment in question.
PFOBP	Primary Fuel Oil Booster Pump
PFOP	Primary Fuel Oil Pump.
pH	The logarithm or reciprocal of hydrogen-ion concentration. A measure of the relative acidity or alkalinity of a solution.. A scale calibrated to determine the extent of the acidity or alkalinity of water, 7 being neutral, from 7 to 14 being alkaline, increasing in alkalinity as the number rises. From 1 to 7 is acid, increasing in acidity as the number decreases. pH too low or too high causes corrosion. When the relative amounts of hydrogen ions and hydroxyl ions in a solution are equal, the solution is neutral.
PHASE	A single electrical circuit.
PHASE CHANGE	Occurs during heat transfer, where there are changes in molecular energy, but these changes do not result as a temperature change. Three phases, or states of matter are solids, liquids, and gases.
PHASE DIFFERENCE	The time in electrical degrees by which one wave leads or lags another.
PHASE SHIFT	Changes the phases of voltage to match another.
TRANSFORMER	

PHOSPHATES (PO <sub>4</sub> )	A group of chemicals used in a steam plant. The purpose of the phosphate treatment is to precipitate any hardness (calcium and magnesium) in boiler water that may have sneaked through our external treatment system or which may have entered the feedwater system via condenser leaks. Without any internal treatment, hardness precipitates as calcium or magnesium carbonate or sulfate, and deposits on boiler metal as scale. Phosphate ties up calcium and magnesium as a flocculent phosphate precipitate which can be removed through boiler blowdown. For this reaction to take place, enough alkalinity must be present. Calcium is not precipitated properly below a pH of 9.5. This is why we use caustic, to maintain sufficient alkalinity for the proper precipitation of hardness as a phosphate flocculent. Forms of phosphate commonly used for pH control include monosodium phosphate (acid) and trisodium phosphate (alkaline). Disodium phosphate (about neutral) is used to control pH and prevent scaling on/in tubes and drums.
PHOTOELECTRIC CELL	A device that uses light to produce electricity.
PHOTOELECTRIC EFFECT	The principle of producing electricity by using light. Certain materials will generate electricity when they are exposed to light. For example, a solar cell contains this type of material. When the light intensity is increased, more electricity is generated.
PHOTOMETER	An instrument for measuring a property of light, especially luminous intensity or flux.
PHOTON	A quantum of radiant energy; light ray.
PHOTOVOLTAICS	A module that produces electrical current when exposed to sunlight.
PI	A symbol for a constant value that is approximately equal to 3.14159; a constant that is used to calculate the area of a circle.
PID CONTROL	Control action that combines a proportional response with a reset response and a rate response. Also known as proportional-plus-integral-plus-derivative control.
PIE GRAPH	A circular, or "pie" shaped, graph that is frequently used to show percentages.
PILOT EXCITER	A generator that supplies current for the electromagnet in the stator of a DC exciter. A small DC generator used to control the field of the main exciter.
PILOT LIGHT	A small light usually near the control switch to indicate the condition of the circuit being controlled.

PILOT OIL TORCH (OIL SIDE IGNITOR)	Designed to serve as an ignition torch for main oil guns and gas torches. The pilot torch is a spark ignited, oil torch with flame indication, which is operated remotely from the control board. The torch itself consists of a mounting plate, torch head, torch nozzle, atomizer assembly and spark plug assembly.
PILOT TORCH AIR SYSTEM	Designed to provide adequate combustion air to the pilot torches at all normal operating conditions.
PILOT VALVE (THROTTLE VALVE BY-PASS)	For startup control; full arc conditions; capacity is approx. 20% of full load at rated throttle pressure.
PILOT VALVE, OR SPOOL VALVE	Guides, or controls, the flow of hydraulic fluid to and from an actuator. The amount of fluid entering the cylinder and bled from the cylinder must be accurately controlled, to accurately position a valve. The pilot valve is connected to the actuator by fluid lines. Consists of a valve body, solenoids, a spool, a spring at each end of the spool, a hydraulic fluid supply port, two hydraulic fluid ports to the actuator, and two hydraulic fluid vent ports. The pilot valve is operated by the solenoids, which respond to signals from a controller to position the spool. One solenoid is attached to the top of the spool, and the other is attached to the bottom. When both solenoids are de-energized, the springs return the spool to a neutral, or centered, position. This blocks the fluid lines going to the actuator and holds the actuator's piston in place. When the lower solenoid is energized, the spool is pulled downward, and hydraulic fluid is supplied through the lower fluid line to the actuator. The fluid enters the actuator cylinder at the bottom, pushing the piston up and opening the valve. At the same time, fluid is forced out of the top of the cylinder through the upper vent port, and back to the hydraulic fluid line, back through the pilot valve, out through the upper vent port, and back to the hydraulic fluid supply. The filling and venting of the actuator's cylinder is reversed by de-energizing the lower solenoid, and energizing the upper solenoid. When the upper solenoid is energized, it pulls the spool up, blocking the upper vent line and the path for supply fluid to the lower fluid line. Hydraulic fluid is supplied to the top of the actuator's cylinder, pushing the piston down and closing the valve. The fluid below the piston is vented through the lower fluid line, back through the pilot valve, out through the lower vent port, and back to the hydraulic fluid supply. The piston can be held in place by de-energizing the upper solenoid. This allows the springs to return the spool to a neutral position and blocks the fluid lines to the cylinder, holding the piston and the valve in position.
PINCH VALVE	Sometimes used to control the flow of heavy sludge and slurries.

**PIPING &  
INSTRUMENTATION  
DIAGRAM (P&ID)****PISTON AND CYLINDER  
RECIPROCATING PUMP****PITTING****PLANNED DERATING (PD)****PLANNED OUTAGE (PO)**

The basic types of pinch valves are enclosed-body pinch valves and open-frame pinch valves. Both types are relatively easy to recognize. An enclosed-body pinch valve has a cylindrical body that encloses most of the valve parts. In an open-frame pinch valve, all of the valve parts are visible. The enclosed-body pinch valve consists of a stem, which may be attached to a handwheel; a bar, or clamp; and a flexible tube through which fluid flows when the valve is open. When the handwheel is turned to close the valve, the stem pushes the bar against the tube. This action squeezes, or pinches, the tube between the bar and the valve body, stopping the flow of fluid through the tube. In some pinch valves, the bar may be connected to the top of the tube. This connection helps the tube return to its original shape as the valve is opened. Since most of the valve's components are outside of the flexible tube, there are no components in the flow path of the fluid through the valve for materials to collect on. For that reason, pinch valves are ideally suited for handling fibrous slurries and sludge.

Diagrams that show the components in a system and how those components are connected. A diagram that shows where components are located in the flow path of a plant system. Shows material flows, equipment in the system, and the devices used to monitor and control conditions in the system.

Has a cylinder, which is located inside the casing, and a piston, which is attached to a connecting rod. The pump also has two valves: a suction and a discharge valve. During operation, when the piston moves back on the suction stroke, the pressure inside the cylinder is reduced. The reduced pressure closes the discharge valve, opens the suction valve, and draws a specific amount of liquid into the cylinder. When the piston moves forward on the discharge stroke, it exerts a force on the liquid in the cylinder that increases the pressure. The increased pressure shuts the suction valve, opens the discharge valve, and pushes the liquid out of the pump. After the liquid is displaced, the piston moves back, and more liquid is drawn into the pump to begin this cycle again.

A form of localized attack that causes pits to be formed in metal. Caused by localized anodic sites that are formed by metal surface cracks, scratches, or oxygen differentials. Usually with low flow water rates.

A derating that is scheduled well in advance and is of a predetermined duration.

An outage that is scheduled well in advance and is of a predetermined duration, lasts for several weeks, and occurs only

PLASTICIZER	once or twice a year. Turbine and boiler overhauls or inspections, and testing are typical Planned Outages.
PLC	Any of various liquid or solid organic substances added to modify viscosity, flexibility, or strength.
PLC PID	Programmable Logic Controller. The computer (usually housed in the main electrical control panel) which contains the programming through which the equipment is electrically controlled and/or monitored.
PLUG (COCK) VALVE	PLC Proportional Integral Derivative. The PLC 4-20 milliampere analog outputs are varied between 4 and 20 mA based on feedback from process variables i.e. flow, level, etc. The PID controller in the PLC program is the module which provides this control, based on the operator selected set-point. PID control may also be used to control the pulse rate of a discrete output which will vary from 0-100 pulses per minute.
PLUMB BOB	A type of valve generally used in small piping systems. Consists of a body in which a cylinder or plug is fitted with close tolerances. The cylinder has a slot which permits flow through the valve when it is in one position and stops or prevents flow when the cylinder is rotated 90 degrees. Generally used for on/off purposes in situations that require quick valve operation and a tight shutoff, such as a gas line. Usually recognized by its cylindrically shaped mid-section and flat bottom. Open to close is about 1/4 turn. When the valve handle is in line with the piping, the valve is open.
PLUME	A type of direct level measurement device that consists of a weight and a measuring tape.
PLUMMET	A characteristically-shaped stream of materials entering the environment (air or water) from a localized source such as a stack or discharge pipe. A plume may be visible (smoke, water droplets, etc.) or invisible (heated air, colorless gas, heated water, etc.).
PNEUMATIC ACTUATOR	A actuator that uses air pressure to produce motion to position a valve. Probably the most common type of actuator used in process systems.
PNEUMATIC TRANSMITTER	An instrument that senses and measures a process variable and produces an air output signal that represents the value of the process variable.
PO4	Phosphate. Serves as a weapon to combat deposition/scaling. A

	major component in formation of the soft compound in the boiler that doesn't adhere to the boiler metal surfaces and can be blown down.
POINT OF MAXIMUM EFFICIENCY	The point at which a pump provides the maximum flow for the least amount of power.
POISONED CATALYST	A catalyst that can no longer function properly.
POLAR MOLECULE	A molecule that exhibits equal and opposite charges on opposite sides.
POLARITY	Pertaining to, or designating a pole. An indicated polar extreme: an electric terminal with positive polarity.
POLE	One of the ends of a magnet where most of its magnetism is concentrated.
POLLUTANTS	Substances that cause detrimental effects to the environment.
POLLUTION	Contamination of the environment by the discharge of harmful substances.
POSITION TRANSDUCER	Position indicating devices which provides a continuous (actual position) feedback signal as to the valve/equipment status. Provides a 4-20 milliamp signal to the control signal. 4 milliamp indicates closed, while 20 milliamp indicates 100% open.
POSITIONER	A device that uses a separate supply of air to ensure that an actuator correctly positions a valve in response to a change in the air signal from a controller. A typical positioner has three gauges. One indicates the supply air pressure to the positioner, another indicates the output air pressure to the actuator, and the third indicates the input signal pressure from the controller. A mechanical linkage joins the actuator stem to the positioner. This mechanical linkage is sometimes called a feedback linkage. As the actuator stem moves up or down, it also moves the linkage. The position of the linkage indicates to the positioner when enough movement has occurred to correspond with the air signal from the controller. When a positioner is used with an actuator, the signal from the controller goes to the positioner instead of directly to the actuator. The positioner controls a source of air that is sent to the actuator through a supply line. When the controller sends a signal to close the valve, the positioner receives the signal and converts it to the appropriate air pressure using its air supply. This pressure is then applied to the actuator to close the valve. The feedback linkage indicates to the positioner how far the valve is from the desired position, which, in this case is

POSITIVE CONDUCTOR	fully closed. As the valve moves toward the fully closed position, the feedback linkage causes the positioner to change the air supply to the actuator so that as the valve reaches the fully closed position, actuator movement is stopped.
POSITIVE DISPLACEMENT COMPRESSOR	A conductor connected to the positive terminal of a source of supply.
POSITIVE DISPLACEMENT PUMP	Work by trapping a certain amount of gas and forcing it into a smaller volume. A common type is a reciprocating compressor.
POTENTIAL	A pump in which a constant positive volume of liquid is displaced or moved during each pumping cycle. The volume of liquid pumped or moved is equal to the volume displaced by the piston or other moving parts. Positive displacement pumps can be further divided into two classes determined by the motion of the pumping element. These types or classes are reciprocating where the motion is back and forth, and rotary where rotational motion is used.
POTENTIAL DIFFERENCE	The degree of electrification of a body, voltage or electrical pressure. Electricity at rest. Static voltage or static electricity.
POTENTIAL ENERGY	The force that causes electrons to move or flow in a conductor. Voltage; electromotive force. Unit of measurement is the volt. It takes a difference of one volt to force a current of one ampere through a resistance of one ohm.
POTENTIAL TRANSFORMER (PT)	Energy possessed by a body due to its position or elevation. Energy of an object at rest. Stored energy that is waiting to do work.
	A small instrument transformer for measuring voltage of a power circuit. Used in electrical power system to step down system voltage to a safe value, which is then fed to low ratings meters and relays.
	A component that typically steps line voltage down to a lower voltage that is in direct proportion to the amount of line voltage. The lower voltage can then be used by measuring instruments and protective devices. Designed so that the output voltage will be 120 volts when the maximum input voltage is applied. Connected in parallel with or across the main circuit. These transformers are usually fused on both the input and output sides. The output side fuses are provided to protect the PT against faults in the output circuit. The input side fuses are primarily provided to protect the main circuit in case of a fault in the potential transformer. In most cases the PT's are mounted in draw-out disconnect enclosures.

	<p>When drawn out the PT is not only disconnected, but is automatically grounded at the same time.</p> <p>The use of instrument transformers with standard output ratings makes it possible to have standard meters, indicators and relays. It is only necessary to provide the correct scale for the meter.</p>
POWER	<p>The amount of work done in a given interval of time. The rate at which work is done or energy is expended. The unit of electrical power is the watt. Unit is foot/pounds per second. Work (ft/lbs) ÷ Time = ft-lb/sec.</p> <p>1 (one) Horsepower is equal to 550 ft-lb/sec.</p>
POWER (MATH)	A number that indicates how many times a base number is to be multiplied by itself.
POWER BLOCK	Turbine, generator, electrical equipment.
POWER CONDITIONER	The "FerroPowr" Power Line Conditioner protects the performance of the computer system and other sensitive equipment by providing:
	<ol style="list-style-type: none"><li>1. Protection from noise, voltage spikes and transients.</li><li>2. Continuous line regulation to compensate for both brownouts and overvoltages.</li><li>3. Instant response, with no moving parts.</li><li>4. Reliable and maintenance-free operation with no failure-prone semiconductors.</li><li>5. Complete isolation from the AC line for enhanced safety.</li></ol>
POWER CURVE (PUMPS)	Shows how much power a manufacturer expects will be used to operate a pump at given flow rates under normal conditions.
POWER FACTOR	The amount of difference (amount out of phase) between the voltage sine wave and current sine wave, on each individual stator coil. Sometimes referred to and measured as VARS (volt-ampere-reactive). The ratio of the true power of an alternating current, as measured by a wattmeter, to the apparent power, as indicated by ammeter and voltmeter readings. True power divided by apparent power. The power factor, if an indicator of capacitance or inductance, is an expression of electrical losses.
POWER FACTOR OF 1	Current sine waves are exactly the same as voltage sine waves. Voltage and current are considered to be at unity. If the current (amperage) sine waves differ from the voltage sine waves, the PF has been reduced. Current leads voltage.
POWER TRANSFORMER	The main transformer, where power comes into the plant. It converts the incoming high voltage from the distribution lines to a lower voltage that is used within the plant.

POWERLINE 1320, Nalco 7220, COAGULANTS, or DISPERSENTS	Used to gather up iron, copper, or soft sludge compounds in the boiler. It can then be blown down more efficiently. Caution should be used when injecting these chemicals. Some may suppress the pH of the boiler system.
PRECIPITATE	To chemically cause (a solid substance) to be separated from a solution. To be chemically separated from a solution as a precipitate.
PRECIPITATOR	A device used to separate particulates from flue gas leaving a boiler.
PRESSURE	Force applied over a surface, measured as force per unit of area. Measured in pounds per square inch, psi. Collision of molecules. 3 ways to create pressure: <ol style="list-style-type: none"><li>1. Weight of a substance - The weight of the body divided by the area on which the body rest.</li><li>2. Mechanical force</li><li>3. Heating a fluid in a closed container</li></ol>
PRESSURE BREAKDOWN BUSHING	A device used to reduce pump stuffing box pressures. It is also called a throttle bushing by some manufacturers.
PRESSURE BREAKDOWN ORIFICE	A flow restriction used to reduce a pressure by limiting the flow.
PRESSURE GAUGE	Instruments for measuring the difference between atmospheric pressure and the pressure in a pipe or vessel. Bourdon Tube Gauge.
PRESSURE LOSS ACROSS	The difference between the inlet and outlet.
PRESSURE REDUCING VALVE (COMPRESSOR)	Reduces instrument air from 120 psi (service air) to a value needed for use in pneumatic instruments and devices throughout the plant.
PRESSURE SWITCH	Responds to changes in pressure by opening or closing an electrical circuit.
PRESSURE TRANSMITTER	Converts the pressure to a 4-20 milliamp signal which is read by the control system in a remote location. Only one sensing line into it.
PRESSURIZED FURNACE BOILER	A boiler in which the pressure of the incoming air from a forced draft fan pushes flue gas out through the stacks.
PRIMARY (REAR) SUPERHEATER	Low temperature elements or first stage of steam superheating. A superheater located in the gas pass, above the economizer. Heated primarily by convection.
PRIMARY CELL	A type of battery that releases energy by chemical action without

	being charged; typically, a dry cell.
PRIMARY CIRCUIT	The first, in electrical order, of two or more coupled circuits, in which a change in current induces a voltage in the other or secondary circuits; such as the primary winding of a transformer.
PRIMARY ELEMENT	The element of a control system that senses changes in a process variable; float, thermocouple. A sensing device that is located where the process variable is monitored.
PRIMARY F.O. HEATER	A heat exchanger installed on the side of the fuel oil storage tank and piped to the suction of the transfer pump. It is used to heat only that portion of fuel oil which flows to the suction of the pump.
PRIMARY WINDING	The winding of a transformer to which the electrical energy is supplied; the coil that draws power from the source.
PRIMING	The act of removing air and filling a component with fluid before putting the component into operation.
PROCESS CONTROL SYSTEM	Monitors the value of a process variable and provides actions that control the value of the variable. Two basic types are manual control and automatic control.
PROCESS DISTURBANCE	An event that causes the value of a process variable to change away from set point.
PROCESS FLOW CHART	A block diagram. The blocks represent pieces of equipment in a process system, and the lines represent flows. This type of diagram is often used to describe a process system.
PROCESS INSTRUMENTATION	Instruments that monitor and/or control process variables.
PROCESS VARIABLE	A process-related condition, such as temperature, level, pressure or flow, that is subject to change. The actual controlled process; what value you have at the moment. A physical condition whose variation can affect the operation of an industrial process. Actual value minus live zero, divided by span, equals percentage.
PROGRAMMABLE CONTROLLER	A computer-based process control device that uses a control logic program to control a process such as safety interlocks and to control operations. Commonly used to establish protective circuits in sequential process systems.
PROPORTION	An equation stating that two ratios are equal.
PROPORTIONAL BAND	The amount of controller output change (Delta Output) in relation to a given amount of input change (Delta Input); usually expressed as a percentage. $PB = \text{Input} \div \text{Output}$ ; $PB \times 100\% = \% PA$

PROPORTIONAL CONTROL	A control's output signal is proportional to its input signal. If the input to a proportional controller changes by a given amount, the controller's output will also change by a given amount.
PROPORTIONALITY	A mathematical relationship in which a change in one variable causes a proportional change in another variable.
PROTECTIVE RELAY	A relay, the principal function of which is to protect service from interruption or to prevent or limit damage to apparatus.
PROTON	A positively charged particle contained in the nucleus of an atom.
PSIA	Pounds Per Square Inch Absolute. Indicates a pressure valve that uses a scale range where atmospheric pressure is 14.7 PSI of pressure. Zero absolute pressure is a perfect vacuum.
PSIG	Pounds Per Square Inch Gauge. Indicates a pressure valve that uses a scale where atmospheric pressure is zero gage pressure.
PTI	Power Technologies Incorporated
PULL OUT POINT	Point at which generator loses synchronism.
PUMP	A machine or device for transferring a liquid or gas from a source or container through tubes or pipes to another container or receiver. Grouped in two categories: positive displacement pumps and centrifugal pumps.
PUMP STROKE CONTROL	A method of adjusting either manually or automatically the length of stroke of a pump piston, so as to vary the quantity of chemical feed.
PURGE CYCLE	A sequence of operations involving a continuous time interval during which combustible gases are removed from the boiler and fuel cannot be admitted.
PURGE INTERLOCK	An interrelated combination of boiler safety devices which must be satisfied before the initiation of the purge cycle.
PURITY ANALYZER	A device that measures the percentage of hydrogen, in air, inside a hydrogen-cooled generator.
P-V ENERGY	Arises from the pressure and the volume of a substance. Steam under pressure possesses this form of energy. Numerically equal to the product of pressure and volume.
PVC	Poly Vinyl Chloride
PYROMETER	An instrument that measures the temperature of the substance it is in contact with.

QUICK LOAD PICKUP (QLPU)	Sufficient generating unit capability must be available such that, upon tripout of <u>any one unit</u> , the remaining units will have sufficient quick load pick-up capability to restore system frequency to at least 58.5 Hz within three seconds after tripout.
<b>R</b>	
R CHART	Indicates the range of the variable that is being measured. The lower control limit is often set at zero. The X axis is used to display how often samples are taken, in the appropriate units. The Y axis is used to display the range of the sample group, again in the appropriate units. Centerline sometimes called R bar.
RACES (BEARING)	Grooves in the inner and outer rings of a typical ball bearing, that the balls travel in. The inner ring fits tightly around the shaft. The outer ring is fixed in a housing.
RACK IN OR OUT	Connecting or disconnecting the control and power terminals of a circuit breaker to the external circuit.
RACKING OUT	The process of physically separating a circuit breaker from an electrical system.
RADIAL FLOW PUMP	Centrifugal pump. Main internal components are an impeller and a volute. Higher discharge pressures, but do not move as much liquid as other types of centrifugal pumps. Has a 90° liquid run.
RADIAL LOADS	Forces that act along a radius of a bearing or shaft.
RADIAL MOVEMENT	Movement that is up or down, or from side to side.
RADIAL SEAL	A type of seal that extends from the center axis of an air heater along the radius; used to prevent air from leaking into the gas.
RADIATION	A method of heat transfer in which heat is transferred directly across an open space. The transfer of heat due to the property of materials to emit and absorb electromagnetic waves. Energy radiated in the form of waves or particles.
RADIOACTIVE DENSITY ANALYZER	An analyzer that measures density without making direct contact with a process liquid.
RADIUS	The distance from the center of a circle to the edge of the circle.
RAMP RATE	For a generator, the speed at which the generator changes load. The rate at which turbine metal temperature can be increased each hour during startup or decreased each hour during shutdown.
RANKINE	Based on the fact that temperature is a measure of the average speed at which the molecules of a substance are moving. It can be

RANKINE EFFICIENCY	theoretically calculated that all molecular motion stops at a temperature of -460°F. This point is defined as 0 Rankine.
RATE	The design efficiency of a cycle with normal values for its operating parameters.
RATE CONTROL	A comparison of two quantities through division; one of the quantities is usually time.
RATEAU BLADE	Control action that responds to the speed at which a process variable deviates from set point. The faster the variable changes, the greater the amount of rate change action. Normally combined with proportional control, so it is often called proportional-plus-rate control. Sometimes called proportional plus-derivative, or PD, control.
RATED KVA OF A TRANSFORMER	Turbine blades designed with a combination of impulse and reaction type blading; 80% efficient.
RATING	The output which can be delivered for the time specified at rated secondary voltage and rated frequency without exceeding the specified temperature limitations.
RATIO	Limits placed on operating conditions of a machine, apparatus, or device based on its design characteristics. Such limits as load, voltage and frequency may be given in the rating.
RATIO OF A TRANSFORMER	Designated limit of operating characteristics based on definite conditions.
REACTANCE (X)	A comparison of two related quantities by division.
REACTANT	The turns ratio between the windings of a transformer.
REACTION	The opposition offered to the flow of an alternating current by the inductance and/or capacitance. Used to convert inductance and capacitance into values which are equivalent to resistance. Reactance may be inductive or capacitive or the result of a combination of these. Measured in ohms.
REACTION BLADES	The starting materials in a chemical reaction.
	A reverse or opposing action. For every action, there is an equal, opposite action.
	Turbine blades that basically act like moving nozzles, creating a reaction force that causes the turbine rotor to turn in the opposite direction from the steam flow. Reaction blading is more predominant in the lower pressure stages of the turbine, where the blades are longer. Moving blading in which the space between blades is smaller at the exhaust than at the inlet. Energy transfer in reaction blading results in a decrease in steam pressure and

REACTION RATE	velocity. Flat stationary blades used in the LP section; 90% efficient. Small change in temperature and pressure drops, which occurs at the blades. Large blades, takes more stages, and most efficient at full load.
REACTION TURBINE	A measure of the amounts of reactants that are converted into products in a given period of time. Number of atoms, and efficiency of atoms colliding affect reaction rate. Four variables that can also affect reaction rate are temperature, pressure, concentration, and surface area.
REACTIVE POWER	A turbine in which the expansion of steam causes the rotating blades to turn.
REACTOR	Power that does not work; power that must be supplied to a load to compensate for the effects of inductive or capacitive reactance. The non-useful portion of the total power and results from the reactance (either inductive or capacitive) in the circuit. It is measured in units of VAR (volt-ampere-reactive). The amount it takes to get the voltage out into the system.
REBOILER SYSTEM	A device, the primary purpose of which is to introduce inductive reactance into a circuit, for purposes such as motor starting, paralleling transformers, and control of current.
RECEIVER	A closed system which provides for the generation of steam to be used in the primary and secondary fuel oil heaters. Using either its normal supply from the #2 bleed (cold reheat at W7&8) or back-up supply from the auxiliary steam system, the reboiler generates steam to be used for heating the fuel oil heaters. The condensate from the fuel oil heaters returns to a drip tank. From the tank it is pumped to the reboiler where it is again generated into steam. Drips from the bleed or auxiliary steam supply to reboiler coils are normally returned to the #2 feedwater heater or condenser. W7&8 reboiler drips return to the #3 heater, and W3&4 reboiler drips return to the deaerator. If no reboiler were used, and bleed steam was admitted directly to the fuel oil heater, any tube rupture in the fuel oil heater would cause contamination of the entire condensate system. By using a reboiler, this possibility is removed, as the rupture would contaminate the reboiler system only. Inspection windows are provided in the fuel oil heater drip tank, at normal operating level, for the purpose of observing if any contamination of the system has occurred.
	A large tank used to store dry, filtered, compressed air until needed for pneumatic instruments and control devices. Saves the compressors from running continuously.

RECIPROCATING COMPRESSOR	A positive displacement compressor that relies on the back and forth motion of a piston within a cylinder to compress air. Gas enters the cylinder, and is trapped inside the cylinder. The gas is then forced into a smaller space by the action of the piston. Forcing the gas into a smaller space increases the pressure of the gas. The compressed gas is then discharged.
RECIPROCATING PUMP	A positive displacement pump that relies on the reciprocating motion of a solid object. A piston moves back and forth in a cylinder. Liquid is forced through the discharge valve as power is applied to the piston. The discharge pressure of the pump is determined by the discharge piping or head and not by the pump. The piston will develop whatever pressure is necessary to cause the liquid to flow from the cylinder through the discharge valve. The discharge pressure is limited only by the mechanical strength of the pump and the power of the driving unit. On many reciprocating pumps there is an air chamber installed on the discharge to make the flow more steady. The air in the chamber is compressed during the discharge stroke. When the piston reaches the end of the stroke, expansion of the air tends to keep the liquid in motion and the pressure up until the next stroke begins. In general, reciprocating pumps are most efficient for relatively small flow rates and high pressures. They are usually operated at slow speeds ( 40-200 crankshaft rpm ) because of the reciprocating motion and the valves. These pumps may be classed as single or double acting depending on whether one or both ends of the piston are used. In addition, they may be classified according to the number of pistons used. A simplex pump has one, a duplex two and a triplex three cylinders. The driving mechanism may be a reciprocating device, a motor, or turbine, in which case the rotary motion of the driver is converted to reciprocating motion by a crankshaft. Another type of reciprocating pump is a diaphragm pump. The diaphragm is attached to a connecting rod with a motor-driven device called an eccentric.
RECIRCULATION LINES	Lines used in pumps that require a minimum flow to prevent increased friction or high turbulence that could damage the pump.
RECORDER	A device that provides a continuous, permanent record of the value of a process variable.
RECORDING PSYCHROMETER	An analyzer that is used for continuous humidity measurements.
RECTIFIER	An electronic device that allows alternating current to flow in only one direction, that is, changes alternating current into direct

	current.
RECTIFY	To change an alternating current to a direct current.
REDUNDANT PROTECTION	A type of protection associated with the use of multiple sensors; designed to ensure that a malfunctioning sensor will not initiate an equipment trip.
REGENERATION	The process of restoring an ion exchanger's capability for exchanging ions.
REGENERATION OF EXCHANGERS	A method of feeding either acid or alkali to the demineralized exchange beds in order to reactivate the capacity of the units in service.
REHEAT STEAM SYSTEM	A system that increases the energy of steam exhausted from the HP section of the turbine before it enters the IP section and thus improves plant efficiency.
REHEAT STOP VALVES	Purpose is to provide an additional safety device to prevent overspeeding of the turbine should the interceptor valve fail to close when the overspeed trip mechanism operates. These valves utilize a rotary motion thus eliminating the hazards associated with reciprocating valve stems. When the auto trip valve is latched, the reheat stop valves open and remain open during normal operation, being held open by a supply of high pressure oil fed through an orifice. The oil supply to each of these stop valves is connected to drain through the overspeed trip valve so that when the overspeed trip valve opens, the valves close preventing flow of steam from the reheater to the intermediate pressure turbine. These valves should never operate in the partially open position. The position of the valve is indicated visibly or audibly by a signal from a switch mounted on the stop valve.
REHEATER	A boiler component that adds heat to steam after it has moved through a portion of the turbine. The reheated steam then flows through the remainder of the turbine. The boiler re heater, located above the secondary superheater, raises the steam temperature back to the original level of the main steam (resuperheated). After passing through the high pressure stage of the turbine, steam is returned to the re heater, at reduced pressure and temperature, via the "cold" reheat lines. Passing through the re heater, steam is "reheated" to the superheater outlet temperature. Reheated steam is then returned to the turbine IP section via the "hot" reheat line. The re heater is equipped with three safety valves, two are on the reheat inlet piping and the third valve is on the re heater outlet line.
REHEATER DESUPERHEATER	Two desuperheaters are installed in the cold reheat lines supplying steam to the re heater inlet header from the high pressure section of

the turbine. A mechanical atomizing water spray nozzle is located at the inlet of the desuperheater to make it possible to reduce, if necessary, the temperature of the steam returning to the turbine, and maintain the same at its design value within the limits of the nozzle capacity. The desuperheaters are positioned before the reheat to ensure against water carryover to the turbine, and also to eliminate the necessity for high temperature resisting materials in the desuperheater construction itself. The source of spray water is from the feedwater circuit, and it is important that the take-off line be located upstream from any chemical injection lines. It is essential that the spray water be chemically pure and free of solids in order to prevent chemical deposition in the reheat and carryover to the turbine.

**RELATIVE HUMIDITY**

A ratio of the actual amount of water vapor in the air at a specific temperature to the maximum amount of water vapor that the air could hold at that temperature. Expressed as a percent of the maximum amount of water vapor that the air could hold.

**RELAY**

A device that is operated by a variation in the conditions of one electric circuit to effect the operation of other devices in the same or another electric circuit. Some relays sense abnormal circuit conditions and send a signal that trips a breaker. Relays convert transmitter signals to control signals.

**RELIEF VALVE**

Normally closed. Operated to open when the actual pressure in a line or vessel reaches a given point, and is designed to protect the line or vessel from an overpressure condition. Handles non-compressible fluids - water, petroleum products, etc. Designed to open only as far as is necessary to hold the pressure at its relief point. Generally will have an isolation valve. Consists of a valve body, a disc, a seat, a spring, a valve stem, an adjusting screw, and lock nut. The valve body, or casing, provides a path for the liquid to flow and holds the other valve parts in their proper positions. The valve body has an inlet and outlet. The disc rests on the seat and is held in place by the spring when the system is at normal pressure. The valve stem guides the disc up and down. A relief valve is set to open when the pressure in a system reaches a predetermined value, such as 200 psi. If the pressure in the system reaches 200 psi, the pressure on the disc begins to overcome the force of the spring, and the disc begins to lift off of the seat. As this happens, the pressurized fluid is released through the valve outlet. If pressure in the system continues to rise, the disc will continue to lift, until it has risen as far as it can go. As system pressure begins to decrease, the valve begins to close. When the system pressure decreases to just below 200 psi, the

	force exerted by the spring pushes the disc back onto the seat. The adjusting screw is used to change the force exerted by the spring. Tightening the adjusting screw increases the force exerted on the disc, thereby raising the pressure setting at which the valve opens, or lifts. Loosening the adjusting screw reduces the amount of force on the disc and allows the valve to open at a lower pressure. The lock nut holds the adjusting screw in position after the force exerted by the spring has been set. The top of the assembly is usually covered by a cap that protects the adjusting screw.
REMOTE INDICATOR	Indicators located away from the process variable.
REPLACEMENT REACTION	A chemical reaction in which one type of atom is replaced with a different type of atom. An example is the removal of dissolved mineral ions from water that is being treated in devices called demineralizers. An ion is an electrically charged atom.
REPOWERING	A means of increasing the output and efficiency of conventional thermal generating facilities. For example, adding combustion turbines to supplement or replace steam from fuel combustion used to power steam turbines.
RESET CONTROL	Control action in which a controller continues to adjust its output until the value of a process variable returns to set-point. Does not exist without proportional control. Reset control is actually proportional-plus-reset control, since it adds an additional corrective action to the proportional action to eliminate offset. Sometimes called proportional-plus-integral, or PI control, because it is based on a mathematical function called integration.
RESIN BEAD	A small, porous, usually plastic bead that contains electrically charged areas where ions are exchanged; may be either a cation bead or an anion bead.
RESISTANCE (I)	Opposition to current flow. Electricity flowing through conductors encounters a form of friction, and some of the electric energy is converted into heat. Resistance is that property of a circuit which limits, opposes, or resists the flow of electricity through it. Normally expressed in ohms or megohms.
RESISTANCE THERMO DETECTOR (RTD)	Works on the principle that a wire's resistance to the flow of electric current changes as the temperature of the wire changes. The greater the temperature, the higher the resistance. The amount of resistance in a circuit is usually determined by the amount of load placed on the circuit, as well as the physical properties of the materials that make up the circuit. Contains a resistor whose electrical resistance changes with temperature. The

	resistor is connected to an electronic circuit, which is connected to an indicator. As the temperature changes, so does the resistance of the resistor. This causes a change in the amount of current flowing through the resistor. The electronic circuit detects this current change and converts it to a corresponding temperature reading.
RESISTOR	A circuit element whose chief characteristic is resistance; used to oppose the flow of current.
RESONANCE	A vibration of large amplitude in a mechanical or electrical system caused by a relatively small periodic stimulus of the same or nearly the same period as the natural vibration period of the system. That condition in an alternating current circuit which exists when the capacitative reactance exactly balances the inductive reactance.
REVERSE OSMOSIS	The flow of fresh water through a semipermeable membrane when pressure is applied to a solution (as seawater) on one side of it.
REVERSE POWER RELAY	A protective relay that operates when a generator draws power from the electrical system.
RHEOSTAT	A device that controls current flow by increasing or decreasing the amount of resistance in a circuit. An adjustable resistor so constructed that its resistance may be changed without opening the circuit in which it may be connected.
RMS	Abbreviation of Root Mean Square. See Effective Value.
ROLLING CONTACT BEARING	A bearing in which one surface rolls over another surface; there is lubricant between the two surfaces to reduce friction. Contains an inner ring, rolling elements, a retainer, or cage, an outer ring, and a housing. The inner ring is attached to a shaft, and the outer ring is attached to a housing. During operation, the inner ring rotates with the shaft, and the outer ring remains stationary. As the shaft rotates, the rolling elements roll between the two rings, allowing the shaft to turn with greatly reduced friction. The rolling elements maintain an equal distance between the rings, so radial movement is prevented.
ROLLING ELEMENT BEARING, OR ANTI-FRICTION BEARING	Use rolling elements to help reduce friction. The rolling elements can be balls, cylinders, barrel-shaped rollers, or tapered rollers. The rolling elements are held in place between an inner ring and an outer ring. A metal retainer, or cage, often holds the rolling elements in position and keeps them from rubbing against each other. Many rolling element bearings have a metal shield on one side, or sometimes on both sides. The shield helps keep lubricants in and dirt out.

ROOT	The quantity that when multiplied by itself a specific number of times equals a given number.
ROOT MEANS SQUARE (RMS), OR EFFECTIVE VALUE	Refers to the mathematical method used to calculate the average of the different voltage values in a cycle. A measure of the amount of work that can be accomplished by an AC circuit in relation to an equivalent DC value; mathematically determined by multiplying the peak AC value times .707.
ROOT VALVE	Valve downstream of process. On boiler bottom blowdown, valve between process and block valve. Opened before block valve is opened, and closed after block valve is closed.
ROTAMETER	A type of flow meter, consisting basically of a tapered tube and a float, that measures and indicates flow rate. Readings are generally taken at the widest part of the float.
ROTARY COMPRESSOR	A positive displacement compressor that uses rotation to compress gases. For example, rotary screw compressors compress gases using helical, or screw-shaped, rotors. Main parts include an inlet, a discharge, and two helical rotors. One rotor is the main rotor, and the other is the secondary rotor. The two rotors mesh as they rotate. A groove on the secondary rotor passes the inlet before it meshes with the main rotor. As the groove passes by the inlet, gas enters the groove and is trapped. As the rotor turns further, a lobe rolls progressively farther into the groove, compressing the trapped gas. As the groove passes by the discharge, the compressed gas flows out.
ROTARY PUMP	A positive displacement pump in which the action is one of rotation rather than reciprocating. The flow from a rotary pump is fairly steady whereas the flow from the reciprocating pump is pulsating. There are many different designs of rotary pumps. Some use gears, vanes, lobes, or screws to move the process liquid.
ROTARY STRAINER	A strainer with several baskets or cages that rotate, allowing continuous operation while strainer elements are cleared.
ROTARY SWITCHES	Switches that are rotated to start, stop, or position equipment.
ROTOR	The rotating member of a machine.
ROTOR (GENERATOR)	The rotating part of the generator which carries the magnetic field winding. Basic requirement is to produce a strong magnetic field. The rotor body in which the field winding is located forms the path of the magnetic lines for the part of the circuit while the stator core and air gap provide the return path for the flux. The rotor is made from a single steel forging. An axial hole is

provided to check the properties of the forging and to carry the leads from the collector rings to the field winding. Longitudinal slots are machined radially in the body to contain the field coils. The field coils are held in the slots against centrifugal force by steel wedges. These wedges are individually fitted and driven into dovetailed openings machined in the rotor slots. The field winding consists of rectangular bars formed into coils. Several turns in one pair of slots around one pole form a coil. Several coils are assembled around each pole to form the winding. The end turns of windings are held in place against centrifugal force by heavy retaining rings machined from high strength, heat-treated alloy steel forging. These rings are shrunk and keyed on centering rings on the rotor shaft. Current is supplied to the field winding through collector rings. These rings are connected to the winding through insulated copper bars assembled in the drilled-out center of the rotor forging. At one end of the connection bars, terminal rods or studs assembled in gas-tight bushings in the rotor shaft connect the winding with bars. At the other end, similar studs connect the bars with the collector. The generator rotor is connected to the turbine rotor through a solid bolted coupling with an integral machined coupling half on each shaft. The rotating field, field winding, and stator core are cooled by hydrogen flow circulated through the generator by fans mounted on the rotor shaft.

**ROTOR (TURBINE)**

The high-intermediate pressure turbine rotor is machined from a solid alloy steel forging. A separate stub shaft is bolted to the inlet end to form the thrust bearing collar and to carry the oil impellers and the overspeed trip. The low pressure rotor is likewise machined from a solid alloy steel forging. The entire rotors, after being completely bladed and machined, are given a running test and an accurate dynamic balance test. A flanged, rigid-type coupling is used between the high-intermediate pressure turbine and low pressure turbine rotors. The rotating element thus formed is located axially by the high pressure turbine thrust bearing. The low pressure rotor is in turn, connected to the generator by a rigid coupling. The main rotating element thus formed (consisting of high pressure-intermediate pressure turbine rotor, low pressure turbine rotor, and generator rotor) is carried in six bearing.

**ROTOR END-TRAVEL GAGE**

Provision is made for mounting a rotor end-travel gage in each end of the low pressure turbine cylinder cover. It is used primarily to determine the relative movements of the low pressure turbine rotor and cylinder during the initial operation of the unit, or following a general inspection or major overhaul.

ROTOR POSITION MICROMETER	A hole is provided in the overspeed trip end cover through which a standard depth micrometer can be inserted to determine the axial location of the rotor, relative to the cylinder, while the unit is in operation.
ROTOR-LONG CONDITION	A condition in which the rotor of a turbine expands faster than the shell. Raising turbine load or main steam temperature too quickly.
ROTOR-SHORT CONDITION	A condition in which the rotor of a turbine contracts faster than the shell. Reducing load or steam temperature too quickly.
RUN (SPEC)	A group of data points consistently falling above or below the process centerline.
RUPTURE DISC	See breakable diaphragm.
RUST	A destructive, continuing type of corrosion formed by the reaction of iron and oxygen under high oxygen conditions; causes equipment made of iron to weaken and deteriorate.
R-VALUE	In thermal insulation, the thermal resistance of insulation materials or constructions.

**S**

SAYBOLT UNIVERSAL SECONDS UNITS (SUS or SSU)	The unit of measurement for viscosity of fuel oil. The higher the SSU, the less thick it is.
SAE	Society of Automotive Engineers
SAE SYSTEM	Indicates oil viscosities with numbers referred to as weights. The higher the weight, the thicker the oil, and the higher the viscosity.
SAFETY AIR LATCH	The stationary union of the oil gun is provided with a safety latch assembly. By opening the valve on the aspirating air line, air is introduced to the air latch chamber. The aspirating air pressure overcomes the spring tension and forces the plunger to move in, away from the annular groove in the removable union. A cover, hinged to the stationary union, has been provided to close off the guide pipe after a gun has been removed. The edge of this cover is grooved to seat the plunger of the safety air latch. The cover is locked by the safety air latch. It can be unlocked by opening the aspirating air.
SAFETY VALVES	Valves that protect a system from damage due to over pressurization. Generally for compressible gases such as steam, air, etc. Contains "pop seats" and plugs relieving at full flow. Designed to open wide very quickly, and stays open until the pressure in the process system drops to a predetermined value. No

isolation valve. Relieving capacity at a pressure not exceeding 103% of its seat pressure. Closes at 96% of its set pressure. Consists of a valve body, a disc, a seat, a spring, a valve stem, an adjusting screw, a lock nut, and a manual release lever. The manual release lever is often used to test the operation of the safety valve. The disc has a lip that is not exposed to system pressure when the valve is closed. The center portion of the disc is always exposed to system pressure. If the valve is set to open, or lift, when the system pressure reaches a preset limit, such as 200 psi, the disc will start to lift when that pressure is reached. When this happens, the lip of the disc is suddenly exposed to system pressure, as well. Since a larger area of the disc is exposed to system pressure, more force is exerted on the bottom of the disc. The increased force overcomes the force exerted by the spring and causes the disc to pop open to about 60% open position. This allows a large volume of fluid to escape rapidly. If pressure in the system continues to increase, the pressure acting on the bottom of the disc will also increase and cause the disc to lift even higher. Once the excess pressure in the system has been relieved, the system pressure begins to drop. As pressure decreases, the force acting on the bottom of the disc also decreases. Eventually, the force exerted by the spring takes over and pushes the disc down. However, when the system pressure drops to the point at which the valve popped open, which was 200 psi, the valve will not close, because the lip of the disc is still exposed to the pressure of the escaping fluid. The valve will not close until system pressure drops below the pressure needed to pop the safety valve open. The opening pressure setting can be changed using the adjusting screw. Tightening the adjusting screw increases the force exerted on the disc and raises the pressure setting at which the valve opens. Loosening the adjusting screw reduces the amount of force on the disc and allows the valve to open at a lower pressure. The lock nut holds the adjusting screw in position after the force exerted by the spring has been set.

**SAIF**

System Average Interruption Frequency. Measures the average number of service interruptions that our customers experienced.

**SALT**

An ionically bonded compound that is composed of a metal and a non-metal.

**SAMPLE COOLING COIL**

A coil that circulates cooling water around a hot sample in order to bring it down to approximate room temperature, so that laboratory tests can be performed on the sample.

**SATURATED LIQUID**

A liquid that is at its boiling point for its pressure.

SATURATED STEAM	The general power plant usage of this term indicates steam which contains no superheat for the pressure involved. The pressure/temp. relation is as shown in the steam tables for saturated steam. Saturated steam may be either "dry" or "wet", that is, it may or may not contain excess moisture.
SATURATED STEAM (DRY)	Steam or water vapor at the saturation temperature which has no water present; a colorless vapor.
SATURATION TEMPERATURE	The precise temperature for each pressure at which water or any liquid boils. The temperature at which any liquid boils depends on the pressure on it.
SCALE	A coating of a salt or an oxide deposited on a metal surface, which decrease the heat transferring ability of the metal. Results from the presence in the boiler water of calcium and magnesium salts. These materials form a hard scale on the boiler tubes. Reduced heat transfer through the boiler tubes would result in overheating and possible rupture of the tube.
SCALING	The formation of a precipitate on a surface in contact with water as the result of a physical or chemical change.
SCAN CYCLE	The sequence of a programmable controller's activities that takes place many times a second when the programmable controller is running.
SCBA	Self-Contained Breathing Apparatus
SCHEDULED OUTAGE EXTENSION (SE)	An extension of a Planned Outage (PO) or a Maintenance Outage (MO) beyond its estimated completion date.
SCHEMATIC DIAGRAM	A drawing that identifies the components in an electrical system and shows them in their proper electrical sequence.
SCIENTIFIC NOTATION (MATH)	The expression of a quantity as a decimal number times a power of ten.
SCREEN TUBES	Boiler water circulating tubes used as a screen to shield the secondary superheater from furnace radiation.
SCREW PUMP	Uses screws to create the rotary motion that displaces the liquid. Consists of a casing with a suction port and a discharge port. Inside the casing are two screws: a driver screw and a idler screw. During operation, liquid enters the pump through the suction port and is directed to the suction end of the screws. As the screws turn, liquid is trapped in the spaces between the casing and the threads on the screws. The liquid is moved along until it reaches the discharge port, where it is forced out of the pump.
SCRUBBER	A device that uses chemical processes to reduce the amount of

	pollutants such as particulates and sulfur oxides in flue gas leaving a boiler.
SCRUBBERS (BOILER DRUM)	Apparatus located in upper part of main steam drum designed to cause abrupt change in direction of steam flow to throw out moisture and entrained solids by centrifugal force.
SCRUBBING	The removal of non-condensable gases from water, for example, as extraction steam flows across the surface area in an open heater.
SEAL FLUSH	The external fluid used to lubricate the seal rings in a mechanical seal.
SEAL OIL BACKUP	The seal oil backup from the main bearing oil feed system is normally closed. If the seal oil pump should stop, or if the seal oil pressure at the seals should decrease to 8 psi above the hydrogen pressure, the back-up regulator valve will open automatically and provide oil pressure for the seals at 8 psi above the machine gas pressure. This back-up pressure may be supplied from several sources; namely: the main oil pump on the turbine shaft, the AC motor-driven auxiliary oil pump and the AC and DC motor-driven turning gear oil pumps. The main oil pump on the turbine shaft and the AC motor-driven auxiliary oil pump supply 50 psig pressure to the back-up pressure regulator valve. The AC and DC motor-driven turning gear oil pumps will provide 5 psig oil pressure at the seals. When the 50 psig seal oil back-up is not available, such as when on turning gear or at standstill with the AC motor-driven auxiliary pump shut down, pressure switch "B" will close when seal oil pressure at the seals decreases to 5 psi above the hydrogen pressure. When the pressure switch "B" is closed, the DC motor-driven seal oil back-up pump will start automatically and maintain the seal oil pressure at the seals at 12 psi above the hydrogen pressure. The hydrogen pressure should be reduced to 2 psig or less when the DC seal oil back-up pump starts unless the AC motor-driven auxiliary oil pump is placed into service, as the next back-up is only 5 psig from the AC and DC motor-driven turning gear oil pumps. Should the seal oil pump start while the DC seal oil back-up pump is operating, the seal oil back-up pump must be stopped by push-button, as it is held in by an interlock in the motor control. The generator may be operated hydrogen-cooled with seal oil supplied by the seal oil back-up from the main turbine oil pump or auxiliary oil pump, but a bottle or two of hydrogen per day will be required to maintain the hydrogen purity as the seal oil pump is the only supply that is vacuum treated.

SEAL OIL PUMP	The seal oil pump draws treated oil from the bottom of the vacuum tank. It pumps part of it through a seal oil cooler to the seals, and part back to the spray nozzles in the vacuum tank through a differential pressure regulator which maintains the seal oil pressure at the seals at 12 psi above the machine gas pressure. The seal oil is circulated in this way through the vacuum tank a number of times before going to the seals. In the vacuum tank the oil flows over a series of trays which provide a large area for the separation of gas and vapors.
SEALED BEARINGS	Bearings that do not have to be re-lubricated for the life of the motor.
SEALING AIR	Since the furnace is pressurized, sealing air is required to seal off furnace openings (observation ports, soot blower wall boxes, oil guns, etc.). Sealing air is supplied continuously via the forced draft fan.
SEALING STEAM SYSTEM	A system that supplies auxiliary steam to the turbine gland seals to protect, or seal, the turbine from air leaking into or steam leaking out of the turbine casing.
SEAT	A stationary part of a valve onto which a flow control component (disc) presses to stop flow through the valve.
SECONDARY (FRONT) SUPERHEATER	High temperature element or final stage of steam superheating. Located above the furnace, and heated primarily by radiation. From the secondary superheater outlet header the superheated steam is led to the turbine via the main steam line.
SECONDARY AIR	Combustion air; air to the burners.
SECONDARY CELL	A type of battery cell that must be charged before it can release energy by chemical action; typically, a wet cell.
SECONDARY WINDING	The winding of a transformer from which the load is supplied; the coil that delivers the energy at the transformed or changed voltage to the load.
SEDIMENTATION	The third stage of the clarification process, in which floc particles that have settled to the bottom of the clarifier form an accumulation called sludge.
SELECTOR SWITCH	A form of air switch arranged so that a conductor may be connected to any one of several other conductors.
SELF CONTAINED VALVE	Normally closed globe valve, but is self actuated for line pressure control. The line pressure triggers the valve to open or close at predetermined set-points.
SELF-INDUCTION	The production of a counter-electromotive force in a conductor

SELF-PRIMING PUMP	when its own magnetic field collapses or expands with a change in current in the conductor.
SEMI-OPEN IMPELLER (CENTRIFUGAL PUMPS)	Pumps that stay filled with liquid when they are shut down.
SENSIBLE HEAT	Can be used for pumping thin liquids, since there is a shroud to direct the liquid between the vanes. Can also be used for heavier liquids and slurries, since they minimize clogging.
SENSIBLE HEAT TRANSFER	The amount of heat expended whenever a change in temperature results from the addition of heat.
SENSING ELEMENT	Heat transfer that causes a temperature change.
SERIES CIRCUIT	The element in a control loop that senses the value of a process variable.
SERIES CONNECTION	A circuit with only one path for current flow.
SERIES-PARALLEL CIRCUIT	An arrangement of cells, generators, condensers, resistors, conductors, etc., so that each carries the entire current of the circuit.
SERVICE AIR COMPRESSOR	A circuit that contains both series and parallel current paths.
	Approx. controlled pressure is 90-105 psig. Air at atmospheric pressure and temperature enters the system through the intake filters, is compressed with the first stage compressor, passed through the intercooler and separator, the second stage compressor, the aftercooler and separator and then to the air receiver. The inter and aftercoolers are equipped with Y strainers and air traps.
	Air compressor accessories:
	<ol style="list-style-type: none"><li>1. Intake Air Filters - prevents dust and other impurities from entering cylinder. Dust can cause sticking valves, scored cylinder and excessive wear.</li><li>2. Intercoolers - to lower the temperature of air entering the next stage. Also, to cool air vapor below saturation temperature corresponding to pressure and remove moisture.</li><li>3. Separators - to remove moisture and oil from air by mechanical means. Either a change in direction, or centrifugal force.</li><li>4. Aftercoolers - reduce temperature and moisture content of compressed air.</li><li>5. Receivers - dampen pulsation or pressure waves in compressor discharge. Also acts as reservoirs and precipitate any moisture that may have carried over from the aftercooler.</li></ol>

6. Y Strainer - prevents any grit or foreign matter from entering the air trap.
7. Air Traps - used to remove condensed moisture without loss of compressed air.
8. Protective Devices - relief valves in receivers. No-flow switches shut down compressor if flow of cooling water to compressor is stopped.

From the air receiver, air is supplied to the following:

1. Soot blower panel (power)
2. Air preheater auxiliary drive motors
3. Ignitors
4. Air for burner scavenging
5. Burner cleaning station
6. Boiler aspirating air system
7. Fuel oil tank area
8. Soda ash mixing
9. Back-up for instrument air
10. Miscellaneous hose connections located throughout the plant

SERVICE WATER SYSTEM	Vertical, deep-well, turbine-type pumps, installed in the circulating water pump well structure that pump sea water to the tube side of the auxiliary cooling water heat exchangers. Service water discharged from the heat exchangers is returned to Pearl Harbor via the condenser circulating water discharge tunnel. Each service water pump well structure is designed so that it may be fed from either the circulator inlet tunnels or from the pond water.
SERVOMOTOR	A mechanism controlled by governor oil to operate steam inlet valves on a turbine.
SET POINT	A specific value at which a process variable is maintained by a control system. The desired value of a process variable.
SETTLING BASIN	A basin utilized for holding and sedimentation of particulates or coagulants in plant waste water.
SHEWHART, WALTER	Bell lab studies, 1924. Came up with a way to mathematically determine boundaries of natural variation for a process. Shewhart developed a chart to display this variation, known as the Shewhart control chart. The chart had limits for the amount of variation that should occur in a process. Walter Shewhart essentially became the father of SPC.
SHIELDING	A metallic covering used to prevent magnetic or electrostatic coupling between adjacent circuits.

SHORT CIRCUIT	An abnormal connection of relatively low resistance, whether made accidentally or intentionally, between two points of different potential in a circuit.
	A circuit in which the resistance drops to almost zero and current reaches an extremely high value. An electrical fault that occurs when electricity takes an unwanted path. When a portion of a complete circuit is "cut off" for some reason, bypassed. Brings the negative and positive directly together, causing heat, smoke, circuit breakers to open, fuses to blow.
SHRINK	The decrease in water level that occurs when boiling stops and the number bubbles is reduced.
SHROUD (MOTORS)	The protective covering on the end of a motor, opposite the shaft.
SHROUDING	A metal band attached to the outer edge of a turbine's moving blading to dampen blade vibration, and to provide greater strength and rigidity.
SHUNT	Parallel. A parallel resistor placed in an ammeter to increase its range.
SHUNT FIELD	The main field of the exciter; the field that the operator controls manually at the control board with the "field rheostat", which, in turn controls the strength of the field in our main generator and hence the output voltage of the power plant.
SHUT-OFF HEAD	Maximum amount of pump discharge head pressure.
SHUTTERS (AIR DOORS, REGISTERS, OR DAMPERS)	An adjusting device for controlling the air flow to each fuel burner.
SIGHT FEED	A visible means for detecting fluid flow through a pipe.
SIGNAL CONVERSION	The process of converting digital signals to analog signals, or analog signals to digital signals. Performed by devices called signal converters. Digital signals are converted into analog signals by digital-to-analog, or D-to-A, converters. Analog signals are converted to digital signals by analog-to-digital, or A-to-D, converters.
SILICA	One of the dissolved solids in raw water that is checked very closely to prevent buildup in the boiler water system. It is capable of scaling out of boiler surfaces as well as distilling over with the steam and depositing on turbine blading. Can only be removed by boiler blowdown.
SINE OF THETA	The ratio between the opposite side of a right triangle and the hypotenuse.
SINE WAVE	The curve traced by the projection of a rotating vector on a

SINGLE ELEMENT DRUM LEVEL CONTROL	uniform time scale. All electrical equipment is designed to produce or utilize alternating currents and voltages of a particular shape. This shape is known as a sine wave. A sine wave may be produced by rotating an arrow about a point so that it describes a circle. If the angle that the arrow has rotated through is laid out as a horizontal line, and the vertical height of the arrow is plotted on the vertical, a sine wave will result. It takes a rotation of 360° to complete one full cycle. The same curve is repeated every 360°. Each complete curve or 360° rotation is known as a cycle. Also known as a sinusoidal wave.
SINGLE LINE DIAGRAM	Feedback control; Feedwater does not change until the drum level experiences changes.
SINGLE STAGE PUMP	A drawing of an electrical system that uses single lines to represent electrical paths and symbols to represent individual components.
SINGLE-ACTING COMPRESSOR	A pump that increases fluid pressure only once.
SINGLE-ACTING DIAPHRAGM ACTUATOR	A compressor in which gas or air is only compressed on the forward stroke of the piston.
	Called single acting because air pressure acts on only one side of the diaphragm to position a valve. Consists of a casing, a diaphragm, an air supply port, an air vent, a spring, a stem, and a valve position indicator. The indicator shows the position of the valve. The center of the diaphragm is supported by metal plates, and the outer edge is sandwiched between the rims of the upper and lower halves of the casing to form an airtight seal. This arrangement divides the casing into two chambers: an upper chamber and a lower chamber. The upper end of the actuator stem is connected to the metal plates and the diaphragm. The lower end moves the valve disc. When the actuator receives a signal from a controller to close the valve, air pressure is applied to the upper chamber. The diaphragm and the actuator stem are pushed downward, the spring is compressed, and the valve closes. Air in the lower chamber is exhausted through the air vent. When air pressure to the upper chamber is reduced, the spring moves the actuator stem upward, and the valve opens. Stem movement and valve position are proportional to the amount of air pressure applied to the actuator. Controlling the applied pressure enables the actuator to position the valve anywhere within the limits of travel for the actuator. This type of actuator can be called an air-to-close/spring to open actuator, because air pressure moves the stem to close the valve, and a spring moves the stem to open the valve. This means that if air pressure to the actuator is lost, the

control valve that is connected to the actuator will “fail open”, since spring pressure will raise the stem and open the valve. Some single-acting diaphragm actuators are designed to close a valve, or “fail closed”, when air pressure is lost. During operation of a “fail closed” actuator, air pressure is fed into the lower chamber. This causes the diaphragm to lift, which expands the spring, raises the stem, and opens the valve. When air pressure is reduced, the spring pulls the diaphragm and the stem downward, closing the valve. A control valve using this kind of actuator is said to “fail closed” because if air pressure is lost, the spring in the actuator will close the valve. A diaphragm actuator with an air line to only the lower chamber is typically an air-to-open/spring-to-close type, which causes a control valve to fail closed. A diaphragm actuator with an air line to only the upper chamber is typically an air-to-close/spring-to-open type, which causes a control valve to fail open. As long as the applied pressure is properly controlled, either of these actuators can be used to position a valve anywhere within the limits of travel for the actuator.

**SINGLE-ACTING HYDRAULIC ACTUATOR**

Consists of a cylinder, a fluid port at the base of the cylinder, a vent, a spring, a piston, and a piston rod, which is connected to the valve disc. When there is no fluid pressure against the piston, the spring pushes against the piston to keep the valve closed. When fluid flows through the port into the cylinder, the piston moves, compressing the spring and opening the valve. The vent exhausts air from the cylinder as the piston moves. When the flow of fluid stops, the fluid pressure and the spring hold the piston and the valve at their new positions. When the hydraulic fluid pressure is decreased, the spring moves the piston to close the valve, and fluid flows from the cylinder through the fluid port. The piston can be positioned anywhere in the cylinder by controlling the amount of fluid entering the cylinder or bled from the cylinder. This type of actuator is considered to be single acting, because fluid enters the cylinder through only one port and acts on only one side of the piston. It is also described as a spring return, because a spring moves a piston to close the valve. If hydraulic fluid pressure is lost, the spring will cause the valve to fail closed.

**SINGLE-ACTING PISTON ACTUATOR**

A controller or similar device controls the air pressure on one side of a piston. When air is fed through the air supply port, the piston moves along a cylinder, compressing a spring, and opening the valve. Air on the other side of the piston leaves the cylinder through an air vent. When air pressure is reduced, the spring expands, moving the piston in the opposite direction and closes the valve. If air pressure drops below a predetermined value or is

SINGLE-BED ION EXCHANGER	lost completely, the spring will force the piston down to close the valve. In other words, the valve will fail closed.
SINGLE-SCREW, OR PROGRESSIVE CAVITY, PUMP	A ion exchanger that contains either anion resin or cation resin.
SINGLE-STAGE CENTRIFUGAL COMPRESSOR	Rotary pump. Contains a single screw located inside a casing. One end of the screw is normally connected to a driver. As the pump operates, process liquid is drawn into the pump through the suction port. As the screw rotates, cavities form between the casing and the screw. These cavities move, or progress, toward the discharge of the pump, carrying the process liquid along. When the liquid reaches the discharge, it is forced out of the pump. Can move extremely viscous fluids, like sludge and gels, without clogging.
SITES	A compressor in which air is compressed in one step. Main components include a shaft, which is connected to a motor, seals, a shaft bearing, and an impeller. The compressor casing contains a volute, a suction line, and a discharge line. The shaft is used to rotate the impeller. The seals prevent gas from leaking out of the compressor, and lubricant from leaking out of the bearing along the shaft. The shaft bearing supports the shaft and allows the shaft to rotate. Single-stage centrifugal compressors produce fairly high gas flow rates, but their discharge pressures are relatively low.
SKIM TANK	Charged areas on resin beads that are occupied by ions.
SLIDING PRESSURE CONTROL	A baffled tank used for separating oil from water.
SLIDING SURFACE BEARING	Varying main steam pressure in order to prevent turbine control valves from operating near their cracking points and to minimize frictional losses. Lowering boiler drum pressure while maintaining main steam (superheat) temperature. This avoids temperature and pressure losses at the valves; efficiency.
SLIDING VANE COMPRESSOR	A bearing in which two surfaces, with lubricant between them, slide over each other.
	A rotary compressor. Consists of a cylinder, a slotted rotor, and vanes that fit into the rotor slots. The vanes are free to slide in and out of the slots. The rotor is mounted off center in the cylinder, so that a crescent-shaped space is left between the rotor and the cylinder wall. Since the vanes can slide freely, centrifugal force holds them out against the cylinder wall during operation. Each pair of vanes forms a separate gas pocket. The size of each pocket varies as the vanes are moved around the cylinder. The gas pockets are largest at the inlet, where the distance between the

rotor and the cylinder wall is greatest. As the vanes move towards the outlet, the distance shrinks, and the gas pockets become smaller. Gas flows into the pockets formed by each pack of vanes at the compressor's inlet. Once the vanes pass the inlet, the gas is trapped. As the rotor continues to turn, the volume of each gas pocket gets smaller, compressing the trapped gas. As the vanes pass the compressor's outlet, the compressed gas flows out of the cylinder.

SLIME	A deposit formed by the growth of biological organisms.
SLING PSYCHROMETER	A device that is commonly used for spot-check humidity measurements.
SLIP	The difference in rotational speed between the driver element (or impeller) and the driven element (or runner) in a variable speed coupling. The slip of an induction machine is the difference between its synchronous speed and its operating speed and may be expressed as a percent of synchronous speed.
SLUDGE	The solid substance that exist or precipitates out of a solution. The sediment at the bottom of a clarifier; made up of floc particles.
SLURRY	A mixture of solids and water. A thin mixture of a liquid, especially water, and any of several finely divided substances, such as cement plaster, or clay particles.
SMOKE POINT	The excess O <sub>2</sub> level where a visible plume occurs (approximately 10% opacity).
SODIUM CHLORIDE (H2500)	Salt (sodium+) + (chlorine-)
SODIUM HYDROXIDE (CAUSTIC SODA, LYE)	A white brittle solid that is a strong caustic base; used to increase alkalinity and raise pH of various waters.
SODIUM SULFATE	A bitter salt; used as an oxygen scavenger
SOLDER POTS (MCC)	An alloy thermal overload device. The solder pot has a heater, a ratchet wheel, a rod, and solder. The solder is an alloy that surrounds the rod. Current that flows through the motor controller's power circuit to the motor flows through the heater. When current flows through the heater, it generates heat. If the current exceeds the rated value of the overload device, enough heat is generated to melt the solder. This will cause the overload device contacts to open, interrupting current flow in the control circuit to the "M" coil. As a result, contacts in the motor controller are opened. Opening these contacts interrupts the current flow in the power circuit to the motor, and the motor stops.

**SOLENOID**

A coil of wire with a movable core of soft iron or other permeable material. When current passes through the coil, the resulting magnetic field draws the core into the coil. This movement is called solenoid action. Uses a magnetic field to open circuit breaker contacts. An electrical conductor wound as a helix with a small pitch, or as two or more coaxial helices.

**SOLENOID ACTUATOR, OR  
SOLENOID**

Used for on/off control of a valve. Can position a valve from fully open to fully closed quickly, so they are particularly useful for the emergency shutoff of valves. Consists of a wire coil; a spring; an armature, or core; and a stem, which is connected to a valve. When current flows through the wire coil, it creates a magnetic field around the coil. As a result, the coil, in effect, becomes an electromagnet. The armature, which is a solid metal core, is attracted to the magnetic field. This attraction pulls the armature toward the center of the coil. As the armature moves, it compresses the spring and moves the stem, which opens the valve. When current flow through the coil stops, the magnetic field is lost. This allows the spring to push the armature and stem back to their original positions, closing the valve. When current flow through the coil starts or stops, the movement of the armature is almost instantaneous. When current flow starts, the actuator fully opens the valve, and when current flow stops, the actuator fully closes the valve. There is no intermediate, or in-between, position, so there is no way that a solenoid actuator can throttle a valve. Since most solenoids operate this way, they are typically used with on/off valves. Also, solenoid actuators do not produce a great deal of force when they operate. When more force is needed to position a valve, a different type of actuator is generally used.

**SOLENOID TRIP**

A solenoid is provided, which when energized, raises the protective trip dump relay releasing the auto-stop oil and high pressure operating fluid to drain. This feature permits tripping the unit from some remote point, or by means of protective relays in the generator circuit.

**SOLID PARTICLE EROSION**

The erosion on internal turbine components (usually the nozzle block and the turbine blades in the first few stages of the HP section) caused by solid particles that are trapped in the steam and carried into the turbine.

**SOLID WASTES**

Generated from electric generating systems as a result of cleaning operations such as slag and ash from boiler firesides, wastes from chemical cleaning, contaminated soils and other materials, and from oil or unusable chemicals.

**SOLIDLY GROUNDED**

A circuit or equipment grounded through an adequate ground

(DIRECTLY GROUNDED)	connection in which no impedance has been inserted intentionally.
SOLUTE	The material in a solution that is dissolved.
SOLUTION	A special type of mixture called a homogeneous mixture. The term "homogeneous" refers to the fact that the materials in a solution are evenly mixed. Can be a mixture of solids, liquids, or gases, or a combination of any of these, as long as the materials involved are evenly mixed.
SOLVENT	The material that the solute is dissolved in.
SOOTBLOWER (IKS & IRS)	A device that uses steam or compressed air to blow off soot that collects on boiler tubes; also used to control exit gas temperature. A system of automatic sequential steam-blowing, air-operated soot blowers is furnished to aid in keeping the gas passages of the superheaters, economizer, and air heater clear. A typical sootblower is made up of a lance tube with nozzles, a feed tube, and a poppet valve. When the poppet valve is open, a blowing medium is sent through the feed tube under pressure and discharged through the nozzles in the lance tube. High pressure steam is extracted from a point between the primary superheater outlet and the secondary superheater inlet. A pressure reducing station drops the pressure to 600 psi, and orifices at each blower reduce the pressure to the final required levels.
SORBENT POWDERS	Powders that have the ability to absorb substances.
SPC	Statistical Process Control
SPCC	Spill Prevention Control and Countermeasure Plan.
SPECIAL FUNCTION KEYS (COMPUTER)	Used to start tasks that are performed frequently.
SPECIFIC CONDUCTANCE	The specific conductance of water is a measure of the ability of the water to conduct an electric current. Specific conductance is inversely proportional to electrical resistance. Pure water is highly resistant to the passage of an electric current and therefore has a low specific conductance. However, if the water contains ions, the water becomes a better conductor of electricity and the specific conductance is increased. Therefore, the conductivity test is a means of measuring the total ionizable (dissolved) solids in the water.
SPECIFIC GRAVITY	A measure of the relative density of a substance compared to the density of water. Divide the density of the substance by the density of water. Density of water is 62.4 lbs per cubic foot, or 1 gram per cubic centimeter.

SPECIFIC HEAT	The amount of heat required to raise the temperature of one pound of the substance one degree Fahrenheit.
SPECIFIC VOLUME	The measurement of the amount of space occupied by one pound of a substance. Usual units are cubic feet per pound. Volume divided by mass.
SPEED CHANGER	The part of a turbine governor which is used to change the speed of rotation before the unit is synchronized, and to change load after synchronizing. With a fixed setting of the speed changer compression spring, the governing control oil pressure varies in accordance with the turbine speed, while with a fixed speed, the governing control oil pressure depends upon the setting of the speed changer compression spring. The position of the speed changer determines the spring force acting on the transformer cup valve. There is then a change in either turbine speed or governing control oil pressure for every change in speed changer setting. When a turbine-generator is running alone and controlling frequency, then a movement of the speed changer brings about a very small change in governing control oil pressure, a corresponding change in the position of the governing valves and a change in steam flow through the turbine. This change in steam flow, if an increase, causes the turbine speed to increase until the governor impeller discharge pressure balances the increased spring force of the spring. For parallel operation with a utility system or with large units in the same plant, the turbine speed is controlled by the electrical tie of the generator. Under such operating conditions, the speed changer actually becomes a load changer. This is true because the changing the steam flow through the turbine can only change the torque while the speed of the turbine is scarcely affected. Accordingly, then there is a different governing control oil pressure necessary to keep the transformer cup valve in equilibrium. For every value of governing control pressure there is a definite governing valve position and consequently a definite electrical load, if the system frequency remains constant. Turning the speed changer handwheel in the "Increase" direction ("Raise" on Main Governor type "W" switch at control bench) increases the force of the compression spring and hence increase the turbine speed (or load). Turning the speed changer handwheel in the opposite direction ("Lower" at type "W" switch) decrease the force on the compression spring and hence decreases the turbine speed (or load).
SPHERICAL ROLLER BEARING	Resists axial movement in two directions.
SPILL STRIP PACKING	Seals used to seal between the moving blades and the turbine

	casing.
SPINNING RESERVE	That reserve generating capability connected to the bus and ready to take load.
SPONTANEOUS COMBUSTION	Combustion that is self-starting, without outside ignition (heat source).
SQUIRREL CAGE WINDING	A permanently short-circuited winding, usually insulated (chiefly used in induction machines), having its conductors uniformly distributed around the periphery of the machine and joined by continuous end rings.
SSU	Saybolt Seconds Universal
STABILITY	Stable point above carrying capacity of wire or pull out point of generator.
STABILIZING FIELD	A small field in the exciter that is connected to the 125 volt plant DC system. Remains in service at all times under normal operating conditions. The control operator has no control over this field other than the manual breakers on the 125 volt DC panel. These breakers are opened only under special conditions for maintenance purposes.
STAGE	One row of fixed blading and one row of moving blading.
STANDARD DEVIATION	A measure of the way data points are distributed within a normal distribution. Within a normal distribution, around 68% of the plotted values should fall within a certain distance of the mean value. The distance from the mean value to each line is known as one standard deviation. About 95% of the readings should fall within two standard deviations. About 99.7% should fall within three standard deviations. The lines for three standard deviations are commonly used as control limits on SPC control charts.
STARTUP FAILURE (SF)	An outage that results when a unit is unable to synchronize within a specified startup time following an outage or Reserve Shutdown. The startup period for each unit is determined by the operating utility. It is unique for each unit, and depends on the condition of the unit at the time of startup (hot, cold, standby, etc.). A startup period begins with the command to start and ends when the unit is synchronized. An SF begins when the problem preventing the unit from synchronizing occurs. The SF ends when the unit is synchronized, another SF occurs, or the unit enters another permissible state.
STATIC	A fixed non-varying condition; without motion.
STATIC ELECTRICITY	A stationary charge of electricity. Voltage with no current;

	electrical potential. Occurs when a large number of electrons builds up on a surface. A common cause of this type of buildup is friction. The buildup of electrons on a surface results in a high electrical charge and, consequently, a high electrical potential. When the potential is great enough, the electrons move, or flow, from one place to another. This flow of electrons is referred to as an electrostatic discharge.
STATIC EXCITER	An exciter that has no moving parts.
STATIC HEAD	Related to the level of liquid. The vertical distance between the top of a column of fluid and the discharge from that column.
STATIC HEAD (PUMPS)	The head caused by a nonmoving liquid as a result of its height. The static head exerted on the inlet of a pump is measured from the centerline of the inlet to the level of the liquid.
STATION BATTERIES (125 VOLT)	Supply a reserve source of power for the operation of circuit breakers, control circuits, motors, lamps, alarms, and emergency lighting. They also feed inverters for an emergency source of alternating current for the house telephones, public address systems, and the company radios. Each plant also has a gasoline engine-generator set for emergency supply of 125-volt direct current.
STATION SERVICE	Auxiliary and other facilities for station use in a generating, switching, converting, or transforming
STATIONARY BLADES	Non-moving turbine blades, or nozzles, located between turbine stages and used to redirect the flow of steam to the next set of moving blades.
STATIONARY SOOTBLOWER (IR'S)	Remain inside the cooler section of the boiler, usually the economizer area, and have a row of openings along the length of the lance for cleaning. This type of lance turns in a 360° arc.
STATISTICAL PROCESS CONTROL (SPC)	A way of monitoring a process to maintain consistent quality and thereby reduce failure cost. Relies on using mathematical laws of statistical probability. These laws have to do with the probability of something occurring either naturally or because of an outside influence.
STATOR	The part of a machine which contains the stationary parts of the magnetic circuit with their associated windings.
STATOR OR ARMATURE	A hollow cylinder in which the rotor is located. Stationary coils which produce three phase electricity that are 120 degrees apart from each other. Consists of a frame which supports the entire assembly and a core of steel in which there are slots for containing the stator conductors. The function of the core is to provide a

return path for the lines of magnetic force from the field. The magnetic lines of force generated by the rotating field are, in effect, a series of loops which leave the north pole of the rotor, travel through the stator core and return to the south pole of the rotor. The stator core must be made of steel which easily permits the lines of force to pass through (high permeability steel). The stator core consists of a series of iron laminations, called punchings, pressed by a hydraulic press during the stacking process and finally clamped by insulated bolts. After assembly, the core is varnished and baked to protect it from rust and to further insulate the punchings. There are two conductors per slot in the stator and that the stator conductors are distributed equally all around the stator. The armature winding is formed by insulated bars of half coils and assembled in the stator core slots. They are joined at the ends to form coils and connected in the proper phase belts by connection rings at the end of the winding. The stator bars are composed of insulated copper conductors (strands) arranged in the form of rectangular bars. The bars are so assembled that each strand occupies every radial position in the bar at some point along the length of the bar. This arrangement causes all strands to share the load current equally and minimizes circulating current losses within the bar. The main armature leads (high voltage and neutral) are brought out at the bottom of the generator casing through the generator terminal boards, at which point the desired connections are made. On most generators these connections are provided at the collector ring end of the generator. The armature connections are brought through the terminal boards by means of gas-tight voltage bushings. These bushings consist of one-piece porcelain insulators containing a copper conductor. Silver-plated terminal studs are provided at each end of the bushings for making the connections. The voltage produced in the stator conductors depends on the strength of the rotating magnetic field, the length of the conductor and the speed of the rotation. The length of the conductor is fixed by the design of the machine and the speed is normally fixed by the requirement of producing 60-cycle power. The only variable under control of the operator then is the strength of the magnetic field. As the field rotates, a sine wave voltage is induced into the stator conductors. As long as the generator OCB is open, there is no current flow because there is no complete circuit. When the OCB is closed, the circuit is completed and current will flow due to the induced voltage.

**STATOR WINDING**

Coils of windings in the stator, that surround the rotor. Current flow through the stator windings produces magnetic fields. The

STATOR	The stationary part of a motor or generator. It consists of the frame, the core, and the windings.
STEADY-STATE CONDITIONS	stator windings have been dipped in an insulating varnish and then baked. The varnish insulates the windings from each other and prevents short circuits or grounds that could damage the windings.
STEAM CHEST	Conditions in which the value of a process variable remains relatively constant over a period of time.
STEAM CYCLE	A collection area designed to reduce the turbulence of steam before the steam enters the turbine control valves. On the new, larger utility units, the steam chests are mounted outside of the turbine casing, usually one on each side of the high pressure turbine element. Each steam chest is anchored to the foundation independently to isolate forces and moments built up by thermal expansion as components heat up. In reality, the steam chest is a manifold which provides structural support for the governing valves. It can also be described as the area where the steam pressure of the steam flowing through the throttle valve is equalized.
STEAM FLOW LIMIT VALVE	In a power plant, the complete loop from the boiler, through the turbine, through the condenser, and back to the boiler.
STEAM INLET VANES	Essentially a high grade oil pressure regulating valve.
STEAM SEAL SYSTEM	Spaces, or lanes, between condenser tubes that direct steam flow around all of the circulating water tubes, thus insuring an even heat transfer throughout the condenser.
STEAM SEAL UNLOADING VALVE	Prevents leakage (steam out/air in), and controls thermal stress. Usually provided with two chambers. The chamber on the side of the seal nearest the turbine is connected to the steam seal supply and leakoff system. The outer chamber, nearest atmosphere, is connected to a gland steam condenser. Steam that leaks past the labyrinth seal toward atmosphere is collected in this chamber and then piped to the shell side of the gland steam condenser. The shell side of the condenser is provided with an air exhauster which maintains a slight vacuum in the shell.
STEAM TABLE	A valve in a steam seal system that dumps steam to the condenser, instead of letting it flow to a low pressure feedwater heater, when too much steam enters the system.
STEAM VAPOR	Complete calculations of the values of the various properties of steam and water for a wide range of pressures and temperatures. Arranged in tabular form, each variable such as specific volume and enthalpy has three values for each pressure. One of these is for the saturated liquid, one for the saturated vapor, and the third is the change in quantity when going from liquid to vapor.

	Always given in terms of absolute pressure so as to provide a constant reference point and makes the tables universally acceptable. Gauge pressure cannot be used this way because its reference point is atmospheric pressure which changes with location.
STEAM TEMPERATURE	The boiling temperature for a given pressure. For each pressure there is a corresponding boiling temperature, or steam temperature.
STEAM TRAP	A component in a steam system that removes condensation without removing steam. Located at low points in steam lines where condensate naturally collects. Three types are mechanical, thermostatic, and thermodynamic.
STEP DOWN TRANSFORMER	A transformer in which the primary is the high voltage winding (more windings) and the secondary is the low voltage winding (less windings).
STEP INPUT (STEP CHANGE)	A sudden change in the value of a process variable.
STEP UP TRANSFORMER	A transformer in which the primary is the low voltage winding (less windings) and the secondary is the high voltage winding (more windings).
STOICHIOMETRIC AMOUNT	The exact amount of oxygen required to react with all the carbon and hydrogen, with no excess amount of oxygen, carbon, or hydrogen left unreacted. Peak flame temperature occurs when the quantity of air supplied to the burner is near the stoichiometric amount. As the quantity of air is increased above the stoichiometric amount, the excess air absorbs some of the energy released from the fuel, thereby lowering the flame temperature. On the other hand, if less air than stoichiometric requirement is supplied to the burner, there is not enough oxygen to react with the fuel. This results in incomplete combustion of the fuel and a reduction in flame temperature as less than the total energy is released from the fuel. Due to non-ideal fuel and air mixing in large furnaces with many burners, utility boilers operate with excess air to achieve complete combustion of the fuel.
STOP LOG	One of a set of timber pieces, usually square, which serve to form a dam to check the flow of water.
STOP VALVES	See main stop valves.
STRAINER (PUMP)	Used to trap and remove solids from process liquid before they can enter the pump and cause damage.
STRAPPING CHART	Conversion chart to convert the depth of oil in a tank in feet and inches to the volume in barrels.

STRATIFICATION	The formation of layers of different-temperature air in the furnace as a result of air in-leakage.
STRESS	The result of applied forces. These forces can alter the molecular structure of a solid, causing it to change shape. Tension, compression, bending, twisting.
STRIP CHART	A chart plotted on a linear strip of paper. Scales include time and process variable values.
STRONG BASE ANION DEMINERALIZER	Contains strong base resin which removes the weakly charged silica ion and any negatively charged ions which passed through the preceding bed. pH values should be in the 6.0 to 8.5 range and conductivities less than 10 $\mu\text{mhos}$ .
STUFFING BOX (PUMP)	A sealing method used on most smaller pumps and when the pressure is low. Consists of an annular space in the casing around the shaft. Rings of packing material are placed in this space. The packing rings are compressed and held in place by a follower or gland. The gland is in turn held in place by studs with adjusting nuts. As the adjusting nuts are tightened, they move the gland in and compress the packing. This in effect squeezes the packing out radially making a tight seal between the rotating shaft and the inside wall of the stuffing box. The shaft is rotating at high speed and is rubbing against the packing which causes a lot of friction. If there is no lubrication the packing will quickly burn up and can seriously damage the shaft. Lubrication is normally provided by keeping the gland loose enough so that a small flow of liquid leaks out of the pump. The liquid acts as a lubricant and keeps the packing cool. This method of sealing cannot always be used. If the pump suction is under a vacuum so that leakage outward is impossible or if the liquid is too hot to provide adequate packing cooling, a different type of seal must be used. Usually in these cases a supply of cool, clean water is piped to the stuffing box. This water, known as cooling or gland sealing water, is injected through a drilled passage in the case into a ring usually located at approximately the center of the stuffing box. The ring known as a lantern ring or sealing ring is usually constructed of metal made in a skeleton design. The ring distributes the sealing water uniformly around the shaft. To insure that sealing water flows in both directions along the shaft the sealing water pressure should be approximately 10 psi higher pressure than the pump suction pressure.
STUFFING BOX (VALVES)	Holds the valve packing, which is installed around the stem.
SUBCOOLED WATER	Water at a temperature below the saturation temperature.

SUBSTATION	A facility in which electric power from several sources is combined in one location for local distribution. A network of electrical components, including transformers and circuit breakers, used to deliver power to transmission or distribution lines.
SUCTION EYE	The area in the center of the impeller; low pressure area. The pressure at the intake, or suction eye, of a pump.
SUCTION HEAD	The head at the inlet of a pump. The height of fluid above the suction of a pump.
SUDDEN PRESSURE RELAY	A protective relay that senses internal faults in a transformer and initiates circuit breaker trips to isolate the faulted transformer from the rest of the system. A relay designed to detect a rapid buildup of pressure inside a transformer.
SULFUR DIOXIDE (SO <sub>2</sub> )	A colorless, extremely irritating gas or liquid, used in many industrial processes, especially the manufacture of sulfuric acid.
SULFUR DIOXIDE AND SULFUR TRIOXIDE FORMATION	Sulfur contained in the fuel reacts with oxygen in the combustion process to form sulfur dioxide and sulfur trioxide. Typically, 97-99% of fuel-bound sulfur forms SO <sub>2</sub> , and only 1-3% of the SO <sub>2</sub> is subsequently converted to SO <sub>3</sub> . The SO <sub>2</sub> passes through the boiler and is emitted as a gas. The SO <sub>3</sub> will condense to form sulfuric acid mist (and other sulfate and sulfite compounds) at temperatures below approx. 300°F. If the gas temperatures at the air heater and stack are less than 300°F, sulfuric acid deposition will lead to weak acid corrosion of metallic surfaces. If the stack temperature is greater than 300°F and a high concentration (>10ppm) of SO <sub>3</sub> is present, a visible, "whitish colored" condensate plume may be visible depending on atmospheric conditions.
SULFUR OXIDES (SO <sub>X</sub> )	Sulfur and oxygen; pollutant gases produced in a boiler when fuel containing sulfur is burned. Can cause harm to the environment; health problems.
SULFUR TRIOXIDE (SO <sub>3</sub> )	A corrosive compound, having three solid forms that may coexist in a given sample, used in the sulfonation of organic compounds.
SULFURIC ACID	A highly corrosive, dense oily liquid, colorless to dark brown depending on purity and used to manufacture a wide variety of chemicals and materials including fertilizers, paints, detergents, and explosives. Contains hydrogen ions and sulfate ions.
SUPERCritical CONDITIONS	Steam conditions above the critical point of 705°F and 3206 psi.
SUPERHEATED STEAM	Heat added to saturated steam after it is formed in the boiler. Steam that is heated to a temperature above its saturation

	temperature; 500°F and over. The higher the boiler pressure the hotter the steam and the greater will be the temperature difference between the steam and whatever is being heated, and the faster will be the flow of heat or heat transfer across the heat transfer surfaces.
SUPERHEATED VAPOR	A vapor whose temperature is higher than its boiling temperature.
SUPERHEATER	Composed of two sections, namely the primary (rear) superheater (low temperature) and the secondary (front) superheater (high temperature), through which the steam passes after it has been formed in the main boiler tubes. The hot gases of combustion come in contact with the superheater tubes and add heat to the saturated steam. It then becomes superheated steam. The purpose of a superheater is simply to get more heat (or BTU's) into each pound of steam. This also raises the temperature of the stream above the boiling or saturation temperature. Therefore when the steam gets to the apparatus it is to operate it can do more work, as in a steam turbine.
SUPERHEATER DESUPERHEATER	A desuperheater installed in the link from the primary superheater outlet header to the secondary superheater inlet header. A steam assisted water spray nozzle is fitted in the entering end of the desuperheater to make it possible to reduce the steam temperature, when necessary, and maintain the same at its design value within the limits of the nozzle capacity. Steam for assisting the atomization of the spray water flows continuously, from the steam drum, whether there is a desuperheater water flow or not. The desuperheater is positioned before the high temperature superheater to ensure against water carryover to the turbine, and also to eliminate the necessity for high temperature resisting materials in the desuperheater construction itself.. The source of spray water is from the feedwater circuit, and it is important that the take-off line be located upstream from any chemical injection lines. It is essential that the spray water be chemically pure and free of solids in order to prevent chemical deposition in the superheater and carryover to the turbine. The intermediate signal comes from the primary superheater outlet temperature, and a final signal is from the secondary superheat outlet temperature.
SUPersonic	Having, caused by, or related to a speed greater than the speed of sound in a specified medium. Critical flow in a turbine; just above mach .9.
SUPERVISORY COMPUTER	Directs the activities of the system's process controllers by establishing set-points. However, it does not directly control the values of process variables.

SUPERVISORY CONTROL SYSTEM	A type of digital control system in which a supervisory computer directs the activities of many process controllers.
SUPPLY PRESSURE	A constant pressure air supply piped to pneumatically operated instruments and controls.
SURFACE CONDENSER	A condenser in which circulating water or air passes through tubes, while exhaust steam passes around the tubes.
SURGE	Sudden changes of current or voltage in a circuit.
SURGE (COMPRESSORS)	When a decrease in flow below the minimum flow rate can cause a series of momentary reversals of flow through the compressor. Surging results in violent fluctuations in discharge pressure. When an electric motor is used as a driver, surging can cause extreme variations in motor current. Other symptoms include low system gas flow, excessive vibration, and a muffled banging sound inside the compressor.
SURGE TANK	A standpipe or storage reservoir at the downstream end of a closed feeder pipe to prevent sudden variations in pressure and to furnish water quickly.
SUSPENDED SOLIDS	Solids carried by water. An impurity that will not dissolve.
SWELL	The increase in water level that occurs during boiling, when the number of bubbles increases rapidly.
SWING CHECK VALVE	A type of check valve that is usually larger than a lift check valve; it can be mounted in any upright position, provided the weight of the disc is on the seat. Consists of a valve body, a seat, a disc, an arm, and a pivot pin. The disc is hinged at the top of the valve body by means of the arm. The pivot pin goes through the valve body and the arm to allow the disc to hang in place. The disc closes against the seat to block fluid flow. When pressure is under the seat and disc, the disc pivots, or swings away from the seat, opening the check valve and allowing flow through it. When flow through the valve stops, the force of gravity pulls the disc onto the seat. As fluid flow through the valve starts to reverse, backflow pressure pushes the disc against the seat to fully close the valve. On some swing check valves, the arm that holds the disc is weighted to assist in closing the valve. In other valves, a spring is used to help close the valve. The direction of flow through a check valve is commonly indicated on the outside of the valve's body. Usually, an arrow is cast into the valve's body to help ensure that the valve is installed to allow flow in the proper direction. As long as the flow through a swing check valve is constant, the disc will remain raised. However, if the flow is intermittent, the disc may repeatedly rise and fall and slam against

	<p>the seat. This action can damage the disc and the seat and result in leakage through the valve. This condition can often be detected, because as the disc slams against the seat, noise and vibration are produced in the piping. Swing check valves are not very effective for controlling the flow of fluids containing solid particles, because solids can accumulate between the disc and seat and prevent the valves from closing. Because they may not close completely, swing check valves should never be relied on to isolate a component or system from fluid pressure in another part of a process system. Using swing check valves for isolation purposes could be extremely dangerous when a process system is about to be opened up for maintenance. In this type of situation, precautionary measures such as shutting the appropriate isolation valves should be taken to ensure that the system is isolated.</p>
SWITCH	A device that can be opened or closed to start or stop current flow in a circuit. A device for opening or closing a circuit which is not carrying any load. Switches are manually operated, slow moving devices which operate in air. Since it is slow moving and has no special arc extinguishing provisions, a switch should not be used for opening or closing a circuit which is carrying any appreciable load. The primary purpose of a switch is to positively isolate a circuit after all load has been removed. Switches are usually operated from a remote location through a mechanical linkage or by a switching stick. In this way the operator can be at a safe location in the event that an arc develops due to the circuit not being de-energized.
SWITCHYARD	A facility that combines the output from a number of generators and transmits the combined output to different service areas. A network of circuit breakers that direct electricity to transmission lines. The area of a plant where the combined outputs of the plant's generating units are directed to a power system.
SYNCHRONISM	Matched electrical speed.
SYNCHRONIZATION	The process of matching the frequency of an off-line generator with the frequency of the grid.
SYNCHRONOUS	Happening at the same time; having the same period and phase.
SYNCHRONOUS CONDENSER	A synchronous phase modifier running without mechanical load, the field excitation of which may be varied so as to modify the power factor of the system or through such modification to influence the load voltage.
SYNCHRONOUS GENERATOR	A synchronous alternating current machine which converts mechanical energy into electrical energy.

**(ALTERNATOR)****SYNCHRONOUS MOTOR**

An AC motor whose rotor field is constant. Typically, the rotor field is provided by a permanent magnet or by an electromagnet whose power is supplied from an external source. The rotors of synchronous motors turn at a speed the same as the speed of alternation, or rotation, of the stator fields.

**SYNCHROSCOPE**

A device used to match a generator's output voltage and frequency with that of the grid. A device that measures the difference in electrical frequency between the power system and the generator.

**SYNCHROVERIFIER BYPASS  
(W5&6)**

These switches referred to as 325/BPS and 125/BPS on the electrical drawings are to be used only during an actual blackout and should be locked in the "OFF" position during normal plant operation and blackstart tests. During an actual blackout, these switches should be turned to the "ON" position, thus bypassing the synchro-check relays which normally monitor the generator OCB's and the 2.3 KV auxiliary breakers. Bypassing the synchro-check relays during an actual blackout allows the operator to both close the running generator (Unit 5 or 6) onto a dead 138 KV bus and also to synchronize the running generator to the solar gas turbine which may be running at a frequency other than 60 Hz.

**SYNTHEZIZED  
HYDROCARBON (SHC)**

A synthetic oil that is able to continue flowing at very low temperatures and to resist oxidation at very high temperatures.

**SYNTHETIC**

Produced by synthesis; especially, not of natural origin; man-made. Not genuine; artificial; devised.

**SYNTHETIC LUBRICANTS**

Designed to have the exact properties desired for specific operating conditions.

**SYSTEM DIAGRAMS**

Drawings and diagrams that represent parts of a system and the flows between the parts. Three types are block diagrams, piping system diagrams, and electrical diagrams.

**SYSTEM LOAD**

The total demand for power from the grid.

**T****TANGENT OF THETA**

The ratio between the opposite side of a right triangle and the adjacent side.

**TANK STRAPPING TABLE**

A table for a specific container that lists various levels of fluid and their equivalent volumes.

**TAPERED ROLLER BEARING**

Bearings utilizing rollers instead of balls. Resists axial movement in one direction.

TARGET	A supplementary device used in conjunction with a relay to indicate that it has functioned.
TELEMETERING	Transmission of intelligence long distances, usually from stations to the dispatcher's office, by direct wire or carrier current.
TEMPERATURE	A measure of how hot or cold a body is in relation to a scale. Can be thought of as the degree, or intensity, of heat in a substance. At the molecular level, temperature is a measure of the average molecular kinetic energy of a substance. Molecular motion.
TEMPERING AIR	Temperature control air for the recirculating gas system.
TENON	A raised knob on the end of a moving blade that is peened over shrouding to rivet the shrouding to the blading.
TENSION	Occurs when external forces try to pull a body apart.
TERMINAL TEMPERATURE DIFFERENCE (TTD)	The difference between a feedwater heater's outlet temperature and the saturation temperature of the steam in the condensing section.
TETRAFLUOROETHYLENE, OR TEFLON	A solid lubricant that is a slippery plastic material. It can be formed into different shapes. For example, a simple sleeve bearing or a sleeve bearing with a thrust face can be made of Teflon.
THERMAL CONDUCTIVITY	The ability of materials to allow the passage of heat through them. This ability varies, depending on the material. The ability of a substance, such as a gas, to conduct heat.
THERMAL INSULATION	Insulation that prevents condensation on pipes and also prevents heat from escaping.
THERMAL OVERLOAD DEVICE (MCC)	Operate on the heat generated from current. Use a heating element, referred to simply as a heater. Current flowing to the motor first flows through the heater, where it generates heat: the greater the current flow, the more heat is produced. When the level of current flow causes enough heat to be produced, the overload device is activated.
THERMAL POLLUTION	Waste heat that can cause damage to the environment.
THERMAL STRESS	Total temperature change in a mass of metal, in a given time. Total temperature change of more than 75° F., thickness of metal, rate of temperature change.
THERMOCLINE	A naturally occurring or man-made phenomenon in which a warm layer of water floats above a layer of cooler water.
THERMOCOUPLE	A temperature sensing device consisting of a junction of two dissimilar metals which will generate a voltage proportional to the

	temperature. Converts heat into electricity to measure temperature. Consists of two wires of different metals joined at one end. The opposite ends of the wires are connected to an indicator. When heat is applied to the joined ends, a small voltage is generated in the wires. The electrical circuit detects the voltage and converts it to a corresponding temperature indication.
THERMODYNAMIC TRAP	A trap that responds to the heat energy in condensate. Operate by utilization of the differences in thermodynamic energy available from steam and hot condensate to control the opening and closing of the trap. Impulse trap; disc trap.
THERMODYNAMICS	Scientific study of heat and motion.
THERMOMETER	An instrument for measuring temperature that uses the expansion of fluids or metals to indicate a measurement.
THERMOMETER WELL	A protective tube for a temperature sensing element.
THERMOSTATIC TRAP	A trap that responds to the difference in temperature between steam, condensate, and air. Actuated by the temperature of the liquid flowing to the trap. Open on cool condensate, and close near steam temperature. Bellows trap.
THETA	Either of the angles in a right triangle that is not the 90° angle.
THREE ELEMENT DRUM LEVEL CONTROL	Drum level, feedwater flow, and steam flow. Uses the steam flow as a feed-forward signal. When steam flow changes, it changes the feedwater flow immediately, not waiting for the drum level to change. Steam flow and feedwater flow become the primary controlling factors.
THREE PHASE GENERATOR	A generator that has three sets of stator windings and produces three outputs.
THREE-WAY VALVE	A multiport valve. Allows a routing of the normal flow to 1 of 2 other directions. It is a combination of the globe and angle valve types. Has one L-shaped opening.
THROTTLE AND EMERGENCY VALVES	Each provide the same protection to the turbine; that of isolating the turbine from the main steam supply in the event of a turbine shutdown. The throttle valve is used to control steam flow to the turbine during start-up periods from turning gear operation to at or near rated speed. During this period the governing or control valves are in the wide open position. As the turbine approaches rated speed, the governing valves start to close and take over control of the turbine speed. The combination stop valve-throttle valve is essentially two valves in one, a small throttle valve being contained inside a larger valve which is the stop valve. There is a hole or port in the disc of the stop valve which is closed off by the

throttle valve when the combination stop valve-throttle valve is in the closed position. Operation of this valve is as follows: When oil pressure is increased in the throttle valve servomotor (operator) the valve stem starts to move outward. This valve stem is connected to the throttle valve only. The throttle valve (or valves) will pass sufficient steam to bring the turbine up to rated speed, after which the governing valves take over the turbine speed control. Further opening of the throttle valve causes it to shoulder against the stop valve disc internally and further travel of the valve stem opens the stop valves. This type of valve is used on Westinghouse turbines.

#### THROTTLE PRESSURE

The steam pressure between the boiler and the main stop valves; also called "before-seat" pressure.

#### THROTTLE PRESSURE REGULATOR (INITIAL PRESSURE REGULATOR)

This regulator is provided to protect the turbine against sudden failure of steam inlet pressure and possible resultant carry-over from the boiler. This device will monitor steam inlet pressure and if the pressure falls below a predetermined value it will partially close the steam chest governing valves. If the boiler pressure continues to fall, the load will be reduced to some minimum value above no load. This prevents motoring and leaves the tripping of the unit to the operator. The TPR is connected through a ball check valve to the governing control oil system. Adjusted to start closing the governor valves at approx. 80% rated throttle pressure. Prevents water induction.

#### THROTTLE VALVES

The primary function of the throttle valves is to shut off the flow of steam to the turbine in the event of overspeeding beyond the setting of the overspeed trip, which is set to operate at 11 percent overspeed. These valves are also used for controlling the steam flow to the turbine during the period when the unit is being brought up the speed. The throttle valve is designed with an inner plug valve as well as with a larger valve. This inner valve is usually big enough to get 20-25 percent load at full throttle pressure on about 60 percent effective valve travel. However, it is not used to control load on the turbine unit. One other important reason for the smaller inner valve is to permit steam pressure to be equalized on both sides of the main valve so that the servo motor can lift (open) the main valve. High pressure oil fed through an orifice located in the multiple orifice and check valve body is regulated by a relay valve for controlling the position of the throttle valve. When the auto stop trips for any reason, the throttle operating oil is automatically connected to drain and the throttle valves will trip instantaneously. After the throttle valves are tripped, it is necessary to wind the handwheel back to the closed

	<p>position before the throttle valves can be reopened. The throttle valve is hydraulically opened and spring closed.</p>
THRUST	A force created when moving steam strikes the blades in the turbine; the thrust is in the direction of the steam flow.
THRUST BEARING (AXIAL BEARING)	Maintains the position of the turbine rotor in correct axial position with respect to the casing. A sliding surface bearing designed to limit axial movement. With this type of bearing, a raised section, called a collar, is attached to the shaft. On both sides of the collar are bearing surfaces that fit around the shaft. These bearing surfaces are held in place by the bearing housing. The collar and the bearing surfaces are separated by a thin film of oil. Whenever the shaft tries to move axially, the collar pushes against a bearing surface, and the movement is stopped. Actual contact between the collar and the bearing surfaces is prevented by the film of oil. The bearing is flooded with oil under pressure at all times. The oil is supplied directly from the main bearing supply line. As the thrust collar rotates with reference to the shoes, the film of oil between each shoe and the loaded collar will tend to take a wedge shape with the thick side of the wedge on the forward or entering edge of the shoes. Thus, the oil is carried between the bearing surfaces by the motion of the collar and assures proper lubrication of these surfaces. The amount of oil flowing through this bearing is determined by the two orifice screws located in the discharge lines from the thrust bearing cage. Thrust bearing metal temperature (T/C at center of shoe):  <ul style="list-style-type: none"><li>a. Up to 185°F normal</li><li>b. Alarm at 200°F</li><li>c. Trip at 225°F</li></ul>
THRUST BEARING TRIP DEVICE	A circuit designed to activate a solenoid trip when turbine movement exceeds a certain preset value. The thrust bearing trip device is to warn the operator of wearing of the thrust bearing shoes and to shut down the unit in case the wearing of the shoes increases to the point where it may cause serious damage to some other turbine parts. It consists of two small nozzles whose openings are close to the thrust collar faces. High pressure oil is supplied to each nozzle through an orifice and pressure is built up in the line through ball check valves to a spring loaded diaphragm. Should excessive thrust bearing wear occur, the thrust bearing collar will move towards one of these nozzles and the oil pressure in the line will increase. When this pressure rises to 30 psig a pressure switch will close and sound an alarm. Should wear continue, the pressure will continue to rise and when it reaches 80

	psig the diaphragm will overcome the spring load and open the dump relay through the same mechanism as the other protective devices and thus release the overspeed trip valve.
THRUST LOADS, OR AXIAL LOADS	Back-and-forth forces exerted on a bearing or shaft in a direction parallel to the axis of the shaft.
TILTING DISC TRAP	A simple type of thermodynamic trap in which the only moving part is a disc.
TIME OVERCURRENT RELAY	An overcurrent relay that initiates a circuit breaker trip after a certain pre-established time has elapsed.
TITLE BLOCK	The section of a diagram that identifies the unit and the system that the diagram represents.
TORQUE	The moment of force, a measure of its tendency to produce torsion and rotation about an axis, equal to the vector product of the radius vector from the axis of rotation to the point of application of the force by the force applied.
TORQUE CONVERTER	A variable-speed coupling that transfers rotary motion from one shaft to another through hydraulic fluid.
TOTAL FLOW	The total amount of fluid that has passed a designated point.
TOTAL HEAD (PUMPS)	The amount of head, or pressure, produced inside a pump. Can be compared to flow rate.
TRACER LINES	Any pipeline installed in or adjacent to a companion line for the purpose of heating the contents of the companion line by the passage of steam or hot condensate through the tracer.
TRAFFIC DIRECTOR	A component in a distributed control system's communication network that helps to manage the flow of data.
TRANSDUCER	A device that changes, or converts, one type of signal to another type of signal.
TRANSFER POINT	A point during startup when control of steam flow is transferred from the stop valves to the control valves.
TRANSFORMER	An electric device by which electromagnetic induction transforms electric energy from one or more circuits to one or more other circuits at the same frequency, usually with changed values of voltage and current.
	It is desirable to generate or produce power at relatively low voltages, transmit it at high voltages and use it at low voltages. These voltage changes are accomplished by the use of transformers. A power transformer is a device whose primary

function is to change the voltage level of a system. Consists of two separate circuits, the input or supply circuit and the output or load circuit. To avoid confusion these two circuits should be identified as the high voltage side and the low voltage side. Each circuit or side of the transformer consists of a number of coils or turns of wire. The two circuits are located adjacent to each other in a common container but are not connected. An AC voltage is supplied to one side of the transformer. As the current passes through this side of the transformer it creates a magnetic field around the coils. The coils are wound in a manner that concentrates or strengthens the magnetic field. The strength and size of a magnetic field produced in this manner depends on the amount of current flowing. Since alternating current is supplied, the current flowing through the coils is constantly increasing and decreasing. The magnetic field will also be continuously increasing and decreasing. As the current increases, the magnetic lines of force build-up and extend outward. As the current decreases the lines of force collapse back inward toward the coils. This alternate build-up and collapse of the lines of force actually is equivalent to a moving magnetic field. The coils in the output circuit are located so that the expanding and collapsing magnetic field cuts across them. This action produces a potential difference and a current flow in the output circuit. The output voltage will alternate at the exact same frequency as the input voltage. In order to concentrate the magnetic field and make more efficient use of it, the transformer is usually provided with an iron core. The core concentrates the lines of force and allows more of them to cut across the coils in the output circuit. The core is usually made up of sheets of iron which are insulated from each other. This is known as a laminated core. Its purpose is to cut down the circulating current in the core. The magnitude or value of the voltage that is produced in the output circuit depends, among other things, on the number of turns or coils in both the input and output circuits. If it is desired to have the output voltage higher than the input circuit, there must be more turns in the output circuit than in the input circuit. In general, the ratio of the voltages will be the same as the ratio of the number of turns. For example, if the input circuit has 10 turns and the output circuit has 20 turns, the output voltage will be 20/10 or two times as large as the input voltage. If it is desired to use the transformer to reduce voltage there will be less turns in the output circuit than the input circuit. It must be understood that a transformer does not generate or produce electric power, it just transforms it. In order for a change in voltage to take place, there must be a corresponding change in some other electrical quantity. In the case of a

transformer the corresponding change is in the current. The transformer changes the voltage in direct proportion to its turns ratio and changes the current in inverse proportion to the turns ratio. This means that if the transformer is used to increase the voltage by a factor of two, the current will be decreased by a factor of two. The product of voltage times current on each side of the transformer must be equal. Whenever there is a change in one of these quantities there must be a corresponding change in the opposite direction in the other quantity. Transformers are highly efficient pieces of equipment. In general their efficiency is approximately 98-99%. The small loss that occurs shows up as heat in the windings and core. This heat must be removed for continued operation of the transformer. Small to medium size transformers are installed dry and are cooled by air through natural convection such as our lighting transformers. Larger transformers, such as our main and auxiliary transformers, are installed in a tank filled with oil. The oil helps insulate the windings and acts as the heat transfer medium. The oil absorbs heat from the windings and core. This heat is then removed from the oil by transfer to the air. In many cases, the tank is fitted with radiators to provide more surface area for cooling the oil. The oil flow may be either natural or forced by pumps and the air flow may also be either natural or forced by fans. The rating of a transformer, like most electrical equipment, depends largely on the ability to remove heat from it. If the cooling equipment is shut down for any reason, the capacity of the transformer will usually be limited.

**TRANSMISSION LINE**

A line used for electric power transmission.

**TRANSMITTER**

An instrument in a control loop that senses and measures a process variable and produces a signal representing the value of the process variable.

**TRAP**

A device that allows moisture to flow out of components without allowing air or other gases to escape.

**TRAVELING SCREENS**

Loops of screen segments that prevent leaves and debris in raw water from entering the plant.

**TREND**

An indication of a change in the operation of a system or an individual piece of equipment. A consistent pattern of points, that gradually move in an upward or downward direction. Could be an indication that process equipment is malfunctioning or that the proportions of the materials entering a process have changed. Could also be an indication that properties of materials, such as the purity, density, or viscosity, have changed.

TRIGONOMETRY	The study of triangles.
TRIGONOMETRY FUNCTION TABLE	A table that lists various values for theta and the corresponding values for functions such as sine, cosine, and tangent.
TRIP	An accessory or the act of divorcing a piece of equipment from its source of energy.
TRIP CIRCUIT	An electric circuit that automatically shuts down plant equipment in an emergency. <ol style="list-style-type: none"><li>1. Boiler - The stopping of all fuel flow to the boiler and the stopping of the ignitors.</li><li>2. Electrical - The opening of a circuit breaker's contacts to open a circuit.</li><li>3. Generator - The opening of a generator's circuit breakers, disconnecting the generator from the power system; will also trip the boiler and the turbine.</li><li>4. Turbine - The shutting off of all steam flow to the turbine; will also trip the generator and the boiler.</li><li>5. Unit - A condition in which the generator, the turbine, and the boiler in a generating unit are tripped.</li></ol>
TRIP COIL	An electromagnet used for opening a circuit breaker.
TRIPPING MECHANISM	An electrically or mechanically operated device which releases the holding means and permits the contacts of the circuit breaker to open.
TRISODIUM PHOSPHATE (TSP)	Raises the PO <sub>4</sub> levels and pH values of boiler water. Ties up calcium and magnesium as a flocculent phosphate precipitate which can be removed through boiler blowdown. Elevates the total dissolved solids levels, therefore causing conductivity to rise.
TROUBLE-SHOOTING	Five major steps: <ol style="list-style-type: none"><li>1. Identifying the problem</li><li>2. Taking preventive action</li><li>3. Determining the cause of the problem</li><li>4. Correcting the problem</li><li>5. Returning the process to normal operation</li></ol>
TRUE POWER	The amount of power that is actually doing work in an AC circuit.
TU	Termination Unit.
TUBE SHEETS	Sheets that support circulating water tubes at their ends and separate the steam in the shell from the circulating water in the water boxes.
TUBE SUPPORTS	Plates that support and align the circulating water tubes in a

	condenser.
TUBING PUMP	Rotary pump. The process liquid is contained inside a flexible tubing that is part of the pump. The pump's rotor works with the tubing to force the liquid through the pump. During operation, liquid is drawn into the tubing at the suction of the pump. The rollers turn with the rotor and compress the tubing, trapping liquid inside. As the rotor continues to turn, the rollers force the trapped liquid through the tubing and out the pump's discharge. Normally do not have as high a flow rate as other types of rotary pumps.
TURBIDITY	The cloudiness or haziness of a fluid as a result of a high concentration of suspended solids that are usually invisible to the naked eye. A measure of undissolved particulate matter in a solution. The measurement of Turbidity is an important test when trying to determine the quality of water. It is an aggregate optical property of the water and does not identify individual substances; it just says something is there.
TURBIDITY METER	An instrument that measures the concentration of suspended particles in a solution.
TURBINE	A machine capable of converting thermal energy to rotating mechanical energy. Provides torque and speed. The work the turbine produces is the power required to turn a large AC generator. The turbine is one of the biggest, most powerful piece of equipment in the world, and is 40 efficient. The average clearance throughout the turbine is about 40/1000 of an inch.
TURBINE CONTROL SYSTEM	Fundamentally all controls are operated hydraulically utilizing the oil supplied by the shaft mounted main oil pump. The 150 psi pressure is used to obtain the necessary force to actuate the servomotor pistons. The same 150 psi pressure is orificed and regulated by various controllers to obtain lower pressures necessary to monitor the position of the servomotors, by means of autostop and control oil pressures. The controls of steam turbines can be divided into those for the <u>control of the flow of steam</u> , and those for the <u>protection of the turbine</u> . The main steam controls include the servomotors (operating mechanisms) for moving the governing valves and interceptor valves which determine the flow of steam into the turbine. These valves are positioned by the control oil pressure produced by the various control devices (governor, load limit valve, throttle pressure regulator, or auxiliary governor). The valves are designed to <u>open on a decrease in control oil pressure, and close on increase in control oil pressure</u> . The response range of the interceptor valves is higher than the response range of the governing valves. This difference in

response range makes it impossible during normal operation to operate with the interceptor valves closed and the governing valves open. The protection controls include the throttle valves and reheat stop valves and their operating mechanisms. The throttle valves have the additional function of controlling steam for starting. The reheat stop valve is either full open or closed and should never operate in the partial open position. These valves are under the control of auto stop oil which is produced by latching the overspeed trip valve. During normal operations the steam to the turbine is regulated by the steam chest governing valves. All other valves are wide open and only during load dump operation is the interceptor valve used to regulate the steam flow. The control oil pressure ranges from 35 psi, steam chest valves closed to 10 psi steam chest valves wide open. This control pressure can originate from any of the following controllers: Main Governor, Load Limit Valve, Throttle Pressure Regulator, or Auxiliary Governor. The controller maintaining the highest pressure will assume control of the steam chest servomotors and consequently the load carried by the turbine. The speed or load of the turbine is controlled by the main governor with the conventional motor operated speed changer. This governor controls the positioning of the steam inlet (or governing) valves through servomotors one of which is connected to each steam chest. At normal frequency the governing is done by the main governor, or auxiliary governor.

**TURBINE CROSSOVER PIPE ASSEMBLY**

The purpose of the crossover pipe is to guide the steam from the intermediate pressure exhaust to the low pressure turbine with a minimum of pressure loss. This is accomplished by building into each mitered corner a guide vane assembly consisting of multiple vanes to smooth the steam flow as it changes direction. A manhole is provided in the top of the pipe for inspection and maintenance. When not in use it must be kept tightly covered and sealed.

**TURBINE FLOW METER**

A meter that uses fluid velocity to determine flow rate. Has blades that are attached to a rotor. The rotor is placed in the path of the fluid flow. As fluid passes around the blades, the rotor begins to rotate. The speed of the rotation is proportional to the speed of the fluid. The number of rotations that the rotor makes is converted to an indication of flow rate.

**TURBINE INLET PIPING AND NOZZLE CHAMBERS**

Inlet piping carries main steam exiting the governor valves to the high pressure turbine element. The inlet piping is a flexible piping system that allows for thermal expansion and contraction without producing higher than allowable stresses on the turbine casing. The inlet pipes are connected to nozzle chambers through an inlet

sleeve which has a bell type, pressure seal arrangement. This permits radial movement between inlet pipes, nozzle chambers, and the inner cylinders. The high temperature steam goes through the nozzles in the nozzle block to the first row of rotating blades. This combination of stationary nozzles and rotating blading is known as the control stage. The nozzle block (containing the stationary nozzles) is bolted onto the nozzle chamber. Westinghouse utilizes separate nozzle chambers that allow maximum freedom for thermal expansion between chambers. These stationary nozzles convert the pressure energy of the main steam into velocity energy by issuing a steam jet. The jet is directed on the row of rotor mounted blading, causing the blades to rotate at high velocities.

**TURBINE LOW PRESSURE CYLINDER**

The steam exhausting from the intermediate turbine flows directly to the LP cylinder or cylinders. Most of the LP turbines are of the divided or double flow type. Steam is admitted to the center section of the rotor and the steam flows to both ends. The blades from the center to the ends are the same type on both halves but are opposite because of opposite steam flow. The steam is exhausted from the LP to the condenser.

**TURBINE PROTECTIVE TRIP DEVICES**

The trip devices operate directly to rapidly close the throttle valves and reheat stop valves. The governing valves and interceptor valves are hydraulically interlocked with the trip devices and are also closed whenever the turbine is tripped. These valves open with hydraulic pressure against a spring tension, when a trip occurs, the oil is automatically directed to drain and the valves close by the pressure from the spring. The various trip devices are:

1. Overspeed trip valve
2. Solenoid trip
3. Low vacuum trip
4. Low bearing oil pressure trip
5. Thrust bearing trip
6. Manual trip

**TURBINE SEALS:**

N1 SEALS - Seals located at the exhaust end of the HP section and used to seal between the casing and the rotor.

N2 SEALS - Seals located between the HP and IP sections and used to seal between the casing and the rotor; also called midspan seals.

N3 SEALS - Seals located at the exhaust end of the IP section and used to seal between the casing and the rotor.

**TURBO-GRAF CASING**

Measures the movement of the governor pedestal relative to a

**EXPANSION RECORDER**

fixed point (the foundation). In as much as one end of the unit (near the centerline of the LP turbine) is secured to the foundation, the casings will expand axially away from this anchored point. The opposite end of the unit (the governor pedestal) is designed to move freely along lubricated longitudinal keys. The recorder indicates expansion and contraction of the casings during starting and stopping periods, and for changes in load, steam temperature, etc. The recorder charts casing movement using a potentiometer type transmitter located at the governor pedestal end of the unit.

**TURBO-GRAF  
DIFFERENTIAL EXPANSION  
RECORDER**

When steam is admitted to a turbine, both the rotating parts and the casings will expand. Because of its smaller mass, the rotor will heat faster and therefore expand faster than the casings. Axial clearances between the rotating and the stationary parts are provided to allow for differential expansion in the turbine, but contact between the rotating and stationary parts may occur if the allowable differential expansion limits are exceeded. The purpose of the differential expansion recorder is to chart the relative motion of the rotating and stationary parts. It gives a continuous indication of the axial clearance while the turbine is in operation. The recorder charts movement using a pair of pick-up coils located between the LP turbine and the generator.

**TURBO-GRAF GOVERNOR  
VALVE POSITION & SPEED  
RECORDER**

This instrument with its two-scale strip chart records rotor speed or governing valve position. The selection of either valve position or speed input to the recorder is controlled by the position of the main generator breaker. A speed record is maintained with the main generator breaker open and a valve position record with the breaker closed. For operators convenience, a switch provided on the power drawer of the instrument can be energized for a speed recording with the unit on the line.

**TURBO-GRAF ROTOR  
ECCENTRICITY RECORDER**

When a turbine has been shut down, the rotor will tend to bow due to uneven cooling if the upper half of the casing enclosing the rotor is at a higher temperature than the lower half. By rotating the rotor slowly on turning gear, the rotor will be subjected to more uniform temperatures, thereby minimizing bowing. The bowing of the rotor is recorded continuously as eccentricity from turning gear to approx. 600 rpm. Two matched pick-up coils are mounted 180 mechanical degrees around the circumference of a disc which is located at the governor end of the turbine.

**TURBO-GRAF ROTOR  
POSITION RECORDER**

This instrument measures the relative axial position of the turbine rotor thrust collar with respect to the thrust bearing support and provides a second independent rotor position monitoring device as required by the Emergency Trip System. It uses the same type of rotor position pickup and power drawer as the Casing Expansion

	and Rotor Position Instrument but the power drawer contains only rotor position circuitry. There is only one set-point on this instrument. The alarm function is adjusted to the trip set-point so that any movement beyond this set-point activates trip alarm contacts and causes the turbine to trip through channel two of the Emergency Trip System.
TURBO-GRAF VIBRATION RECORDER	Measures and records vibration of a turbine rotor at speeds above 600 rpm. The vibrations are measured on the rotor near the main bearings. Excessive vibrations serve as a warning for abnormal and possible hazardous conditions in the turbine.
TURBULENCE	A swirling effect that takes place in the furnace; necessary for the mixing of fuel and air for complete combustion.
TURNING GEAR	A motor and gear arrangement that keeps the rotor turning at a constant speed during turbine shutdown to maintain uniform cooling of the rotor and thus prevent the rotor from warping or bending, minimizing rotor eccentricity. Also serves as a jacking device to turn the shaft in small increments at desired intervals for inspection. Ample power to start the rotor from rest and rotate it at approx. 3 rpm. The turning gear is an electrically-driven speed-reducing device. Driving torque is transmitted to the turbine-generator coupling spacer ring by a train of spur gears.  Lubrication for turning gear operation is supplied by the turning gear oil pump. This pump can be started by a pressure switch that is connected to the bearing oil line when the bearing oil pressure recedes to somewhere between 5 to 8 psig. Another pressure switch which is also connected to the bearing oil line prevents this motor from starting until the bearing oil pressure has risen to somewhere between 2 and 4 psig. Before the turning gear motor can be started, the manually operated valve in the oil supply line must be opened. The turning gear is engaged manually at the turbine.
TWO-POSITION CONTROL	Control action in which a signal from a controller causes a final control element to move from one extreme to another, such as from on to off.
TWO-SCREW PUMP	Rotary pump. One of the screws is attached to a shaft that is coupled to the pump's driver. This screw is known as the power, or driver screw. The other screw is often referred to as the idler screw. Power is transmitted from the driver screw to the idler screw through a set of timing gears. During operation, process liquid enters the suction of the pump and is directed toward both ends of the casing. As the screws rotate, the liquid becomes trapped between the casing and the screws. The liquid is moved

from both ends of the pump toward the center, which is also the discharge of the pump. The force that is exerted by the screws pushes the liquid out of the pump and through the discharge piping.

**U**

U CHART (SPC)	Used to plot the average number of defects per item. The horizontal axis represent time, and the vertical axis represents the number of defects per sample. The sampling size is based on the number or amount of product samples needed to determine a data point for the chart. The sampling size is constant for a particular application.
UNBURNED COMBUSTIBLES LOSS	Loss due to combustible material in the fuel that does not burn.
UNDERVOLTAGE RELAY	A protective relay that opens a circuit breaker when the voltage in the circuit falls below a pre-determined value.
UNGROUNDED SYSTEM (INSULATED SUPPLY SYSTEM)	A system in which no point is deliberately connected to earth except through potential or ground detecting transformers or other very high impedance devices.
UNION (PIPING)	Each end of a union is connected to a piece of pipe and held in place with a threaded collar.
UNIT SYSTEM	A system complete in itself. Normally not connected with other systems.
UNIT TRANSFORMER	A component that receives power from a generator and increases the voltage while decreasing current.
UNITY POWER FACTOR	An operating condition in which true power and apparent power are equal.
UNPLANNED (FORCED) DERATINGS:	D1 Immediate - A derating that requires an immediate reduction in capacity. D2 Delayed - A derating that does not require an immediate reduction in capacity but requires a reduction with six hours. D3 Postponed - A derating that can be postponed beyond six hours but requires a reduction in capacity before the end of the next weekend.
UNPLANNED (FORCED) OUTAGES:	U1 Immediate - Unscheduled unit trips. An outage that requires immediate removal of a unit from service, another outage state, or a Reserve Shutdown state. This type of outage usually results from immediate mechanical, electrical, or hydraulic control

	systems trips, and operator-initiated trips in response to unit alarms.
	U2 Delayed - An outage that does not require immediate removal of a unit from the in-service state but requires removal with six hours. This type of outage can only occur while the unit is in service
	U3 Postponed - An outage that can be postponed beyond six hours but requires that a unit be removed from the in-service state before the end of the next weekend. This type of outage can only occur while the unit is in service..
UPS (UNINTERRUPTED POWER SUPPLY)	Purpose is to supply uninterrupted AC power of high quality, even when the incoming commercial power is interrupted. The necessary storage of reserve electric energy is done by means of an internal battery pack. Batteries are only capable of storing DC power, whereas the critical load requires AC power. The UPS performs this important conversion from DC to pure conditioned AC. Consists of a rectifier that converts AC power to DC power to feed its own battery bank. The DC output of the rectifier in turn supplies the inverter and float charges the battery. The inverter converts the DC power back to AC power to feed the DCS (Digital Control System). The battery bank, upon loss of AC power will feed the DCS for approx. 2 hours, depending on the battery bank's condition. The system is also equipped with a static bypass switch that will transfer the critical load automatically, without any break, to the bypass source whenever the inverter fails to supply the required output. This can be due to an overload situation (more power is demanded than the inverter can deliver) or a short circuit in the load. As soon as the abnormal situation is corrected, the static switch transfers the load to the inverter again, without any interruption of power to the load.
URAL	Underexcited Reactive Ampere Limit.
V	
VACUUM	Negative pressure measured from atmospheric pressure downward, usually expressed in inches of mercury.
VACUUM BREAKER	A valve connected to the main condenser that, when opened, lets air into the condenser; closed during startups and usually opened during shutdowns.
VACUUM PUMP AND SEPARATOR TANK	A vacuum pump maintains a high vacuum in the vacuum tank and draws off the gases and vapors which are liberated from the oil in the vacuum tank. The vacuum is 1 inch of mercury absolute

pressure or less. The vacuum pump exhausts into a separator tank where the vapors condense, but the gases pass on out through a vent to atmosphere. The oil in the separator tank lubricates and seals the vacuum pump. The water settles to the bottom and is drained manually every eight hours.

**VACUUM TANK**

Oil from the air side of the gland seals flows by gravity into the gland oil reservoir. Oil from the defoaming tanks is drawn into this tank through a float valve and spray nozzles. The oil flows over a series of trays which provide a large area for separation of gas and water vapor. The float valve in the vacuum tank maintains the oil level in the vacuum tank at a fixed position. Any gas and water vapor trapped in the oil tends to cause a thick layer of foam in the vacuum tank. If this foam builds up to the level of the connection to the vacuum pump, some of the foam will be drawn over to the pump and impair its operation. To prevent this, there is a large float in the vacuum tank connected to an external level indicator and to three mercury switches. Two of these switches operate high and low oil level alarms. The third makes contact on a rising float, energizing the solenoid valve mounted on the vacuum tank which admits a small quantity of air into the vacuum tank to "blow down" the foam.

**VALENCE**

The number of electrical charges, positive or negative, carried by an ion.

**VALENCE ELECTRONS**

Electrons in the outermost shell of an atom. They affect every chemical reaction that occurs.

**VALENCE NUMBER**

A number notation that expresses the number of electrons involved when an atom reacts chemically and whether those electrons are given up or accepted.

**VALVE**

A device used to start, stop, or regulate the flow of a fluid in a system.

**VALVE STEM FREEDOM TEST (INTERCEPTOR AND REHEAT STOP VALVE)**

The interceptor valves and reheat stop valves should be exercised at least weekly to detect possible valve stem sticking. This test can be carried out at any load, with no or negligible effect on the load. There is no manual control for the reheat stop valve, and the reheat stop valve can not be opened unless the corresponding interceptor valve is closed. A test panel with suitable interlocks is normally provided for testing the interceptor valves and reheat stop valves. On units with two reheat lines the interlocks prevent testing of both sets of valves at the same time. The normal test procedure is to test only one set of valves at a time, however. In addition, the test circuit is so arranged that the interceptor valve closes first. When it is closed, a limit switch energizes the test

**VANE ACTUATOR**

solenoid on the reheat stop valve causing it to close. The reheat stop valve has a limit switch that holds the interceptor valve test solenoid energized. Releasing the test switch allows the reheat stop to open first, and then the interceptor valve opens. Proper valve closing is shown by indicator lights on the test panel.

**VANE PUMP**

Uses air pressure acting against a paddle, or vane, to position a valve. Simple in design and relatively small for the amount of force it can supply to open or close a valve. Used primarily with rotary-type valves such as a ball, plug, and butterfly valves, because the valve rotates the valve disc. When air pressure is applied through the air supply port of a valve actuator that operates a butterfly valve, it pushes against a vane, causing the vane to swing across a housing. This swinging motion turns a shaft, which opens the valve. Air on the other side of the vane is bled off through another air supply port. When air pressure is supplied to the opposite supply port, the vane is moved in the opposite direction, closing the valves. Air on the other side of the vane leaves through the other supply port. Vane actuators, like other actuators, can be spring loaded or set up with other devices so that a valve will fail in a safe position.

**VAPOR EXTRACTOR**

A rotary pump in which the rotating member, with its sliding vanes is set off-center in the casing. The vanes slide in and out of the rotating part and always stay in contact with the inside of the case. The entering liquid is trapped between the vanes and is carried around to the discharge.

**VAR**

Volt-ampere reactive.

**VARIABLE**

Liable or likely to change or vary; subject to variation; changeable.

**VARIABLE DATA**

Measurements taken from the process, such as temperature, pressure, pH, or weights.

**VARIABLE SPEED COUPLING**

A device that allows pump speed to vary while driver speed remains constant. Allows the speed of driven machinery to be changed while in operation. Could be used as a final control element.

**VARIABLE SPEED MOTOR**

A motor that can be provided with varying amounts of electricity to operate at varying speeds.

**VARIAC**

Adjustable transformer used to change level of voltage. Similar to rheostat in its effect and mechanical operation.

VARS	Volt-ampere-reactive. The unit of reactive power. The non-useful portion of the total power, and results from the reactance (either inductive or capacitive) in the circuit; line loss. The amount it takes to get the voltage out into the system. Increasing generator rotating magnetic field voltage causes the voltage and current sine waves to disassociate, or move off each other. This creates the volt-ampere-reactive, or VARS. VARS can either be "pushed" into the system, raising power distribution system voltage, or "drawn" into the generator, lowering power system voltage.
VELOCITY	Distance traveled in a specified amount of time. Speed and direction. The velocity of a body can be changed by changing either its speed or its direction. Units of length divided by time (ft/sec).
VELOCITY HEAD	Related to the level of liquid. The pressure that results from the flow of fluid. The change in static head caused by velocity.
VENT CONDENSER	Generally, a small condenser that condenses the steam in the steam/air mixture, for example, in the vents from a deaerator.
VENTURI	A primary device used for establishing pressure differentials used in the measurement of flow through pipes.
VIBRATION VIBROMETER	An instrument used to check bearings and other components for vibration.
VISCOSITY	A measure of the internal friction in a fluid; of the thickness, or pourability of an oil; a measure of a liquid's resistance to flow. High viscosity is thick, low viscosity is thin. Viscosity is greatly affected by temperature. An oil's viscosity, or thickness, increases as the temperature drops. The colder it gets, the thicker oil becomes, and the less easily it flows. High viscosity oil which has a high resistance to flow, is generally more suitable for use at high temperatures. As the temperature rises, viscosity decreases. Oil gets thinner and flows more easily. Low viscosity oil which has a low resistance to flow, is used more with low temperatures.
VOLATILE CHEMICAL	A chemical that vaporizes easily.
VOLT (E)	The unit by which voltage is measured; unit of electromotive force. The unit used to measure the potential difference between two points. A measure of the force that causes electricity to flow.
VOLTAGE	Electrical pressure, measurement of electrical flow. Potential difference; electromotive force. The energy necessary to cause current flow.
VOLTAGE REGULATOR	A regulator which functions to maintain the voltage of a

	synchronous generator, condenser, or motor at a predetermined value.
	An automatic circuit that adjusts the exciter output to maintain the generator output voltage and power factor at acceptable levels, when utilizing the main exciter. It also provides for minimum excitation changes. The generator terminal voltage and current provide the sensing source for voltage regulation. The regulator uses this signal to control the field of the generator.
VOLTAGE RELAY	A relay which functions at a predetermined value of voltage. It may be an overvoltage relay, an undervoltage relay, or a combination of both.
VOLTAGE TO GROUND	The voltage between any live conductor of a circuit and earth.
VOLTAMPERE	The basic unit of apparent power. The mathematical product of the volts and amperes in an electrical circuit. The practical unit of apparent power is Kilovoltampere (KVA).
VOLTMETER	A device used to measure voltage.
VOLUME (V)	A measure of space occupied by a material body; the capacity of a vessel. Flow units are gallons per minute, or cubic feet. $V = L \times W \times H$
	A measure of space or the capacity of a vessel. Product of 3 lengths, or length cubed (Length x Width x Height)
VOLUME FLOW RATE	The volume of the fluid that passes a specific point in a unit of time.
VOLUMETRIC FLOW RATE	The amount of material measured as a unit of volume per unit of time, such as cubic feet per second or gallons per minute.
VOLUTE	A continually widening chamber that is connected to a gas discharge line.

**W**

WASTE WATER POND	A pond, usually with large surface area, utilized for holding, transfer, evaporation, percolation, or chemical treatment of in-plant waste water.
WATER (H <sub>2</sub> O)	A tasteless, odorless, colorless liquid in its pure form. Each molecule of water is composed of two atoms of hydrogen and one atom of oxygen. Has a tremendous capacity to absorb and store heat. Absorbs more heat for a given temperature rise than any other common inorganic substance. The heat of vaporization of water is 970 Btu, indicating that 970 Btu of heat must be added to a pound of water (at boiling temperature) to change it to steam.

At normal atmospheric pressure water freezes at 32°F and boils at 212°F. Increasing or decreasing pressure changes these limits. When water evaporates at normal atmospheric pressure, its volume increases 1600 times. With a pressure increase to 3200 psig. (the critical pressure), water goes directly to steam without a volume change. Raw water has to be processed before being used for steam generation because all natural waters contain varying amounts of dissolved and suspended matter and dissolved gases. The amount of dissolved material varies from about 35,000 ppm in seawater to about 30 to 80 ppm in the best of fresh water supplies. Impurities must be removed from boiler feedwater because they cause scaling, corrosion, and carryover. Impurities are removed, or at least reduced to tolerable levels by water treatment. External treatment is done by demineralizers and deaerators. Internal boiler water treatment is the feeding of chemicals directly to the boiler or feedwater system to: precipitate impurities as a sludge in the water rather than as a scale on the boiler metal; condition the sludge to keep it from sticking to the metal so it can be removed by blowdown; and adjust the water composition to make it non-corrosive. Internal treatment complements external treatment by taking care of any impurities entering the boiler with the feedwater (hardness, oxygen, silica, etc.). In connection with internal treatment, boiler blowdown plays an important part in maintaining a low level of impurities. All dissolved and suspended solids entering a boiler with the feedwater remain in the drum and tubes as steam is generated. Continued addition of make-up produces higher and higher solids concentration in the boiler drum. Every boiler has a limit for total solids above which priming and carryover occur. In general, the higher the boiler pressure, the less will be the tolerance of solids. The limit may be suspended solids, total solids, silica content, alkalinity, etc. To keep within these limits some of the concentrated boiler water must be removed from the drum. This is accomplished by blowdown. Internal treatment should prevent scaling and corrosion not only in the boiler itself but also in the condensate and feedwater systems.

**WATER DETECTORS  
(GENERATOR)**

Trays are provided under each gas cooler to catch any leakage or condensate from the cooler. Pipes are provided to drain water from these trays to the bottom of the machine housing. There are also openings in each frame ring so that any moisture will drain to the water detectors. These are float-operated mercury switches in small housings under the generator frame and main lead box. Isolating valves are provided so the switches can be inspected at any time, and a drain valve is provided for draining off any

	accumulated water.
WATER HAMMER	One of the conditions that cause pipes to rattle and vibrate. The force or shock of confined water when its flow is suddenly arrested. Condensate which forms in a cold line may be driven up and down the line by steam with such a force sufficient to wreck the line or tear it from its hangers. High temperature water under high pressure flashing into steam when admitted into a cold steam line is another cause.
WATER INDUCTION	The entrance of water into a turbine.
WATER JACKET	A space between the compression chamber and the casing through which cooling water circulates. The cooling water picks up heat from the compressor and removes it.
WATER SEAL SYSTEM	A turbine support system that uses water to seal air out of the turbine and seal steam in. Usually located on the atmospheric side of the steam seals and on the low pressure turbine where the shaft emerges from the casing. Sealing water is usually supplied by gravity feed from some form of head tank. The seals on the low pressure turbine are non-circulating. They are provided with a supply line and valve only, and seal water leakage is drawn into the turbine. Water is circulated through the seals on the intermediate and high pressure turbines. These seals are provided with supply and return lines and valves. Adjustment of these valves permits regulation of sealing water flow, pressure and temperature at each water seal. Normal practice is to maintain sealing water temperature leaving the seals at 165°F to 185°F. If temperature is permitted to go too high, flashing occurs at the seals. If temperature is held unnecessarily low, a large temperature differential will be created on the turbine shaft at the seal. This can result in shaft distortion and vibration.
WATERBOX PRIMING SYSTEM	A system that removes air from the condenser waterbox to insure that the circulating water tubes are completely filled with water.
WATER-STABILIZED GREASE	Protects against corrosion due to contact with water. An additive in this grease makes water and the grease mix thoroughly, thus preventing the formation of water pockets that could corrode a bearing.
WATERWALLS	Vertical tubes, filled with a water/steam mixture, that line the inside of a boiler furnace.
WATT (P)	The unit by which electrical power is measured. A unit of electrical power produced by a current of one ampere at one volt. $P(\text{watts}) = E(\text{volts}) \times I(\text{amps})$ . The rate of energy transfer equivalent to one ampere flowing due

	to an electrical pressure of one volt at unity power factor. One watt is equivalent to about 1/746 horsepower (746 watts = 1 HP).
WATTHOUR	A unit of electrical energy equal to one watt of power acting for one hour.
WAVE	An electromagnetic impulse, periodically changing in intensity and traveling through space. More specifically, the graphical representation of the intensity of that impulse over a period of time.
WAVEFORM	The shape of the wave obtained when instantaneous values of an AC quantity are plotted against time in rectangular coordinates.
WAVELLENGTH	The distance traveled by a wave during the time interval of one complete cycle.
WEAK BASE ANION EXCHANGERS	This exchanger contains a weak base anion resin which exchanges strongly charged negative ions such as chlorides, sulfate and nitrates for hydroxyl ions.
WEARING RINGS	Replaceable metal rings that are mounted between the impeller and the casing of a pump, forming a seal.
WEIGHT	The result of gravitational force acting on mass.
WEIR	A flat restriction with a notch at its top that is installed across an open channel to cause fluid level to rise. The fluid's level can then be converted to a flow rate. Basically a dam with a notch at its top.
WET BULB TEMPERATURE	The wet bulb temperature of air is the lowest temperature indicated by a moistened thermometer bulb when it is exposed to a current of the air. Wet bulb temperature is important because at any given dry bulb temperature, it is indicative of the amount of moisture held in the air and also the total heat of a unit of the mixture of air and water vapor.
WET CELL	A type of battery in which the electrolyte is a liquid; typically, a secondary cell.
WET SCRUBBER	A method of controlling sulfur oxides in the exhaust gases. Combustion gases are passed through liquid sprays. Particulates in the combustion gases stick to the liquid and collect in the bottom of the scrubber. The liquid spray also separates sulfur oxides from the combustion gases by absorption. The sulfur oxides are absorbed into the liquid, which falls to the bottom of the scrubber. Both the particulates and the sulfur oxides are removed from the scrubber along with the spent liquid.
WET STEAM	Steam that contains tiny particles of water, which gives the steam

	its white color.
WETT	Whole Effluent Toxicity Test.
WETTING (SURFACE)	The result of the adhesive forces between the liquid molecules and the molecules of the container.
WHEEL	In a turbine, a round hub containing a set of rotating blades.
WIDE PROPORTIONAL BAND	A proportional band that is greater than 100%. A large change in input to the controller produces a smaller change in output. Can minimize the amount of cycling in a system, but, there is more offset.
WINDBOX	A steel box that distributes air to the burner registers. Designed so that it provides essentially equal air pressure at each burner. Connected to the furnace by openings for each burner. <ul style="list-style-type: none"><li>• With 90-95% RTP (1620-1710 psig) - control pressure is 10 psig</li><li>• With 80% RTP (1440 psig) - control pressure is 30 psig</li><li>• With 70% RTP (1260 psig) and 15-20% of maximum load (13-17 MW), throttle and reheat temp. drops held to 150° F. or less. If not, shut down unit.</li></ul> Reduced throttle pressures cause decrease in steam density and pressure drop across the turbine, ultimately resulting in heat rate degradation.
WORK	The movement of an object through a distance. The force applied to an object times the distance the object travels. Weight x distance. Basic unit is foot/pounds.
WYE CONNECTION	A type of electrical connection formed by connecting one side of each of three phases of a component to a single point.

## X

X BAR CHART	The X represents the value of the variable that is being measured in a process. The bar above the X is a mathematical symbol that represents an average. An X bar chart is used to plot the average of the values taken from the sample group that is collected from a process. The Y axis displays the average value of the samples taken from the process, in the appropriate limits. The X axis displays how often samples are taken, again in the appropriate limits.
XY GRAPH	A graph consisting of a horizontal axis and a vertical axis; commonly used to show the relationship between two or more

variables.

## **Y**

### **Y-TYPE STRAINER**

A strainer used to filter small amounts of solid impurities from a fluid in a piping system.

## **Z**

### **ZEOLITE SOFTENER**

A component that softens water by removing dissolved hardness solids such as calcium and magnesium.

### **ZERO POINT**

The level of a liquid or a solid is the position of the surface of that substance above or below a fixed reference point, often called the zero point.

### **ZOM**

Zone of Mixing.