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Glossary, Aircraft Engine Starting and Auxiliary Power Systems

1. SCOPE:

The Aircraft Engine Starting and Auxiliary Power System Glossary presents definitions of terms commonly encountered and associated with aircraft engine starting and auxiliary power systems. Terms have been arranged alphabetically.

1.1 Purpose:

The purpose of the Aircraft Engine Starting and Auxiliary Power System Glossary is to promote the consistent usage of terms commonly encountered and associated with aircraft engine starting and auxiliary power systems. The usage of terms presented herein will serve to promote clarity and avoid many misunderstandings throughout the aerospace industry.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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SAE ARP906 Revision B

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP147	Nomenclature, Aircraft Air Conditioning Equipment
AS194	Nomenclature - Engine Cooling Fan
ARP243	Nomenclature, Aircraft Hydraulic and Pneumatic Systems
AS425	Nomenclature and Abbreviations for Use On The Flight Deck
ARP480	Nomenclature Guide for Propulsion Systems Support Equipment
ARP1931	Glossary of terms with Specific Reference to Electrical Wiring and Cable
AIR1615	Thesaurus for Fuel System Components
AS8033	Nickel Cadmium Vented Rechargeable Aircraft Batteries

1999 (Annual) SAE Aerospace Standards Index

Tomsic, Joan L., SAE Dictionary of Aerospace Engineering, 2nd Edition, 1998, 758 pp.

TSB003, Rules for SAE Use of SI (Metric) Units

2.3 Definitions:

ACCUMULATOR: Pressure vessel used to store fluid under pressure, fluid typically held under pressure by a piston or diaphragm backed by a compressed spring or pressurized gas, usually a component of hydraulic or fuel systems.

AIR BOTTLE: Container specifically designed to store gases at a designated pressure, designed to a maximum or minimum pressure, typically twice the storage pressure, supplied air pressure is typically regulated down to starter entry working pressure, typically spherical or cylindrical with hemispherical ends.

AIRCRAFT QUALITY: Workmanship and finish of a component of sufficiently high grade to insure satisfactory operation, reliability and durability consistent with the application and storage life requirements.

AIR FLOW PARAMETER: Mathematical expression of gas flow, $\frac{W\sqrt{T}}{P}$ or $\frac{W\sqrt{\theta}}{\delta}$, with conditions of pressure and temperature defined at the component inlet interface, sometimes called Air Flow Factor, Air Flow Function, or Corrected Flow.

AIRFLOW or WEIGHT FLOW: Amount of air provided to the starter inlet, flow rate controlled by the starter nozzle size and depends on the pressure and temperature of the air, describes amount of air ingested into an APU or a design condition for a heat exchanger.

AIRFRAME MOUNTED ACCESSORY DRIVE (AMAD): Accessory drive package consisting of a gearbox and secondary-power components, mounted to the airframe remote from the main engine, may be powered by an APU; by the propulsion engine through a PTO (power take-off) shaft; by bleed air; or by a combination of the three, sometimes referred to as the Airframe Mounted Accessory Gearbox (AMAG) or Accessory Drive Gearbox (ADG).

2.3 (Continued):

AIRSTART ENVELOPE: Portion of the flight envelope (altitude and airspeed) in which airstarts may be successfully initiated, generally divided into assisted and unassisted (windmilling) subenvelopes.

AIR STARTING: Process of starting a main propulsion engine while inflight by either windmilling, or with starter-assist.

AIR TURBINE STARTER: Air turbine device that provides shaft power to start an engine, generally includes an inlet scroll, turbine, reduction gears, an engagement mechanism or clutch and may include a speed switch or speed signal to signal cutoff speed, a machine that converts the kinetic energy of moving air to mechanical power by the impulse of the fluid upon blades arrayed about the circumference of the shaft, sometimes referred to as "Pneumatic Starter"

ANTI-DRIVE END: End of the starter or accessory opposite the end which mates with the engine, or driver device.

ASSISTED WET CAVITY: Oil lubrication arrangement used in some starters that denotes partial shared oil lubrication with the propulsion engine gearbox, arrangement eliminates shaft seals and assures a supply of oil.

AUTO-SHUTDOWN: Uncommanded shut down of the APU, usually caused by the activation of one or more built-in self-protection features to limit the rotor speed, oil temperature, exhaust gas temperature or other APU engine parameter.

AUTOSTART: Associated with digital engine controls such as FADEC, sequence steps in starting a power plant engine programmed into the control and initiated by pushing a button in the cockpit, typically, if the engine does not successfully complete the first attempt, the control will "lean" the fuel schedule for two additional start attempts before shutting off, also utilize in an APU.

AUXILIARY POWER: Non-propulsive power generated on board the aircraft for the purpose of providing pneumatic and/or shaft power and/or electric power.

AUXILIARY POWER UNIT (APU): Internal combustion engine (usually a gas turbine) used to generate shaft power and/or bleed air to power the aircraft's accessory components, applications of power generated by APU:

- a. Providing air for the environmental control system and starter.
- b. Driving the AMAD or starting the main propulsion engine.
- c. Driving electrical generators and hydraulic pumps, sometime emergency power components.

BACKLASH: Limited rotational motion of shafting in a component or power drive train, when shaft torsion applied in clockwise then, counterclockwise direction.

2.3 (Continued):

BACK PRESSURE: Static differential pressure level measured between the starter exhaust pressure (P_2) and altitude ambient pressure usually due to nacelle venting restrictions and/or overboard ducting.

BATTERY POWER - Imp RATING: Maximum power discharge current, declared as a minimum by the manufacturer and expressed in amperes, which the fully charged, 23 °C cell or battery shall be capable of delivering immediately prior to the conclusion of a 15 s maximum power discharge, controlled so as to maintain a constant terminal voltage at 1/2 of the rated value. See AS8033.

BLEED AND BURN: Describes a process whereby air (extracted from a compressor or air bottle) is combined with fuel and burned to release the potential energy of the mixture.

BLOWOUT: Used to indicate that a combustor has ceased burning its fuel; i.e., the fire has been blown out. Sometimes called "Flameout".

BREAK-IN: Initial run procedure used to condition mating surfaces on component parts (e.g., gears, piston and cylinder) operating relative to each other, after break-in, best practices require replacing the lubricant to remove residual burrs and wear particulates.

BURST PRESSURE: Maximum pressure that a unit or vessel must withstand without rupture or catastrophic failure, typically two times the proof pressure, minimum burst pressure test applied at maximum operating temperature. See "Proof Pressure".

CARTRIDGE STARTER: Accessory starter mounted physically on a gas turbine and powered by hot gases from a one-shot, solid-propellant cartridge with a built-in initiator, for manned aircraft, the starter's combustion chamber is designed so that the cartridge is easily replaceable, some unmanned vehicles (such as cruise missiles) have a starter incorrectly described as a "Cartridge Starter"; however, utilize a combustion chamber preloaded with a one-shot, non-replaceable charge of solid propellant.

- a. **BREECH:** Combustion chamber on a cartridge starter that contains the cartridge and in which the cartridge is fired.
- b. **BREECH CAP:** Removable portion of the breech, which contains the electrical contacts for initiating combustion.
- c. **BREECH CHAMBER:** Fixed portion of the breech, which directs the cartridge gas to the starter.

2.3 (Continued):

CARTRIDGE: Gas generation device, packaged to include ignition, propellant and other required hardware, utilize solid propellant composed of both the fuel and the oxidizer mixed together in a solid form.

- a. **MONOPROPELLANT:** Cartridge using a single propellant, e.g., Hydrazine in liquid form.
- b. **BI-PROPELLANT:** Cartridge using a fuel and an oxidizer, generally in liquid form.
- c. **SOLID PROPELLANT:** Cartridge which incorporates a fuel and oxidizer in solid form, two bases, Double Base - a homogeneous mixture of fuel and oxidizer while, Composite Base a heterogeneous mixture of fuel and oxidizer.

CHARGE TIME: See "Fill Time".

CHOP:

- a. **FUEL CHOP:** Shutoff of fuel when engine is running.
- b. **THROTTLE CHOP:** Rapid throttle movement from any power setting to idle or cutoff.

CLUTCH: See "Engaging Mechanism".

COMPRESSOR BLEED VALVE: Valve used to control air flow from an engine compressor to provide:

- a. Additional compressor stall margin during starting and/or acceleration, used for stall margin during operation at high shaft/low pneumatic loads on integral bleed APU.
- b. An air source for various applications.
- c. Quick flow dump capability to prevent surging when flow demand is instantaneously terminated.

CONSECUTIVE STARTS: Attempts to start the engine that closely follow a previous start attempt, engine may or may not come to rest before the next start attempted.

CONSTANT HORSEPOWER LINE: Locus of points on a curve where the product of torque and speed is constant.

CONTAINMENT: Ability of the starter or APU to retain within its envelope all high energy fragments of the turbine(s) or other rotating components if these parts are caused to fail by separation.

2.3 (Continued):

CONTAINMENT DEVICE: Shroud or shield surrounding a selected area(s) of an APU and/or air turbine starter that will retain within its envelope all high energy fragments of a turbine(s) or other rotating components if the rotating components fail, may be an integral part of the component housing.

CORRECTED SPEED: Of a turbine or compressor utilized to present performance adjusted for temperature variation. usually expressed as $\frac{N}{\sqrt{T}}$ or $\frac{N}{\sqrt{\theta}}$ where, T and θ defined as temperature and corrected temperature respectively at the inlet of the starter or APU, T and θ are corrected to standard conditions.

CRANK (verb): To rotate the main shaft of an engine prior to lightoff by means of a starter.

CRANKING SPEED: See "Speed".

CROSS BLEED: Ducted air from the compressor section of an operating engine to another unfired engine such that this compressed air can be used for starting the unfired engine or for other purposes.

CROSS-BLEED STARTING: Starting of one engine utilizing cross-bleed air from another operating engine.

CUTOUT SWITCH: Switch activated by a speed sensing device used to terminate starter operation at a predetermined engine rotor speed, sometimes located on the output shaft side of the starter.

CUTOUT SPEED: See "Speed, Starter Cutoff".

CUTTER: Feature in a starter to ensure turbine wheel containment, severs the turbine disk in the event of turbine wheel overspeed or failure, both axial and radial containment of rotating material considered. See "Containment Device".

DECOUPLER: Device used to decouple the starter from the engine (or AMAD gearbox) in the event the starter clutch locks-up resulting in the engine driving the starter turbine, sometimes used to decouple the AMAD from engine so that starter may be used to motor the AMAD for electrical, hydraulic, or fuel boost power during ground maintenance.

DELAYED LIGHTOFF: Delay in initiation of combustion in the combustion of a gas turbine engine or rocket relative to expectations.

DETAIL SPECIFICATION: Aircraft or engine manufacturer's document or military specification used to define the applicable design and performance parameters required for a particular starter or component application.

2.3 (Continued):

DISCONNECT, AMAD: Term “decoupler” should be used instead of “AMAD disconnect”.

DISENGAGEMENT: Uncoupling of the starter from the engine by means of the starter clutch, or engaging device, normally occurs at starter cutout speed or starter maximum speed.

DUAL CLUTCH: Engagement mechanism used in some starters making use of a primary and secondary element to increase reliability.

DUAL RATIO: Provides two gear ratios from the power source to the driven components, typically, one gear ratio used for propulsion engine starting, and another gear ratio used for driving the generator and hydraulic pump during ground servicing, typically two gear systems isolated from each other by over-running clutches.

DUAL RANGE VALVE: Starter control air valve with dual solenoid valves, typically the higher pressure level for propulsion engine starting and a lower pressure level for motoring speed of the starter.

DUTY CYCLE: Load (electrical, hydraulic, mass flow, torque) versus time profile of a component performing its intended function, maximum recommended continuous operating time of an air turbine starter (minutes).

EFFICIENCY, POWER (TURBINE): Ratio of “shaft-power-out” to “air-horsepower-in”.

EFFICIENCY, VOLUMETRIC: Ratio of actual flow to that flow defined by the design parameters of interest (i.e., speed, displacement) for a specific item.

ELECTRONIC SEQUENCING UNIT (ESU): Electronic Control Unit (ECU), Digital Electronic Control Unit (DECU) or Engine Control Unit (ECU): Analog or digital controller contains control logic for gas turbine engine systems including but not limited to starting, fuel scheduling, IGVA scheduling, SCV operation, and PMG operation, usually contains built-in test capability and will shutdown the engine for faults such as overspeed, overtemperature, overvoltage, no-light and insufficient start energy.

EMERGENCY POWER UNIT (EPU): Device that provides emergency electric, pneumatic, and/or hydraulic power in the event of a primary power system failure, i.e., a ram air turbine (RAT).

ENERGY LIMITED STARTER: Starter that can provide only a fixed amount of energy on a given start, i.e., a cartridge starter, a hydraulic starter operating from an accumulator, an air bottle driven starter or a battery-operated electric starter.

2.3 (Continued):

ENGAGEMENT: Coupling dynamics (directly or indirectly) of the starter output shaft to drive the engine, sometimes called “re-engagement” if the engine is not at rest.

- a. **RUNNING ENGAGEMENT or RE-ENGAGEMENT:** The coupling of the starter to the engine while the engine is running (usually decelerating or steady windmilling) at some speed below starter cutout speed, except for the effects of backlash in the drive train, the engagement takes place when the starter speed is the same as that of the engine.
- b. **CRASH ENGAGEMENT:** Coupling of the starter to the engine while the engine is decelerating and the starter is running at or accelerating to a no-load speed which is greater than that of the engine, differential speed that exists at engagement can cause a destructive crash engagement.

ENGAGING MECHANISM: Mechanical device for connecting a power source to the driven component, i.e., linking a starter to an engine or an APU to the AMAD.

- a. **JAW TYPE:** Engaging mechanism that uses matching elements with a jaw teeth formed on their faces, one pair typically attached to the engine-side accessory shaft, other attached to the starter, moves axially into engagement with the engine-side jaw, permits the starter elements to come to rest between start cycles.
- b. **OVERRUNNING CLUTCH:** Mechanism that allows torque to be transmitted in one direction of rotation, but no torque transmitted in the other direction.
- c. **SLIP CLUTCH:** Clutch which may be incorporated into a starter or AMAD to limit maximum torque (impact and steady) that can be transmitted by the starter to the accessory drive train or engine.
- d. **PAWL AND RATCHET CLUTCH:** Overrunning clutch consisting of pawls, springs, and a ratchet gear, pawls normally loaded on the ratchet gear by springs, during operation when the centrifugal load exceeds the spring force, the load on the pawls will disengage the ratchet, called “Overrunning”.
- e. **SPRAG CLUTCH:** Overrunning clutch which functions between an inner and outer race. The engagement mechanism uses rollers or caged multi-elements arranged around the circumference of the races for engagement and drive, inner race overrunning clutch and sprag always in contact with the turbine drive-side of the starter, the uni-directional clutch drives only in one direction by the wedge action of rollers or caged elements and rotates freely in the opposite direction preventing the engine from driving the starter.
- f. **SYNCHRONOUS ENGAGEMENT CLUTCH:** Engagement mechanism that uses jaw teeth and engagement and disengagement balls which provide movement of the clutch parts that permit reengagements up to starter cutout speed, never allows the turbine side speed to exceed the output speed.

2.3 (Continued):

EXHAUST PRESSURE: Air pressure at the outlet porting of a starter or APU, designated P_2 in calculations, a value usually above altitude ambient pressure due to installed compartment backpressure build-up.

FILL TIME: Time required to fill a storage vessel (air tank, fuel accumulator, or hydraulic accumulator) or combustor fuel manifold.

FILTER BETA RATING: Unit of measure associated with filtration quality where Beta (x)=[# of upstream particles > x] / [number of downstream particles > x]

FILTER MICRON RATING: Unit of measure associated with filtration quality where one micron equals 1.0×10^{-6} m (3.937×10^{-5} in).

FLAMEOUT: See "Blowout".

FOG TIME: Period between a fuel manifold full condition and lightoff during a ground or airstart attempt, typified by a light fuel mist exiting the engine exhaust nozzle.

GEAR RATIO: Ratio of the revolutions per unit time of one shaft to the revolutions in the same unit time of another shaft connected to the first by a gear device, for starter usually expressed as ratio of starter turbine speed to starter output speed.

GROUND CART: Unit on a trailer or self-propelled that provides energy in the form of starting air, electrical power, and/or other services for an aircraft on the ground, usually an engine and air compressor.

GROUND POWER: Source of power external to the aircraft. Ground power may be obtained from a ground cart, another aircraft, the deck of a ship, or a stationary ground source.

HOT START: Engine start attempt during which engine rotor speed is insufficient for a start and allowable engine turbine exhaust gas temperature (EGT) limits are exceeded. Also applies to APU.

HUNG START: Condition in starting a gas turbine engine wherein the combined torque output of the engine and starter are insufficient to provide positive acceleration at some speed above lightoff but less than idle speed.

HYDRAZINE: Colorless, oily liquid when transformed into a gas is used as an energy source; a powerful reducing agent, (H_4N_2).

IMPINGEMENT STARTING: Starting method wherein nozzle(s) are built into the engine such that the starting media impinges directly on the engine turbine rotors (blades).

2.3 (Continued):

INLET GUIDE VANE ACTUATOR (IGV): Used on gas turbine engines to control the position of the compressor inlet guide vanes, energized by pneumatic or fuel pressure or electric power, usually controlled by the engine control unit.

INSPECTION TESTS: Performed upon a production article to determine acceptability prior to shipment, also referred to as Acceptance Test Procedures (ATP) or Production Acceptance Tests.

INSTALLATION DRAWINGS: Defines the location of a component relative to structure and the procedure for installing the component, typically provide information on the exterior size of the unit and/or its envelope, structure, brackets, location of holes, nuts, bolts, rivets, and adhesives, should define removal envelope, center of gravity, and oil servicing if required.

JET FUEL STARTER: Small gas turbine engine connected to the engine gearbox or AMAD to provide cranking power for starting the propulsion engine, also referred to as "Gas Turbine Starter".

LIGHTOFF: Initiation of combustion in the combustor of a gas turbine engine or rocket.

LINE COMBUSTOR: Device that provides high-pressure, high-temperature gas to a starter by burning fuel and air, typically contains an igniter to initiate the combustion process; fuel and air ported into the combustor and burned to produce high-pressure, high-temperature gas.

LOAD COMPRESSOR: Air supply source separate from a prime mover compressor, mechanically connected to the prime mover.

MODEL SPECIFICATION: Specification by the manufacturer or supplier covering the essential detail and technical requirements of a specific unit design, including a description of the procedures by which it will be verified that the requirements have been met.

MOMENT OF INERTIA: Polar moment of inertia with respect to an axis is the sum of the products obtained by multiplying each element of the area by the square of its distance from the axis, with axis normal to that plane, called the polar moment of inertia, usually expressed in slug-ft² (in English units) or when multiplied by the gravity constant (g), lb-ft².

MOTOR (Verb): Rotate a turbine engine at a constant speed with the starter, usually at reduced speed.

a. **DRY MOTOR:** Rotate a turbine engine without the fuel lever on.

b. **WET MOTOR:** Rotate a turbine engine with the starter, with the fuel lever on and fuel flowing to the fuel nozzles or injectors without actually starting the engine.

2.3 (Continued):

MOUNTING PAD: Surface (pad) on a gearbox to which a component is attached, having studs a pilot diameter or other means of locating the component concentrically with respect to a shaft, shaft usually splined or may have other means of transmitting torque, usually attached to the pad by either studs and nuts or by the use of V-band clamp, inter-seal drain cavity normally provided for collecting possible seal fluid leakage.

NO-LIGHT: Start attempt that failed because the combustible fuel-air mixture did not ignite.

OUTPUT SHAFT: Means by which a driving component, e.g., starter, transfers torque to a driven component, e.g., main engine.

OVER-RUN: Relative speeds of the engine and starter during a start cycle, power transmission initially from starter-to-engine, but as engine speed increases, the engine acceleration rate becomes larger than the acceleration rate of the starter, at this point the starter no longer able to drive the engine, and engine speed quickly becomes greater than starter speed. Thus, the engine overruns the starter, situations where not desired to have the engine drive the starter, an over-running clutch is installed in the system.

OVERSPEED SWITCH: Device that senses starter speed and terminates starter operation at a predetermined speed, when used, located on the starter side of the engaging mechanism, speed setting higher than the normal maximum operating speed of the starter or turbine drive unit. See "Cutout Switch".

PERMANENT MAGNET GENERATOR (PMG): Mounted on APU, JFS, or GTS gearbox, provides electrical power for APU, JFS, or GTS operation when there is no onboard battery, utilized in secondary power systems, hydraulically started by an accumulator and manually operated start valve.

PLENUM, INTAKE: Structure of the APU which inducts air to the APU engine and load compressor.

PNEUMATIC STARTER CONTROL VALVE: On/off or regulating type valve that provides conditioned air from an APU, cross bleeding or ground cart to the starter during starter acceleration, when commanded shut, initiates starter cutout, position: normally closed.

POWER LIMITED: Describes a starter whose output power is limited by the input power supply; i.e., receiving a constant level of power from a pneumatic, electric, or hydraulic ground cart or from an airborne auxiliary power unit. See "Energy Limited Starter".

PRECHARGE PRESSURE: Gas pressure to which an accumulator is charged to provide a desired pressure after loading.

2.3 (Continued):

PRESSURE RATIO:

- a. ACROSS A COMPRESSOR: Ratio of compressor discharge pressure to compressor inlet pressure.
- b. ACROSS A TURBINE: Ratio of turbine inlet pressure to turbine discharge pressure.

PRESSURIZATION:

- a. FUEL PRESSURIZATION: Fuel control movement from cutoff to initiation of fuel flow which causes the fuel manifold to become pressurized.
- b. STARTER PRESSURIZATION: Opening the start valve to initiate starter operation.

PROOF PRESSURE: Typically, maximum pressure a unit or vessel shall be subjected to without any structural deformation or loss in performance or function, still meets all specification parameters.

QUICK-ATTACH-DETACH (QAD) MOUNTING FLANGE: Disconnect device that permits the starter or accessory to be attached to the engine or AMAD special flange, pre-bolted to the mounting pad.

QUICK DISCONNECT: Disconnect device that can be uncoupled or coupled without the use of tools, commonly employed in fuel, hydraulic and pneumatic lines, self-sealing when disconnected.

QUICK RELIGHT: See "Spool-Down Start".

RAMP RATE: Design parameter of an Air Turbine Starter Control Valve which is set to insure starter impact torque remains within acceptable limits, a measure of downstream pressure rise versus time during the opening transient.

RAM AIR TURBINE (RAT): See "Emergency Power Unit (EPU)".

RATED CONDITIONS: Inlet and outlet conditions at which the starter is designed to operate and conditions at which performance calibration is desired, usually expressed in terms of pressure, temperature, and flow rate, or current and voltage.

RE-ENGAGEMENT: Act of the starter engaging the engine while the engine is at any speed between zero and starter cutoff.

RISE RATE, INITIAL INSTANTANEOUS PRESSURE: Pressure rise rate used in graphics measured in the first 1/4 second of pressure rise, expressed in kPa/s (psi/s), equal to the slope of the line from the origin to the pressure time curve at 1/4 second.

RUN-IN: See "Break-in".

2.3 (Continued):

SEAL DRAIN: Drain provision to remove seal leakage oil from between the gearbox accessory drive cavity and the accessory (starter) housing reservoir.

SECONDARY POWER: Modern, more inclusive term for “Auxiliary Power”, covers non-propulsion power generated and other functions on board the aircraft in the form of electric, hydraulic, pneumatic, and/or mechanical operation.

SELF-CONTAINED: Describes independency from outside equipment, e.g., a self-contained lubrication system.

SELF-SUFFICIENT START SYSTEM: Engine starting system that does not require an external source of power to start the main (propulsion) engine, does not require routine maintenance; the stored energy source is replenished on board the aircraft during each mission.

SERVICE LIFE: Operable life of a component during which overhauls are permitted, usually measured in start cycles, hours of engine overrunning, and/or hours of component operation.

SHARED LUBRICATION: See “Assisted Wet Cavity”.

SHEAR SECTION: Decreased cross-section in a shaft or coupling that is designed to shear or fail at a specific torque range to protect parts from further damage. For example, a failed shear shaft in a seized rotating accessory prevents damage to the drive train and gears.

SLIP CLUTCH: See “Engagement Mechanism”.

SPEED:

- a. CRANKING SPEED: Rotor speed prior to lightoff at which the engine is driven solely by the starter.
- b. ENGINE IDLE: Minimum normal operating speed of the engine, speed can either be constant or varying at given altitude.
- c. ENGINE LIGHT-OFF: Rotor speed at which combustion is initiated.
- d. ENGINE SELF-SUSTAINING SPEED: Engine rotor speed at which the engine assistance torque produced by the turbine equals the compressor drag torque; i.e., zero net assistance torque.
- e. FREE RUNNING SPEED: See “No-Load Speed”.
- f. NO-LOAD SPEED: Peak speed to which the starter will nominally accelerate with the load disconnected and a given power available to the starter.

2.3 (Continued):

- g. OVER-RUNNING SPEED: Speed at which the engine side of the engaging mechanism over-runs the starter side. See "Over-Run".
- h. PAD SPEED: Component rotor speed measured on accessory pad where mounted.
- i. ROTOR SPEED: Speed of the engine rotor or starter turbine.
- j. RUNAWAY SPEED: Electrical starter-generator systems, the speed to which the starter-generator will accelerate without load at maximum applied voltage. See "No-Load Speed".
- k. STARTER CUTOFF SPEED: Speed at which the starter ceases to provide starting torque and at which point the power source for the starter is switched off.

SPOOL-DOWN: Process of rotor deceleration from part or full power following a combustor blowout or fuel cutoff as in an engine shutdown.

SPOOL-DOWN START: Engine airstart initiated during rotor spool-down, prior to reaching equilibrium windmilling speed. Sometimes called "Quick Relight".

STANDARD CONDITIONS: Ambient conditions of 15 °C (59 °F) temperature and 101.4 kPa A (14.7 psia) pressure.

START CYCLE: Events which take place between start initiation and when the engine reaches stabilized idle speed.

STARTER-ASSISTED AIRSTART: Engine airstart in which the aircraft starter is engaged either during engine spool-down, engine windmilling, or a non-rotating engine condition.

STARTER-DRIVE: Elements of the starter which engaged the engine and through which the torque to accelerate the engine is transmitted, sometimes called an output shaft coupling: with a shear section or other torque limiting device sized to limit transmitted torque within the intended engine drive rating.

STARTER ENVELOPE: External three-dimensional shape of the starter, space allowance for the starter.

STARTER, FIXED DISPLACEMENT: Hydraulic starter which has a constant flow of fluid per revolution.

STARTER/GENERATOR: Electrical starter that will function as a starting motor when external electrical energy is applied and will also function as an electric generator when driven by the APU or engine.

2.3 (Continued):

STARTER POWER TRANSFORM: Relationship between starter power input (expressed in terms of voltage and current or pressure and flow rate) and starter power output expressed in terms of torque and speed.

STARTER/PUMP: Hydraulic starter which will function as a motor when external hydraulic energy is applied and will also function as a hydraulic pump when driven by the engine.

START SWITCH: Switch or other device used to initiate a start cycle.

START TIME:

- a. **Actual:** Measured length of engine starting time from initiation of the start cycle (e.g., pilot activates start switch to stabilized engine idle speed).
- b. **Calculated:** Time from initiation of the start to engine idle speed; analytically obtained using graphical or tabulated data, or equations describing engine and starter characteristics, includes starter control valve opening time.

START TIME ANALYSIS: Modeling of propulsion engine start time using assumptions of mechanical arrangements of air supply and altitude conditions.

SURGE CONTROL VALVE (SCV): See "Compressor Bleed Valve".

SURGE BLEED VALVE: Valve which operates during a transient, e.g., starting, acceleration and deceleration, to provide satisfactory compressor stall margin for the main engine.

TEARDOWN INSPECTION: Inspection of a component's detail parts imposed as a part of the qualification testing or at the completion of a test program, sometimes called "Strip Inspection".

TESTS:

- a. **ACCEPTANCE TESTS:** Test program usually imposed on production articles run prior to delivery of a component or batch of components to demonstrate that the component meets specific specification requirements, sometimes called an Inspection Test or ATP (Acceptance Test Procedure).
- b. **DESIGN ASSURANCE TESTS:** Tests conducted on a component prior to qualification testing to demonstrate and assure specification requirements are met, sometimes known as "Development Tests".