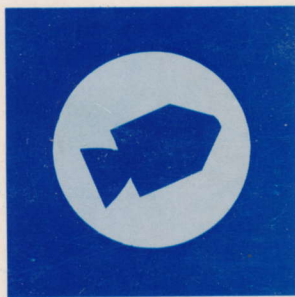
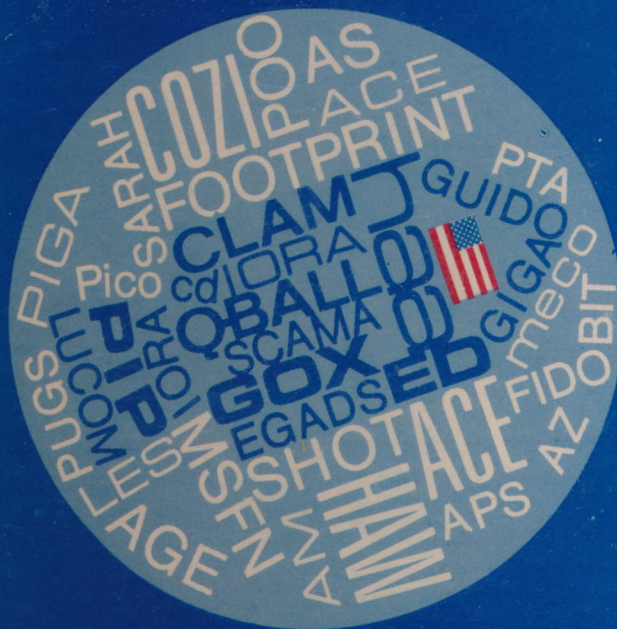




Astronyms

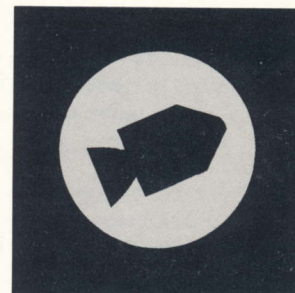


PHILCO-FORD CORPORATION



Astronyms

Acronyms and Space
Terms used in
Spacecraft Communication



PHILCO

Ford

PHILCO-FORD CORPORATION
Philco Houston Operations
1002 Gemini Ave
Houston, Texas 77058

FOREWORD

One of the largest, most sophisticated and most flexible command and control facilities in the world, NASA's Mission Control Center has been the focal point of the U. S. manned space program since Gemini 4 in June, 1965.

From launch through recovery, around the clock, successive teams of flight controllers, systems experts and medical personnel maintain an unblinking watch on the spacecraft and crew. Their eyes and ears are 43 tracking stations scattered around the globe. From ship and plane, from Canton and Tananarive, from Spain and Africa and lonely islands in the Pacific come thousands of pieces of information on vehicle performance, astronaut heartbeat, the temperature of the cabin and the flight path. By radar and radio, by land line and undersea cable, a steady stream of coded signals feeds into the control center's giant computer complex.

But it is men -- not computers -- who must make the decisions. The information is only as useful as the ease and speed with which those men can reach it.

The equipment which does that job includes 1170 cabinets of electrical and electronic equipment, 133 television cameras and 557 receivers, 52 million feet -- 10,000 miles -- of wire, 2 million wire connections, and the largest assembly of television switching equipment in the world. At the touch of a button or the turn of a dial, flight controllers at 171 consoles can call to their individual television screens any one of several thousand computer-updated graphs, tables or pictures.

At the front of the twin Mission Operations Control Rooms, massive expanses of rear-projection screens display television images, maps, and the constantly-moving bright line which is the spacecraft's wavering track across the world map. To the right and left, 10-by-10 foot plotting screens show animated graphs of critical flight dynamic data as it is gathered. Ringing the top of displays and consoles are computer-driven readouts of countdowns, elapsed times, Greenwich Mean Time and system status. There are 16 multi-channel chart recorders,

20,000 discrete events indicators, and six hard-copy printers which can photograph automatically any display appearing on the console television monitors, and produce six dry paper copies per second. The display and control system, with its associated computer/display interface and high-resolution television network, requires the support of 64 digital-to-television converters, and two solid-state video switching matrices larger than those in the major television networks.

A communications system includes electronics for handling more than 200 different types of telemetry, voice communications, a pneumatic tube system, a high-speed teletype system, and a separate system for biomedical data analysis and display.

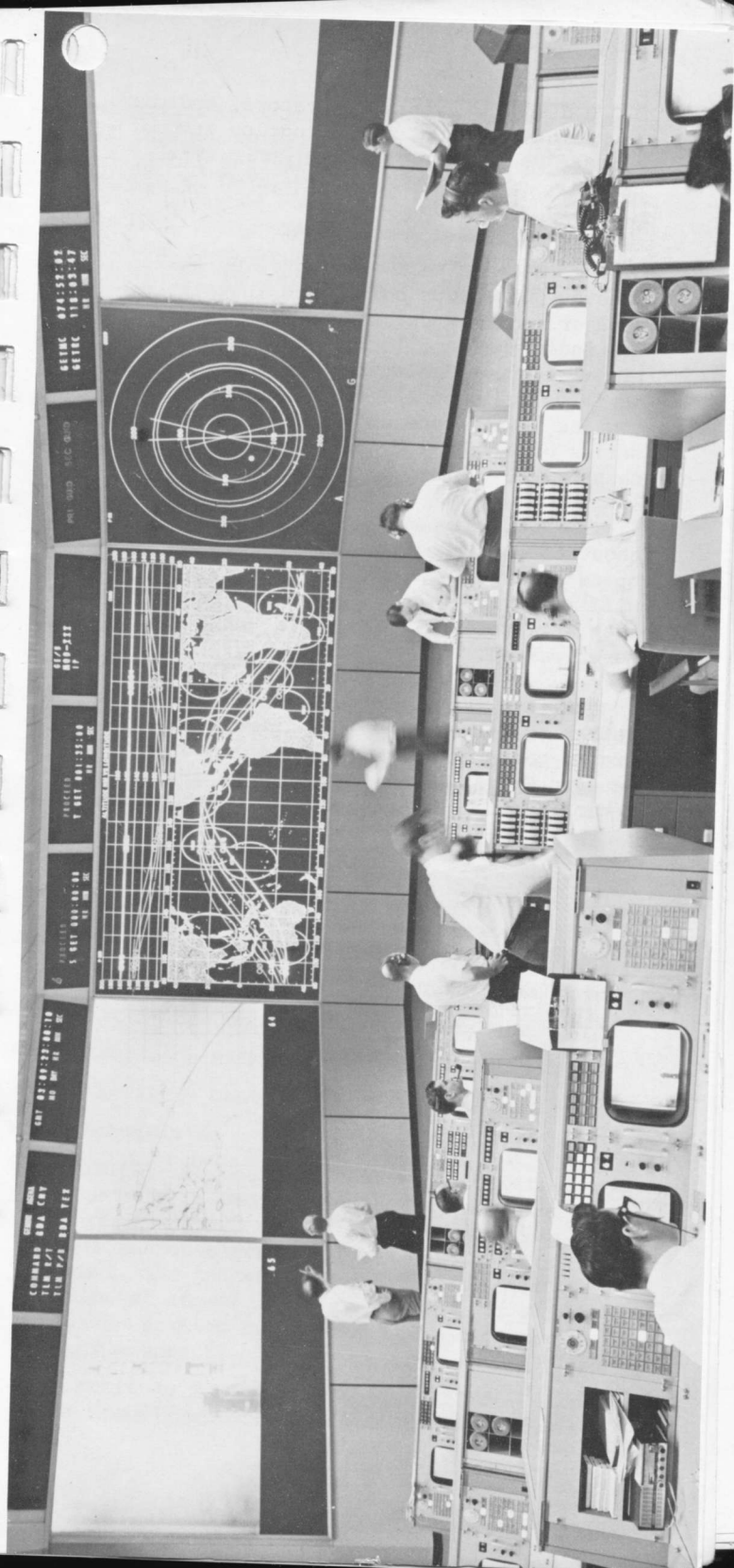
In a nearby building, the Apollo Simulation, Checkout and Training System (ASCATS) provides realistic simulation of manned missions for training both flight crews and flight control personnel. The system links the Mission Control Center with flight-crew trainers located at the Manned Spacecraft Center and Cape Kennedy, Fla., and with simulated "remote sites" used for training the men who will man the tracking stations during an actual mission.

The simulation system provides a way of pre-testing each mission, its procedures, its flight crew and operations personnel by purposely introducing "emergency situations." Potential weak points are detected and corrected before they become a problem, and astronauts and flight controllers have a chance to build mutual confidence in each other before the mission is flown.

As a prime contractor for the Mission Control Center, Philco-Ford began designing, developing and implementing these systems in March, 1963. Under separate contracts, the IBM Corporation provided the Real-Time Computer Complex and Univac the Communications Processor, while Philco was responsible for the integration of their efforts into the center's systems.

In a sense, that job is still going on.

During the past three years configuration of the MCC has changed from flight to flight as each new mission met the problems of a new and



unknown flight environment, the necessity for an early commitment to final mission design, limitations in ground-based simulation facilities, and the sheer scope and complexity of manned space flight.

The 1000-man team that makes up Philco Houston Operations builds and installs new hardware or modifies existing equipment as needed for individual Apollo flights, provides operational support during the flights themselves, performs analyses and requirement studies, does routine maintenance and conducts a constant series of validation tests to insure the readiness of the center.

The first manned flight of Project Apollo is about to open the final chapter in man's first space adventure. In a few months, a human being will step from a strange-looking vehicle to the even stranger soil of a world where man has never walked.

But in a larger sense this is the beginning rather than the end -- the introduction to a new era in man's conquest of the unknown. Philco Houston Operations is proud to be a part of that beginning.

AAP - Apollo Applications Program

ABLATION - The shedding of excessive heat from a surface by vaporization or melting of specially designed coating materials (ablative material). The Apollo heat shield disperses re-entry heat in this manner; the thrust chamber of the service propulsion engine is also ablatively cooled.

ABORT - To cut short a launch or mission because of equipment failure or other problems.

A/C - Aircraft

AC - Alternating Current

ACC - Astronaut Control Console

ACCELERATION - Rate of gain in velocity.

ACCELEROMETER - "Speedometer" in booster or spacecraft control system. A device which measures velocity changes along all three axes and sends signals to the guidance computer, displays, etc.

ACCUMULATOR - A device that stores up, such as hydraulic system apparatus which stores fluid under pressure, or a computer device which stores a continuously higher sum as it adds incoming numbers to that sum.

ACE - Attitude Control Electronics; Automatic Checkout Equipment

ACK - Acknowledge

ACKAID - Acquisition Aid (optical tracker)

ACME - Attitude Control and Maneuver Electronics

ACMR - Attitude Control and Maneuver Rate

ACN - Ascension MSFN station (see ASCENSION)

ACPM - Attitude Control Propulsion Motors

ACQ - Acquisition

ACQUISITION - Process of locating an orbiting spacecraft to begin tracking or gathering telemetry data. *Acquisition and tracking radar* searches for and locks onto a strong signal, and tracks it automatically. *Acquisition of signal* (AOS) is the time at which a given station begins receiving data from the spacecraft.

ACS - Attitude Control System ; Attitude Control and Stabilization; Automatic Checkout System

ACTIVE SEISMIC EXPERIMENT - Experiment for measuring the elastic properties of the lunar surface. Part of ALSEP (see ALSEP).

ACTUATED CHARCOAL - Substance used to remove odors from cabin and suit oxygen supply as it is recirculated.

ACTUATORS - Devices which transform an electrical signal into a mechanical motion, using hydraulic or pneumatic power.

ACV - Alternating Current Volts

ADA - Angular Differentiating Accelerometer

ADAPTER SKIRT - A flange or extension of a booster stage or spacecraft section into which the next stage or section fits.

ADIABATIC - Without gain or loss of heat.

ADPS - Automatic Data Processing System; Ascent and Descent Propulsion System

A&E - Azimuth and Elevation

AE - Ascent Engine (lunar module)

AEC - Aft Equipment Bay (see definition)

AELD (S) - Ascent Engine Latching Device (and Sequencer)

AEROEMBOLISM - Decompression sickness; the bends. Formation of gas bubbles (chiefly nitrogen) in the blood vessels, caused by too-rapid change from high to low pressure. The Apollo spacecraft uses a nitrogen/oxygen cabin atmosphere during launch and its first few orbits; then switches to 100% oxygen.

AEROPAUSE - Boundary area between denser atmosphere and space

AEROTHERMODYNAMIC BORDER - Altitude (about 100 miles) above which the atmosphere is too thin to generate significant heat against a re-entering spacecraft.

AEROZINE - Liquid fuel used in Apollo spacecraft RCS thrusters, lunar module ascent and descent engines, and in the service propulsion engine; half unsymmetrical dimethyl hydrazine and half monomethyl hydrazine. It is storable and hypergolic (see definition) in the presence of nitrogen tetroxide.

AFC - Automatic Frequency Control

AFCS - Automatic Flight Control System

AFD - Assistant Flight Director

AFDO - Assistant Flight Dynamics Officer

AFETR - Air Force Eastern Test Range (formerly Atlantic Missile Range)

AFP - Alternate Flight Plan

AFT EQUIPMENT BAY - Storage area beneath the crew couches in the command module used for pressure suits and spare parts, life vests, umbilicals, lithium hydroxide canisters, helmets and portable life support systems. Also, an unpressurized storage area in the lunar module for electronic equipment, batteries, oxygen supply and cooling equipment.

AFTERBODY - A companion body that trails a spacecraft in orbit, anything from a discarded clamp ring to a spent launch vehicle stage.

AFTERBURN - Irregular burning of fluid left in firing chamber of booster after engine cut-off.

AFT INTERSTAGE - Rearmost portion of the second and third stages of Saturn launch vehicles. The S-IVB aft interstage remains with the spent stage below it during staging and houses retrorockets to slow the spent stage in flight. The S-II interstage houses second-stage ullage rockets and is discarded after second stage main engines ignite.

A/G - Air-to-Ground (voice communications)

AGACS - Automatic Air-to-Ground Communications System

AGC - Apollo (spacecraft) Guidance Computer; Automatic Gain (or Guidance) Control.

AGCS - Automatic Ground Control System (or Station; see definition)

AGCU - Attitude Gyro Coupling Unit (stabilization and control system)

AGE - Apollo Guidance Equipment

AGNE - Apollo Guidance and Navigation Equipment

AGRAVIC - Pertaining to a weightless condition

AGS - Abort Guidance System

A/H/O - Abort/Hold/Orbit (tracking network)

AIRGLOW - Faint visible light appearing in the upper atmosphere at night.

AL - Apolune (see definition)

ALBEDO - Reflecting power of any object in space, expressed as the ratio of reflected light to the total amount of light falling on the object. Albedo has a great effect on the internal temperature of a spacecraft.

ALDS - Apollo Launch Data System

ALEMS - Apollo LM Sensors

ALSEP - Apollo Lunar Surface Experiments Package, a 280 lb. package stored in the descent stage of the lunar module containing eight experiments to be left on the lunar surface after the astronauts departure. Contains its own power supply and transmitting station for returning information to Earth.

ALTDS - Apollo Launch Trajectory Data Subsystem (part of ALDS)

ALVM - Assistant Launch Vehicle Monitor

AM - Aeromedical Monitor

AMBIENT - Surrounding environmental condition, such as pressure or temperature.

AMC - Aeromedical Monitor Console (in the MCC)

AMP - Amplifier

AMPLIDYNE - Special type of direct-current generator used in servo systems as a power amplifier, in which output voltage responds to changes in field excitation.

AMS - Apollo Mission Simulator

ANALOG COMPUTER - Computer which works on the principal of measuring (linear lengths, voltages, etc.) as distinguished from counting. An analog control computer in the instrument unit of the Saturn generates commands for engine actuators and the APS thrusters.

ANECHOIC - Without echoes; may refer to sound or radio-wave echoes.

ANACOUSTIC ZONE - Zone above 100 miles altitude, where the thinning atmosphere will no longer carry sound.

ANG - Antigua MSFN station (see ANTIGUA)

ANGEL - Radar echo caused by something not visible to the eye.

ANGLE OF ATTACK - Acute angle between a reference axis in the spacecraft and the line of flight. See Q-BALL.

ANGULAR ACCELERATION - Acceleration around an axis (see ATTITUDE).

ANHYDROUS - Free of water.

ANNULAR SPACE - Space between the double walls of a fuel or other storage tank, usually pumped out to a nearly perfect vacuum for insulating the tank. Cryogenic tanks aboard the service module are so well insulated in this manner that ice cubes placed inside the tank would take 8 1/2 years to melt.

ANOMALISTIC PERIOD - The perigee-to-perigee interval; the time between a spacecraft's arrival at perigee on one orbit and perigee on the next.

ANOXIA - A *complete* lack of available oxygen. Hypoxia, or lack of *sufficient* oxygen, is preferred.

ANT - Antigua DOD-Eastern Test Range Station (see below).

ANTIGUA - Antigua Island (U.K.), in the West Indies east of Puerto Rico, site of two tracking stations. The MSFN station (ANG) is equipped with a 30-foot antenna and S-Band facilities for earth-orbital and limited lunar-mission support. The DOD-Eastern Test Range station (ANT) is equipped with C-Band, UHF command, VHF voice and telemetry facilities for near-earth-orbital mission support.

AOH - Apollo Operations Handbook

AORA - Atlantic Ocean Recovery Area

AOS - Acquisition of Signal (see ACQUISITION); Acquire on Signal (command network)

APA - Abort Programmer Assembly

APEX COVER - Cover over the forward compartment (point) of the command module, which is jettisoned before the parachute system operates during landing.

APHELION - The point in any object's orbit most distant from the sun.

APO - Apollo Program Office (at NASA Headquarters, Washington, D. C. See ASPO)

APOGEE - Highest point in an elliptical orbit about the earth; as a verb, to reach apogee.

APOLLO - NASA's manned lunar landing program, and the spacecraft which was built to achieve it. Originally, the Greek god of light,

prophecy, and of "embarkers and disembarkers," twin brother of Artemis, the moon goddess.

APOLUNE - The highest point in an orbit about the moon; also called apocynthion.

APS - Auxiliary Propulsion System (of S-IVB); Ascent Propulsion System (of lunar module); Auxiliary Power System

APU - Auxiliary Propulsion Unit (see AUXILIARY PROPULSION SYSTEM)

AQ - Acquisition Message

AQUAID - Acquisition Aid

ARIA - Apollo Range Instrumentation Aircraft, converted C-135's used as part of the tracking network (see MANNED SPACE FLIGHT NETWORK).

ARIS - Advanced Range Instrumentation Ship, ships used as tracking stations (see MANNED SPACE FLIGHT NETWORK).

ARODS - Airborne Radar Orbital Determination System (Saturn launch vehicles)

ARS - Attitude Reference System (stabilization and control system)

ARTC - ALSEP Real-Time Computer (see ALSEP)

ARTS - ALSEP Real-Time System (see ALSEP)

AS - Apollo-Saturn (usually followed by booster number); Ascent Stage

ASA - Abort Sensor Assembly

ASC - Ascension DOD-Eastern Test Range station (see ASCENSION)

ASCATS - Apollo Simulation, Checkout and Training System (see FOREWORD)

ASCENSION - Ascension Island (U.K.), in the South Atlantic off the coast of Africa, site of two tracking stations. The MSFN station (ACN) is equipped with a 30-foot dual antenna and S-Band facilities for earth-orbital and limited lunar mission support. The DOD-Eastern Test Range station (ASC) is equipped with C-Band and VHF telemetry recording facilities only, for near-earth orbital mission support.

ASCENT ENGINE - The 3500-pound thrust engine in the ascent stage of the lunar module, used

for launch from the moon's surface and orbital adjustment, or pre-landing abort.

ASCENT STAGE - The top half of the lunar module, housing crew, controls and ascent engine. Used as a base of operations on the moon and to return the crew to the command module in lunar orbit.

ASE - Active Seismic Experiment (see definition)

ASM - Apollo Systems Manual

ASPO - Apollo Spacecraft Program Office (at MSC, Houston. See APO)

ASTRO - Astronaut

ASTRONOMICAL UNIT - Mean distance between earth and sun (92,907,000 miles), used as a unit for measuring star distances.

ATCA - Attitude and Translation Control Assembly

ATCE - Attitude and Translation Control Electronics; Ablative Thrust Chamber Engine

ATM - Apollo Telescope Mount

ATR - Atlantic Tracking Range

ATS - Atlantic Tracking Ship

ATTITUDE - Position or orientation of the spacecraft as determined by the inclination of its axes to some reference line or plane. The spacecraft's nose may be *pitched* up or down, moving around the Y (lateral) axis; *yawed* to one side or the other, moving around the Z (vertical) axis, or *rolled* around its X (longitudinal) axis. The way it is pointed does not change its speed or direction of travel in orbit.

ATTITUDE CONTROL MODE - One of eight modes in which the stabilization and control system may be used; automatically maintains spacecraft attitude.

ATTITUDE GYRO ACCELEROMETER ASSEMBLY - Part of the stabilization and control system. Three body-mounted gyroscopes to sense attitude changes along three axes, and an accelerometer to measure acceleration.

AUDIO CENTER - Portion of the command module communications system including earphone and microphone controls, voice-operated relay controls and the voice recorder.

AURORA - Northern lights; sporadic light display in the upper atmosphere over high latitudes.

AUTOMATIC GROUND CONTROL STATION - Concrete blockhouse beneath the launch umbilical towers at Saturn IB launch pads, containing computer and checkout equipment used during prelaunch tests and a distribution point for high pressure gases.

AUXILIARY PROPULSION SYSTEM - Six small (150-pound thrust) attitude control engines on the Saturn S-IVB stage, plus a pair of associated ullage control engines, used to control the attitude of the stage and the spacecraft joined to it during the earth orbital coast period.

AXIS - Any of three straight lines about which a spacecraft rotates (see ATTITUDE; X-, Y-, Z-AXIS); one of a set of reference lines for a coordinate system.

AZ - Azimuth (see definition)

AZ&EL - Azimuth and Elevation

AZIMUTH - The horizontal bearing of any object from a fixed point or direction (usually true north) measured in degrees.

AZUSA - A radar tracking and vectoring system operating on the C-Band, used to determine space position and velocity.

BACKOUT - The undoing of things already done during a countdown, usually in reverse order.

BACKPACK - A self-contained portable life support system

BACKUP - An item or system kept available to replace one which fails; an astronaut or astronaut crew trained to replace the prime pilot(s) in event of illness or death.

BAHAMA - Grand Bahama Island, off the Florida coast, site of two tracking stations. The MSFN station (GBM) is equipped with a 30-foot antenna and S-Band capability for earth orbital and limited lunar mission support. The DOD-Eastern Test Range station (GBI) is equipped with C-Band radar, VHF command and UHF voice and telemetry capability for earth orbital and limited lunar mission support.

BALLISTIC TRAJECTORY - The flight path followed by a space vehicle after its propulsive force is cut off, provided it does not attain orbit. Often used as a synonym for a high-arcing, up-and-down "lob shot" in which a spacecraft

is boosted into space briefly and returns to earth downrange.

BAND-PASS FILTER - A combination of capacitors and inductors in an electrical circuit that transmits only frequencies within a selected band. (see S-BAND; C-BAND.)

BARRIER REEFS - Test-pilot slang for the danger areas of flight.

BAT - Battery

BAYS - Storage areas in the command and lunar modules (see AFT EQUIPMENT BAY, LOWER EQUIPMENT BAY, etc.)

BCD - Binary Coded Decimal (see BINARY NOTATION)

BDA - Bermuda MSFN Station (see Bermuda)

BEF - Blunt-End Forward (refers to spacecraft's heat-shield-forward position).

BEM - Biomedical and Environmental Monitor (flight surgeon)

BER - Bit Error Rate (see BIT)

BERMUDA - Site of MSFN Station equipped with a 30-foot antenna and S-Band facilities for earth orbital and limited lunar mission support.

BETA SIGNAL, BETA FEEDBACK - A signal from the engine's hydraulic system to indicate engine deflection.

BFP - Band-Pass Filter (see definition)

BGA - Backup Guidance System

BIA - Boost, Insertion and Abort

BINARY NOTATION - A system of expressing figures for use in computers which utilizes only two digits, one and zero. *Binary Coded Decimal* is a specialized form of binary notation.

BIOMED - Biomedical; Astronaut Biomedical Data (communications network)

BIOMEDICINE - Science concerned with analyzing human tolerance to stress environments such as space flight.

BIOSENSORS - Small devices attached to crew members to sense heartbeat and respiration rate.

BIPROPELLANT - Utilizing two propellants, usually fuel and an oxidizer, which are fed separately into the thrust chamber.

BIRD - Slang for satellite, spacecraft or booster.

BIT - Abbreviation of *binary digit*. Smallest unit of computer-coded information, carried by a single digit of binary notation.

BK - Block; Blocked

BLACK BOX - An automatic control or assisting unit which can be inserted or removed from a larger system as a single package, without knowledge of its internal structure.

BLACKOUT - The fadeout of radio communication between spacecraft and ground during re-entry due to the signals not being able to penetrate a sheath of ionized air particles caused by re-entry heat.

BLEED - To remove all or part of the contents of a tank or fuel line. As a noun, "bleedoff."

BLEED-CYCLE OPERATION - Operation of liquid-fueled rocket engines in which the turbopump is driven by hot gasses bled from the combustion chamber of the main engine during mainstage operation.

BLOCK I, BLOCK II - Designation for Apollo spacecraft. Block I spacecraft were of an earlier design, for the first earth orbital missions, while Block II spacecraft incorporated later design changes and were for use with late earth-orbital and lunar missions. The delay caused by the spacecraft fire in January, 1966, however, has made the terms largely obsolete. The spacecraft used for the first manned mission is a Block I spacecraft with most of the Block II changes incorporated; all other manned mission spacecraft will be Block II.

BLOCKHOUSE - Launch Control Center at Pads 34, 37 or 39, Cape Kennedy, or the Automatic Ground Control Stations at Pads 34 or 37.

BLOWOUT DISK - Thin metal diaphragm used as a safety device to relieve excessive gas pressure.

BMAG - Body-Mounted Attitude Gyro (see below)

BMDADS - Biomedical Data Analysis and Display System

BMG - Body-Mounted Gyro

BODY-MOUNTED ATTITUDE GYROS - Three gyroscopes mounted parallel to spacecraft axes in the

stabilization and control system to sense attitude displacement and send a corrective signal to the reaction control system thrusters, and to the flight director attitude indicator.

BOE - Blackout Exit Time (see BLACKOUT); often preceded by "GMT" or "GET."

BOI - Blackout Initiation Time (see above).

BOILERPLATE - Metal mockup of spacecraft built to same size, weight, and configuration and with the same center of gravity as a manned model, but without all the "working" internal parts.

BOILOFF - The vaporization of super-cold liquids (cryogenic fuels) in the tanks, usually during the final period of countdown; the "steam" seen around the booster on the pad.

BOOSTER - Launch vehicle, as opposed to the spacecraft; Booster Systems Engineer (flight control position).

BOOST PROTECTIVE COVER - The cover over the command module which is attached to the launch escape tower and jettisoned with the tower after launch.

BOOTSTRAP - Self-sustaining cycle; especially, liquid rocket engines in which the gas generator is fed by the main propellants pumped by the turbopump, which in turn is driven by hot gasses from the gas generator system.

BOW WAVE - Shock wave in front of space vehicle during launch or re-entry.

BP - Blood Pressure; Boiling Point; Boilerplate

BPC - Boost Protective Cover. In Apollo, the cover over the command module which is attached to the launch escape tower and jettisoned with the tower.

BPM - Bits Per Minute (telemetry data); Beats Per Minute (heartrate); Breaths Per Minute (respiration rate).

BPS - Bits, Beats or Breaths Per Second (see above)

BRAIN BUCKET - Pressure suit helmet; crash helmet.

BRACING ELLIPSES - A series of ellipses around the earth, each one skimming further into the

atmosphere, followed by a spacecraft returning from lunar orbit. Has the effect of slowing the spacecraft gradually before full re-entry.

BRAKING RETROS - Set of eight retrorockets on the Saturn V's first stage, or set of four on the aft interstage of the S-IVB stage (Saturn IB and Saturn V) which slow the spent stage of the launch vehicle after staging.

BREMSTRAHLUNG - German for braking radiation; electromagnetic radiation produced by the rapid velocity change of a fast charged particle (electron) as it is deflected by the nucleus of an atom.

BRENNSCHLUSS - German for combustion termination; the moment at which rocket propulsion ends or is shut down.

BRIDGEWIRE - See EXPLODING BRIDGEWIRE

BSE - Booster Systems Engineer (flight control position)

BSI - Booster Situation Indicator

BTC - Begin Telemetry Cycle

BTM - Booster Telemetry Monitor

BTU - British Thermal Unit, a measure of heat; the amount of heat it takes to raise one pound of water one degree F. at its maximum density.

BU - Backup

BUBBLING - A system for keeping the temperature of liquid fuel or oxygen uniform throughout its container during fueling and before pressurization of the tank. Gaseous nitrogen is bubbled through suction lines for RP-1 fuel and gaseous helium through liquid oxygen lines in the Saturn IB or V first stage.

BUFFETTING - Random, uncontrolled spacecraft or booster "wobble" caused by turbulence at high speed in the atmosphere.

BUG - (1) Unidentified problem in any complicated system. (2) Slang term for two-man lunar module, based on its awkward, bulging planes and angles and its supporting legs.

BUGS - Backup Guidance System

BULKHEAD - Dome-shaped segment enclosing end of a propellant tank.

BUR - Backup Rate

BURN - Noun or verb, the firing of engines or to fire them, particularly spacecraft engines during a translation maneuver. *Burn time* is the length of the thrusting period.

BURNOUT - Moment when booster exhausts its fuel. *Burnout velocity* is velocity at exact moment of burnout.

BURN POND - Concrete pond containing an underwater burner vent used to dispose of dangerous gasses such as hydrogen which are vented from vehicle or ground storage propellant tanks.

BURP - Backup Rate (of) Pitch

BURR - Backup Rate (of) Roll

BURST DIAPHRAGM - Same as BLOWOUT DISK.

BURY - Backup Rate (of) Yaw

BUS - Main circuit for transfer of electrical current.

BUTTON UP - To close, lock and seal completely any unit or vehicle such as the spacecraft.

BW - Bandwidth

BYTE - A combination of bits (normally 8) representing one letter, one digit of a number, or other character (see BIT).

C - Centigrade (see definition)

CABIN SYSTEM - System for controlling command module temperature and pressure.

CAL - South Vandenburg, Calif., DOD-Western Test Range station, equipped with C-Band radar and VHF telemetry recording for near-earth orbital mission support.

CALIBRATION - Adjustments to the accuracy of a measuring device by comparing its readings to a known standard of accuracy.

CALIFORNIA - See CAL above.

CANARDS - Blunt "wings" on nose cone of launch escape system which open and lock into place when the system is used; aerodynamic forces on the canards tip the spacecraft into a blunt-end-downward position necessary for earth landing.

CANARY - Grand Canary Island (Spain), off the Moroccan coast of Africa, site of MSFN station equipped with 30-foot antenna and S-Band

capabilities for earth-orbital and limited lunar mission support.

CANBERRA - Canberra, Australia, MSFN station operated for NASA by the Australian Department of Supply; one of three stations for full lunar mission support, equipped with an 85-foot dual antenna and S-Band capability.

CANTON - Canton Island, in the South Pacific north of Samoa, site of MSFN station equipped with C-Band radar and VHF voice and telemetry recording for near-earth orbital mission support.

CAPCOM - Capsule Communicator; the console position in the MCC (usually manned by an astronaut) for giving voice directions and information on the crew, either by direct transmission or thru a remote tracking site.

CAPE - Cape Kennedy Fla., site of DOD-Eastern Test Range station, equipped with C-Band radar for near-earth orbital mission support.

CAPILLARY ACTION - Area of special study under zero-G. The tendency of liquids to rise or fall in narrow tubes, particularly fuels in tanks or pipelines.

CAPSEP - Capsule separation (from booster)

CAPSULE - Spacecraft; sealed, pressurized cabin with life-sustaining environment.

CARNARVON - Carnarvon, Australia, site of MSFN station operated for NASA by the Australian Department of Supply, equipped with 30-foot dual antenna and S-Band facilities for earth orbital and limited lunar mission support.

CAS - Crewman Alignment Sight (see definition)

CASRS - Countdown and Status Receiving Status

CASTS - Countdown and Status Transmission System

CAUTION AND WARNING SYSTEM - System which monitors malfunctions or critical conditions of spacecraft systems, causing status light and the master alarm light to illuminate and give a warning buzz.

CAVITATION - Rapid formation and collapse of vapor pockets in a flowing liquid at low pressure; causes structural damage to rocket components. Formation of partial vacuum in a pump, such as fuel pump.

CB - C-Band (see definition); Circuit Breaker

CBA - C-Band Antenna (transponder)

C-BAND - Tracking radar system for manned space flight in near-earth orbit, operating in the 5600-megacycle region. C-Band provides tracking and ranging information only. See S-BAND.

C-BAND TRANSPONDER - C-Band transmitter/receivers, located in four places around base of command module; provide two-way tracking and ranging during launch, earth orbit and re-entry.

CBC - Complete Blood Count

CBX - C-Band Transponder

CC - Computer Command, an operational support position (console) in the MCC; Cubic Centimeter (volume)

C&C - Command and Control

CCATS - Command, Communication and Telemetry System (in MCC)

CCC - Command Communications Console; CCATS Command Controller

CCDP - Command Control Dial Panel

CCGE - Cold Cathode Gauge Experiment (see definition)

CCIA - Console Computer Interface Adapter

CCMTA - Cape Canaveral Missile Test Annex

CCP - Computer Control Panel

CCS - Communication and Control System; Console Communications System

CCTV - Closed Circuit Television

CCW - Counterclockwise

CD - Countdown

C&D - Control and Display

CDH - Constant Height Difference Maneuver

CDP - Central Data Processor

CDR - Commander (see SPACECRAFT COMMANDER)

CDU - Coupling Display Unit (see definition)

CEK - Computer Entry Keyboard

CELESTIAL - Pertaining to the stars. *Celestial Mechanics* is the study of the theory pertaining to the motions of bodies in gravitational

fields. *Celestial Navigation* is onboard navigation using stars for reference.

CENTER COUCH - The middle of the three crew couches in the command module, which is hinged to fold down so that the crewman may stand upright at the navigator's position.

CENTER OF GRAVITY - Central point of a body with regard to the distribution of its mass; the point at which its weight is centered.

CENTI - Prefix meaning one-hundredth

CENTIGRADE - Temperature scale on which water boils at 100 degrees and freezes at 0 degrees. To convert to degrees Fahrenheit, multiply by 9, divide the result by 5 and add 32 degrees.

CENTRAL TIMING EQUIPMENT - The part of the telecommunications system which synchronizes the time-critical functions in the spacecraft by giving elapsed time in a binary-coded format.

CENTRIFUGAL FORCE - In a rotating body, the force which pushes away from the center of rotation.

CENTRIFUGE - Large motor-driven apparatus with long arm which can be revolved at high speed to simulated prolonged acceleration.

CENTRIPEDAL FORCE - In a rotating body, force directed toward the center of rotation.

CEP - Circular Error Probable; Computed Ephemeris Position (see EPHEMERIS)

CES - Control Electronics System (lunar module)

CET - Capsule Elapsed Time

CF - Center Frequency

CFM - Cubic Feet Per Minute

CG - Center of Gravity

CGSS - Cryogenic Gas Storage System

CHAMBER PRESSURE - Pressure in combustion chamber of rocket engine.

CHAN - Channel

CHARACTERISTIC VELOCITY - Sum of all the velocities that have to be overcome in braking spacecraft, at a particular point in flight.

CHARGED PARTICLE LUNAR ENVIRONMENT EXPERIMENT - Measures proton and electron fluxes on the lunar surface. Part of ALSEP (see ALSEP).

CHILLDOWN - Process of cooling down fueling system of launch pad or fuel tank prior to loading cryogenic fuels such as liquid oxygen and liquid hydrogen.

CHUFFING, CHUGGING - Irregular puffing noise resulting from combustion instability in a rocket.

C&I - Communications and Instrumentation

CIRCADIAN RHYTHM - Particular cycle of living organisms on earth, apparently based on the day/night earth rotation cycle. Subject of space research; one school of thought believes that man will not be able to function effectively for long periods without it.

CIRCULAR VELOCITY - Speed required to maintain a spacecraft in circular orbit.

CIRCUMLUNAR - Around the moon. Often used in reference to an early Apollo manned *circumlunar mission* wherein the spacecraft may orbit the moon several times and return to earth without a lunar landing.

CIS - Communications and Instrumentation System

CISLUNAR - Pertaining to space between earth and moon, or between earth and the moon's orbit. See TRANSLUNAR.

CK - Command Keyboard

CKT - Circuit

CL - Clear; Closed Loop

CLA - Contingency Landing Area (as opposed to prime, or intended, recovery areas)

CLAM - Command Load Acceptance Message

CLC - Command Load Controller, an operating position in the CCATS area of the MCC

CLINICAL MONITORING SET - Part of crew equipment for Apollo flights, containing stethoscope, thermometer and device for measuring blood pressure.

CLM - Circumlunar Mission (see CIRCUMLUNAR)

CLOSED LOOP - Automatic control units linked together by a process to form an endless chain.

CLR - Clear

CLT - Communications Line Terminal

CM - Command Module (of Apollo spacecraft); Center of Mass

CMC - Command Computer

CMD - Command

CMP - Command Module Pilot (see definition)

CNB - Canberra, Australia, MSFN station (see CANBERRA)

CNT - Count

CNU - CSM Navigation Update

CNV - Cape Kennedy DOD-Eastern Test Range station (see CAPE)

C/O - Cutoff; Checkout

CO - Carbon monoxide

CO₂ - Carbon dioxide

COASTAL SENTRY - See CSQ

COLD CATHODE GAUGE EXPERIMENT - Experiment to study lunar atmosphere, part of ALSEP (see ALSEP).

COLD-FLOW TEST - Test for conditioning and flow of propellants; tank pressurization, propellant loading and feeding, without firing the engines.

COMM - Communications; Communications System

COMBUSTION INSTABILITY - Unsteady or abnormal combustion of rocket engine fuel.

COMBUSTION OSCILLATION - High-frequency pressure variations caused by uneven propellant consumption.

COMMAND AND SERVICE MODULE - Combination of command module and service module, which remains in lunar orbit after the lunar module descends to the moon. The command and service modules are not separated from each other until shortly before re-entry to earth's atmosphere.

COMMAND DESTRICT - System which destroys the vehicle, actuated on command of the range safety officer when vehicle performance degrades enough to threaten safety. The radio signal which detonates an explosive in the vehicle is the *command destruct signal*.

COMMANDER - See SPACECRAFT COMMANDER

COMMAND MODULE - Apollo spacecraft's control center and living quarters for most of the

lunar voyage. A cone 12 feet high by 12 feet, 10 inches at the base, it is the only part of the spacecraft that will re-enter the earth's atmosphere after the trip. It provides about 70 feet of living area per man, nearly double what was available in the Gemini spacecraft, weighs about 12,500 lb. at launch, and is covered by an all-over heat shield. It has about 2 million functional parts and 15 miles of wiring.

COMMAND MODULE PILOT - The title of the second member of the flight crew, occupying the center couch in the command module, the one crew member who will not set foot on the lunar surface during a lunar mission but remain in the command module in lunar orbit. He is the expert on CM systems, the primary navigator during the trip and the second man in seniority.

COMPANION BODY - See AFTERBODY

COMPARATOR - Electronic processing instrument that compares one set of data with another.

COMPOSITE PROPELLANT - Solid rocket fuel containing fuel and oxidizer.

COMSAT - Communications Satellite Corporation (INTELSAT)

COMSPK - Communications Speaker

COMTECH - Communications Technician

CONDUCTION - Transfer of heat by molecular impact.

CONFIGURATION - Shape; figure or pattern formed by relative position of various things.

CONSOLE - Term applied to grouping of controls, indicators and similar equipment, for monitoring and control of particular sequence of actions, usually housed together in a metal shell.

CONSTANT WEAR GARMENT - Astronaut flight "underwear" or "shirtsleeves", worn under pressure suit. (Pressure suits will be removed for a part of the flight.) Replaced by liquid-cooled garment during lunar exploration.

CONTROL ROCKET - RCS thrusters, vernier rocket, ullage rocket, or retro-rocket used to guide, accelerate or decelerate a space vehicle, as opposed to main propulsion engines.

CONVECTION - Mass motions within a fluid or gas; transfer of heat by currents in the fluid or gas, the currents being produced by unequal heating and expansion.

CONVERSION TABLE -

LENGTH

| | | | | |
|----------------|-------|--------|--------|-------------------------|
| Centimeters | times | 0.3937 | equals | inches |
| Meters | times | 1.0936 | equals | yards |
| Kilometers | times | 0.6214 | equals | miles |
| Miles | times | 0.8684 | equals | nautical miles (N. Mi.) |
| Nautical miles | times | 1.15 | equals | miles |

VELOCITY

| | | | | |
|--------------------|-------|---------|--------|--------------------|
| Feet per minute | times | 0.01136 | equals | miles per hour |
| Feet per second | times | 0.6818 | equals | miles per hour |
| Miles per hour | times | 1.467 | equals | feet per second |
| Miles per hour | times | 0.8684 | equals | knots (N. Mi./Hr.) |
| Knots (N. Mi./Hr.) | times | 1.1515 | equals | miles per hour |

COPY - Synonym for read (see definition), or to read and take down radio transmitted information.

CORIOLIS FORCE - Deflection of a projectile in flight due to the Earth's rotation, diverting horizontal motions to the right in the northern hemisphere and to the left in the southern hemisphere.

CORIOLIS REACTION - Occurs when a man in a spinning aircraft or spacecraft moves his head in the opposite direction; produces severe vertigo, dizziness, nausea, etc.; Neil Armstrong experienced this on Gemini 8 flight when his spacecraft roll rate reached one revolution per second due to a stuck thruster.

COSMIC DUST - Finely divided solid matter (in particles smaller than micrometeorites) moving in interplanetary space.

COSMIC RAYS - High-energy subatomic particles, mostly protons and hydrogen nuclei, which travel the solar system and bombard the earth from all directions.

CORONA - The faintly luminous outer envelope of the sun.

COSPAR - Committee on Space Research of the International Council of Scientific Unions, to which the U. S. belongs through the National Academy of Sciences.

COUNTDOWN - Step-by-step process of preparation for launch, measured in T-time (see definition).

COUPLING DISPLAY UNIT - Assembly of electro-magnetic transducers and gears, and displays to present coordinated data from the Apollo guidance and navigation equipment; couples analog signals of IMU and optics, and converts to digital signals for guidance computer.

COZI - Communications Zone

CP - Control Panel; Control Programmer; Control Point; Communications Processor

CPLEE - Charged Particle Lunar Environment Experiment (see definition)

CPS - Cycles Per Second

CPU - Central (or Communications) Processing Unit (in MCC)

CRITICOM - Critical Communications

CRAWLER-TRANSPORTER - Tank-like mover used to position the Mobile Launch Tower for the Saturn V in the VAB at Cape Kennedy, move tower and Saturn/Apollo (a total weight of over 12 million pounds) three miles to the launch pad after assembly, and move the Mobile Service Structure into place at the pad. Some 131 by 114 feet, the crawler is powered by two 2750-horsepower diesel engines and moves on four double-tracked tank-type treads.

CRAWLERWAY - Special dual roadway from VAB to launch pad, designed to support 17-1/2 million pounds. It is equivalent in width to an 18-lane parkway with a 50-foot median strip and the road-bed is 6-1/2 feet deep.

CREWMAN ALIGNMENT SIGHT - Range-finder type of device used to help astronauts align the command or lunar modules with each other during docking; can be mounted to sight through either rendezvous window.

CRO - Carnarvon, Australia, MSFN station (see CARNAVON).

CRYO - Cryogenic (see definition)

CRYOGENIC - Super-cold, -195°C or less. Refers to fuels or oxidizers which are liquid only at very low temperatures, such as the liquid hydrogen (-423 degrees F) and liquid oxygen (-197 degrees F) used in the Saturn S-IVB stage.

CRYOGENIC GAS STORAGE SYSTEM - System supplying hydrogen and oxygen to fuel cells in the spacecraft, and oxygen for breathing by the crew; they are stored in a semi-gas/semi-liquid state and warmed to a gaseous state.

CS - Command (or Communications) System

CSC - Communications Systems Center

CSCC - Communications System Control Console; Command Support Control Console

CSI - Concentric Sequence Initiation Maneuver (of lunar module)

CSM - Command and Service Module (see definition)

CSQ - USNS Coastal Sentry Quebec, a DOD-Eastern Test Range shipboard station equipped with C-Band radar and telemetry and voice facilities for near-earth orbital mission support.

CSS - Crew Safety System

CSW - Canberra (Australia) Switching Center

CTC - CCATS Telemetry Controller, an operating support position in the MCC

CTE - Central Timing Equipment (see definition)

CTF - C-Band Temperature

CTGY - Contingency

CTN - Canton Island MSFN station (see CANTON).

CW - Continuous Wave

CYI - Grand Canary Island, Spain, MSFN Station (see CANARY).

D

D - Downrange distance during launch

DA - Digital-to-Analog; Dip Angle

DAC - DA Converter

DC - Direct Current

DA&P - Data Acquisition and Processing

DAILY METABOLIC REQUIREMENT - For a man of 154 pounds, about two pounds of oxygen, five pounds of water and a pound of solid food a day. He produces waste products of about two

pounds of carbon dioxide and six pounds of water, urea, minerals and solids. The intake rate is used as a rule of thumb in loading human consumables such as water and oxygen for space flight.

DAMPING - Restraining; slowing down or stopping, usually attitude movements such as roll rate.

DAS - Data Acquisition System

DATA DUMP - See TAPE DUMP

DATA REDUCTION - Transformation of observed values into useful, ordered, and sometimes simplified information.

DB - Decibel (see definition)

D&C - Display and Control (System in the MCC)

DC - Differential correction

DCTVDS - Digital Color TV Display System (in the MCC)

DCU - Data Control Unit; Display and Control Unit

DCU-R - Data Control Unit-Receive (spacecraft)

DCU-T - Data Control Unit-Transmit (spacecraft)

DCV - Direct Current Volts

DDAS - Digital Data Acquisition System

DDS - Data Display System

DE - Descent Engine

DEADBAND - In a control system, the range of values through which a measure can be varied without an effective response; the "play" in the control.

DEBRIEFING - Interrogation of crewmen or others involved after a mission or test in order to obtain useful information.

DEBUG - To isolate and remove malfunctions from a device or system, or mistakes from a routine or program such as a computer program.

DEC - Declination (see definition)

DECA - Descent Engine Control Assembly

DECELERATION - Negative acceleration; rate of loss in velocity

DECIBEL - A measure of sound. The human ear has a comfortable range of 1-130 decibels, 1 being the faintest sound a human can hear.

Sounds over 130 decibels cause pain.

DECLINATION - Angular distance north or south of the celestial equator; the arc of an hour circle between the celestial equator and a point on the celestial sphere (an imaginary sphere assumed for navigational purposes, the center of which coincides with the center of the earth) measured through 90 degrees and labeled north or south to indicate the direction of measurement.

DEEP SPACE - Any space other than that near the Earth.

DEG - Degree

DELTA - Differential

DELTA P (ΔP) - Pressure change

DELTA V (ΔV) - Velocity change

DESCENT ENGINE - The gimballed engine on the lunar module descent stage which may be throttled to any thrust power between 1050 and 10,500 pounds, operated automatically by the guidance and navigation control system or manually by the LM crew. It is used to descend from the command module (in lunar orbit) to the surface of the moon.

DESCENT STAGE - Lower portion of the lunar module, shaped like an octagon, containing descent engine and propellant tanks, landing gear, and storage sections. It serves as a launching platform for the ascent stage when the crew lifts off from the moon, and remains behind on the lunar surface.

DESTRUCT - Detonating a vehicle after launch because it is varying so widely from its intended course as to threaten safety.

DET - Digital Event Timer (see EVENT TIMER)

DF - Direct Flight (see definition); Direction Finding

DGS - Data Ground Station

DIGITAL COMPUTER - A computer which uses the principal of counting as opposed to measuring. (See ANALOG COMPUTER.)

DIPLEXER - Device which permits an antenna system to be used simultaneously by two transmitters.

DIRECT FLIGHT - Flight mode that accomplishes a mission without rendezvous, refueling in

space, or other combination maneuver.

DISPLAY - Visual or graphic presentation of the output from any system, usually measuring devices, processed through a computer system.

DISPLAY AND CONTROL SYSTEM - Consoles in which all display and control devices of various systems are mounted, including computer devices.

DISTRAM - Digital Space Trajectory and Vectoring System

DMT - Detailed Maneuver Table (rendezvous)

DNR - Downrange (see definition)

DOCKING - Closing and locking together two spacecraft following rendezvous.

DOCKING DROGUE - Latching device in the lunar module into which the command module probe is pushed during docking; may be mounted or removed from the transfer tunnel by the crew.

DOCKING LATCHES - Four semi-automatic and eight manual latches to hold the command and lunar modules firmly together when docked; the semi-automatic latches operate the docking probe retraction mechanism when engaged.

DOCKING PROBE - Three-legged extendable device attached to the docking ring on the command module which engages a drogue on the lunar module firmly together; may be mounted or removed from the transfer tunnel by the crew.

DOCKING RING - Aluminum structure just forward of the top command module hatch containing the lunar/command module seals and a pyro charge, and serving as a mounting point for the docking probe and latches.

DOCKING SYSTEM - Docking ring, probe, drogue, latches, crew alignment sight and extensible tubular member device to be used in docking and crew transfer (see definitions.)

DOCKING TUNNEL - Tunnel through which crew transfers between lunar and command modules, located half in the nose of the command module and half in the top of the lunar module; contains mounting points for probe and drogue.

DOD - Department of Defense

DOF - Degree of Freedom (gyroscopes). Direction of Flight

DOMES - Top of large fuel or oxidizer tanks on Saturn launch vehicles.

DOPPLER EFFECT - An apparant change in the frequency of sound waves (pitch), light, radio and radar waves when the distance between the source and the observer or receiver is changing. The shift of receding stars toward the red line in the spectrum is used to measure their distance and velocity (*Doppler Shift*); *Doppler Radar* measures the velocity of a moving object by measuring the shift in carrier frequency of the return signal as the object approaches or recedes from the radar station.

DOPPLER VELOCITY AND POSITION - A tracking system using radio signals sent from a ground station to spacecraft, and returned to the earth on a different frequency. (See above.)

DOS - Department of Supply (Australia). This department operates the three Australian tracking stations for the MSFN at Woomera, Canberra and Carnarvon.

DOSIMETER - Device worn on right side of astronaut helmets and in pockets of the constant wear garment for measuring and recording the amount of radiation to which the astronaut is exposed.

DOVAP - Doppler Velocity and Positioning System (see definition)

DOWNLINK - The part of the communications system that receives, processes and displays data from the spacecraft.

DOWNRANGE - Direction away from launch site toward impact or target area.

DOWNTIME - Total time during which a system is not in condition to function, due to repair, preparation, etc.

DPS - Degrees Per Second; Descent Propulsion System

DRAG - Resistance of the air to a body in motion (see LIFT-TO-DRAG RATIO).

DRAIN RATE - Rate at which electrical power in the system is being consumed.

DRO - Digital Readout

DROGUE PARACHUTES - Two 13.7-foot diameter parachutes which are deployed by mortar cartridges two seconds after the command module

apex cover is jettisoned (at 24,000 feet) during re-entry. They remain reefed (tied) for 8 seconds before opening fully, and are released from the spacecraft before it reaches the 10,000-foot level, where the pilot chutes begin to deploy the main parachutes. The drogue chutes serve only to slow the hurtling spacecraft before the opening of the main parachutes.

DRUL - Downrange Uplink (see DOWNRANGE; UPLINK)

DRY WEIGHT - Weight of booster, spacecraft or stage of a booster without its fuel or other consumables being counted.

DS - Descent System; Docking System

DSB - Double Sideband (see SIDEBAND)

DSC - Dynamic Standby Computer

DSE - Data Storage Equipment (see TAPE RECORDER)

DSEA - Data Storage Electronic Assembly (LM)

DSS - Deep Space Station (see CNB, GDS, MAD)

DT - Dump Telemetry (see TAPE DUMP)

DTTY - Digital-to-Teletype

DTU - Data Transmission Unit

DTV - Digital-to-Television

DUAL PLANE SEPARATION MODE - Method of separation used by the Saturn V in dropping its first stage after burnout, whereby the stage falls away first and the aft interstage of the second stage falls away 30 seconds later, so that the stages actually separate in two places or planes.

DUMP - See TAPE DUMP

DUPLEXER - Device permitting a single antenna system to be used for both transmitting and receiving.

DVD - Delta-V Display (see DELTA V)

DVO - Delta-V On/Off (see DELTA V)

DVU - Delta-V Ullage (see DELTA V; ULLAGE)

DYN - Dynamics

DYNAMIC PRESSURE - Pressure exerted by fluid or gas (air) due to its motion; pressure exerted on an object due to its motion through a fluid or gas, such as on a rocket moving through the atmosphere. The symbol for dynamic pressure is Q . (See MAX Q)

E

EAFB - Eglin AFB, Fla.; Ellington AFB, Houston, Tex.; Edwards AFB, Cal.

EAO - Experiments Activities Officer

EARTH LANDING SYSTEM - Parachute deployment system in the command module.

EARTH ORBIT RENDEZVOUS - Flight mode involving rendezvous and docking, fueling, or transfer in earth parking orbit before continuation of flight.

EBULLISM - Formation of water vapor bubbles in body fluids, caused by low ambient pressure; the boiling of body fluids.

EBW - Exploding Bridgewire (see definition)

ECA - Electronic Control Assembly (SCS)

ECCENTRIC - Not having the same center; varying from a circle. An eccentric orbit is a highly elliptical one with a very high apogee and low perigee. Eccentricity is the degree of deviation from a circular orbit.

ECG - Electrocardiogram (see definition)

ECK - Emergency Communications Key [The push-to-talk switch (see definition) can be used like a telegraph key for emergency transmission.]

ECLIPTIC - Plane of the earth's orbit around the sun, used as a reference plane for other interplanetary orbits.

ECO - Engine Cutoff

ECS - Environmental Control System (see definition)

ECU - Environmental Control Unit (major part of ECS)

ED - Ephemeris Data (see EPHEMERIS); Explosive Device

EDS - Emergency Detection System

EECOM - Electrical Environmental and Communications monitoring console (in MCC)

EEG - Electroencephalogram (see definition)

EEM - Earth Entry Module

EFSSS - Engine Failure Sensing and Shutdown System (Saturn booster)

EGADS - Electronic Ground Arm Destruct Sequencer, used by the range safety officer to destroy

a missile in flight. *EGADS Button* is what he pushes.

EGRESS - As a verb, to exit the spacecraft. As an adjective, describes the exit hatchway, procedures for exiting, etc.

EGT - Elapsed Ground Time; Exhaust Gas Temperature (fuel cell)

EKG - Electrocardiogram (see definition)

EL - Elevation

ELASTICIZER - Elastic substance used in solid rocket fuel to prevent cracking of the propellant grain and to bind the fuel to the combustion chamber case.

ELCA - Earth Landing Control Area

ELECTRICAL POWER SYSTEM - One of two in the Apollo spacecraft. The CM-ECS supplies power to the command module and has major components in both command and service modules. The LM-ECS supplies power to the LM. Both consist of batteries and fuel cells.

ELECTROCARDIOGRAM - Record of heart muscle action made by electric current or voltage wave forms.

ELECTROENCEPHALOGRAPH - Record of brain voltages or waves.

ELECTROMYROGRAPH - Electronic device for recording muscle responses.

ELECTROSTATIC - Electricity at rest; stationary electrical particles.

ELEPHANT EAR - Launch crew term for thick plate on booster to reinforce a hatch or hole.

ELLIPSE - An elongated circle.

ELS - Earth Landing System (see definition)

EM - Escape Motor (see LAUNCH ESCAPE MOTOR)

EMG - Electromyograph (see definition)

EMU - Extravehicular Mobility Unit (see definition)

ENGINE SPRAY - The part of the launch site water deluge fire system directed specifically at cooling the booster combustion chambers during launch.

ENTRY CORRIDOR - Flight path of a spacecraft before and during re-entry. At the velocities attained on a return from the moon, the

path is critical and narrow. Too steep a re-entry and the spacecraft will incur too much heat from air friction; too shallow an entry and the spacecraft will skip out of the atmosphere again like a stone skipping on water.

ENVIRONMENTAL CONTROL SYSTEM - System which maintains 75-degree, 100% oxygen cabin and pressure suit atmosphere, provides hot and cold water, removal of CO₂ odors, waste and heat and recharging of portable life support systems. Components are located in all three spacecraft modules, but primarily in the command module.

EO - Earth Orbit
EOL - Earth Orbit Launch
EOM - Earth Orbital Monitor; Earth Orbit Mission; End of Message
EOR - Earth Orbital Rendezvous (see definition)
EOS - Emergency Oxygen System
EPHEMERIS - Book of tables giving computed daily positions of celestial bodies.
EPO - Earth Parking Orbit (as used initially in lunar mission).
EPS - Electrical Power System (see definition)
EQUI-PERIOD TRANSFER ORBIT - Elliptical lunar orbit to be used by LM to approach within some 50,000 feet of the lunar surface, while maintaining the same orbital period as that of the command and service module.
ERO - European Research Organization
ERS - Earth Recovery System
ESCAPE TOWER - See LAUNCH ESCAPE SYSTEM
ESCAPE VELOCITY - Speed required to overcome the gravitational pull of the earth, and leave the ground or earth parking orbit for deep space; about seven miles per second.
ESCT - Elapsed Spacecraft Time
ESM - Environmental Systems Monitor
ESOP - Event Sequence Override Panel
ESS - Emergency Survival System; Entry Survival System
ET - Elapsed Time; Escape Tower; Estimated Time
ETA - Estimated Time of Arrival (or Acquisition)

ETC - Estimated Time of Correction
ETMD - Extendable Tubular Member Device (see definition)
ETR - Eastern Test Range (formerly AMR)
ETT - Estimated Time of Track
EV - Extravehicular (see definition)
EVA - Extravehicular Activity
EVENT TIMER - Instrument that times an event and records time taken to perform it; a sort of stopwatch.
EVSC - Extravehicular Suit Communications
EVSS - Extravehicular Spacesuit
EVSTC - Extravehicular Suit Telemetry and Communications
EVT - Extravehicular Transfer
EXP - Experiment; Exposure
EXPLODING BRIDGEWIRE - Metal wire which disintegrates at high temperature produced by a large electrical pulse, used for initiating stage retrorockets, separation systems, etc.
EXPLOSIVE BOLT - Bolt incorporating an explosive which explodes on a remote command, releasing whatever was bolted.
EXTENDABLE TUBULAR MEMBER DEVICE - Emergency device for use by the crew in transferring between lunar and command modules if a malfunction prevents docking, or prevents removal of docking drogue and probe from the transfer tunnel; a flat metallic strip that forms a tube when unwound from its storage reel, the end of which hooks onto the command module near the side hatch. Astronaut or equipment can be reeled into the command module.
EXTRADOP - Extended Range DOVAP (see DOVAP)
EXTRATERRESTRIAL - From outside the earth
EXTRAVEHICULAR - Outside the spacecraft
EXTRAVEHICULAR MOBILITY UNIT - The moon suit, including water-cooled undergarment, pressure suit, thermal micrometeoroid garment, boots, gloves, helmet, visors, and portable life support system (backpack), to be used during exploration of the lunar surface.

EYEBALLS DOWN - Pilot's term for positive acceleration stress or G-Force, experienced in a head-to-feet direction, as in the lunar module during ascent.

EYEBALLS IN - Ascent force when crew is lying supine; G-Force in a chest-to-back direction, as during Saturn/Apollo launch.

EYEBALLS OUT - Deceleration stress, in a back-to-chest direction, experience during re-entry.

EYEBALLS UP - Negative G-Force, or acceleration stress in a feet-to-head direction, as experienced in the lunar module during descent braking.

F
F - Fahrenheit

F-1 ENGINE - The first-stage engines of the Saturn V. Five of them clustered in the first stage generate a total of 7.5 million pounds of thrust (1.5 million lbs. each) to lift the 6-million-pound vehicle from a standing start. (This will be uprated to 7.6 million lbs. beginning with the second manned Saturn V flight). They burn a total of 203,000 gallons (1,359,000 lb.) of RP-1 fuel and 331,000 gallons (3,133,000 lb.) of LOX at a ratio of 1 to 2.27. Total burn time is 2-1/2 minutes, by which time the Saturn/Apollo is going 6,000 miles per hour at an altitude of 38 miles.

FAIRING - A streamlined cover used to cover a nonstreamlined object or smooth a junction between two parts or sections.

FB - Feedback

FC - Flight Control; Flight Controller; Fuel Cell

FCC - Flight Control Computer

FCD - Flight Control Division (NASA-MSC)

FCO - Flight Crew Operations

FCS - Flight Control System

FD - Flight Director

FDAI - Flight Director Attitude Indicator (see definition)

FDO - Flight Dynamics Officer (also FIDO)

FDRI - Flight Director Rate Indicator

FEB - Forward Equipment Bay (see LEFT-, RIGHT-HAND FEB)

FHS - Forward Heat Shield (see definition)

FIDO - Flight Dynamics Officer (also FDO)

FIDS - Flight Information Display System

FINAL APPROACH EQUIPMENT (SYSTEM) - System involving the combined usage of Apollo guidance and navigation system, radar, radio altimeter, etc. required in approach and landing either on the moon or earth.

FIRE DELUGE SYSTEM - Remote-controlled pipes, hoses, spray outlets, etc. throughout launch area for deluging the area in event of a fire or explosion on the pad.

FIRE DETECTION SYSTEM - System of thermocouple sensors in the aft thrust structure and fire-wall of the Saturn first stage to detect a fire prior to engine ignition; transmits automatic signal to LCC to start a deluge of cold gaseous nitrogen in the engine compartment.

FIRING ROOM - Room in Launch Control Center of Complex 39 containing controls to monitor and initiate the operation of each facility; controlled from the pad terminal connection room.

FLAME DEFLECTOR - Inverted V-shaped steel devices covered with heat-resistant materials to protect Saturn launch pads from the rocket flame during liftoff. Pad 34 and 37 flame deflectors are fixed; the Pad 39 flame deflector is mobile, moving on rails.

FLARE - Solar flare; bright eruption from sun's chromosphere, associated with burst of high solar radiation.

FLASHBACK - Reversal of flame in a system, counter to its usual direction, such as in a rocket engine.

FLASHING BEACON - Light attached to the top of the command module, which flashes like a strobe light to aid recovery planes in the event of night splashdown.

FLIGHT DIRECTOR ATTITUDE INDICATOR - Device on command module control panel which displays spacecraft attitude, attitude error and rate of attitude change for the crew. Signals are supplied to the FDAI by the guidance and

navigation and stabilization and control systems.

FLIGHT MEASUREMENT PROGRAM - Some 440 separate measurements of events and conditions in the Saturn IB first stage, or about 900 measurements of the Saturn V first stage which are telemetered to the ground during the stage's flight.

FLUTTER - Unstable oscillation of an airfoil in flight caused by the aerodynamic, inertial and elastic characteristics of the components themselves.

FLUX - Rate of flow of some form of energy.

FLY-AWAY DISCONNECTS - Umbilical or other connections between ground or tower and space vehicle which drop away at liftoff.

FM - Frequency Modulation

F/O - Fuel to Oxidizer Ratio

FOD - Flight Operations Division (or Director) (NASA-MSD)

FOOTPRINT - Area of possible landing of the spacecraft based on where it enters the atmosphere, speed, lift-to-drag ratio, etc. The pattern of possible landing points at the time of re-entry forms a footprint-shaped pattern due to the aerodynamic characteristics of the spacecraft.

FOP - Flight Operations Plan (flight plan)

FORWARD HEAT SHIELD - Portion of the command module heat shield near the apex, above the crew compartment.

FP - Fuel Pressure

FPM - Feet per Minute

FPQ - Fixed, Ground, Special-Purpose Radar

FPS - Feet per Second; Frames per Second (motion pictures and TV)

FREE FLIGHT - The flight path or trajectory beginning with the end of propulsion and ending at re-entry. The Apollo spacecraft is in free flight while in earth orbit. Sometimes called free fall.

FREE GYRO - Gyroscope which maintains its orientation with respect to the stars rather than the earth; space reference gyro.

FSECO - First Stage Engine Cutoff

FSS - First Stage Separation

FU - Fuel

FUEL CELL - Device which produces electricity (the main product), water and heat by chemically combining oxygen and hydrogen; uses two electrodes and an electrolyte solution (potassium hydroxide). There are three fuel cell power plants (31 fuel cells each) in the command module, the main source of spacecraft electrical power. The water produced is used for drinking.

FV - Fuel Valve

FWD - Forward

G - The force of Earth gravity, approximately 32 feet per second per second in terms of acceleration. A man accelerated by a rocket at a force of 7 g's "weighs" seven times his normal weight when standing on the ground. Personnel in the centrifuge at MSC have withstood as much as 15 g's for a few seconds. High g forces are best withstood in a chest-to-back direction, "eyeballs in."

GANTRY - Slang for service structure or mobile service structure (see definition).

GARBAGE - Slang for miscellaneous objects left in orbit, such as fairings, burned-out boosters or waste material ejected from spacecraft.

GAS CAP - The compressed air immediately in front of a space vehicle as it hurtles through the atmosphere.

GAS CHROMATOGRAPH - Device carried in the command module to separate and analyze the makeup of gases.

GBI - Grand Bahama Island DOD-Eastern Test Range Station (see BAHAMA)

GBM - Grand Bahama Island MSFN station (see BAHAMA)

G&C - Guidance and Control

GC - Gigacycles (1000 megacycles)

GCC - Goddard Computing and/or Communication Center

GDO - Guidance Officer

GDS - Goldstone, Calif., MSFN station (see GOLDSTONE)

GEGENSCHEIN - Faint light area in the sky, always opposite to the sun on the celestial sphere, believed to be a reflection of sunlight from cosmic dust moving beyond Earth's orbit.

GET - Ground-Elapsed Time; time measured on the ground since the moment of liftoff. The following are abbreviations of event times measured in GET.

GETBOE - Predicted GET of Exit from Blackout

GETBOI - Predicted GET of Initiation of Blackout

GETCO - GET of Termination of Abort Burn

GETIG - GET of Insertion of Abort Burn

GETLC - Predicted GET of Spacecraft Impact

GETTE - GET of Termination of the Insertion Burn.

GH₂ - Gaseous Hydrogen

GHe - Gaseous Helium (used to pressurize propellant tanks)

GIGA - Prefix meaning multiplied by 1,000,000,000.

GIMBAL - Device with two perpendicular and intersecting axes of rotation, on which a reaction engine can be mounted, and which allows it to move or swivel in two directions. As a verb, or swivel or move the motor to correct angle of flight. A motor so mounted is a *gimballed engine*, such as the four outboard engines of the Saturn V first stage.

GIMBAL ACTUATOR ASSEMBLY - Two sealed motor units started by signals from the spacecraft, used to change direction of SPS engine thrust.

GIMBAL POSITION INDICATOR - Display showing angular position of pitch and yaw SPS engine gimbal; also shows fuel tank pressure of second and third booster stages while they are attached to the spacecraft.

GLITCH- Originally, a minute voltage surge in an electrical line which sometimes triggers hairspring-sensitive devices fed off the line. The word has now come to mean a hitch or problem of any nature, especially during a countdown.

GLY - Glycol

GLYCOL - Ethylene glycol, a form of alcohol mixed with water and used for cooling cabin and suit temperatures in the environmental control systems. See WATER GLYCOL.

GMT - Greenwich Mean Time; the mean solar time of the meridian of Greenwich, England, used as a standard throughout the world, particularly in spaceflight. Some abbreviations beginning with GMT are listed below.

GMTLO - GMT of Launch Opportunity (or Lift-off)

GMTOI - GMT of Orbital Insertion

GMTA - GMT of Apogee Crossing

GMTTL - GMT of Translunar Insertion

GMTMC - GMT of Midcourse Correction

GMTLR - GMT of Lunar Rendezvous

GMTBS - GMT of Bug Separation

GMTDM - GMT of Descent Maneuver

GMTBL - GMT of Bug Landing

GMTBT - GMT of Bug Takeoff

GMTTE - GMT of Transearth Injection

GMTRE - GMT of Re-entry

G & N - Guidance and Navigation (System - see definition)

G&N ATTITUDE CONTROL MODE - One of modes in which SCS can be operated; automatically maintains spacecraft attitude based on compared signals from the IMU and coupling display unit.

G&N DELTA-V MODE - One of modes in which SCS can be operated; primary mode when spacecraft velocity changes are required. Controlled by guidance computer, SCS rate gyro signals and thrust vector control electronics.

G&N ENTRY MODE - One of modes in which SCS can be operated; provides automatic control of command module attitude and lift during re-entry.

GN₂ - Gaseous Nitrogen (used for purging propellant tanks)

GNATT - Guidance and Navigation Attitude

GNC - Guidance, Navigation and Control (System); Guidance Navigation Computer (see GUIDANCE COMPUTER)

GO - Functioning properly (ready to proceed)

GO₂ - Gaseous Oxygen.

GODDARD SPACE FLIGHT CENTER - Nerve center for the global communications network linking

NASA tracking stations, used for both manned and unmanned flights; has extensive data acquisition and computer equipment. Located in Greenbelt, Md., a northeast suburb of Washington, D. C.

GOLDSTONE - Goldstone, Cal., site of MSFN station, equipped with 85-foot dual antenna and S-Band capability for full lunar mission support; one of three such stations.

GOSS - Ground Operational Support System (see definition)

GOX - Gaseous Oxygen

GRAIN - Elongated molding of solid propellant for a rocket.

GRAND BAHAMA - See BAHAMA

GRAND CANARY - See CANARY

GRAND TURK - Grand Turk Island (U. K.) in the West Indies east of Cuba, site of DOD-Eastern Test Range Station equipped with C-Band radar, UHF command and VHF voice and telemetry capability for near-earth orbital mission support.

GRASS - Random interference on a radarscope.

GRAVIPAUSE - Neutral point between two planets or satellites where the gravity of one equals the gravity of the other. Between earth and moon, the gravipause is about nine tenths of the distance to the moon, or about 23,760 miles from the lunar surface.

GP/FPI - Gimbal Position and Fuel Pressure Indicator (See GIMBAL POSITION INDICATOR)

GPI - Gimbal Position Indicator (see definition)

GPM - Gallons Per Minute

GROUND OPERATIONAL SUPPORT SYSTEM - Equipment including that for mission control (the MCC), guidance, navigation, tracking, telemetry, communications, logistics and recovery operation, which is used to support manned flights.

GROUND SUPPORT EQUIPMENT - Ground equipment used to inspect, test, adjust, calibrate, gauge, measure, repair, overhaul, assemble or disassemble, transport, guard, record, store or otherwise support a space vehicle either in research and development or operational phases.

GSE - Ground Support Equipment (see definition)

GSFC - Goddard Space Flight Center, Greenbelt, Md. (see definition)

GTK - Grand Turk Island DOD-Eastern Test Range station (see GRAND TURK)

GUAM - Guam Island in the Marianas, site of MSFN station equipped with a 30-foot dual antenna and S-Band capability for earth orbital and limited lunar mission support.

GUAYMAS - Guaymas, Mexico, MSFN station equipped with a 30-foot dual antenna and S-Band capability for earth orbital and limited lunar mission support.

GUID - Guidance

GUIDANCE AND CONTROL SYSTEM - Includes both the Guidance and Navigation System and Stabilization and Control System

GUIDANCE AND NAVIGATION SYSTEM - Apollo's inertial guidance system which provides boost monitoring during the launch phase and Earth parking orbit, and guidance during all other phases of the lunar mission. Separate systems are located in the CM and the LM. Included in the CM are an inertial measurement unit, sextant, Apollo guidance computer, scanning telescope, coupling display units, display and controls and power servo assembly.

GUIDANCE COMPUTER - A digital computer using both erasable and fixed memory; used to compute deviations from required flight path and calculate necessary attitude and thrust commands to correct them.

GUIDO - Guidance Officer

GWM - Guam Island MSFN station (see GUAM).

GYM - Guaymas, Mexico, MSFN station (see GUAYMAS).

GYROSCOPE - Device which utilizes angular momentum of a spinning rotar to sense angular motion of its base about one or two axes at right angles to the spin axis. *Gyro-compass* is a compass which works on the basis of the gyroscope. *Gyro drift* is the angular rate of change of a gyroscope as it deviates from perfect performance.

H₂ - Hydrogen

H-1 ENGINE - First-stage engine of the Saturn IB rated at 2 million pounds thrust. Eight of them burn a total of 42,100 gallons (281,600 pounds) of RP-1 fuel and 66,900 gallons (629,900 pounds) of liquid oxygen in 2.5 minutes to reach an altitude of 37 miles at 5,250 miles an hour.

HA - Harness Assembly (see definition); Height of Apogee; Hazardous Area

HAA - High Altitude Abort (above 120,000 feet)

HARDWARE - Physical equipment (engines, pumps, guidance system, etc.) as opposed to its capability or function.

HARDWIRE LINK - Direct connection of a vehicle system to another system by wire; for instance, a measuring system to a recording system.

HARNESS ASSEMBLY - Two or more electrical conductors laced or jacketed together and assembled with connectors.

HASH - Clutter of unsynchronized signals on a radar screen.

HAW - Hawaii MSFN station (see below).

HAWAII - Kauai Island, Hawaii, MSFN station, equipped with 30-foot dual antenna and S-Band capability for earth-orbital and limited lunar mission support.

HBR - High Bit Rate

HC - Hand Control

HCA - Horizon Crossing Ascending

HCD - Horizon Crossing Descending

HE - Heat Exchanger; Helium (see definitions)

HEAT EXCHANGER - Device for transferring heat from one fluid to another without intermixing the fluids. In CM cabin, unwanted heat is absorbed by a water glycol mixture and transported to space radiators.

HEAT FLOW EXPERIMENT - ALSEP (see definition) experiment to measure heat from the moon's interior.

HEAT SHIELD - Covering that protects a re-entry spacecraft such as the command module from aerodynamic heating. See ABLATION.

HEAT SINK - A relatively cool area in a system which contains or dissipates heat; a heat

sink may be provided by cold-soaking in advance a system which is about to encounter excessive heat.

HELIUM - Gas used in spacecraft and booster to pressurize fuel propellant tanks and force fuel into feed lines.

HERTZ - One cycle per second

HF - High Frequency (3-30 megacycles)

HF E - Heat Flow Experiment (see definition)

HFRA - HF Recovery Antenna (see definition)

HF TRANSCEIVER - Device to aid recovery operations after landing; provides single sideband or double sideband voice and beacon signal transmission to aid in locating command module.

HF RECOVERY ANTENNA - Whip antenna deployed by crew at top of command module after landing, for use with HF transceiver.

HFX - HF Transceiver (see definition)

HGA - High Gain Antenna (2000 mc)

HGT/ALT - Height/Altitude (feet)

H₂O - Water

HOHMAN TRANSFER - Flight path from earth orbit of the moon or other planets which requires the minimum of energy. See TANGENTIAL ELLIPSE.

HOLD - Delay in the launching countdown, scheduled or unscheduled, lasting from seconds to days. May result from technical problems with booster or spacecraft, communications, tracking, or weather. Some holds are scheduled in advance to adjust the launch time.

HON - Honolulu, Hawaii, Switching Center.

HOVER AND TRANSLATION MANEUVER - Maneuver of the lunar module during lunar descent to remain at a stationary attitude above the moon's surface while moving laterally above the landing area.

HP - Height of Perigee (see PERIGEE)

HRA - HF Recovery Antenna (see definition)

HRT - High Resolution Tracking

HS - High Speed; Horizon Scanner (or Sensor); Height Above Spherical Earth; Heat Shield.

H₂S - Hydrogen Sulfide
HSCL - High-Speed Command Link (see UPDATA LINK)
HSD - High-Speed Data
HSLT - High-Speed Telemetry Link
HSP - High-Speed Printer
HTV - USNS Huntsville DOD-Western Test Range station (see below)
HUNTSVILLE - USNS Huntsville, DOD-Western Test Range shipboard station, equipped with S-Band capability for earth orbital and limited lunar mission support.
HV - High Voltage
HYDROSTATIC PRESSURE - Pressure exerted by a column of liquid (water, blood, etc.) under normal earth gravity or under the G-force of acceleration.
HYPERBOLIC RE-ENTRY - Re-entry at speeds above 37,000 fps (25,226 mph)
HYPERGOLIC - Self-igniting. Hypergolic fuel ignites spontaneously upon contact with its oxidizer, thereby eliminating the need for an ignition system. An example is aerzine and nitrogen tetroxide used in the spacecraft RCS thrusters.
HYPERSONIC - Speeds faster than Mach 5 (five times the speed of sound)
HYPOXIA - Lack of sufficient oxygen to maintain life, either in the air being breathed, or from inability of the body tissues to absorb oxygen under low pressure.
HZ - Hertz (see definition)

I - Inclination (of orbit. See definition)
IBP - Initial Boiling Point
ICM - Instrumentation and Communications
ID - Identification
IECO - Inboard Engine Cutoff
IEM - Internal Environment Monitoring
IF - Interface (see definition); Intermediate Frequency
IFA - In-Flight Analysis
IFR - Instrument Flight Rules
IG - Inner Gimbal (see STABILIZED PLATFORM)

IGA - Inner Gimbal Axis (or Angle; Stabilized Platform)
IGE - Instrumentation Ground Equipment
IGN - Ignition
IGNITER - Pyrotechnic squib used to ignite fuel in a rocket engine. *Ignition* is the initiation of combustion in the thrust chamber. The *ignition stage* is that portion of the starting sequence wherein combustion is initiated and stabilized at a low level. In the H-1 and J-2 engines, oxidizer flow is established by gravity alone and fuel is supplied from the start system. The mixture is then ignited.
IGS - Inertial Guidance System (see definition)
ILCC - Integrated Launch Checkout and Control (System)
IMP - Interplanetary Monitoring Platform; Impulse
IMPELLER - Device that imparts motion to fluid or air.
IMU - Inertial Measurement Unit (see definition)
INCLINATION - An angle between two lines or two planes, such as the plane of a spacecraft's orbit and the plane of the earth's equator.
INDUCER - A portion of a centrifugal pump which increases the pressure and motion ("whirl") of a fluid before it reaches the impeller.
INERTIA - The tendency of an object at rest to stay put, and of an object in motion to continue that motion in the same direction and at the same speed, until gravity or some other force slows or stops it. An *inertial orbit* is the orbit of a spacecraft which is not under any propulsive power. It continues to "fall" or "coast" around the earth at the same speed it had reached when propulsion ended, about 17,500 mph. Since men and objects inside the spacecraft are moving at the same speed, a man exiting the spacecraft continues to move along with the vehicle, and it is motionless relative to the man outside.
INERTIAL GUIDANCE - A navigation system using gyroscopic devices and a computer to absorb and interpret such information as speed, position etc. It automatically adjusts the vehicle to a predetermined flight path.

More simply, it knows where its going and where it is by knowing where it came from and how it got there.

INERTIAL MEASUREMENT UNIT - The main unit of the Apollo inertial guidance system, consisting of a stabilized platform (inertial platform) containing three inertial reference integrating gyros, three integrating accelerometers and three angular differentiating accelerometers. It senses any attitude changes or acceleration of the spacecraft.

INERTIAL REFERENCE INTEGRATING GYRO - A single-degree-of-freedom gyro which senses displacement of the stable platform on which it is mounted, and generates signals accordingly.

INFRARED - Electromagnetic radiation of wavelengths from the red end of the visible color spectrum to the microwaves used in radar; light in which the rays lie just below the red end of the spectrum.

INGRESS - As a verb, getting into the spacecraft; as an adjective, describes the entrance hatch, etc.

INJ - Injection (see definition)

INJECTION - (1) The introduction of fuel and oxidizer into the combustion chamber of an engine. The device to do this is an *injector*. (2) The process of putting a spacecraft from earth orbit into a translunar trajectory. (Transfer from launch trajectory to earth orbit is usually called insertion.)

INS - Insertion; Insertion Ship; Inertial Navigation System

INSERTION - Transfer from launch trajectory to orbit.

INSTANTANEOUS READOUT - Readout (by radio transmitter or visual display) of computed information which proceeds instantly as the data is computed.

INSTRUMENT UNIT - In the Saturn booster, an adapter section between launch vehicle and spacecraft, some 3 feet tall, which houses the booster guidance system, telemetry equipment and power supply. It determines booster's course and adapts it as necessary, measures vehicle conditions during flight and radios this information to the ground,

and can initiate an automatic abort in case of emergency.

INTEGRAL TANK - Fuel or oxidizer tank using the skin of the vehicle as its outer wall.

INTEGRATION, TRANSPORT AND LAUNCH CONCEPT - The concept employed with the Saturn V/Apollo, wherein the booster and spacecraft are assembled and checked out in a building away from the launch pad (the VAB) and the entire vehicle is then moved to the pad as a unit.

INTERFACE - The common boundary between one part of a booster, spacecraft or system and another; the place where two parts of a system meet.

INTERFEROMETER - Device which produces and measures interference from two or more wave trains from the same source.

INTEGRATING ACCELEROMETER - A mechanical and electrical device which measures force of acceleration along the longitudinal axis, records velocity and measures the distance traveled.

INTERPLANETARY - Between planets.

INTERSTAGE - Between booster stages. See AFT INTERSTAGE.

INV - Inverter (see definition)

INVERTER - A device for converting direct current produced by spacecraft fuel cells or batteries to alternating current.

I/O - Input/Output

ION - An electrically charged atom or group of atoms. Heat, or radiation will ionize (change into ions) the atoms of a gas such as air. The heat of re-entry forms a layer of ions round the spacecraft, called the *ionized plasma sheath*, which temporarily blacks out radio communication with the craft (See BLACKOUT)

IORA - Indian Ocean Recovery Area

IOS - Indian Ocean Station (or Ship)

IP - Impact Point (or Predictor)

IPB - Illuminated Pushbutton (see PBI)

IPS - Instrumentation Power System

IR - Infrared (see definition)

IRG - Inertial Rate Gyro

IRIG - Inertial Reference Integrating Gyro (see definition)

ISB - Independent Sideband (see SIDEBAND)

ISOSTATIC - Under equal pressure from every side.

I_{sp} - Specific Impulse (see definition)

ISP - Inches per second

ISS - Input Subsystem; Internal (spacecraft) Switching System

ITC(C) - Instrumentation Tracking Controller (Console)

IU - Instrument Unit (see definition)

IVA - Intravehicular Activity (activity inside vehicles, or between two vehicles)

IVI - Incremental Velocity Indicator

J-2 ENGINE - A 225,000-pound thrust upper-stage engine using liquid hydrogen and liquid oxygen propellants, with a built-in restart capability in flight. The S-IVB stage of the Saturn IB and Saturn V is powered by one J-2; the S-II stage of Saturn V by five J-2's with a total thrust of more than 1 million pounds. J-2's have a rated run duration of 500 seconds, or about 8 minutes. It takes some 38,000 pounds (64,000 gallons) of liquid hydrogen and 191,000 pounds (20,000 gallons) of liquid oxygen to fuel the J-2 in the S-IVB stage.

JERK - A vector that specifies the time rate of change of an acceleration; third derivative of displacement with respect to time.

JET STREAM - In spaceflight, the stream of gas expelled by a reaction engine.

JETT - Jettison (to toss or push away; discard)

JITTER - Unstable motion of signal on a radar screen.

J/M - Jettison Motor (see TOWER JETTISON MOTOR)

JPL - Jet Propulsion Laboratory, Pasadena, Cal. Operated for NASA by Cal. Tech.

JUMPING THE COUNT - Advancing the countdown (scheduled time of launch).

K - Symbol for kilo, prefix meaning thousand; Kelvin (see definition)

KB - Kilobits

KBPS - Kilobits per second

KC - Kilocycle (thousand cycles)

KELVIN - Temperature scale on which the degrees equal Centigrade degrees, but on which 0 equals absolute zero.

KENNEDY SPACE CENTER - The John F. Kennedy Space Center at Cape Kennedy (formerly Cape Canaveral) near Cocoa Beach, Florida, some 50 miles east of Orlando on Florida's east coast. Includes, for the Apollo program, launch complexes 34 and 37 for the launch of Saturn IB's and the huge 80,000 acre Merritt Island Launch Area (MILA) for the Saturn V.

KHZ - Kilohertz (thousand Hertz)

KMC - Kilomegacycles (thousand-million, or billion cycles. Also called gigacycles.)

KOH - Potassium Hydroxide (electrolyte used in fuel cells)

KSC - Kennedy Space Center

KV - Kilovolt (thousand volts)

KW - Kilowatt (thousand watts)

LAT - Latitude

LANT - Atlantic Ocean

LAUNCH COMPLEX - Entire complex for preparation and launch of spacecraft and booster, including the pad, service structure, umbilical tower, launch control center, fuel storage and loading facilities and support and check-out equipment.

LAUNCH COMPLEX 34 - A launch complex for Saturn I and Saturn IB flights, including AS 201 and 203, the first two unmanned suborbital Saturn IB flights, and AS 205 (Apollo 7), the first manned flight.

LAUNCH COMPLEX 37 - Situated about 0.7 miles north of LC-34; includes two launch pads, A and B used for Saturn IB flights including AS 203, the first unmanned orbital flight of Saturn IB.

LAUNCH COMPLEX 39 - Located at Merritt Island Launch Area and used for Saturn V flights. Includes two launch pads (A and B), and facilities for assembly of entire Saturn/Apollo stack, which is checked out in the vertical

assembly building before being moved to the pad as a unit. (See VERTICAL ASSEMBLY BUILDING, MOBILE SERVICE STRUCTURE, LAUNCH CONTROL CENTER, MOBILE LAUNCHER, CRAWLER TRANSPORTER, CRAWLERWAY.)

LAUNCH CONTROL CENTER - Igloo-type two-story blockhouse located near LC-34 and 37, designed to withstand blast pressures of 2200 pounds per square inch and housing personnel, instrumentation and control equipment involved in ground checkout and launch. At LC-39, a four-story building southeast of the VAB for checkout, test operations, final countdown and launch of Saturn V's, including ACE and Saturn ground computer systems.

LAUNCH ESCAPE MOTOR - Provides 147,000 pounds of thrust for 3 seconds to pull the command module up and away from the booster in an emergency. (See below.)

LAUNCH ESCAPE PROPULSION SYSTEM - Cluster of three solid-fuel (polysulfide) rocket motors at the top of the launch escape tower. They are the Launch Escape Motor, Pitch Control Motor and Tower Jettison Motor (see definitions).

LAUNCH ESCAPE SYSTEM - The tower on top of the Apollo command module, its propulsion system (see above), its Q-ball or nose cone, and the boost protective cover (to protect the command module from LES rocket exhaust). The system is intended to pull the command module safely away from the booster in the event of a pad or low-altitude emergency. See also CANARD.

LAUNCH OPERATIONS CENTER - Center responsible for integration, test, checkout and launch of space vehicle systems at the Eastern Test Range, Cape Kennedy.

LAUNCH UMBILICAL TOWER - Fixed tower at LC-34 and LC-37 for supporting umbilical arms, with a chamber at spacecraft hatch level and an elevator for crew entry and exit. Tower at LC-39 is mobile; see MOBILE LAUNCHER.

LAUNCH VEHICLE - Booster, as opposed to spacecraft; the Apollo program utilizes the Saturn IB and Saturn V boosters.

LAUNCH VEHICLE DATA ADAPTER - Device in Saturn which receives acceleration and attitude measurements from the inertial platform and

updating commands from the ground and sends attitude signals to the booster's control computer and monitoring signals to spacecraft displays.

LAUNCH VEHICLE DIGITAL COMPUTER - High-speed digital computer which is one of the major components of the booster guidance and control system; located in the instrument unit. Parameters for a particular launch window are fed to the computer, which senses vehicle acceleration, direction and time since launch and determines burn time for engines and direction of thrust required. The signals are passed to the analog control computer for generation of proper control commands.

LAUNCH WINDOW - Limited period of time during which launch can occur if the vehicle is to accomplish its planned mission; limited by position of earth and moon, booster's propulsion capabilities, guidance limits, time of dawn or sunset or both at the site and in downrange recovery or abort recovery areas, etc.

LC - Launch Complex; Launch Coordinator; Launch Countdown

LC-34, -37, -39 - Saturn launch complexes at Cape Kennedy (see definition)

LCC - Launch Control Center (see definition)

LCG - Liquid-Cooled Garment (see definition)

LCO - Launch Control Officer

LCS - Launch Control System

L/D - Lift-to-Drag Ratio (see definition)

LD - London (England) Switching Center

LDS - Launch Data System

LE - Launch Escape

LEB - Lower Equipment Bay (see definition)

LEC - Launch Escape Control

LECA - Launch Escape Control Area

LEFT-HAND EQUIPMENT BAY - Bay to the left of the couches in the command modules containing water, oxygen control panels, and an environmental control unit.

LEFT-HAND FORWARD EQUIPMENT BAY - The command module storage bay above the lower equipment bay at the foot of the couches, which

contains clothing, pressure suit connectors, and the cabin heat exchanger.

LEM - Launch Escape Motor (see definition)

LEPS - Launch Escape Propulsion System (see definition); Launch Escape Pitch Control (see PITCH CONTROL MOTOR)

LES - Launch Escape System (see definition)

LESC - Launch Escape System Control

LET - Launch Escape Tower (see LAUNCH ESCAPE SYSTEM)

LETCS - Launch Escape Tower Canard System (see CANARDS)

LEV - Launch Escape Vehicle

LGC - LM Guidance Computer

LH₂ - Liquid Hydrogen (see definition)

LHe - Liquid Helium (see HELIUM)

LHEB - Left-Hand Equipment Bay (see definition)

LHFEB - Left-Hand Forward Equipment Bay (see definition)

LHSC - Left-Hand Side Console

LIBRATION - Real or apparent oscillatory motion, particularly the oscillatory motion of the moon.

LIFT-TO-DRAG RATIO - Ratio of the spacecraft's aerodynamic lifting force to the drag force of the atmosphere, used in determining the rate of descent of the spacecraft during re-entry. The Apollo command module has a lift-over-drag ratio of about 0.35.

LIOH - Lithium Hydroxide (see definition)

LIQUID-COOLED GARMENT - The undergarment, worn beneath the pressure suit, which will be used for lunar exploration on the 250-degree lunar surface. A small electrical pump in the backpack circulates the water through tiny capillary tubes throughout the garment, and a heat changer in the backpack recools it each cycle.

LIQUID HYDROGEN - High-energy cryogenic fuel which turns from liquid to gas at -423 degrees F; produces, pound for pound, 40 percent more thrust than RP-1 when combined with liquid oxygen.

LIQUID OXYGEN - Cryogenic oxidizer, used by all stages of Saturn booster, which turns from liquid to gas at -297 degrees F. Usually called LOX for short.

LITHIUM HYDROXIDE - Substance used to remove exhaled carbon dioxide from oxygen atmosphere of crew cabin and suit before recirculating the oxygen. Carried in four-pound cannisters, 28 of which are sufficient for a 14-day mission.

LLM - Lunar Landing Mission

LLS - Lunar Landing Site

LLV - Lunar Landing Vehicle

LM - Lunar Module (see definition); Landmark

LM PROPULSION SYSTEM - Descent and ascent engines in the LM, the former a throttleable (1,050 to 10,500 pounds thrust) engine for descent to the lunar surface from the command module, the latter a 3500-pound thrust engine for launching the ascent stage from the moon, using the descent stage as a launch platform.

LME - Launch Monitor Equipment

LMP - Lunar Mission Programmer; Lunar Module Pilot (see definition)

LN₂ - Liquid Nitrogen (see GN₂)

LO - Liftoff; Launch Operations

LOB - Launch Operations Building (see OPERATIONS SUPPORT BUILDING)

LOC - Launch Operations Center (see definition)

LOI - Lunar Orbit Insertion

LOM - Lunar Orbital Mission

LONG - Longitude

LOR - Lunar Orbit Rendezvous (see definition)

LOS - Loss of Signal; Line of Sight

LOWER EQUIPMENT BAY - Largest storage area in command module, located at foot of the crew couches, containing everything from a sextant and telescope to the Apollo guidance computer; location of the navigation duty station.

LOX - Liquid Oxygen (see definition)

LP - Lower (Control) Panel

LPGE - LM Partial Guidance Equipment

LR - Lunar Rendezvous (see LUNAR ORBIT RENDEZVOUS)

LRL - Lunar Receiving Laboratory (see definition)

LSD - Launch Systems Data; Low Speed Data

LSM - Lunar Surface Magnetometer (see definition)

LSO - Lunar Surface Operations; Life Systems Officer

LSS - Life Support System(s)

LSSC - LM Separation Sequence Controller

LTA - Lunar Test Article (a "fake" LM used in unmanned tests)

LTDS - Launch Trajectory Data System; Launch and Tracking Data System

LTS - Launch Tracking Stations; Launch Telemetry System; Lift-off Transmission Systems

LTU - Lift-off Time Update.

LUCOM - Lunar Communications (Systems)

LUNAR GRAVITY - One/sixth that of earth

LUNAR MODULE - The bug-like cabin, resting on an octagonal base and four support legs, which will ferry two astronauts from the command module in lunar orbit, provide a base of operations on the lunar surface and return them to the command module; 19 feet tall by 29 feet wide, carried with legs folded in the spacecraft/LM adapter (SLA) between service module and booster instrument unit during launch. See ASCENT STAGE, DESCENT STAGE.

LUNAR MODULE PILOT - The third man of the Apollo crew; occupying the right couch in the command module, he is the primary expert on lunar module systems. He is occupied largely with spacecraft systems monitoring, especially of the electrical and communications systems, during the translunar and transearth phases of the flight. One of the two men who will descend to the surface of the moon.

LUNAR ORBIT RENDEZVOUS - The method to be used for the lunar voyage, whereby the lunar module will deliver astronauts from a lunar parking orbit (where the command and service module will remain) to the moon and bring them back. When the astronauts are inside

the command module again, the command and service module blasts off for earth, leaving the lunar module "ferry" in lunar orbit.

LUNAR RECEIVING LABORATORY - The specially-constructed quarantine and laboratory facility at NASA-MSC in Houston, Texas, where astronauts and samples returning from the moon will be housed for several weeks after they return. Rock samples will be analyzed, tested and studied first in this facility before further distribution to laboratories all over the world.

LUNAR SURFACE MAGNETOMETER - ALSEP (see definition) experiment to measure the moon's magnetic field.

LUT - Launch Umbilical Tower (see definition)

LV - Launch Vehicle (see definition); Local Vertical

LVDA - Launch Vehicle Data Adapter (see definition)

LVDC - Launch Vehicle Digital Computer (see definition)

LVGC - S-IVB Launch Vehicle Guidance Computer

LVM - Launch Vehicle Monitor

LVSE - Launch Vehicle Systems Engineer

LW - Launch Window (see definition)

LWD - Launch Window Display

MAD - Madrid, Spain MSFN Station (see below)

MADRID - Madrid, Spain, MSFN Station, equipped with an 85-foot dual antenna and S-Band facilities for full lunar mission support; one of three such stations.

MAGNETOMETER - Instrument to be carried aboard the lunar mission, used to determine the direction and size of the lunar magnetic field.

MANNED SPACECRAFT CENTER - One of 11 NASA research and development centers scattered around the country, MSC is responsible for the development and operation of the Mercury, Gemini and Apollo spacecraft and associated equipment, flight control of all manned NASA missions and for selection and training of astronauts. Located in the Clear Lake area of Houston, Texas, 25 miles from downtown Houston.

MANNED SPACE FLIGHT NETWORK - Worldwide network of 17 land stations (supplemented by 10 DOD Eastern or Western Test Range land stations, eight advanced range instrumentation aircraft and eight ships) which supports Apollo manned flights with nearly continuous radar tracking, command signals, telemetry reception and voice contact. MSFN, which includes the MCC in Houston, the LCC at Cape Kennedy and a computing and communications center at Goddard Space Flight Center, is the responsibility of Goddard. Tracking stations are divided into three groupings: lunar mission support stations, equipped with 85-foot dual antennas (see CNB, GDS, MAD); earth orbital and limited lunar mission support stations equipped with S-Band facilities (see ACN, ANG, BDA, CRO, CYI, GBM, GWM, GYM, HAW, HTV, MER, MIL, RED, TEX, VAN, WTN, and ARIA); and the near-earth-orbital mission support stations, most of them modified Gemini network stations without S-Band facilities (see ANT, ASC, CAL, CNV, CSQ, CTN, GBI, GTK, MLA, PAT, PRE, RKV, RTK, TAN, WHS and WOM).

MAN-RATED - Adjective applied to spacecraft, boosters, test items such as a centrifuge and test chambers which have achieved the standards of reliability and safety considered acceptable for human occupancy or for use on a manned flight.

MANUAL THRUST VECTOR CONTROL MODE - One of modes in which the stabilization and control system may be operated; permits manual commands from the rotation control to position the SPS engine gimbals.

MARSHALL SPACE FLIGHT CENTER - NASA center charged with development of Saturn launch vehicles for the Apollo program, including extensive in-house manufacturing and testing capability; located at Redstone Arsenal outside Huntsville, Ala.

MASTER EVENTS SEQUENCE CONTROLLER - Device which provides control and timing for events during ascent, abort and earth landing.

MATE - To assemble two major components of a system, such as two stages of a booster, two modules of a spacecraft, or a spacecraft and booster with each other.

MAX-Q - Maximum dynamic pressure; the point during launch of a booster when the ascending

vehicle is subjected to its severest aerodynamic strain (for the Saturn IB, just over a minute and a quarter after lift-off).

MC - Message Center (in MCC); Midcourse Correction (see definition); Manual Control; Megacycles

MCC - Mission Control Center (see definition)

MD - Mission Director

MDS - Malfunction Detection System

MDV - Map/Data Viewer

MEC - Manual Emergency Controls

MECO - Main Engine Cutoff

MED - Medical; Manual Entry Device

MEDICAL KIT - Equipment and medicine carried in the spacecraft for emergency treatment of illness or injury, including drugs and dressings.

MEE - Mission-Essential Equipment

MEGA - Prefix meaning multiplied by one million

MEMORY - Component of a computer, guidance or control system which records and stores instructions and data while maintaining ready access to the data so that it can be retrieved to solve a problem at any time.

MER - USNS Mercury DOD-Western Test Range station (see below).

MERCURY - USNS Mercury, a DOD-Western Test Range shipboard station equipped with S-Band facilities for earth-orbital and limited lunar mission support.

MERRITT - Merritt Island, Fla., site of MILA and of two tracking stations. The MSFN station (MIL) is equipped with a 30-foot dual antenna and S-Band facilities for earth-orbital and limited lunar mission support. The DOD-Eastern Test Range station (MLA) is equipped with C-Band radar, UHF command and VHF voice and telemetry capability for near-earth-orbital mission support.

MERRITT ISLAND LAUNCH AREA - 80,000 acre site on an island in Florida's Banana River on which is located assembly and launch facilities for Saturn V-Apollo. It is north of the shared NASA-military facilities from which Mercury Atlas and Gemini-Titan launches were made.

MESC - Master Events Sequence Controller (see definition)

MET - Mission Elapsed Time

METEOROID - Solid particles of matter traveling in space at considerable speed. See MICRO-METEOROID.

METRO - Meteorology

MFCO - Manual Fuel Cutoff

MFD - Mission Flight Director

MFV - Main Fuel Valve

MG - Middle Gimbal (see STABILIZED PLATFORM); Motor Generator

MGA - Middle Gimbal Angle (or Axis; see STABILIZED PLATFORM)

MGE - Maintenance Ground Equipment

MHz - Megahertz

MICRO - Prefix meaning divided by 1,000,000, or very small

MICROMETEOROID - Solid particles of matter, less than a millimeter in size, traveling in space.

MIDCOURSE - Refers to activities of lunar mission between earth orbit and lunar orbit. Astronauts will perform *midcourse navigation*, taking optical sightings of star angles and feeding the information to the guidance computer to determine spacecraft position and velocity. Three *midcourse corrections* are performed between earth and moon, with the computer determining the thrust vector and velocity change needed, automatically positioning the spacecraft, and controlling the SPS engine thrust.

MIIA - Merritt Island Industrial Area

MIL - Merritt Island, Fla., MSFN Station (see MERRITT)

MILA - Merritt Island Launch Area (see definition)

MILD DETONATING FUSE - Flexible metal sheath around a core of high explosive in the form of a cord of any desired length, used to separate booster stages, such as the S-IVB stage from the S-II or S-IB stages.

MILK STOOL - Physical arrangement of the three storable propellant rocket engines located

below the main pressure vessel of the LM.

MILLI - Prefix meaning one thousandth

MIN - Minutes (latitude and longitude, for rendezvous; or time)

MISSION CONTROL CENTER - Centralized control point for all phases of Apollo flights, located at the Manned Spacecraft Center in Houston, Texas. See FOREWORD.

MISSION OPERATIONS CONTROL ROOM - Windowless room housing display and control consoles where incoming flight information is displayed and from which the flight is controlled. See FOREWORD.

MISSION OPERATIONS WING - Wing of Mission Control Center which houses two Mission Operations Control Rooms on the second and third floors.

MISSION PROFILE - Flight plan showing all pertinent events scheduled.

MITE - Master Instrumentation and Timing Equipment

MLA - Merritt Island, Fla., DOD-Eastern Test Range Station (see MERRITT).

MLT - Mobile Launch Tower (see definition)

MM - Midcourse Maneuver (see MIDCOURSE); Maximum/Minimum; Millimeter

MMH - Monomethyl Hydrazine (see definition)

M&O - Maintenance and Operations

MOBILE LAUNCH TOWER - Also called Mobile Launcher. Movable launch platform half an acre in size with a 380-foot umbilical tower mounted on it. Base and tower weight 10.5 million pounds and stand 445 feet above ground level, with 18 platforms. It is moved into the VAB, where the Saturn V is assembled on it, then moved to LC-39. It stays with the vehicle until it is launched.

MOBILE SERVICE STRUCTURE - A 400-foot tall steel-truss structure with five platforms, two of them powered and all adjustable, for servicing the Saturn V at LC-39 before launch. It is moved to its parking area 7000 feet away about seven hours before the launch.

MOC - Mission Operations Computer

MOCR - Mission Operations Control Room (see definition)

MOD - Module (see definition)

MODE - Method or sequence of performing a task or sequence of tasks.

MODULE - Section of a spacecraft, or combination of components contained in one package or mounting, which serves one complete function.

MONOMETHYL HYDRAZINE - A component of Aerozine (see AEROZINE).

MONOPROPELLANT - Rocket fuel in which fuel and oxidizer are premixed, ready for immediate use.

MOSL - Mission Operations Support Laboratory

MOW - Mission Operations Wing (see definition)

MPE - Maximum Permissible Exposure (to radiation)

MPM - Maximum Propellant Mission

μ s - Microsecond (millionth)

MS - Millisecond (thousandth)

MSC - Manned Spacecraft Center (see definition)

MSCO - Manual Sustainer (engine) Cutoff

MSEC - Millisecond (thousandth)

MSFC - Marshall Space Flight Center, Huntsville, Ala. (see definition)

MSFN - Manned Space Flight Network (see definition)

MSK - Manual Select Keyboard

MSS - Mobile Service Structure (see definition)

MTS - Master Timing System

MTU - Magnetic Tape Unit (see TAPE DUMP)

MULTI-ENGINE-OUT CAPABILITY - Ability of Saturn first stage to continue flight with more than one engine out; occurs at certain point in launch phase (for Saturn IB, about 10 seconds after liftoff)

MULTIPLEXER - Device for the sharing of a circuit by two or more coincident signals; a device which collects data from many sources and arranges it for simultaneous transmission over a single network. That transmission is called multiplexing. The signals may be separated by time division, frequency division or phase division.

MURPHY'S LAW - The so-called scientific "law" which states: "What can go wrong will go wrong."

MUX (OR MX) - Multiplexer (see definition)

N₂ - Nitrogen

NASA - National Aeronautics and Space Administration (see definition)

NASC - National Aeronautics and Space Council (see definition)

NASCOM - NASA Communications Network; the worldwide network which links all tracking stations, the MCC and LCC with teletype, voice and digital data links, and is the responsibility of Goddard Space Flight Center, Greenbelt, Md. See SCAMA.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION - Civilian agency with research and development responsibility for aeronautical and space activities with the express exception of those primarily associated with weapons systems and military operations.

NATIONAL AERONAUTICS AND SPACE COUNCIL - Statutory advisory council to the President, consisting of the Secretary of Defense, the Administrator of NASA, Chairman of the AEC, Secretary of State and other members as selected by the president.

NAUTICAL MILE - A distance of 6,076.1 feet, or about 1.15 statute miles, used in naval and sea operations, particularly in recovery operations. (See CONVERSION TABLE).

NAV - Navigation

NAVIGATION BASE - Rigid supporting structure for IMU, and sextant and telescope.

NB - Navigation Base (see definition)

NC - Network Controller (or Coordinator, or Countdown); No Contact; Nose Cone (see definition); Normally Closed (Switch)

NCC - Corrective Combination (for rendezvous)

NCI - Phase Adjust Maneuver (rendezvous)

NEG - Negative

NEUTRAL POINT - See NULL POINT

N&G - Navigation and Guidance (see GUIDANCE and NAVIGATION)

NH - Height Adjust Maneuver (rendezvous)

N_2H_4 - Hydrazine (fuel)

NITROGEN TETROXIDE - Oxidizer used in all Apollo spacecraft reaction and attitude control engines, the service propulsion engine, and the lunar module ascent and descent engines. The fuel used with it is either monomethyl hydrazine or blended hydrazine.

NM (OR N.MI.) - Nautical Mile (see definition)

N/O - Normally Open

N_2O_4 - Nitrogen Tetroxide (see definition)

NO GO - Functioning improperly; not ready to proceed

NOISE - Any unwanted sound or disturbance on a useful frequency band which interferes with clear reception of radio or radar signals.

NORAD - North American Air Defense (Command)

NOSE CONE - See LAUNCH ESCAPE SYSTEM; Q-BALL.

NRTF - Navy Recovery Task Force

N/S - Near Space

NSC - Navigation Star Catalogue

NSEC - Nanosecond (Billionth)

NSF - National Science Foundation

NSIF - Near Space Instrumentation Facility

NSR - Circularization Maneuver (rendezvous)

NST - (Flight) Network Support Team

NTO - Nitrogen Tetroxide (see definition)

NULL POINT, NULL CIRCLE - Theoretical point in space where gravitational attraction of one planet balances that of another. Since parts of the solar system are always moving in relation to each other, the null circle is theoretical rather than real.

O_2 - Oxygen

OA - Omnidirectional Antenna (see definition)

O&C - Operations and Checkout

OCCULTATION - The disappearance of one body behind another or larger apparent size, such as the disappearance of the moon "behind" the earth.

OCPS - Oxygen and Cabin Pressure Control Section (of CM)

OCS - Onboard Checkout System

OD - Operations Director

ODCU - Optics Coupling Display Unit (see COUPLING DISPLAY UNIT)

ODM - One-Day Mission

ODOP - Offset Doppler Tracking System (see DOVAP)

ODRN - Orbiting Data Relay Network

OECO - Outboard Engine Cutoff

O/F - Oxidizer-to-Fuel (Ratio)

OG - Outer Gimbal (see STABILIZED PLATFORM)

OGA - Outer Gimbal Angle (or Axis; see STABILIZED PLATFORM)

OGE - Operational Ground Equipment (part of AGE)

OL - Open Loop; Overload

OMNI - Omnidirectional (all directions)

OMNIDIRECTIONAL ANTENNA - Antenna having a non-directional pattern in azimuth and a directional pattern in elevation; there are two VHF omnidirectional antennas on the service module, and four S-Band omnidirectional antennas on the command module.

OMU - Optical Measuring Unit (scanning telescope and sextant in spacecraft)

OPEN ENDED MISSION - Flight for which there is no stated duration, but which continues as long as equipment is working properly or until all flight objectives are met.

OPEN LOOP - A control system in which there is no self-correction action as there is in a closed-loop system.

OPERATIONAL FLIGHT CONTROL - In-flight control by the onboard crew after the launch vehicle separation.

OPERATIONAL GROUND EQUIPMENT - A functional part of a system which operates with the flight vehicle; part of the aerospace ground equipment (see definition).

OPERATIONS SUPPORT BUILDING - Building which houses maintenance areas and engineering activities for launch complexes 34 and 37, located adjacent to the LC-34 LCC.

OPS - Operations Director

OPTICAL NAVIGATION - Navigation by optical sighting as opposed to mathematical methods.

ORBIT - Spacecraft's path around earth or moon, beginning and ending at a fixed point in *space* and requiring only 360 degrees of travel. (The point on the *earth* where the orbit began will not be the same, since during the period of orbit, the earth will have revolved in the same direction. Compare REVOLUTION.) *Orbital confirmation* is mathematical confirmation on the basis of tracking data that a stable orbit has been achieved by the spacecraft. *Orbit nodes* are the points in an orbit where the path crosses a specified reference plane such as the equatorial plane. An *orbital period* is the time it takes for the spacecraft to complete one orbit; this depends on height and velocity. *Orbital velocity* is that required to establish and maintain a spacecraft in orbit.

ORDNANCE INSTALLATIONS - Components of spacecraft systems considered hazardous; explosive components such as pyrotechnic squibs, explosive bolts, exploding bridgewires, hypergolic igniters and solid propellant motors.

ORDNANCE TOWER - Specific structure where ordnance items are installed, checked out and connected in a relatively remote area and under closely controlled conditions.

OSW - Operations Support Wing (of MCC)

OT - Optical Tracker

OTOLITH - Portion of the inner ear which plays a part in the sense of balance and orientation.

OUTGASSING - The tendency of some solid materials to produce gas in a hard vacuum, such as in space or in a depressurized spacecraft.

OVERBURN - Overlong burn of engines resulting in too much speed, or arrival at incorrect position if not corrected.

OX (OR OXID) - Oxidizer (see definition)

OXIDIZER - Substance that supplies the oxygen necessary for burning. (Normal burning on earth utilizes the free oxygen in the atmosphere for this purpose.)

ΔP (DELTA-P) - Pressure change

PA - Pad Abort (see PAD); Pressure-Actuated (switch); Power Amplifier

PAC - Pacific Ocean

PACE - Prelaunch Automatic Checkout Equipment

PAD - Area from which booster is launched; immediate launch site as opposed to complex. A *pad abort* is stopping the mission on the pad because of malfunction or other problems. The *pad chief* is the individual charged with coordinating the overall operations on the launch pad. The *pad deluge* is water sprayed on the pad during launch to disperse the heat of booster launching. The *pad terminal connection room* refers specifically to Complex 39, and contains connections between the launch control center and the mobile launch tower, as well as operations, checkout and monitoring equipment for the ECS, propellant and high-pressure-gas storage facilities.

PARABOLA - A curve or partial circle that does not return into itself. A *parabolic orbit*, or *parabola of escape*, is such that the spacecraft has escape velocity at every point along it. *Parabolic re-entry* is re-entry at speeds of less than 36,500 fps (24,886 mph).

PARACHUTE - One of eight in the Apollo earth landing system. The three main chutes are 83.5-foot ringsail chutes, any two of which could safely lower the 12,500-pound spacecraft to a water landing from 10,000 feet, where they are first deployed. (see PILOT CHUTES, DROGUE CHUTES.)

PARALLAX - The apparent displacement of any object viewed from two different points, or the apparent difference in direction of its motion; refers to everything from another object in space as seen from the spacecraft to the reading on a dial as viewed from two different couches in the spacecraft.

PARALLEL REDUNDENCY - Describes two methods or systems working at the same time to accomplish the same task, although either could handle it alone.

PARAMETER - A characteristic element or constant factor or value; often, a limiting value or set of values.

PARKING ORBIT - Intermediate orbit around the earth or moon where a spacecraft can await the proper moment for translunar or trans-earth injection.

PASSIVE SEISMIC EXPERIMENT - ALSEP (see definition) experiment to measure lunar quakes.

PAT - Patrick AFB, Fla. DOD-Eastern Test Range tracking station (see below)

PATRICK - Patrick AFB, Fla., site of DOD-Eastern Test Range tracking station equipped with C-Band radar for near-earth orbital mission support.

PAYLOAD - That which a booster carries over and above what is necessary to get it where it is going; the spacecraft.

PB - Pushbutton

PBI - Pushbutton Indicator (see definition)

PC - Pitch Control; Program Control; Printed Circuit

PCB - Printed Circuit Board

PCC - Pilot Control Console

PCHA - Pitch Attitude

PCM - Pulse Code Modulation (see definition); Pitch Control Motor (see definition)

PCMGS - PCM Ground Station

PCMTEA - Pulse Code Modulation and Timing Electronics Assembly

PDA - Precision Drive Axis (of the onboard sextant)

PENDULOUS INTEGRATING GYRO ACCELEROMETER - Part of the spacecraft stabilization and control system which provides acceleration data for automatic termination of the service propulsion engine, and for display.

PERICYNTHION - The perigee of orbit about the moon. Also called periselene.

PERIGEE - The point in an elliptical orbit at which the spacecraft is closest to earth. Its opposite, the highest point, is the apogee.

PERIHELION - The point in an orbit about the sun closest to the sun.

PERTURBATION - Disturbance in the regular motion

(orbit, etc.) of a planetary body or satellite.

PF - Powered Flight; Preflight

PFM - Pulse Frequency Modulation

PGA - Pressure Garment Assembly (see definition)

PGNCS - Primary Guidance and Navigation Control System

pH - Alkalinity to Acidity Content (hydrogen ion concentration in fuel cells)

PHONOCARIOGRAM - Measurement and recording of a heartbeat by sound.

PHOTOMETRY - Measurement of the intensity of light.

PICKET SHIP - Tracking or recovery ship supporting a space flight.

PICO - Prefix meaning one trillionth (.000000000001)

PIGA - Pendulous Integrating Gyroscopic Accelerometer (see definition)

PIGTAIL - Short, coiled connecting wire or bundle of wires, such as an igniter connection.

PILOT - See LUNAR MODULE PILOT, COMMAND MODULE PILOT.

PILOT CHUTE - Three ring-slot 'chutes in Apollo earth landing system that pull the main 'chutes out of their casings. They are fired by mortars at about 10,000 feet altitude and inflate to a diameter of 7.2 feet, pulling the main parachutes and shroud lines free.

PIP - Predicted Impact Point; as a word, the signal on oscilloscope screen of an electronic instrument produced by a sharply peaked voltage pulse.

PIPA - Pulsed Integrating Pendulous Accelerometer (see definition)

PITCH - Attitude movement of the spacecraft wherein the nose tips up or down, rotating around the Y (lateral) axis.

PITCH CONTROL MOTOR - Small rocket engine in the spacecraft's Launch Escape System that applies 2,850 pounds of sideways thrust for half a second after the Launch Escape Motor has been fired, to kick the ascending

spacecraft out of the path of the ascending booster behind it. (See LAUNCH ESCAPE SYSTEM.)

PITCHOVER - The programmed maneuver that turns the ascending booster during the launch phase from vertical flight to a more horizontal direction.

PKG - Phonocardiogram

PL - Postlanding

PLA - Planned Landing Area

PLASMA - The envelope of ionized gas particles which surrounds the spacecraft as it re-enters the atmosphere at hypersonic speed. Caused by the heat of re-entry, it interferes with radio and radar reception and transmission to and from the spacecraft (see BLACKOUT).

PLC - Propellant Loading Console (see definition)

PLIM - Postlaunch Instrumentation Message

PLO - Pacific Launch Operations

PLPS - Propellant Loading Pressurization System

PLSS - Portable Life Support System; Post-Landing Survival System (see definitions)

PLUS COUNT - The count from the moment of ignition of the booster forward, through the launch phase, lasting until the powered portion of the boost ends.

PLV - Post-Landing Ventilation (of command module)

PLVC - Post-Landing Ventilation Control

PM - Phase (or Pulse) Modulation (see PULSE CODE MODULATION)

PMP - Promodulation Processor (see definition)

P/O - Printout (of data from a computer)

PO - Parking Orbit (see definition)

POGO EFFECT - Vertical oscillation of booster stage, specifically Saturn V first stage, encountered in early flights.

POMS - Precision Orbital Measuring System

POO - Program zero-zero. (Term used for clearing the spacecraft computer or returning it to zero for another computation.)

PORTABLE LIFE SUPPORT SYSTEM - Backpack containing oxygen, water circulation and cooling, air condition, telemetry and communications equipment, worn for exploration of the lunar surface.

POS - Positive; Position; Pacific Ocean Ship

POSIGRADE MOTION - Orbital motion in the same direction as the spacecraft is already moving. A *posigrade thruster* or rocket is one which thrusts forward, or in the direction the vehicle is traveling.

POSITIVE G - Eyeballs down; acceleration experience in a downward (head-to-feet) direction.

POST-LANDING SURVIVAL SYSTEM - Survival kit stowed in the command module for use in case of landing in an unplanned or hostile environment. Contains water, a desalter kit, life raft, radio beacon, strobe flashlight, machete, medical kit, compass, etc.

POSTPASS - After the spacecraft's orbital pass overhead.

POT - Potable

POTABLE - Drinkable; usually refers to fuel-cell produced water.

POWER SERVO ASSEMBLY - Contains most of electronic modules used in G&N servo loops and power supplies.

PP - Partial Pressure; Postpass; Present Position

PPI - Plan Position Indicator

PPK - Pilot's Preference Kit

PPM - Parts Per Million; Pulses Per Minute

PPM - Pulse Position Modulation; Postpass Message

PPS - Pulses Per Second

PPS - Primary Propulsion System

PR - Pulse Rate

PRD - Pre-Retro Update Display (see definition)

PRE - Pretoria, South Africa, DOD Eastern Test Range tracking station (see below).

PRECESSION - Change in direction of the rotation axis of a spinning body or plane of an orbiting body when acted on by an outside force.

PREGNANT GUPPY - The unlikely-looking four-engined aircraft developed for transporting the S-IV stage of the Saturn I booster. Once the largest aircraft in the world, it has been replaced in this regard by the even larger Super Guppy. Both are owned by Aero Spacelines, Inc.

PRELORT - Precision Long-Range Tracking Radar

PREMODULATION PROCESSOR - Assimilation, integration and distribution center for all forms of spacecraft data (telemetry, data storage, television, central timing and audio signals) and voice and command signals from the ground. The processor mixes and switches the signals to the appropriate transmitter.

PRERETRO UPDATE - Update information on timing, duration and spacecraft attitude at retro-fire, sent to the spacecraft before re-entry.

PRESSURE GARMENT ASSEMBLY - Space suit, including inner comfort layer, pressure layer and outer restraint layer, boots, gloves, cloth earphone cap, and bubble helmet.

PRESTAGE - Prelaunch engine combustion sequence, in which a partial flow of propellants to the thrust chamber is started and ignition takes place.

PRETORIA - Pretoria, South Africa, site of DOD-Eastern Test Range station equipped with C-Band radar and VHF telemetry facilities for near-earth orbital mission support.

PREVALVES - Leakproof valves in propellant feed systems which open to allow propellant to reach the turbopumps before engine ignition.

PRIMARY VOICE LINK - Radio frequency promising most efficient voice communication under current condition of flight; usually VHF/AM in near-earth orbit, and S-Band in deep space.

PRM - Posigrade Rocket Motor (such as ullage rockets; see POSIGRADE)

PRN - Pulse Ranging Navigation; Pseudo-Random Noise

PROGRAMMED ROLL - Automatically controlled roll of the booster before pitchover.

PROGRAMMED TURN - Turn of booster from the vertical after liftoff; pitchover.

PROGRAMMING - Booster movement through assigned trajectory maneuvers.

PRONE G - Eyeballs out; acceleration in a back-to-chest direction.

PROP - Propellant

PROPELLANT FEED SYSTEM - Piping, sensors, main propellant valves and turbopumps which move propellant from tanks to thrust chamber.

PROPELLANT LOADING CONSOLE - Control center for loading fuel and oxidizer into booster tanks before launch.

PROPELLANT UTILIZATION CONTROL SYSTEM - Valve assembly in oxidizer feed lines operated to increase or decrease the flow of oxidizer.

PSA - Power Servo Assembly (see definition)

PSE - Passive Seismic Experiment (see definition)

PSI - Pounds per Square Inch (pressure)

PSIA - Pounds per Square Inch Absolute (pressure)

PSID - Pounds per Square Inch Differential (pressure)

PSS - Pad Safety Supervisor

PST - Pacific Standard Time

PTA - Pitch Trim Angle

PTPS - Propellant Transfer Pressurization System

PTT - Push-to-Talk

PTV - Pitch Thrust Vector

PU - Propellant Utilization; Propulsion Unit

PUCS - Propellant Utilization Control System (see definition)

PUD - Preretro Update Display (see definition)

PUGS - Propellant Utilization and Gauging System

PULSE CODE MODULATION TELEMETRY - Pulse modulation in which the signal is periodically sampled, and each sample is quantized and transmitted as digital code. Information transmitted is contained in the prime position of the pulse in relation to a known reference point. Pulse Code Modulation telemetry equipment in the command module combines signals from various sources into

a single signal, which is sent to the pre-modulation processor.

PULSED INTEGRATING PENDULOUS ACCELEROMETER - A measuring system to sense acceleration and velocity which can be synchronized with a digital computer.

PULSED INTEGRATING PENDULUM - A single-degree-of-freedom pendulum which is the acceleration-sensing device of the pulsed integrating pendulous accelerometer.

PULSE POSITION MODULATION TELEMETRY - Telemetry in which the information transmitted is indicated by the presence or absence of a pulse within a known block of pulses.

PURGE - To get rid of the residual fluid in a line or tank; to flush out a system. A purging system introduces a gas such as carbon dioxide or nitrogen into the ullage space of a tank above the propellants to sweep out toxic or combustible fumes when the tanks are being drained.

PUSHBUTTON INDICATOR - Control which is both an indicator (which lights up when attention to its function is needed) and a control button for initiating the action necessary.

PUSH-TO-TALK - Microphone switch located in the crewman's umbilical cable which is pushed when the astronaut wishes to transmit his voice.

PVSE - Primary Vehicle Systems Engineer

PVT - Pressure-Voltage-Temperature

PYRO - Pyrotechnic

PYROTECHNIC - Explosive. Pyro batteries are used to provide power to explosive devices such as explosive bolts or bridgewires.

Q - Symbol for dynamic pressure. (See DYNAMICS; MAX-Q)

Q-BALL - Device in the nose cone of the launch escape system which measures pressure changes and the angle of the launch vehicle, providing data to the launch vehicle guidance system, the emergency detection system and to an indicator on the command module's main display console.

QD - Quick Disconnect (fitting)

QDXR - Quadriplexer (see MULTIPLEXER)

QLR - Quick-Look Report.

QTY - Quantity

QUAD - Group of four RCS thrusters, each facing 90 degrees away from its neighbor. See REACTION CONTROL ENGINE.

QUANTIZE, QUANTIZATION - To convert continuous values of information to a finite number of discrete (individual, single) values.

QUICK-DISCONNECT FITTING - Any electrical or other fitting designed for instant "unplugging," i.e., umbilical cords, etc.

R - Range; Roll

RA - Radar Altimeter

RACON - Radar Beacon

RADAR - Radio Direction and Ranging

RADIATION SURVEY METER - Hand-held meter to record radiation level in the command module cabin.

RADIATORS - See SPACE RADIATORS

RADIOISOTOPE THERMOELECTRIC GENERATOR - Device which furnishes power for ALSEP experiments. See ALSEP.

RADOT - Real-Time Automatic Digital Optical Tracker

RADVS - Radar Altimeter and Doppler Velocity Sensor

RAE - Range, Azimuth and Elevation

RAFDO - Re-entry Assistant Flight Dynamics Officer

RANGE SAFETY SYSTEM - System of receiving antennas, detonators, safe-and-arm devices and associated equipment which detonates shaped charges in the propellant tanks of a booster stage to destroy the vehicle and disperse its propellants; activated by radio command from the ground in the event of dangerous booster malfunction or deviation in flight path. Each Saturn stage has redundant range safety systems.

RANGE TRACKER - USNS Range Tracker, DOD-Eastern Test Range tracking ship equipped with C-Band radar for near-earth orbital mission support.

RANGING - Determining the distance of a spacecraft from a ground-based tracking station

by one of several techniques.

RATE GYRO ASSEMBLY - Three rate gyros in the command module which emit signals indicating the rate of angular motion (attitude change rate) to the FDAI and to automatic stabilization and control system equipment.

RAT'S NEST - Area in the spacecraft which is crowded with complicated circuits and electronic equipment.

RB - Recovery Beacon; Radar Beacon

RBA - Recovery Beacon Antenna

RCC - Recovery Control Center; Range Control Center

RCE - Re-entry Control Electronics

RCP - Recovery Command Post (remote)

RCS - Reaction Control System

R&D - Research and Development

REACTION CONTROL ENGINE - One of the spacecraft RCS thrusters used for attitude control of the command and service module, command module alone, or lunar module. The service and lunar modules have 16 100-pound-thrust RCS engines each, grouped in clusters of four (see QUAD.) The lunar command module has 12 93-pound-thrust RCS engines. See below. All use the hypergolic propellants aerazine and nitrogen tetroxide.

REACTION CONTROL SYSTEM - System of small attitude control thrusters which operate in response to automatic signals from the spacecraft stabilization and control system, in conjunction with the guidance and navigation system, or can be controlled manually by the crew. The service module RCS provides attitude control for the joined command and service modules for most of the mission; the command module RCS is not normally used until during re-entry, after the service module is jettisoned.

REACTION ENGINE - Rocket engine; one in which propulsion force is the "opposite and equal reaction" to the action of ejecting a stream of hot gases from a nozzle, according to Newton's third law of motion (law of action and reaction). This is the same principal as is involved in the recoil of a gun; contrary to a popular notion, the gas stream

does not push against the outside atmosphere.

READ - Understand, as a voice transmission

READOUT - The transmission and subsequent display of data.

REAL TIME - As it happens. Term is usually applied to reporting of events as they happen, or computation of data as it comes in, with nearly instantaneous readouts.

REAL TIME COMPUTER COMPLEX - Computer system in the MCC which provides real-time readouts of various flight events. (See FOREWORD)

RECOVERY - Location and retrieval of astronauts and spacecraft at the end of a mission.

RECOVERY BEACON - Flashing light attached to the top of the command module to aid in recovery.

RECOVERY BEACON TRANSMITTER - VHF transmitter which signals continuously during spacecraft descent to earth to pinpoint landing place for recovery forces.

RECY - Recovery

RECYCLE - To stop the countdown and return to an earlier place in the sequence; to return to the beginning of a computer program without reloading the program or inputting new data.

RECY CONT - Recovery Controller

RECY COR - Recovery Commander

RECY RM - Recovery Room

RED - USNS Redstone DOD-Eastern Test Range tracking station (see below).

REDSTONE - USNS Redstone, Apollo Support Ship, equipped with S-Band facilities for earth orbital and limited lunar mission support.

REDUNDANCY - A second means for accomplishing a given task. As an adjective, redundant (See PARALLEL, STANDBY REDUNDANCY).

RE-ENTRY - Return of the spacecraft into the atmosphere after space flight.

RE-ENTRY CORRIDOR (OR WINDOW) - Region through which the spacecraft must pass for successful re-entry. It is limited by altitude and velocity parameters.

REGENERATIVE COOLING - Cooling of a part of an engine (usually the thrust chamber) by circulation of the fuel or oxidizer around it

before the fuel is used.

RENDEZVOUS - Meeting of two or more spacecraft in orbit at a planned time and place.

RENDEZVOUS WINDOWS - Rectangular window in lunar module used for visibility in rendezvous and docking and pair of small, triangular windows facing the nose (apex) of the command module for the same purpose.

REQ - Request

RESTART - To load a computer program from tape or other input device; to refire an engine.

RET - Retransmission

RETICLE - Sight used by spacecraft crew in aligning a vehicle for docking.

RETRO - Short for retrograde, or retrograde rocket (retrorocket).

RETROGRADE - Backward; behind; in a reverse direction; opposite to normal motion or to current direction of travel.

RETROCKET - Short for retrograde rocket, that thrusts in the direction opposite to the motion of travel, the effect being to slow the vehicle's speed. The Saturn IB launch vehicle has 4 solid propellant retro-rockets on the interstage between first and second stages, to slow the spent first stage. The Saturn V has 8 first-stage retro-rockets, and 4 on the interstage between second and third stages.

REV - Revolution

REVOLUTION - Circuit of the earth or moon beginning and ending at a fixed point on the earth or moon rather than a fixed point in space. Since the earth is also revolving in the same direction, while the spacecraft is circling it, the point at which the revolution began has moved further ahead and the spacecraft must "catch up" with the reference point at the end of the revolution. A revolution is therefore more than 360 degrees of travel and takes about six minutes longer than an orbit. (Compare ORBIT.)

RF - Radio Frequency; Recovery Forces

RGA - Rate Gyro Assembly (see definition)

RGS - Radio Guidance System

RH - Right-Hand; Relative Humidity

RHEB - Right-Hand Equipment Bay (see definition)

RHFEB - Right-Hand Forward Equipment Bay (see definition)

RHI - Range-Height Indicator

RHSC - Right-Hand Side Console

RIGHT-HAND EQUIPMENT BAY - Storage area at right of crew couches containing waste management system controls and storage compartment, electrical power equipment, mission and earth landing system sequencers, signal conditioners, fuse box, circuit utilization box and phase correction capacitor box.

RIGHT-HAND FORWARD EQUIPMENT BAY - Storage area above the lower equipment bay at the foot of the couches containing survival kits, medical supplies, sanitary supplies, and television camera and mount, and tools.

RIPS - Radar Impact Prediction System

RKV - USNS Rose Knot Victor DOD-Eastern Test Range tracking station equipped with telemetry and voice relay and C-Band radar for near-earth orbital mission support.

RN - Downrange Error

RNDZ - Rendezvous

RNTY - Re-entry

R/O - Readout; Recovery Operations

ROCR - Recovery Operations Control Room (in MCC)

ROGER - Okay; will do.

ROLL - Rotation of the spacecraft around its X (longitudinal) axis.

ROM - Rough Order of Magnitude

ROSE KNOT - USNS Rose Knot Victor, a tracking ship (see RKV).

ROTARY HYDRAULIC ACTUATOR - Radial vane and cylinder assembly used to rotate the swing arms of the launch umbilical tower or mobile launcher in a horizontal direction.

ROTATION CONTROLLER - Control sticks which are turned to give manual signals to the attitude control thrusters or to provide proportional rate command signals for spacecraft attitude; they can be mounted on the left or right couches and at the navigator's position.

ROTI - Recording Optical Tracking Instrument

RP-1-Rocket Propellant, Type 1; the fuel used in H-1 and F-1 Saturn first-stage engines, a highly refined form of kerosene.

RPM - Revolutions per minute

RPS - Revolutions per second

RR - Recovery (control) Room; Respiration Rate; Rendezvous Radar

R&R-DOT - Range and Range Rate

RR/T - Rendezvous Radar/Transponder

RS - Remote Station (or Site); Range Safety

RSC - Range Safety Control (or Command; see RANGE SAFETY SYSTEM)

RSCSS -Range Safety Command Shutdown System

RSDP - Remote Site Data Processor

RSO - Range Safety Officer

RSP - Respiration

RSTC - Remote Site Telemetry Computer

RT - Real Time; Rate; Retro Table

RTA - Real-Time Accumulator (see REAL-TIME; ACCUMULATOR)

RTC - Real-Time Computer (or Command; see definition)

RTCC - Real-Time Computer Complex (see definition)

RTG - Radioisotope Thermoelectric Generator (see definition)

RTK - USNS Range Tracker DOD-Eastern Test Range tracking station (see RANGE TRACKER).

RTTV - Real-Time Television

RTV - Recovery Task Unit

RUMBLE - Form of combustion instability causing a low-pitched rumbling noise.

RZ - Return to Zero (see POO)

S- (ONE-B) STAGE - First stage of Saturn-IB (Uprated Saturn) launch vehicle, powered by eight H-1 engines burning RP-1 and liquid oxygen for a total thrust of 1.6 million pounds; weighs 45 tons dry and nearly 500 tons fueled, is 80 feet tall.

S-IC (ONE-C) STAGE - First stage of the Saturn V

launch vehicle, powered by five F-1 engines burning RP-1 and liquid oxygen for a total thrust of 7.5 million pounds; weighs 150 tons dry and more than 2400 tons fueled, is 138 feet tall.

S-II (TWO) STAGE - Second stage of Saturn V launch vehicle, powered by five J-2 engines burning liquid hydrogen and liquid oxygen for a total thrust of 1.1 million pounds; weighs 47 tons dry and 520 tons fueled, is 81 feet tall.

S-IVB (FOUR-B) STAGE - Second stage of Saturn IB (Uprated Saturn) launch vehicle; also third stage of Saturn V launch vehicle, powered by a single restartable J-2 engine burning liquid hydrogen and liquid oxygen for a thrust of 225,000-230,000 pounds; weighs 15 tons dry and 126 tons fueled (Saturn IB version), or 17 tons dry and 131 tons fueled (Saturn V version), is 58 feet tall.

SA - Spacecraft Adapter; Spin Axis (Vector); Systems Address; formerly Saturn-Apollo, which is now Apollo-Saturn or AS

SARAH - Search and Range Homing (Beacon)

SATURN IB (ONE-B) LAUNCH VEHICLE (UPRATED SATURN) - Two-stage booster for the first manned Apollo flight; has made four unmanned flights (Feb. 26, 1966-Jan 22, 1968); with spacecraft it is 224 feet tall and weighs 86 tons dry and more than 650 fueled. It can place a 20-ton payload into earth orbit.

SATURN V (FIVE) LAUNCH VEHICLE - Three-stage booster to be used for Apollo flights subsequent to the first manned mission, including the lunar mission. With the spacecraft, it is tall as a 30-story building (363 feet), weighs as much as a Navy destroyer (215 tons dry; 3,097 tons fueled), and it can lift a 50-ton payload to the moon.

SATURN ELECTRICAL SYSTEM - In the Saturn IB, two 28-vdc batteries in the first stage; three 28-vdc and a 56-vdc battery in the second stage. In the Saturn V, two 28-vdc batteries in the first stage, four in the second, and three 28-vdc and a 56-vdc battery in the third. Each battery and its associated distributors and inverters form a separate power system which is used for a specific group of functions.

SATURN GUIDANCE AND CONTROL SYSTEM - Contained

in the Instrument Unit onboard both the Saturn IB and Saturn V launch vehicles; system determines and controls the booster's position, velocity and attitude throughout the powered portion of the flight. An all-inertial system utilizing an inertial platform, two computers and control and rate gyros.

S-BAND - 2100-to-2300 megacycle band (frequency), carrying voice, PCM telemetry, television, scientific data, coherent two-way Doppler, and tracking updata during all phases of the flight and especially in deep space during the lunar mission. There it is the primary voice link. There are 17 MSFN stations located around the globe with Unified S-Band capability.

SBX - S-Band Transponder

S/C - Spacecraft (see definition)

S&C - Stabilization and Control

SCAMA - Switching, Conferencing and Monitoring Arrangement (see below)

SCAMA-PHONE - Voice communications (telephone) switchboard system linking all MSFN stations and control centers; part of NASCOM

SCAT - Space Communications and Tracking

SCE - Signal Conditioning Equipment (see definition)

SCGSS - Super Critical Gas Storage System

SCIENTIFIC INSTRUMENTATION SYSTEM - Tools and instruments for performing scientific experiments on the lunar surface, including a lunar atmosphere analyzer; devices for measuring gravity, magnetism, the lunar crust, and radiation; rock and soil analysis equipment; a seismograph, soil temperature sensor, and a still camera and TV camera. This equipment will be used by the astronauts on the spot, as opposed to the ALSEP equipment to be left behind for future readings (see ALSEP).

S/CO - Spacecraft Observer

SCOM - Spacecraft Communicator (CAPCOM)

SCPA - SCS Control Panel

SCR - Signal Conditioner (see SIGNAL CONDITIONING EQUIPMENT)

SCREAMING - A form of combustion instability in a booster engine characterized by a high-pitched scream.

SCRUB - To cancel or postpone a flight; as a noun, the cancelation or postponement itself.

SCS - Stabilization and Control System (see definition)

SCSCP - Sequence Control System Control Panel (see SEQUENCER)

SC/SM - Spacecraft Systems Monitoring

SCS MODES - One of several control modes in which the SCS may be used, taking its "directions" from various sources. The system will automatically maintain current spacecraft attitude (SCS attitude control mode); maintain attitude with respect to earth (SCS local vertical mode); use a manual start of the SPS engine with automatic cutoff at preset velocity (SCS delta-V mode); or operate with strictly manual control of attitude and vectoring (SCS entry mode).

SCSS - Spacecraft Control System

SCT - Scanning Telescope (G&N System)

SCTE - Spacecraft Central Timing Equipment (see CENTRAL TIMING EQUIPMENT)

SDA - (Sextant) Shaft Drive Axis

SDC - Spacecraft Digital Computer

SDF - Single Degree-of-Freedom (gyros)

SDP - Site Data Processor

S-E - Sequence of Events

SE - Southeast (rendezvous navigation)

SEA MARKER - Powdered fluorescein dye packed in a metal container; colors the sea water brilliant yellow-green around the spacecraft after landing to assist spotting from recovery aircraft.

SECO - Sustainer (or Secondary) Engine Cutoff (see SUSTAINER)

SECS - Sequential Events Control System (sequencer)

SEF - Small-End Forward

SEISMOGRAPH - Part of the scientific instrumentation system, provides instrument for investigating sub-surface structure of the

moon by measuring shock waves from a charge exploded beneath the lunar surface.

SELENOCENTRIC - Relating to the moon as a center.

SEP - Separation

SEPS - Service (Module) Electrical Power System

SEQ - Sequencer; Sequential

SEQUENCER - Mechanical or electronic device that initiates a series of events in a particular order, by a preset schedule.

SERVICE MODULE - 22-foot tall cylindrical spacecraft section containing the service propulsion engine, spacecraft electrical power system and part of the environmental control system. Located between the command module and the lunar module adapter at launch, it remains attached to the command module throughout most of the lunar mission, being jettisoned just before re-entry into earth atmosphere.

SERVICE PROPULSION SYSTEM - Main propulsion engine for return from the moon, a 21,500-pound-thrust engine burning aerzine and nitrogen tetroxide for a total burn time of about 8 1/2 minutes in up to 36 separate firings. It is gimbal-mounted and automatically controlled by the guidance and navigation system, stabilization and control system or the crew. It provides course correction during translunar and transearth coast phases, injection into lunar orbit and into the transearth phase, and the power to return the command module to earth atmosphere during a high-altitude abort.

SERVICE STRUCTURE - A 5200-ton 300-foot tower at Launch Complex 37 for erection, assembly and checkout of the Apollo-Saturn IB. Self-propelled on rails, it includes a number of platforms and six split "silo" enclosures around the work platforms to the 248-foot level for weather protection. See also MOBILE SERVICE STRUCTURE.

SET - Spacecraft Elapsed Time

SFA - Sun-Finder Assembly

SFC - Specific Fuel Consumption

SGET - Spacecraft Ground Elapsed Time

SGLS - Space-to-Ground Link Subsystem

SHA - Sidereal Hour Angle (see SIDEREAL)

SHEAR-COMPRESSION PADS - Pads which are sheared during separation of the service and command modules.

SHEDDING HER SKIRT - Colorful phrase referring to the spray of ice particles which break free from a booster at liftoff; the ice formation is the result of the cold from cryogenic propellants in the first-stage tanks.

SHIRTSLEEVE ENVIRONMENT - Nominal pressure and temperature inside the command module in which the flight crew is not required to wear pressure suits.

SHOCK DIAMONDS - Visible, wedge-shaped shock waves in the exhaust of a booster at launch.

SHOCK STRUTS - Shock attenuating devices for support of the couches and structural parts of the command and lunar modules.

SHOCK WAVE - Compressed air wave ahead of the forward edge of the command module's blunt end during re-entry.

SHOT - Slang for launch or flight.

SHUTDOWN - The whole sequence of ending propulsion, as opposed to cutoff, which usually refers only to closing the main propellant valves; includes shutting off turbopump power source, cutoff of propellant flow and tail-off of residual propellants and gases.

SID - Sudden Ionospheric Disturbance

SIDE - Suprathermal Ion Detector Experiment (see definition).

SIDEBAND - Two frequencies located on both sides of the carrier frequency, termed upper and lower sideband.

SIDEREAL - Of or pertaining to time as measured by stars. A sidereal day is one rotation of the earth as measured from the stars, four minutes shorter than the normal day as measured from the sun.

SIGNAL CONDITIONING EQUIPMENT - Devices which take source signals from telemetry sensors and transducers and put them in proper format for transmission to the ground.

SILS - Shipboard Impact Location System

SIM - Simulation (see definition)

SIM NET - Simulations Network

SIM NET SIM - Simulated Network Simulation

SIMULATION - Operating test under conditions designed to duplicate actual use, with possible "emergencies" and "malfunctions" deliberately introduced for training purposes.

SINGLE PLANE SEPARATION MODE - Separation of two stages of a booster at only one point between the two stages (see STAGING.)

SIS - Scientific Instrumentation System (see definition)

SIU - Sequence Initiate Update

SKIN TRACKING - Tracking by radar

SKIRT - See ADAPTER SKIRT

SL - Starline

SLA - Spacecraft/LM Adapter (see definition)

SLANT RANGE - Distance of booster or spacecraft from launch site or tracking station after liftoff, measured in a straight line from ground to vehicle.

SLOSHING - Back-and-forth splashing of liquid fuel or oxidizer in booster tanks, which can create problems of stability and flight control in the vehicle.

SLOS - Star Line-of-Sight

SLTC - Spacecraft Landing Time Countdown

SLV - Saturn Launch Vehicle (see SATURN IB, SATURN V)

SM - Service Module

SMI - Service Module Insertion

SMJC - Service Module Jettison Controller

SMP - Summary Maneuver Plan

SM-RCS - Service Module Reaction Control System

SMSC - Service Module Sequence Controller

SNR - Signal-to-Noise Ratio

SNU - S-IVB (stage) Initiation Update

S/O - Switchover; Signoff; Shutoff

SOFAR NET - Hydrophone system used to provide impact location of re-entry vehicles by measuring the arrival of sound waves through the ocean. SOFAR is Sound Fixing and Ranging.

SOIL TEMPERATURE INSTRUMENT - Part of the scientific instrumentation system; an instrument for measuring lunar surface temperature and temperatures below the surface.

SOLAR FLARES - Violent, sudden disturbances of the sun's surface, resulting in a sharp increase in high-energy radiation in certain regions of space, depending on where the flare occurs. See SOLAR STORMS.

SOLAR PARTICLE ALERT NETWORK - A network of telescopes trained on the sun which will maintain a watch for sunspot activity during Apollo missions, particularly the lunar mission, in order to give astronauts sufficient warning of the bursts of intense radiation in space which accompany sunspots. Astronauts exploring the moon's surface would have about 12 hours warning, more than enough to return to the lunar module, and if the strength of the radiation were sufficient, to return to the command module in lunar orbit.

SOLAR STORMS - Storms of electrical particles hurled out by the sun during solar disturbances (see SOLAR FLARES) raising radiation levels in space to a dangerous level for astronauts if they are outside the protection of the spacecraft.

SOLAR WIND EXPERIMENT - ALSEP (see definition) experiment to measure the energy range of protons and electrons flowing from the sun (*solar wind*).

SOLENOID - A coil of closely-wound wire surrounding an iron bar which is free to move under the magnetism of the coil when the coil is electrified; used in a number of remote controls for valves, antenna, tracking systems, etc.

SOLID FUEL - Rocket propellant containing both fuel and oxidizer combined into a solid, plastic-like cake called a grain, used in Saturn booster ullage and retrorockets and in the spacecraft launch escape system rocket motors.

SOM - Suborbital Mission

SOP - Standard Operating Procedure; Simulation Operations Plan

SOUTH VANDENBURG - Site of DOD-Western Test Range Station (see CAL).

SOV - Shutoff Valve

SP - Static Pressure; Solid Propellant (see definition)

SPA - Signal Processor Assembly; Servo Power Assembly; S-Band Power Amplifier

SPACECRAFT - The command, lunar and service modules as distinguished from the Saturn launch vehicle.

SPACECRAFT COMMANDER - The commander of the three-man Apollo crew, occupying the left-hand couch in the command module and probably the left position in the lunar module. He is first in seniority and cross-trained in the skills of both the command module pilot and lunar module pilot. He runs the mission from the standpoint of the crew, performs most of the actual burns in the spacecraft, and is one of two men who descend to the lunar surface during the lunar mission.

SPACECRAFT/LM ADAPTER - The 28-foot high tapered cylinder between the service module and the launch vehicle instrument unit which encloses the lunar module during launch and earth orbit. After translunar injection, a detonating fuse separates the command and service module of the spacecraft from the booster's third stage (S-IVB) and the lunar module. As the CSM turns around to dock with the lunar module, explosive charges and spring-loaded cables open the four hinged sections of the SLA like the petals of a flower. The CSM pulls the lunar module out of the SLA.

SPACE RADIATOR - Two 30-square-foot panels on the outside of the service module, using exposure to the cold of space to cool the water glycol, which in turn is used as a spacecraft coolant. The water glycol flows through sets of thin-walled tubes in the radiators. (See WATER GLYCOL)

SPAN - Solar Particle Alert Network (see definition)

SPECIFIC IMPULSE - An expression of the performance limit of rocket propellants arrived at by dividing the thrust in pounds by the weight flow rate in pounds-per-second. The result is expressed in seconds.

SPECIMEN CONTAINER - Small container to be filled with lunar material and brought back to earth for analysis; sealed against air and bacteria.

SPIDER BEAM - Spider-like framework which holds the top of the booster's propellant tanks together and transmits thrust to the upper stages.

SPLASHDOWN - Impact of spacecraft on the ocean during landing.

SPS - Service Propulsion System (see definition); Secondary Propulsion System

SPU - Service Propulsion Unit

SQUIB - Small pyrotechnic device which produces heat, used for ignition; not to be confused with a detonator, which explodes.

SRA - Spin Reference Axis

SRCS - Stabilization and Reaction Control Subsystems

SRO - Superintendent (Supervisor) of Range Operations

SS - Signal Strength; Subsystem

SSA - Spacesuit Assembly

SSB - Single Sideband (see SIDEBAND)

SSC - Sensor Signal Conditioner

SSECO - Second-Stage Engine Cutoff

SSI - Second Stage Ignition

SSM - Spacecraft Systems Monitor

SSR - Staff Support Room (in the MCC)

SSSA - Spacecraft System Support Area

SSTO - Second-Stage Tailoff (see TAILOFF)

SSU - Switch Selector Update

STA - Station

STABILIZATION AND CONTROL SYSTEM - System which provides control and monitoring of the spacecraft attitude, thrust vector control of the service propulsion engine and a backup inertial reference system. For automatic control, RCS thrusters and the service propulsion engine gimbal are actuated; for manual operation, the information on angular displacement and angular rate is fed to crew displays. Separate systems are located in the command and lunar modules.

STABILIZED GYROSCOPE - One which is stabilized so as to effect coincidence between the vertical axis of the gyro itself and the

vertical with respect to earth as established by a weighted pendulum; or, in another axis, the gyro may be stabilized with respect to the electromagnetic field surrounding the earth or with the true north direction through appropriate computers.

STABILIZED PLATFORM - Major part of Apollo inertial measurement unit, composed of a platform stabilized by three gyroscopes in a fixed position relative to a predetermined reference point. Six accelerometers mounted on it perpendicular to each other measure acceleration along the X, Y, or Z axis; the measurements are fed into a computer to determine velocity and position in space.

STAGE - Independent propulsive section of a launch vehicle which is jettisoned when depleted of its fuel.

STAGING - Separation of burned-out stage from remainder of the vehicle. In the Saturn IB, staging occurs at 37-40 miles altitude, assisted by four retrorockets on the first stage which slow its flight after the separation. In the Saturn V, the first stage drops away at about 38 miles altitude, slowed by eight retrorockets, and the second stage's aft interstage drops 30 seconds later (dual plane separation). The second staging point is at about 114 miles altitude, assisted by four retrorockets on the second stage.

STAIID - Station Identification

STANDBY REDUDANCY - Applies to a system where the alternate or backup method is not used unless the primary system fails.

STATIONARY ORBIT - See SYNCHRONOUS ORBIT

STATION KEEPING - Remaining in a particular, precise orbit with a constant velocity, usually at a given distance from a companion body or another spacecraft.

STF - S-Band Temperature Fahrenheit

SUAR - Start Unload Address Register

SUIT SYSTEM - Part of the environmental control system which automatically controls suit oxygen circulation, pressure, and temperature, and removes debris, excess moisture and carbon dioxide from the oxygen as it recirculates. Suit system remains in operation even when the crew is out of pressure suits, and serves to remove carbon dioxide

and water from the cabin atmosphere.

SUM - Summary

SUNSPOT CYCLE - An 11.1 year (average) cycle in the frequency and size of solar disturbances or sunspots. The number of sunspots each year rises from a minimum of 10 or less to a maximum of 50 to 140 about four years later, then declines more slowly.

SUPER GUPPY - World's largest airplane, a four-engined aircraft developed by Aero Space-lines, Inc. specifically for air transport of the Saturn S-IVB stage, the instrument unit and the spacecraft/LM adapter. It has an inside diameter of 25 feet and a length of more than 141 feet; tail height is almost five stories about the ground.

SUPRATHERMAL ION DETECTOR EXPERIMENT - ALSEP (see definition) experiment to study lunar ionosphere.

SURGE TANK - Tank in the left-hand equipment bay of the command module which provides oxygen for earth atmosphere re-entry and descent, after separation of the command and service modules from each other.

SW - Sea Water; Switch

SWB - Meteorological Group, Suitland, Maryland

SWBD - Switchboard

SWD - Single Word Dump (see TAPE DUMP)

SWE - Solar Wind Experiment (see definition)

SWIMMER'S UMBILICAL - Part of the tether which ties the sea marker to the command module as it floats in the ocean; carries an electrical connection (phone plug) to allow recovery-crew frogmen to talk to the flight crew inside the spacecraft.

SW/O - Switchover

SXT - Sextant

SYNC - Synchronize

SYNCHRONOUS ORBIT - One in which a spacecraft or satellite matches speed and direction (west-to-east) with the earth's rotation, so that it remains over one spot on the ground at all times.

SYS - System

T - Temperature

T-TIME - Any specific time, minus or plus, during launch countdown, referenced to "T" as the moment of ignition.

TANGENTIAL ELLIPSE - Transfer ellipse from earth orbit to lunar orbit, designed to intercept those orbits at the smallest possible angle and to use a minimum of fuel. Also called Hohmann Transfer.

TAN - Tananarive MSFN station (see below)

TANANARIVE - Tananarive, Malagasy Republic, site of MSFN station, equipped with C-Band radar, voice and telemetry capability for near-earth orbital mission support.

TAPE DUMP - The playback of telemetry data (from operational systems or biomedical sensors) which has been stored temporarily on a 14-track tape recorder aboard the spacecraft, done when the spacecraft is in convenient range of a ground receiving station.

TARGET - The passive partner in rendezvous. On the outbound portion of the lunar mission, the lunar module will be the passive target for the maneuvering command module during rendezvous and docking. After lunar landing, the roles are reversed, and the command module becomes a passive target for the maneuvering lunar module.

TB - Total Burn (total length of thrusting period)

TBAFT - Total Burn (time) of AFT-firing thrusters.

TBFWD - Total Burn (time) of radial firing thrusters

TC - Thrust Chamber; Telecommunications; Thermocouple; Translation Controller (see definition)

TCA - Thrust Chamber (or Translation Controller) Assembly (see definition)

TCFP - Thrust Chamber Fuel Purge (see PURGE)

TCFV - Thrust Chamber Fuel Valve

TCOA - Translational Control A

TCOB - Translational Control B

TCOP - Thrust Chamber Oxidizer Purge (see PURGE)

TCOV - Thrust Chamber Oxidizer Valve

TCP - Thrust Chamber Pressure; Telemetry Control Position

TCS - Telecommunications System (see definition); Temperature Control System

T&D - Tracking and Data

TE - Transearth (see definition)

TEC - Transearth Coast

TEI - Transearth Insertion

TEO - Transearth Orbit

TELECOMMUNICATIONS SYSTEM - System which provides voice, television, telemetry, and tracking and ranging communications between spacecraft and ground, between command and lunar modules, between astronauts exploring the lunar surface and spacecraft, and between suited astronauts in the spacecraft. It includes the central timing equipment.

TELEMETRY - The technique of sensing everything from astronaut blood pressure to the strength of the earth's magnetic field, transforming the information into coded signals, and transmitting it to a ground station where it is decoded and fed into a computer for tabulation and readout. Telemetry measures the quantity or degree of such things as vehicle performance, medical information, temperature, pressure, radiation, velocity, heat rate, and angle of attack of the spacecraft.

TELEVISION CAMERA - The spacecraft TV camera can be positioned in one of three locations or hand held, and transmits a video signal by Unified S-Band which must be processed to be made compatible with commercial television stations. It will be transformed to the lunar module during lunar exploration, and left mounted on the descent stage of the lunar module on the moon.

TERMINAL COUNT - Last half-hour to hour of the launch countdown.

TERMINAL GUIDANCE - Guidance required in the last phase of spacecraft rendezvous.

TERMINAL PHASE INITIATE - The beginning of the last phase of rendezvous between lunar and command modules, as they match orbits with each other.

TERMINATOR - Line separating the sunlit and dark portions of the moon's surface.

TET - Transearth Trajectory (see TRANSEARTH)

TEX - Corpus Christi MSFN station (see below).

TEXAS - Corpus Christi, Texas site of MSFN station, equipped with S-Band facilities and a 30-foot antenna for earth-orbital and limited lunar mission support.

TF - Time to Function

TFE - Time from Event.

TFL - Time From Launch

TGD - Trajectory and Guidance Data (see TRAJEC-TORY)

TGET - Target Ground Elapsed Time (rendezvous)

TGT - Target (rendezvous - see definition)

THERMAL LOAD - Expansion or contraction stresses (or both) imposed on booster or spacecraft structure because of aerodynamic heating or the supercold of cryogenic propellants in the tanks.

THERMAL MICROMETEOROID GARMENT - Bulky outer garment covering pressure suit and backpack, worn by crewmen exploring the lunar surface for protection from extremes of heat and micrometeoroids. Made of lightweight felt and aluminized mylar, it limits the heat leak into the suit to about 250 BTU's per hour.

THERMISTER - A temperature sensitive resistor with a negative temperature coefficient of resistance.

THERMOCOUPLE - Device which converts thermal energy directly to electrical energy; consists of two metals side-by-side which produce a current when heated. The strength of the current can be measured to produce a temperature reading.

THERMODYNAMICS - Study of the relationships between heat and mechanical energy.

THRUST - Push. The force developed by a rocket engine, measured by multiplying the propellant mass flow rate by the exhaust velocity relative to the vehicle, and expressed in pounds.

THRUST CHAMBER - The combustion chamber of a rocket engine; the place where fuel is burned in the presence of an oxidizer to produce high velocity gases, which exit through the engine nozzle to produce thrust.

THRUST VECTOR - The direction of thrust. Thrust vector control is achieved by moving one or more gimbal-mounted engines so that the direction of thrust can be changed in relation to the spacecraft or booster's center of gravity, producing a turning movement. (Small engine thrusters, such as the RCS thrusters, are mounted in sets, aimed in different directions, rather than on gimbals.)

THRUST-WEIGHT RATIO - Term used to express engine performance, and obtained by dividing the thrust output by the engine's dry weight.

TIC - Telemetry Instrumentation Controller (see TELEMETRY)

TICC - Telemetry Instrumentation Control Console (see TELEMETRY)

TIGN - Time of Ignition

TIME - Time Subsystem

TIME HACK - Specific moment, especially during countdown, which is called out so that all operations personnel involved can synchronize their time count.

TIN-CANNING - Various metal contraction noises, pressure bleedoff sounds, etc. which a large booster such as Saturn makes when it is fueled and ready for liftoff.

TJM - Tower Jettison Motor (see definition)

TK - Track (see TRACKING)

TL - Translunar (see definition)

T/L - Talk/Listen

TLC - Translunar Coast

TLI - Translunar Injection

TLM - Telemetry (see definition)

TLO - Translunar Orbit

TLT - Translunar Trajectory

TM - Telemetry (see definition)

T/M - Talk/Monitor

TMC - Telemetry Monitor Console (in MCC)

TMCC - Telemetry Monitoring and Control Console (in MCC)

TMG - Thermal Micrometeoroid Garment (see definition)

TMR - Triple Modular Redundancy (see definition)

TMS - Telemetry Multiplexing System (see MULTIPLEXING)

TO - Booster Liftoff Time

TOI - Transfer Orbit Insertion (see TRANSFER ORBIT)

TOMCAT - Telemetry On-Line Monitoring, Compression and Transmission (System)

TOPPING OFF - Replacing fuel or oxidizer lost by boiloff in the booster tanks shortly before ignition; replacing RP-1 as it is consumed during thrust buildup just before the first movement of liftoff (done by automatic pad equipment).

TORQUING COMMAND - Command given to spacecraft gyros to maintain attitude of the spacecraft.

TORR - Term expressing pressure (replacement for old "millimeter of mercury" or "mm of Hg") and equal to the pressure of a millimeter of Mercury at standard gravity and zero degrees C.

TOWER JETTISON MOTOR - Launch escape system motor which provides a 1-second, 32,000 pound thrust to discard the escape tower when it is no longer needed. (see LAUNCH ESCAPE SYSTEM.)

TP - Turbopump (see definition)

TPA - Turbopump Assembly

TPF - Velocity Match Maneuver (during rendezvous)

TPI - Terminal Phase Initiate (rendezvous - see definition)

TPM - Tank Pressure Monitor

T/R - Transmit/Receive; Transmitter/Receiver; Time to Retrofire

TRACKING - Following a spacecraft or booster by radar, optical sighting or photography.

TRAJECTORY - Flight path traced by space vehicle under power or as a result of power.

TRANSCEIVER - Unit combining radio or radar transmitter and receiver into one unit, as is used in a transponder.

TRANSDUCER - Device which converts energy from one form to another; it is actuated by energy from one transmission system and supplies it to another system in a different form, such

as a microphone or loudspeaker, which transforms electrical energy to acoustical (sound) energy. See THERMOCOUPLE as another example.

TRANSEARTH - Phase of flight from lunar orbit to earth orbit, or re-entry. The *transearth trajectory* is the flight path from moon to earth.

TRANSFER ELLIPSE, TRANSFER ORBIT - See TANGENTIAL ELLIPSE; HOHMANN TRANSFER.

TRANSFER TUNNEL - Passageway between lunar and command modules when they are docked, for transfer of astronauts from one to the other, reached by forward tunnel hatches in the command module, and a hatch in the LM.

TRANSLATION - Propelling spacecraft from one given position to another. *Translation controllers* are T-shaped handles in the CM which control translation maneuvers.

TRANSLUNAR - Commonly-used term referring to the portion of the lunar flight from Earth orbit to lunar orbit; technically incorrect since the term means space outside the moon's orbit about the earth.

TRANSPONDER - Radio or radar device triggered by a received signal of a certain frequency which transmits or returns the signals to the interrogator automatically; used in positive tracking and identification. There are four C-Band transponders around the command module.

TRANSPOSITION AND DOCKING MANEUVER - Turnaround of command service module to dock with the lunar module immediately after separation of CSM and LM.

TRC - Countdown Recycle Time

TRIDOP - Triangulation Doppler (see DOPPLER)

TRIPLE MODULAR REDUNDANCY - A computer system for correction of random failures or errors whereby three identical circuits provide outputs of the same information which are then automatically compared; where one does not agree, the computer "votes" and the majority rules.

TRK - Tracking

TRS - Time Reference System (spacecraft)

TRVV - Time, Radius and Velocity Vector

TS - Telecommunications System (see definition)

TTB - Time to Blackout (re-entry)
TTC - Time to Control; Telemetry, Tracking and Command
TTCA - Thrust/Translation Controller Assembly (see TRANSLATION)
TTE - Time to Event
TTY - Teletype
TUMBLING - Unsatisfactory situation in which spacecraft somersaults, nose-over-blunt end, along its flight path.
TUNNEL PRESSURE - Atmosphere (oxygen) pressure in the tunnel connecting the command and lunar modules. (see TRANSFER TUNNEL.)
TURBOPUMP - Turbine-driven pump which supplies oxidizer and fuel to launch vehicle engine thrust chambers at the required pressures and flow rates.
TURK - See GRAND TURK
TV - Television System Monitor
TVC - Thrust Vector Control (see THRUST VECTOR)
TVCS - Thrust Vector Control System (see THRUST VECTOR)
TVSM - Television System Monitor
TWX - Teletypewriter Message
TX - Time to Reset; Transmit; Transmitter; Transmission
TXR - Transmitter
UA - Urinalysis
UC - Uplink Command (see UPLINK)
UDL - Updata Link (see definition)
UDMH - Unsymmetrical Dimethyl Hydrazine (see definition)
UDOP - Ultra-high frequency Doppler
UFS - Unified Frequency System
UHF - Ultra-High Frequency (300-3000 mc)
UK - United Kingdom
ULLAGE - The volume in a tank above the surface of the stored liquid (usually fuel), partially a function of temperature. An *ullage maneuver* is a quick forward thrust of the launch vehicle or spacecraft, made before

firing the main engines in order to shift the propellant to the rear of the fuel tanks so that it will feed properly. *Ullage rockets* are small rockets, burning solid fuel, used to impart forward thrust for an ullage maneuver. There are eight ullage rockets on the Saturn V's S-II aft interstage, and two main-engine ullage rockets plus a pair of smaller ones for the APS engines on the S-IVB stage. The Saturn IB's S-IVB stage has three main ullage rockets and two APS ullage engines.

UMBILICAL - (1) Any of the servicing electrical or fluid lines between the ground (or tower) and the spacecraft or booster, used during launch preparation. These *umbilical cords or connections* are ejected immediately before or during the first instant of launch. An *umbilical service arm or swing arm* is a metal arm supporting the service lines, and fastened to the umbilical tower by a hinged joint. (2) The oxygen hose and electrical power cable between astronaut pressure suit and spacecraft and an oxygen line to the backpack.

UNSYMMETRICAL DIMETHYL HYDRAZINE - Component of Aerozine; see AEROZINE.

UPDATA LINK - UHF/FM unified S-Band receiver and decoding device (updata digital decoder) on spacecraft which receives data from ground stations, decodes it and routes it to the proper system.

UPL - Uplink (see UPLINK DATA)

UPLINK DATA, OR UPDATA - Telemetry information from ground to spacecraft.

UPDATED SATURN - The Saturn IB launch vehicle, which was updated from the no-longer-used Saturn I development vehicle.

UPRIGHTING SYSTEM - Three air bags, inflated by small compressors, located in the forward compartment of the command module, which can be inflated to right the spacecraft if it lands apex-down in the ocean after re-entry.

UPTL - Uplink Telemetry

UR - Uprange

μ s - Microsecond (millionth)

USB - Unified S-Band (see S-BAND)

USBE - Unified S-Band Equipment
USBS - Unified S-Band System
USNS - United States Navy Ship
USWB - United States Weather Bureau
UT - Universal Time
UTL - Up Telecommunications Switch (in command module)

V - Velocity; Voice; Verb; Volt

ΔV - (Pronounced "Delta V") Velocity Change

V-A - VERLORT Azimuth (see VERLORT)

VAB - Vertical Assembly Building (see definition)

VAC - Volts Alternating Current

VAL - Validation

VAN - Vanguard DOD-Western Test Range station (see below).

VANGUARD - USNS Vanguard, Apollo Support Ship equipped with S-Band facilities for earth orbital and limited lunar mission support.

VAN ALLEN BELTS - Two doughnut-shaped bands of high-energy charged particles trapped in the earth's magnetic field. The lower edge of the inner belt ranges from about 100 miles altitude (near the magnetic poles) to more than 1,000 miles (at the equator). The upper edge of the outer belt extends to about 40,000 miles at the equator.

VANDEBURG - South Vandenberg, Calif., site of DOD-Western Test Range station, (see CAL).

VAP - Vehicle (spacecraft) Antenna Position

VCO - Voltage Controlled Oscillator

VCS - Voice Control Switch

VD - Voice Data

VDC - Volts Direct Current

VDTCF - Voice Data Technical Control Facility

V-E - VERLORT Elevation (see VERLORT)

VECO - Vernier Engine Cutoff (see VERNIER ENGINE)

VECTOR - Magnitude of speed plus direction.

Used as short form of *velocity vector*, which is the speed of the vehicle's center of

gravity at a certain point on the flight path, and the angle between the local vertical and the direction of the speed. *Vector control or vector steering* is controlling the flight of the booster by tilting one or more gimbal-mounted thrust chambers to change the direction of thrust and produce a turning movement.

VEDS - Vehicle Emergency Detection System

VEH - Vehicle (booster or spacecraft)

VEL - Velocity (see definition)

VELOCITY - Rate of motion (speed) in a given direction. (see VECTOR.)

VELOCITY CHANGE INDICATOR - Spacecraft indicator which shows velocity change remaining; crew can insert desired velocity change and can operate the SPS engine through this device.

VER - Verification; Verify

VERLORT - Very Long Range Tracking (Radar)

VERNIER ENGINE - Rocket engine of small thrust used primarily to obtain fine adjustments in velocity and trajectory of booster or spacecraft, just after final cutoff of the main engines.

VERTICAL ASSEMBLY BUILDING - The 526-foot high, 7 1/2-acre building on Merritt Island, largest manmade structure in the world, used to stack and assemble the stages and sections of the Saturn V booster and Apollo spacecraft. The building, including high- and low-bay areas, is 716 by 518 feet; it would swallow the Pentagon and the Chicago Merchandise Mart. Four Saturn V/Apollo could be assembled in the high bay simultaneously.

VF - Verification of Function

VFC - Voice Frequency Channel

VGP - Vehicle Ground Point

VHAA - Very High Altitude Abort

VHF - Very High Frequency (30 -300 megacycles); see below for use of VHF channels from spacecraft.

VHF/AM TRANSCEIVER - Provides two-way voice communication between spacecraft and ground stations in near-earth orbit, between lunar and command modules and between astronaut outside spacecraft and spacecraft; is also

the backup voice circuit between command module and recovery forces, and backup for recovery beacon.

VHF/FM TRANSMITTER - Transmits PCM telemetry from spacecraft to ground stations in near-earth orbit.

VHF MULTIPLEXER - Permits simultaneous transmission and receipt of VHF signals with a single antenna system.

VHF RECOVERY ANTENNA - One of two, one connected to the VHF recovery beacon (see below) and the other to the VHF multiplexer for use with the VHF/AM transceiver when it is used as a (backup) voice circuit or beacon during recovery. They are automatically deployed a few seconds after the main parachutes open.

VHF RECOVERY BEACON - Transmitter which provides line-of-sight direction finding for location of the command module by recovery forces after splashdown.

V_I - Insertion Velocity

V_I - Velocity Inertial

VISORS - A double set of tinted covers for the bubble helmet of the astronaut pressure suit, worn to protect the eyes from glare while exploring the lunar surface.

VOICE-OPERATED RELAY - Transmit/receive circuitry which is automatically switched to "transmit" by the sound of the astronaut's voice and returns to "receive" when the sound ceases.

V-OT&R - VERLORT-On Track and Range (see VERLORT)

VOX - Voice-Operated Relay (see definition)

V-R - VERLORT Range (see VERLORT)

VRB - VHF Recovery Beacon (see definition)

VSE - Vehicle Systems Engineer

VSM - Video Switching Matrix (in MCC - see FOREWORD)

VTO - Velocity of Tailoff (see TAILOFF)

VX, VY, VZ - Velocity component in x, y and z direction (see VELOCITY)

W

W - Watt; Word; Weight

WARNING STREAMERS - Protective covers for space vehicle protuberances and apertures which are removed before flight.

WASTE MANAGEMENT SYSTEM - System which collects and disposes of or stores body waste from the crew. Fecal matter is neutralized and stored in plastic bags in the right-hand equipment bay; urine is stored temporarily and vented overboard. System includes a vacuum cleaner to remove food particles and lint from the cabin atmosphere.

WATER GLYCOL - Mixture of water and ethylene glycol used to cool cabin atmosphere. It is in turn cooled by circulation through the space radiators (see definition).

WATER MANAGEMENT SYSTEM - System which collects potable drinking water as a by-product of the fuel cells and stores it in a 17-quart tank, and collects waste water condensed from pressure suit circuits for storage in a waste-water tank, where it is changed to steam and vented overboard. The coiled plastic tube and delivery valve through which the astronauts drink is the *water delivery assembly*.

WATERTOWN - USNS Watertown, DOD-Western Test Range tracking ship equipped with S-Band facilities for earth orbital and limited lunar mission support.

WAVEGUIDE - A system of boundaries capable of guiding waves.

WB - Wideband

WBD - Wideband data

WBDL - Wideband Data Link

WEIGHT FLOW RATE - The flow rate of a liquid propellant expressed in pounds per second.

W/G - Water Glycol (see definition)

W/H - Watt-Hour

WHITE NOISE - Static; radio noise containing the whole spectrum of frequencies.

WHITE ROOM - Clean room, free of dust or contaminants, in which assembly or preparation of spacecraft components is done.

WHITE SANDS MISSILE RANGE - Site used for evaluating the launch escape system, for various tests and other operations of NASA, including a DOD-Eastern Test Range tracking station,

equipped with C-Band radar for near-earth orbital mission support. Located at White Sands, N.M.

WHS - White Sands, N.M. tracking station (see above)

WILCO - Will comply

WINDOW - Limited period of time during which a booster can be launched if it is to accomplish its mission (*launch window*); area at limit of earth's atmosphere through which a spacecraft on a given trajectory must pass for a successful re-entry (*re-entry window*).

WMS - Waste Management System; Water Management System (see definition)

WOM - Woomera, Australia MSFN Station (see below)

WOOMERA - Woomera, Australia, site of MSFN station operated for NASA by the Australian Department of Supply, equipped with C-Band radar for near-earth orbital mission support.

WPM - Words per Minute

WPS - Words per Second

WSMR - White Sands Missile Range (see definition)

WSTF - White Sands Test Facility

WTN - USNS Watertown, DOD-Western Test Range tracking station (see WATERTOWN)

WTR - Western Test Range (DOD); range extending from Vandenburg AFB, Calif. launching site.

WWV - National Bureau of Standards' Time Station

WX - Sometimes used to designate U. S. Weather Bureau

X - Prefix meaning "trans."

X-AXIS - Longitudinal axis running from nose through base of the spacecraft; associated with roll maneuvers, in which the spacecraft rolls or spins around its X-axis.

XCVR - Transceiver (see definition)

XDUCER - Transducer (see definition)

XEQ - Execute

XFER - Transfer

XFMR - Transformer

XMIT - Transmit

XMITR - Transmitter

XPNDR OR XPONDER - Transponder (see definition)

XSTR - Transistor

XTAL - Crystal

X-TIME - Sometimes used for T-Time (see definition)

XTNL CR - External Counter

X, Y, Z - Cartesian coordinates for distance, velocity or acceleration

Y - Yaw Deviation or cross-range deviation, off-range

YAW - Sideways twist of the spacecraft, rotating around its vertical (Z) axis, measured in degrees. A lateral movement.

Y-AXIS - The lateral axis running through the spacecraft, from side to side parallel to the earth. Associated with pitch maneuvers, in which the spacecraft turns or twists about its Y-axis.

YD - Yaw Deviation

YTA - Yaw Trim Angle

YTV - Yaw Thrust Vector

Z - Letter designation for spacecraft station.

Z-AXIS - The vertical axis running through the spacecraft at right angles to the earth. Associated with yaw maneuvers, in which the spacecraft turns or twists about its Z-axis.

ZERO - In a countdown, the moment of booster ignition.

ZERO GRAVITY OR ZERO G - Weightlessness.

ZLV - Zero-Length Vector

ZODIACAL LIGHT - Planes or wings of faint light which extend on either side of the sun, approximately on the plane of the ecliptic, visible after sunset and before sunrise. An extension of the outer solar atmosphere.

ZULU - Time reading based on Greenwich Mean Time. All space flights are coordinated according to Zulu, or GMT time.