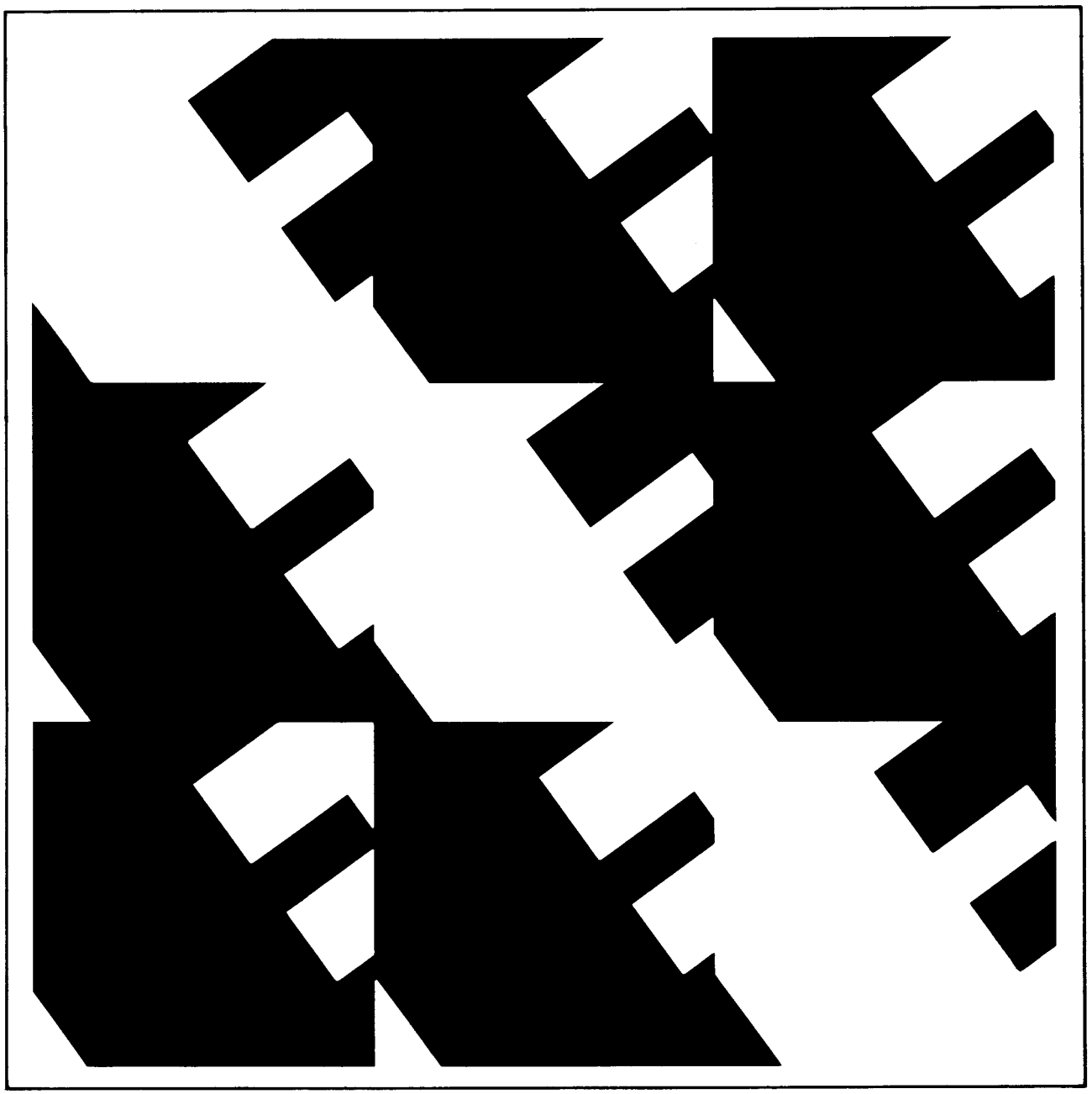
IEEE Std 172-1983
(Revision of ANSI/IEEE
Std 172-1971)

IEEE Standard
Definitions of Navigation Aid Terms



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Sponsor

Guidance and Control Systems Panel of the
IEEE Aerospace and Electronic Systems Society

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Foreword

(This Foreword is not a part of IEEE Std 172-1983, IEEE Standard Definitions of Navigation Aid Terms.)

This standard represents a revision of material contained in the previous edition of IEEE Std 172-1971.

The committee reviewed all of the terms, selected those which it considered appropriate, and deleted others. In preparation for this revision, the committee has included additional definitions relating to marine navigation, updated navigation equipment definitions, and included navigation terms where appropriate for completeness. This revision additionally encompasses suggestions and recommendations from a number of IEEE committees and panels who have contributed to this standard.

This standard was prepared by the Guidance and Control Panel of the IEEE Aerospace and Electronic Systems Society (AES). The following members have contributed to this standard:

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absolute altimeter. A device that measures altitude above local terrain. In its usual form it does this by measuring the time interval between transmission of a signal and the return of its echo, or by measuring the phase difference between the transmitting signal and the echo.

absolute delay (loran). The interval of time between the transmission of a signal from the master station and transmission of the next signal from the slave station.

accelerometer. A device that senses inertial reaction to measure linear or angular acceleration.

NOTE: In its simplest form, an accelerometer consists of a case-mounted spring and mass arrangement where displacement of the mass from its rest position relative to the case is proportional to the total non-gravitational acceleration experienced along the instrument's sensitive axes.

acoustical depth finder. *See:* **echo sounder.**

active homing guidance. A system of homing guidance wherein both the source of illuminating the target and the receiver for detecting the energy reflected from the target, as a result of illuminating the target, are carried within the vehicle.

ADF. *See:* **automatic direction finder.**

aerometeorgraph. A self-recording instrument for the simultaneous recording of atmospheric pressure, temperature, and humidity.

AEW. Abbreviation for airborne early warning, describing an early-warning radar carried by an airborne or spaceborne vehicle.

aerophase (air operations). A name for a **radio beacon.**

AFCS. *See:* **automatic flight-control system.**

aid to navigation. *See:* **navigational aid.**

air data system. A set of aerodynamic and thermodynamic sensors, and a computer which provide flight parameters such as air speed, static pressure, air temperature, and Mach number.

air-derived navigation data. Data obtained from measurements made at an airborne vehicle.

air navigation. The navigation of aircraft.

airport surface-detection equipment (ASDE). A ground-based radar for observation of the positions of aircraft and other vehicles on the surface of an airport.

airport surveillance radar (ASR). A medium range (for example, 60 nmi) surveillance radar used to control aircraft in the vicinity of an airport.

airposition indicator (API). An airborne computing system which presents a continuous indication of the aircraft's position on the basis of aircraft heading, air speed, and elapsed time.

air-route surveillance radar (ARSR). A long range (for example, 200 nmi) surveillance radar used to control aircraft on airways beyond the coverage of airport surveillance radar (ASR).

air speed. The rate of motion of a vehicle relative to the air mass.

air-speed indicator. An instrument for measuring air speed.

Alford loop. A multi-element antenna, having approximately equal amplitude currents which are in phase and uniformly distributed along each of its peripheral elements, producing a substantially circular radiation pattern in the plan of polarization (originally developed as a four-element horizontally polarized VHF loop antenna).

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alignment (inertial navigation equipment). The orientation of the measuring axes of the inertial components with respect to the coordinate system in which the equipment is used.

NOTE: Inertial alignment refers to the result of either the process of bringing the measuring axis into a desired orientation or the computation of the angles between the measuring axis and the desired orientation with respect to the coordinate system in which the equipment is used. The initial alignment can be accomplished by the use of non-iertial sensors. *See also:* **gyrocompass alignment** and **transfer alignment.**

almanac. A periodic publication of astronomical data useful to a navigator.

altimeter. An instrument which determines the height of an object with respect to a fixed level, such as sea level. There are two common types: an aneroid, or barometric altimeter, and the radio, or radar altimeter.

altitude. (1) Angular distance above the horizon — the arc of a vertical circle between the horizon and a point on the celestial sphere. (2) Vertical distance above a given datum.

ambiguity (navigation). The condition obtained when navigation coordinates define more than one point, direction, line of position or surface of position.

anemometer. An instrument for measuring the speed of wind.

aneroid altimeter. *See:* **barometric altimeter.**

angle of attack. The angle between the mean chord or the wing and the line of flow of the air past the aircraft.

angle of climb. The angle between a climbing aircraft's flight path and the horizontal.

angle of cut (navigation). The angle at which two lines of position intersect. Also called **crossing angle.**

angle of descent. The angle between a descending aircraft's flight path and the horizontal.

angular deviation sensitivity. The ratio of change of course indication to the change of angular displacement from the course line.

angular width. *See:* **course width.**

A-N radio range. A radio range providing four radial lines of position identified aurally as a continuous tone resulting from the interleaving of equal amplitude **A** and **N** International Morse Code letters. The sense of deviation from these lines is indicated by deterioration of the steady tone into audible **A** or **N** code signals.

antenna effect (radio direction finding). The presence of output signals having no directional information and caused by the directional array acting as simple nondirectional antenna; the effect is manifested by angular displacement of the nulls, or a broadening of the nulls.

apogee. That orbital point farthest from the earth, when the earth is the center of attraction.

apparent altitude. That sextant altitude corrected for reading and reference level inaccuracies.

apparent bearing (direction finding). A bearing from a direction-finder site to a target transmitter determined by averaging the readings made on a calibrated direction-finder test standard; the apparent bearing is then used in the calibration and adjustment of other direction finders at the same site.

apparent horizon. Visible horizon.

apparent vertical. The direction of the vector sum of the gravitational and all other accelerations.

approach navigation. Navigation during the time that the approach to a dock, runway, or other terminal facility is of immediate importance.

approach path. That portion of the flight path between the point at which the descent for landing is normally started and the point at which the aircraft touches down on the runway.

artificial horizon. (1) A device for indicating the horizontal, as bubble, gyroscope, pendulum, or the flat surface of a liquid. (2) A gyroscopic flight instrument that shows the pitching and banking attitudes of a vehicle with respect to a reference line horizon. Also called **gyro horizon.**

assumed position. A point at which a craft is assumed to be located.

astern. Bearing approximately 180° relative.

astrocompass. An instrument which, when oriented to the horizontal and the celestial sphere, indicates horizontal reference direction relative

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to the earth. It is used to obtain true heading by reference to celestial bodies.

astro-inertial navigation equipment. *See:* **celestial-inertial navigation equipment.**

astronomical position. (1) A point on the earth where coordinates have been determined as a result of the observation of celestial bodies. (2) A point on the earth defined in terms of astronomical latitude and longitude.

astrotracker. An automatic sextant which has the ability to sight on and track selected stars throughout the day and night, providing heading and position data. The tracker may be optical or radiometric. Also known as **star tracker.**

A-trace (loran). The first (upper) trace on the scope display.

attitude. The position of a body as determined by the inclination of the axes to some frame of reference.

attitude control. Devices or system that automatically regulates and corrects attitude.

attitude-effect error (navigation). A manifestation of polarization error; an error in indicated bearing that is dependent upon the attitude of the vehicle with respect to the direction of signal propagation. *See:* **heading effect error.**

attitude and heading-reference system (AHRS). *See:* **heading and attitude reference.**

aural radio range. *See:* **A-N radio range.**

automatic chart-line follower. A device which automatically derives error signals proportional to the deviation of the position of a vehicle from a predetermined course line drawn on a chart.

automatic direction finder. A direction finder which automatically and continuously provides a measure of the direction of arrival of the received signal. Data are usually displayed visually.

automatic flight control system (AFCS). An autopilot or automatic pilot. A system that controls the attitude, direction, and speed of a vehicle and directs it to travel along a selected course in response to manual or electronic commands. Stabilizes the dynamic response of the vehicle.

automatic track-follower. *See:* **automatic chart-line follower.**

automatic tracking. Tracking in which a system employs some feedback mechanisms, such as a servo or computer, to follow automatically some characteristic of a signal or target such as range, angle, Doppler frequency, or phase. *See also:* **tracking, tracking radar.**

autonavigator. Navigation equipment which includes means for coupling the output navigational data derived from the navigation sensors to the control system of the vehicle.

autopilot. *See:* **automatic flight control system.**

autopilot coupler (navigation). The means used to link the navigation system-receiver output to the automatic pilot.

azimuth. (1) The direction of a celestial point from a terrestial point, expressed as the angle in the horizontal plane between a reference line and the horizontal projection of the line joining the two points.

NOTE: True North is usually but not always implied where no reference direction is stated.

(2) The angle between horizontal reference direction and the horizontal of the direction of boresight of the antenna.

(3) Bearing.

azimuth marks (markers). Calibration marks for **azimuth.**

back course (ILS). The course which is located on the opposite side of the localizer from the runway.

bank (navigation). Lateral inclination of an aircraft in flight. *See:* **list.**

barometric altimeter. Essentially an aneroid barometer, an instrument which determines atmospheric pressure and is graduated in feet above sea level.

barothermograph. An instrument which automatically records pressure and temperature.

baseline (navigation). The line joining the two points between which electrical phase or time is compared in determining navigation coordinates. For two ground stations, this is normally the great circle joining the two stations, and, in the case of a rotation collector system, it is the line joining the two sides of the collector.

baseline delay. The time interval needed for a signal from a loran master station to travel to the slave station.

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basic repetition frequency (loran). The lowest pulse repetition frequency of each of the several sets of closely-spaced repetition frequencies employed.

basic repetition rate. *See:* **basic repetition frequency.**

bathythermograph. A recording thermometer for determining the temperature of the sea at various depths.

BDHI (bearing distance heading indicator). A display device which presents continuous references as to course and distance to destination.

beacon. (1) A fixed aid to navigation. (2) An unlighted aid to navigation. (3) Anything serving as a signal or conspicuous indication, either for guidance or warning. (4) In radar, a transponder used for replying to interrogations from a radar. *See:* **Examples.**

Examples of Beacons:

fan-marker beacon. A beacon that transmits vertical beam-horizontal cross section in the shape of a double convex lense.

homing beacon. A beacon that provides homing guidance.

identification beacon. A beacon that transmits coded signals to identify a geographic position.

landing beacon. A beacon used to guide aircraft in landing.

lighted beacon. A beacon that transmits signals by light waves (for example, light house).

marker or marker beacon. A radio beacon to designate a small area.

marker-radio beacon. A beacon that indicates specific location.

racon. *See:* **racon.**

radar beacon. *See:* **radar beacon.**

radio beacon. A beacon that transmits signals by only electromagnetic energy.

z-marker beacon. A vertical beam — horizontal cross section in the shape of a circle.

beam error (navigational systems using directionally propagated signals). The lateral or angular difference between the mean direction of the actual course and the desired course direction.

NOTE: Sometimes called **course error.**

beam noise (navigational systems using directionally propagated signals). Extraneous disturbances tending to interfere with ideal system performance.

NOTE: Beam noise is the aggregate effect of bends, scalloping, roughness, etc.

bearing. (1) The horizontal direction of one terrestrial point from another, expressed as the angle in the horizontal plane between a reference line and the horizontal projection of the line joining two points. (2) **Azimuth.** A bearing is often designated as **true, magnetic, compass, grid,** or **relative** and is dependent upon the reference direction.

bearing error curve. (1) **(DF equipment).** A plot of the instrumental bearing errors versus either indicated or correct bearing. (2) (in **DF installations**). A plot of the combined instrumental bearing error (of the equipment) and site error versus indicated bearings.

bearing offset, indicated (DF installations). The mean different between the indicated and apparent bearings of a number of signal sources, the sources being, for the most part, uniformly distributed in azimuth.

bearing reciprocal. *See:* **reciprocal bearing.**

bearing sensitivity, DF. The minimum field-strength input to a direction-finder system to obtain repeatable bearings within the bearing accuracy of the system.

bend. A departure of the course line from the desired direction at such a rate that it can be followed by the vehicle.

bend amplitude (navigation). The measured maximum amount of course deviation due to bend; measurement is made from the nominal or bend-free position of the course.

bend frequency (navigation). The frequency at which the course-indicator oscillates when the vehicle track is straight and the course contains bends; bend frequency is a function of the vehicle velocity.

bend-reduction factor (navigation). The ratio of bend amplitude existing before the introduction of bend-reducing features to that existing afterward.

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binnacle. The stand in which a compass is mounted (marine navigation).

binocular. An optical instrument for use with both eyes simultaneously.

blinking (pulse systems). A method of providing information by modifying the signal at its source so that the signal presentation on the display at the receiver alternately appears and disappears, for example, in **loran,** blinking is used to indicate that the signals of a pair of stations are out of synchronization.

blip. A deflection, or a spot of contrasting luminescence on a radar display caused by the presence of a target.

blur (null-type DF systems). The output (including noise) at the bearing of minimum response expressed as a percentage of the output at the bearing of maximum response.

boresighting. The process of aligning or determining the angle of the electrical or mechanical axes of a navigation system to a set of vehicle reference axes. Usually accomplished by an optical procedure.

boundary marker (ILS). A radio-transmitting station near the approach end of the landing runway, which provides a fix on the localizer course.

B-trace (loran). The second (lower) trace on the scope display.

buoy. A floating object, other than a lightship, moored or anchored to the bottom of the sea, which is an aid to navigation.

Examples of Buoys:

buoys classified to location: channel, midchannel, turning, fairway, bifurcation, junction, sea.

combination buoy. A buoy that has more than one means of conveying intelligence.

danger or hazard buoy. Classified as: obstruction, wreck, telegraph, cable, fish net, dredging.

lighted buoy. A buoy with a light that has characteristics for detection and identification.

radio-beacon buoy. A buoy equipped with a marker-radio beacon.

sonobuoy. A buoy that automatically transmits a signal when triggered by an underwater-sound signal.

sound buoy. A buoy equipped with a characteristic sound signal.

CADF. *See:* **commutated-antenna direction finder.**

calibration marks. Indications superimposed on a display to provide a numerical scale of the parameters displayed.

carrier-controlled approach system (CCA). An aircraft-carrier radar system providing information by which aircraft approaches may be directed by way of radio communication.

CCA. *See:* **carrier-controlled approach system.**

ceilometer. An instrument for measuring the height of clouds.

celestial-inertial navigation equipment. An equipment employing both celestial and inertial sensors. Also **astro-inertial navigation equipment** and **stellar-inertial navigation equipment.**

celestial fix. A position fix established by observation of celestial bodies.

celestial navigation. Navigation with the aid of celestial bodies. Applied principally to the measurement of the attitudes of a celestial body.

centerline. The lows of the points equidistant from two reference points or lines, as the perpendicular bisector of the baseline of a hyperbolic system of navigation, such as **loran.**

CEP. *See:* **circular probable error.**

chain. A network of similar stations operating as a group for determination of position or for furnishing navigational information.

challenge. To cause an interrogator to transmit a signal which puts a transponder into operation.

chart. A map intended primarily for navigation use.

chart-comparison unit. A device for the simultaneous viewing of a navigational chart in such a manner that one appears superimposed upon the other.

check point. *See:* **way point.**

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chronometer. A time piece with a nearly constant rate. Set approximately to *Greenwich Mean Time.*

circular probable error (CPE or CEP). In two-dimensional error distribution, the radius of a circle encompassing half of all errors.

clearance. (1) **(ILS).** The DDM in excess of that required to produce full-scale deflection of the course-deviation indicator in flight areas outside the on-course sector; when the DDM is too low the indicator falls below full-scale deflection and the condition of *low clearance* exists. (2) **(air-traffic control).** Permission by a control facility to the pilot to proceed in a mutually understood manner.

clearance antenna array (directional localizer). The antenna array that radiates a localizer signal on a separate frequency within the pass band of the receiver and provides the required signals in the clearance sectors as well as a back course.

clearance sector (ILS). The sector extending around either side of the localizer from the course sector to the back course sector, and within which the deviation indicator provides the required offcourse indication.

clinometer. An instrument for indicating the degree of slope or the angle of roll or pitch of a vehicle, according to the plane in which it is mounted.

clutter. Atmospheric noise, extraneous signals, etc, which tend to obscure the reception of a desired signal.

coding delay (loran). An arbitrary time delay in the transmission of pulse signals from the slave station to permit the resolution of ambiguities; the term **suppressed time delay** more accurately represents what is being accomplished and should be used instead of **coding delay.**

collision-avoidance system. A system providing the means of detection and prevention of impending collision between vehicles. The system performs one or more of the following functions: detection of intruders in surrounding vicinity, evaluation of *miss distance* of a collision hazard, determination of precise maneuver needed to avoid the hazard and specification of when an avoidance maneuver should be initiated.

command guidance. Guidance in which information transmitted to a craft from an outside source causes it to follow a prescribed path.

commutated antenna direction finder (CADF). A system using a multiplicity of antennas in a circular array and a receiver which is connected to the antennas in sequence through a commutating device for finding the direction of arrival of radio waves; the directional sensing is related to phase shift which occurs as a result of the communication.

compass. An instrument for indicating a horizontal reference direction relative to the earth.

compass bearing. Bearing relative to compass north.

compass course. Course relative to compass north.

compass deviation. *See:* **magnetic deviation.**

compass heading. Heading relative to compass north.

compass locator. *See:* **nondirectional beacon.**

compass north. The direction north as indicated by a magnetic compass.

compass repeater. That part of a remote-indicating compass sytem which repeats, at a distance, the indications of the master compass.

compass rose. A compass used to assist in aircraft magnetic compass compensation.

composite pulse (pulse navigational systems). A pulse composed of a series of overlapping pulses received from the same signal source but by way of different paths.

cone of ambiguity. A generally conical volume of airspace above a navigation aid within which navigational information from that facility is unreliable.

cone of silence. A conically shaped region above an antenna where the field strength is relatively weak because of the configuration of the antenna system.

consol. A keyed **C-W** short-baseline-radio navigation system operating in the L/MF frequency band, generally useful to about 1500 nmi (2800 km), and using three radiators to provide a multiplicity of overlapping lobes of dot-and-

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dash patterns which form equisignal hyperbolic lines of position. These lines of position are moved slowly in azimuth by changing rf phase, thus allowing a simple listening and counting or timing operation to be used to determine a line of position within the sector bounded by any pair of equisignal lines.

consolan. A form of consol using two radiators instead of three.

constant-delay discriminator. *See:* **pulse decoder.**

coriolis correction (navigation). An acceleration correction which must be applied to measurements of acceleration with respect to a coordinate system relative to inertial space.

corrected-compass course. *See:* **magnetic course.**

corrected-compass heading. *See:* **magnetic heading.**

correction angle. The angular difference between heading and course of a vehicle. Preferably called **drift-correction angle.**

coupler. That portion of a navigational system which receives signals of one type from a sensor and transmits signals of a different type to an actuator. *See:* **autopilot coupler.**

course. (1) The intended direction of travel, expressed as an angle in the horizontal plane between a reference line and the course line, usually measured clockwise from the reference line. (2) The intended direction of travel as defined by a navigational facility. (3) Common usage for **course line.**

course line. The projection in the horizontal plane of a path (proposed path of travel).

course linearity (ILS). A term used to describe the change in DDM of the two modulation signals with respect to displacement of the measuring position from the course line but within the course sector. Also called **desired track** or **flight path.**

course-line computer. A device, usually carried aboard a vehicle, to convert navigational signals such as VOR/DME into course extending between any desired points regardless of their orientation with respect to the source of the signals.

course-line deviation. The amount by which the track of a vehicle differs from its course line, expressed in terms of either an angular or linear measurement.

course-line deviation indicator (course-deviation indicator). A device providing a visual display of the direction and amount of deviation from the intended course. Also called **flight path deviation indicator** or **course indicator).**

course made good. The direction from the point of departure to the position of the vehicle on the horizontal plane.

course push (pull). An erroneous deflection of the indicator of a navigational aid, produced by altering the attitude of the receiving antenna.

NOTE: This effect is a manifestation of polarization error and results in an apparent displacement of the course line.

course roughness. A term used to describe the imperfections in a visually indicated course when such imperfections cause the course indicator to make rapid erratic movements. *See:* **scalloping.**

course scalloping. *See:* **scalloping.**

course sector (ILS). A wedge-shaped section of airspace containing the course line and spreading with distance from the ground station; it is bounded on both sides by the loci of points at which the DDM is a specified amount, usually the DDM giving full-scale deflection of the course-deviation indicator.

course-sector width (ILS). The transverse dimension at a specified distance, or the angle in degrees, between the sides of the course sector.

course sensitivity (navigation systems). The relative response of a course-line deviation indicator to the actual or simulated departure of the vehicle from the course line. In VOR, Tacan, or similar omnirange systems, course sensitivity is often taken as the number of degrees through which the omnibearing selector must be moved to change the deflection of the course-line deviation indicator from full scale on one side to full scale on the other, while the receiver omnibearing-input signal is held constant.

course softening. The intentional decrease in course sensitivity upon approaching a navigational aid such that the ratio of indicator de-

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flection to linear displacement from the course line tends to remain constant.

course width. Twice the displacement (of the vehicle), in degrees, to either side of a course line, which produces a specified indication on the course deviation indicator (usually the specified indication is full scale).

crab angle. Deprecated. *See:* **drift correction angle** or **drift angle.**

crossing angle. *See:* **angle of cut.**

crossover characteristic curve (navigation systems such as **VOR** and **ILS).** The graphical representation of the indicator current variation with change of position in the crossover region.

crossover region (navigation systems). A loosely defined region in space containing the course line and within which a transverse flight yields information useful in determining course sensitivity and *flyability.*

cytac. The designation of **loran C** in an earlier stage of development.

data stabilization (vehicle-borne navigation systems). The stabilization of the output signals with respect to a selected reference invariant with vehicle orientation.

DDM. *See:* **difference in depth of modulation.**

dead reckoning (DR). The determining of the position of a vehicle at one time with respect to its position at a different time by the application of vectors representing courses and distances.

Decca. A radio navigation system transmitting on several related frequencies near 100 kHz, useful to about 200 nmi (370 km) in which sets of hyperbolic lines of position are determined by comparison of the phase of (a) one reference continuous wave signal from a centrally located master with (b) each of several continuous wave signals from slave transmitters located in a star pattern, each about 70 nmi (130 km) from the master.

decision gate. A specified point near the lower end of an ILS approach at which a pilot must make a decision either to complete the landing or to execute a missed-approach procedure.

declinometer. An instrument for measuring magnetic declination.

dectra. An adaptation of the **Decca** low frequency (lf) radio navigation system in which two pairs of continuous wave (cw) transmitters are oriented so that the center lines of both pairs are along and at opposite ends of the same great circle path, to provide course guidance along and adjacent to the great circle path. Distance along track may be indicated by synchronized signals from one transmitter of each pair.

degaussing. Neutralization of the strength of the magnetic field of a vessel.

depth-finder. An instrument for determining the depth of water, particularly an echo sounder.

derived envelope (loran C). The waveform equivalent to the summation of the video envelope of the rf received pulse and the negative of its derivative, in proper proportion; the resulting envelope has a zero crossing at a standard point (for example, 25 μs) from the pulse beginning, serving as an accurate reference point for envelope time-difference measurements, and as a gating point in rejecting the latter part of the received pulse which may be contaminated by skywave transmissions.

derived pulse (loran C). A pulse derived by summing the received rf pulse and an oppositely phased rf pulse so that it has an envelope which is the derivative of the received rf pulse envelope; the resultant envelope has a zero point and an rf phase reversal at a standard interval (for example, 25 μs) from the pulse beginning and its serves as an accurate reference for cycle time-difference measurements and as a gating point in rejecting the latter part of the received pulse which may be contaminated by sky-wave transmissions.

desired track. *See:* **course line.**

deviation. The angle between the magnetic meridian and the axis of a compass card. Indicates the offset of the compass card from magnetic north.

deviation sensitivity. The rate of change of course indication with respect to the change of displacement from the course line.

DF (direction finder). *See:* **radio direction finder.**

DF antenna. Any antenna used for radio direction finding.

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DF antenna system. One or more DF antennas, their combining circuits and feeder systems, together with the shielding and all electrical and mechanical items up to the termination at the receiver-input terminals.

DF noise level. In the absence of the desired signals, the average power or rms voltage at any specified point in a direction finder system circuit.
NOTE: In rf and audio channels, the DF noise level is usually measured in terms of the power dissipated in suitable termination. In a video channel, it is customarily measured in terms of voltage across a given impedance, or of the cathode-ray deflection.

DF sensitivity. That field strength at the DF antenna, in microvolts per meter, which produces a ratio of signal-plus-noise to noise, equal to 20 dB in the receiver output, the direction of arrival of the signal being such as to produce maximum pickup in the DF antenna system.

difference in depth of modulation (DDM) (directive systems employing **overlapping lobes** with **modulated signals** such as **ILS).** A fraction obtained by subtracting from the percentage of modulation of the smaller signal and dividing by 100.

differential position (loran, omega, GPS). The difference between position axis determined by separated receivers or antennas. Close proximity error sources are minimized, thereby greatly enhancing the accuracy of this parameter.

directed reference flight. That type of stabilized flight which obtains control information from external signals which may be varied as necessary to direct the flight; for example, flight of a guided missile or a target aircraft.

direction. The position of one point in space relative to another without reference to the distance between them; direction may be either three dimensional or two dimensional, and it is not an angle, but is often indicated in terms of its angular difference from a reference direction.
NOTE: Five terms used in navigation — **azimuth, bearing, course, heading,** and **track** — involve measurement of angles from reference directions. To specify the reference directions, certain modifiers are used. These are: **true, magnetic, compass, relative, grid** and **gyro.**

directional homing. The process of homing wherein the navigational quantity maintained constant is the bearing.

directional localizer (ILS). A localizer in which maximum energy is directed close to the runway centerline, thus minimizing extraneous reflections.

direction finder (DF). *See:* **radio direction finder.**

direction finder deviation. The amount by which an observed radio bearing differs from the corrected bearing.

direction finding. *See:* **radio direction finder.**

display. The visual representation of output data.

distance measuring equipment. *See:* **DME.**

DME (distance measuring equipment). A radio aid to navigation which provides distance information by measuring total round-trip time of transmission from an interrogator to a transponder and return.

Doppler-inertial navigation equipment. Hybrid navigation equipment which employs both Doppler navigation radar and inertial sensors.

Doppler navigator. A self-contained, dead reckoning navigation aid transmitting two or more beams of electromagnetic or acoustic energy outward and downward from the vehicle and utilizing the Doppler effect of the reflected energy, a reference direction, and the relationship of the beams to the vehicle to determine speed and direction of motion over the reflecting surface.

Doppler radar. A radar which utilizes the Doppler effect to determine the radial component of relative radar target velocity or to select targets having particular radial velocities.

Doppler VOR. A vhf radio range, operationally compatible with conventional VOR, less susceptible to siting difficulties because of its increased aperture. In it the variable signal (the signal producing azimuthal information) is developed by sequentially feeding an rf signal to a multiplicity of antennas disposed in a ring-shaped array; the array usually surrounds the central source of reference signal.

DR: *See* **dead reckoning.**

draft gauge. A hydrostatic instrument installed in vessels to indicate the depth to which a vessel is submerged.

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drift. (1) Drift angle, (2) component of a vehicle's ground speed perpendicular to heading and (3) distance a craft is moved by current and wind.

drift angle. The angular difference between the heading and the track.

drift correction angle. The angular difference between the course and the heading. Sometimes called the **crab angle** or **correction angle.**

dynamic vertical. *See:* **apparent vertical.**

earth's rate correction. A rate applied to a gyroscope to compensate for the apparent precession of the spin axis caused by the rotation of the earth.

echo (radar). The portion of energy of the transmitted pulse which is reflected to a receiver.

echo ranging. The process of determination of distance by measuring the time interval between transmission of a radiant energy source, usually sound, and the return of its echo. *See* **radio acoustic ranging.**

echo sounder. An instrument used for echo sounding. Also called **depth finder.**

echo sounding. Determination of the depth of water by measuring the time interval between emissions of a sonic or ultrasonic signal and the return of its echo from the bottom.

echo suppressor (navigation). A circuit component which desensitizes the receiving equipment for a period after the reception of one pulse, for the purpose of rejecting pulses arriving later over indirect reflection paths.

electrical distance. The distance between two points expressed in terms of the duration of travel of an electromagnetic wave in free space between the two points.
NOTE: An often used unit of electrical distance is the light-microsecond, approximately 300 m (983 ft).

electronic position indicator (EPI). A radio navigation system used in hydrographic surveying which provides circular lines of position.

elements of a fix. The specific values of the navigation coordinates necessary to define a position.

equiphase zone. The region in space within which difference in phase of two radio signals is indistinguishable.

equisignal localizer. A localizer in which the localizer on-course line is established as an equality of the amplitudes of two signals.

estimated position. The most probable position of a craft determined from incomplete data or data of questionable accuracy.

false course (navigation systems normally providing one or more course lines). A spurious additional course line indication due to undesired reflections or to a maladjustment of equipment.

fan marker. A vhf radio facility having a vertically-directed fan beam intersecting an airway to provide a fix.

final approach path. *See:* **approach path.**

fire-control radar. A radar whose prime function is to provide information for the manual or automatic control of artillery or other weapons.

fix. A position determined without reference to any former position.

flag alarm. An indicator in certain types of navigation instruments used to warn when the readings are unreliable.

flare-out. That portion of the approach path of an aircraft in which the slope is modified to provide the appropriate rate of descent at touchdown.

flarescan. A ground-based navigation system used in conjunction with an instrument approach system to provide flare-out vertical guidance to an aircraft by the use of a pulse-space-coded vertically-scanning fan beam that provides elevation-angle data.

flight instrument. A vehicle instrument used in the control of the direction of flight, attitude, altitude, or speed of a vehicle.

flight path. A proposed route in three dimensions. *See:* **course line.**

flight-path computer. Equipment providing outputs for the control of the motion of a vehicle along a flight path.

flight-path deviation. The amount by which the flight track of a vehicle differs from its desired flight path, expressed in terms of either angular to linear measurement.

flight-path deviation indicator. A device provid-

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ing a visual display of flight path deviation. Also called **course-line deviation indicator.**

flight track. The path in space actually traced by a vehicle.

flux gate. The magnetic direction-sensitive element of a gyro flux-gate compass also called **flux valve.**

flux-gate compass. Short for **gyro flux-gate compass.**

flux valve. *See:* **flux gate.**

gap coding (navigation). A process of communicating in which a normally continuous signal (such as an rf carrier) is interrupted so as to form a telegraphic-type message.

gate (navigation systems). (1) An interval of time during which some portion of a circuit or display is allowed to be operative, or (2) The circuit which provides gating.

GCI. Abbreviation for **ground controlled intercept.**

GEE. An electronic navigational system establishing hyperbolic lines of position similar to those of loran.

geocentric latitude. The acute angle between (1) a line joining a point with the earth's **geometric center** and (2) the earth's **equatorial plane.**

geocentric vertical. *See:* **geometric vertical.**

geodesic. The shortest line between two points measured on any mathematically derived surface which includes the points.

geodetic latitude. The angle between the normal to the spheroid and the earth's equatorial plane; the latitude generally used in maps and charts. Also called **geographic latitude.**

geographic latitude. *See:* **geodetic latitude.**

geographic (map) vertical. The direction of a line normal to the surface of the geoid.

geoid. The shape of the earth as defined by the hypothetical extension of mean sea level continuously through all land masses.

geometrical factor (navigation). The ratio of the change in a navigational coordinate to the change in distance, taken in the direction of maximum navigational coordinate change; the magnitude of the gradient of the navigational coordinate.

geometric vertical. The direction of the radius vector drawn from the center of the earth through the location of the observer.

ghost pulse. *See:* **ghost signals.**

ghost signals (loran). (1) Identification pulses which appear on the display at less than the desired loran station full pulse repetition frequency. (2) Signals appearing on the display which have a basic repetition frequency other than that desired.

gimbal. A device for supporting anything, such as an instrument, in such a manner that it still remains essentially horizontal when the support tilts.

glide path. The path used by an aircraft in approach procedures as defined by an instrument landing facility.

glide slope. An inclined surface generated by the radiation of electromagnetic waves and used with a localizer in an instrument landing system to create a glide path.

glide-slope angle. The angle in the vertical plane between the glide slope and the horizontal.

glide-slope deviation. The vertical location of an aircraft relative to a guide slope, expressed in terms of the angle measured at the intersection of the glide slope with the runway; or the linear distance above or below the glide slope.

glide-slope facility. The ground station of an **ILS** which generates the glide slope.

glide-slope sector (ILS). A vertical sector containing the glide slope and within which the pilot's indicator gives a quantitative measure of the deviation above and below the glide slope. The sector is bounded above and below by a specified difference in depth of modulation, usually that which gives full scale deflection of the slide-slope deviation indicator.

global positioning system (GPS). A radio navaid using a multiple of satellites in high orbit with vehicle position fixes determined by range and range-rate measurement. *See:* **satellite navigation.**

goniometer. A combining device used with a plurality of antennas so that the direction of maximum radiation or of greatest response may be rotated in azimuth without physically moving the antenna array.

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gravity vertical. *See:* **mass attraction vertical.** Also called **local vertical.**

Greenwich time. Time based upon the Greenwich meridian as reference as contrasted with that based upon a local or zone meridian.

grid bearing. Bearing relative to **grid north.**

grid converence. The angular difference in direction between **grid north** and **true north.**

grid course. Course relative to **grid north.**

grid heading. Heading relative to **grid north.**

grid lock. A community of members that know their position accurately relative to one another in a tactical grid and are able to unambiguously identify targets are considered **grid locked.**

grid north. An arbitrary reference direction used in connection with a system of rectangular coordinates superimposed over a chart.

grid variation. Grid magnetic angle (also called **grivation**).

ground-based navigation aid. An aid which requires facilities located upon land or sea.

ground-controlled approach. A ground radar system providing information by which aircraft approaches to landing may be directed by way of radio communications; the system consists of a **precision-approach radar (PAR)** and an **airport surveillance radar (ASR).**

ground-controlled interception. A radar system by means of which a controller on the ground may direct an aircraft to make an interception of another aircraft.

ground-derived navigation data (air navigation). Data obtained from measurements made on land or sea at locations external to the vehicle.

ground-position indicator (GPI). A dead-reckoning tracer or computer similar to an air-positon indicator, with provision for taking account of drift.

ground-referenced navigation data. Data in terms of a coordinate system referenced to the earth or to some specified portion thereof.

ground speed (navigation). The speed of a vehicle along its track; the horizontal component of the rate of motion of a vehicle relative to the earth's surface.

guidance. The exercise of directing influence over the movements of a vehicle, with particular reference to the selection of a flight path.

gyroscope (gyro). A device using angular momentum (usually a spinning rotor) to sense angular motion of its case with respect to inertial space about 1 or 2 axes orthogonal to the spin/axis.

gyrocompass. A compass having one or more gyroscopes as a directive element, and tending to indicate **true north.**

gyrocompass alignment (inertial navigation). A process of self-alignment in azimuth based upon measurements of misalignment draft about the nominal *east-west* axis of the system.

gyrocompassing. *See:* **gyrocompass alignment.**

gyro flux-gate compass. A remote indicating, gyro-stabilized earth-inductor compass which senses the horizontal component of the earth's magnetic field. Also called **flux gate compass.**

gyro horizon. A gyroscopic instrument indicating the attitude of vehicle with respect to the horizontal. *See* **artificial horizon.**

H (H beacon). A designation applied to two types of facilities: (1) a nondirectional radio beacon for homing by means of an airborne direction finder and (2) a radar air-navigation system using an airborne interrogator to measure the distance from two ground transponders.

heading. The horizontal direction in which a vehicle is pointed, expressed as an angle between a reference line and the line extending in the direction the vehicle is pointed, usually measured clockwise from the reference line.

heading and attitude reference system. A system employing gyroscopes and gravity sensors providing electrical signals analogous to the attitude (roll and pitch) and heading of a vehicle. Vertical and directional references may be entirely separate instruments, or, the functions may be combined into either a stable platform or operated in a strap-down system configuration. Also called **attitude and heading-reference system (AHRS).**

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heading effect error (navigation). A manifestation of polarization error causing an error in indicated bearing that is dependent upon the heading of a vehicle with respect to the direction of signal propagation.

NOTE: **Heading effect error** is a special case of **attitude effect error** where the vehicle is in straight level flight; it is sometimes referred as a **course push** (or pull). Also called **attitude effect error.**

head-up display (HUD). A display device which presents flight information to the pilot in his forward real-world view while operating in a head-up position. The display provides a collimated image that is optically superimposed on the real-world view.

homing. The process of approaching a desired point by maintaining constant some navigational parameter (other than altitude).

homing guidance. Guidance in which a craft is directed toward a destination by means of information received from the destination.

hybrid navigation equipment. Navigation equipment which employs two or more types of sensors.

hydrophone. A listening device for receiving underwater sounds.

hyperbolic system. A generic term for navigation systems deriving position by measurement of differential distance to several stations. Two stations provide a hyperbolic line of position **(LOP),** three or more stations provide a position fix. Examples of hyperbolic systems are **decca, loran** and **omega.**

ILS. An internationally adopted instrument landing system for aircraft, consisting of a vhf localizer, a uhf glide slope, and 75 MHz markers.

ILS marker beacon. A radio beacon transmitting signals which define a specific region above an instrument landing system (**ILS localizer course**).

ILS reference point. A point on the center line of the ILS runway designated as the optimum point of contact for landing; in ICAO standards this point is from 150 m to 300 m (500 ft to 1000 ft) from the approach end of the runway.

inclinometer. An instrument for measuring (1) inclination to the horizontal, particularly of the longitudinal axis of a vehicle and (2) the lines of force of the earth's magnetic field.

indicated bearing (direction finding). A bearing from a direction finder site to a target transmitter obtained by averaging several readings; the indicated bearing is compared to the apparent bearing to determine accuracy of the equipment.

inertial measurement unit (IMU). A subsystem containing gyroscopes, accelerometers, and associated electronics which, when integrated with an external computer, will provide the functions of inertial navigation equipment. An **inertial navigation system (INS).**

inertial navigation system (INS). A self contained, dead-reckoning navigation aid using inertial sensors (for example, gyroscopes and accelerometers), a reference direction and initial position to determine direction, distances, and speed. Accelerations are sensed dynamically by devices stabilized with respect to inertial space, and the navigational quantities (such as, vehicle velocity, angular orientation, or position information) are determined by computers. Also called **inertial navigator.**

inertial navigator. *See:* **inertial navigation system (INS).**

inertial space. A frame of reference defined with respect to the *fixed* stars.

initial conditions (inertial navigation). The values of position, velocity, level, azimuth, and sensor calibration data imposed on the system before departure.

inner marker. *See:* **boundary marker.**

INS: *See:* **inertial navigation system.**

instrumental error (navigation). Error due to the inaccuracies introduced in any portion of the system by the mechanism that translates pathlength differences into navigation coordinate information, including calibration errors and errors resulting from limited sensitivity of the indicating instruments.

instrument approach. The process of making an approach to a landing by the use of navigation instruments without dependence upon direct visual reference to the terrain.

instrument approach system (navigation). A system furnishing guidance in the vertical

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and horizontal planes to aircraft during descent from an initial-approach altitude to a point near the landing area.

instrument landing system. A generic term for a system which provides the necessary lateral, longitudinal, and vertical guidance in an aircraft for a low approach or landing. *See:* **ILS.**

interrogation. In a transponder system, the signal or combination of signals intended to trigger a response.

interrogator. (1) *Same as:* **interrogator-responsor.** (2) The transmitting part of an **interrogator-responsor.**

interrogator-responsor. A combined radio transmitter and receiver for interrogating a transponder and reporting the resulting replies independently of a radar echo display.

ionospheric error (navigation). The total systematic and random error resulting from the reception of the navigational signal by way of ionospheric reflections; this error may be due to (1) variations in transmission paths, (2) nonuniform height of the ionosphere, and (3) nonuniform propagation within the ionosphere.

inospheric height error (navigation). The systematic component of the total ionospheric error due to the difference in geometrical configuration between ground paths and ionospheric paths.

ionospheric tilt error (navigation). The component of the ionospheric error due to nonuniform height of the ionosphere.

Janus system. A technical used in Doppler navigation which uses beams directed forward and astern for computation of ground speed components.

jitter. Small, rapid variations in the size, shape, or position of displayed information, frequently caused by mechanical and electronical switching systems or faulty components.

Kalman filter. A method of estimating the variables of a system subjected to random disturbances and providing a procedure to combine measurements derived from multiple sources for increased accuracy. Used in hybrid navigation systems and in initial alignment or subsequent realignment of inertial navigation systems.

lag. The delay between the change in conditions and the indication of the change of an instrument.

lambda. A development of two-range Decca which includes lane identification.

landing aids. Any illuminating light, radio beacon, radar device, communications device, or any system of such devices for aiding vehicles in an approach and landing.

land navigation. Navigation of vehicles across land or ice. The expression is generally used in connection with the crossing of a region devoid of roads or land marks so that methods similar to those employed in air or marine navigation must be employed. Also called **surface navigation.**

lane (navigation system). The projection of a corridor on a navigation chart, the right and left sides of the corridor being defined by the same (ambiguous) values of the navigation coordinate (phase or amplitude), but within which lateral position information is provided, (for example, a Decca lane in which there is a 360° change of phase).

lattice (navigation). A pattern of identifiable intersecting lines of position, whose lines are laid down by a navigation aid.

leader-cable system. A navigation aid in which a path to be followed is defined by the detection and comparison of magnetic fields emanating from a cable system that is installed on the ground or under water.

leveling (inertial navigation). *See:* **platform erection.**

linearity region (instrument-approach system and in similar **guidance systems).** The region in which the deviation sensitivity remains constant within specified values.

line-of-position (LOP). The intersection of two surfaces of position, normally plotted as lines on the earth's surface, each line representing the locus of constant indication of the navigation information.

list. Inclination to one side of a vessel. *See:* **bank.**

lobe switching. A means of direction finding in which a directive radiation pattern is periodically shifted in position so as to produce

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a variation of the signal at the target. The signal variation provides information on the amount and direction of displacement of the target from the pattern mean position.

localizer. A radio facility which provides signals for use in lateral guidance of aircraft with respect to a runway center line.

localizer sector (equisignal localizer). The sector included between two radial lines from the localizer, the lines being defined by specified equal differences in depth of modulation (usually full scale right and left, respectively, of the flight path deviation indicator).

local level. The plane normal to the local vertical.

local vertical. The vertical at the location of the observer. It may be plumb-bob, geographic, or mass attraction vertical.

locator. *See:* **nondirectional beacon.**

log (marine navigation). An instrument for measuring the speed, or distance, or both, traveled by a vessel.

LOP. *See:* **line-of-position.**

loran. A long distance radio navigation system in which hyperbolic lines of position are determined by measuring arrival time differences of pulses transmitted in fixed time relationship from two fixed-base transmitters. **Loran A,** generally useful to distances of 500 nmi to 1500 nmi (900 km to 2800 km) over water, depending upon the availability of sky-wave, uses a baseline of about 300 nmi (550 km) operates at approximately 2 MHz and gives time difference measurement by the matching of the leading edges of the pulses, usually with the aid of an oscilloscope. **Loran C,** generally useful to distance of 1000 nmi to 1500 nmi (1800 km to 2800 km) over water, operates at approximately 100 kHz; it provides a coarse measurement of time difference through the matching of pulse envelopes, and a fine measurement by the comparing of phase between the carrier waves. **Loran D** is a shorter baseline and lower power adaptation of loran C for tactical applications.

loran-repetition rate. *See:* **pulse-repetition frequency.**

lorhumb line (navigation system chart, such as a **loran chart** with its **overlapping families** of **hyperbolic lines).** A line drawn so that it represents a path along which the change in values of one of the families of lines retains a constant relation to the change in values of another of the families of lines.

low-clearance area (instrument approach system). Any area containing only low-clearance points.

low-clearance points (ILS). Locations in space outside the course sector at which course deviation indicator current is below some arbitrary value, usually the full-scale deflection value.

lubber's line. A reference line on any direction indicating instrument marking the reading which coincides with the heading.

machmeter (Mach indicator). An instrument for measuring Mach number. *See:* **air-speed indicator.**

Mach number. A number expressing the ratio of the speed of a body with respect to a surrounding medium or the speed of flow, to the speed of sound.

magnetic azimuth. Azimuth relative to magnetic north.

magnetic bearing. Bearing relative to magnetic north.

magnetic compass. A device for indicating the direction of the horizontal component of a magnetic field.

magnetic course. Course relative to magnetic north.

magnetic declination. *See:* **magnetic variation.**

magnetic deviation. Angular difference between compass north and magnetic north caused by magnetic effects in the vehicle. Also called **compass deviation.**

magnetic dip. The angle between the horizontal and the lines of force of the earth's magnetic field.

magnetic heading. Heading relative to magnetic north.

magnetic north. The direction of the horizontal component of the earth's magnetic field toward the north magnetic pole.

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magnetic variation. The angle between the geographic and magnetic meridians. Also called **variation.**

magnetometer. An instrument for measuring the intensity, or direction, or both, of a magnetic field or a component of a magnetic field in a particular direction.

NOTE: The term is more usually applied to instruments that measure the intensity of a component of a magnetic field.

map vertical. *See:* **geographic vertical.**

marine navigation. The navigation of watercraft.

marker (air navigation). A radio facility whose signals are geographically confined so as to serve as a position fix. *See:* **fan, boundary, middle, outer** and **z markers.** Also called **marker beacon.**

m-array glide slope (ILS). A modified null-reference glide-slope antenna system in which the modification is primarily an additional antenna used to obtain a high degree of energy cancellation at the low elevation angles.

NOTE: Called *M* because it was 13th in a series of designs. This system is used at locations where higher terrain exists in front of the approach end of the runway, in order to reduce unwanted reflections of energy into the glide-slope sector.

mass-attraction vertical. The normal, to any surface of constant geopotential; it is the direction indicated by a plumb-bob on a nonrotating earth. *See* **local vertical.**

master compass. That part of a remote indicating-compass system which determines direction for transmission to various repeaters.

master station. One station of a group of stations, as in loran, which is used to control or synchronize the emission of the other stations.

mechanical modulator. (1) A device that varies some characteristic of a carrier wave so as to transmit information, the variation being accomplished by physically moving or changing a circuit element. (2) **(ILS).** A particular arrangement of rf transmission lines and bridges with resonant sections coupled to the lines and motor-driven capacitor plates that alter the resonance so as to produce 90 Hz and 150 Hz modulations.

microwave landing system. An airfield approach radar generating a guideline for vehicle landing.

midcourse guidance. Guidance from the end of the launching phase to some arbitrary time when terminal guidance begins.

meridian. A north south reference line, particularly a great circle through the geographical poles of the earth.

middle marker. A marker facility in an ILS which is installed approximately 1000 m (3500 ft) from the approach end of the runway on the localizer course line to provide a fix.

minimum en route altitude (MEA). The lowest altitude between radio fixes which assures acceptable navigational signal coverage and meets obstruction clearance requirements for instrument flight.

minimum reception altitude (MRA). The lowest enroute altitude at which adequate signals can be received to determine specific vor/vortac/tacan fixes.

most probable position (navigation). A position obtained by using all available position information (usually DR and one LOP) weighted statistically in accordance with individual estimated errors.

moving-base-derived navigation data. Data obtained from measurements made at the moving cooperative facilities located external to the navigated vehicle.

moving-base-navigation aid. An aid which requires cooperative facilities located upon a moving vehicle other than the one being navigated.

NOTES: (1) The cooperative facilities may move along a predictable path which is referenced to a specified coordinate system such as in the case of a nongeostationary navigation satellite.

(2) Such an aid may also be designed solely to permit one moving vehicle to home upon another.

moving-base-referenced navigation data. Data in terms of a coordinate system referenced to a moving vehicle other than the one being navigated.

moving-map display. A navigation device which displays the vehicle's navigation position on moving film of a navigation chart. This device often displays indicated course and distance to destination etc and is driven by various navigation systems (for example, loran, tacan, inertial, Doppler).

multipath. The propagation of a wave from one point to another by more than one path.

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When multipath occurs in radar, it usually consists of a direct path and one or more indirect paths by reflection from the surface of the earth or sea or from large man-made structures. At frequencies below approximately 40 MHz, it may also include more than one path through the ionosphere.

multipath error. The error (for example, in the measurement of angle of arrival) caused by multipath.

multiple rho. A generic term referring to navigation systems based on two or more distance measurements for determination of position.

Naveam. A radio navigational warning of dangers to shipping in the Eastern, Atlantic, Mediterranean, and Red Seas.

navigation. The process of directing a vehicle so as to reach the intended destination.

navigational aid. An instrument, system, device, chart, or method intended to assist in the navigation of a vehicle.

navigational astronomy. That part of astronomy of direct use to a navigator, comprised principally of celestial coordinates, time, and apparent motions of celestial bodies.

navigational satellite. An artificial earth orbiting satellite designed for navigational purposes. *See:* **satellite navigation, global positioning system.**

navigation coordinate. Any one of a set of quantities; the set serving to define a position.

navigation parameter. A measurable characteristic of motion or position used in the process of navigation.

navigation quantity. A measured value of a navigation parameter.

NDB. *See:* **nondirectional beacon.**

night effect (radio navigation systems). A special case of error occurring predominantly at night when sky-wave propagation is at the maximum.

nondirectional beacon (NDB) (air navigation). A radio facility which can be used with an airborne DF to provide a line of position; also known as a **compass locator, H, H-beacon, locator.**

north. The primary reference direction relative to the earth. True north is the direction of the north geographical pole. Magnetic north is the direction north as determined by the earth's magnetic line of force.

null (direction finding systems). The condition of minimum output as a function of the direction of arrival of the signal, or of the rotation of the response pattern of the DF antenna system.

null-reference glide slope. A glide-slope system using a two element array in which the slope angle is defined by the first null above the horizontal in the field pattern of the upper antenna.

OBI (omnibearing indicator). An instrument which presents an automatic and continuous indication of an omnibearing.

octant. *See:* **sextant.**

octantal error (navigation). An error in measured bearing caused by the finite spacing of the antenna elements in systems using spaced antennas to provide bearing information (such as VOR): this error varies in a sinusoidal manner throughout the 360° and has four positive and four negative maximums.

odolite. An optical instrument for accurately measuring horizontal and vertical angles.

odometer. A device attached to a vehicle for counting the number of revolutions of a drive shaft or wheel.

offset course computer. An automatic computer which translates reference navigational coordinates into those required for a predetermined course.

omega. A very long distance navigation system operating at approximately 10 kHz, in which hyperbolic lines of position are determined by measurement of the difference in travel time of continuous wave signals from two transmitters separated by 5000 nmi to 6000 nmi (9000 km to 11 000 km) or in which changes in distances from the transmitters are measured by counting rf wavelengths in space of *lanes* as the vehicle moves from a known position, the lanes being counted by phase comparison with a stable oscillator aboard the vehicle.

omnibearing. A magnetic bearing indicated by a navigational receiver on transmission from an omnirange.

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omnibearing converter. A device which combines the omnibearing signal with vehicle heading information to furnish electrical signals for the operation of the pointer of a radio magnetic indicator.

omnibearing-distance facility. A combination of an omnirange and a distance measuring facility, so that both bearing and distance information may be obtained; tacan and VOR/DME are Omnibearing Distance Facilities.

omnibearing-distance navigation. Radio Navigation utilizing a polar coordinate system as a reference, making use of omnibearing-distance facilities, often called **rho-theta** navigation.

omnibearing indicator. *See:* **OBI.**

omnibearing line. *See:* **radial.**

omnibearing selector. A control used with an omnirange receiver so that any desired omnibearing may be selected; deviation from on-course for any selected bearing is displayed on the course line deviation indicator.

omnidirectional range (omnirange). A radio facility providing bearing information at or from such facilities at all azimuths within its service area and providing direct indication of the magnetic bearing (omnibearing) of that station from any direction.

omnirange. *See:* **omnidirectional range.**

on-course curvature (navigation). The rate of change of the indicated course with respect to distance along the course line or path.

operating range. The maximum distance at which reliable service is provided by an aid to navigation.

optical landing system. A shipboard gyro stabilized or shore-based device which indicates to the pilot his displacement from a preselected glide path.

optical tracker. A device for determining the direction of a luminous body relative to a set of reference axes using visible light vice, infrared, or radio frequencies.

orbit. The path of a celestial body relative to another body around which it revolves.

outer marker. A marker facility in an ILS which is installed at approximately 5 nmi (9 km) from the approach end of the runway on the localizer course line to provide height, distance, and equipment functioning checks to aircraft on intermediate and final approach.

over-the-horizon-radar. Radar using sufficiently low carrier frequencies, usually in the high-frequency (hf) band, so that ground-wave or ionospherically refracted sky-wave propagation can allow detection far beyond the ranges allowed by line-of-sight propagation.

PAR. Abbreviation for **precision approach radar.**

passive homing guidance. Guidance in which a craft or missile is directed toward a destination by means of natural radiation from the destination.

path (navigation). (*See:* **flight path, flight track, course line**). A line connecting a series of points in space and constituting a proposed or traveled route.

perigee. That orbital point nearest the earth when the earth is the center of attraction.

periscope. An optical instrument which displaces the line of sight parallel to permit a view which otherwise may be obstructed itself.

periscopic sextant. A sextant designed to be mounted inside a vehicle, with a tube extending vertically upward through the skin of the vehicle.

phase localizer. A localizer in which the on-course line is defined by the phase reversal of energy radiated by the sideband antenna system, a reference carrier signal being radiated and used for the detection of phase.

pick-up factor, DF antenna system. An index of merit expressed as the voltage across the receiver input impedance divided by the signal field strength to which the antenna system is exposed, the direction of arrival and polarization of the wave being such as to give maximum response.

pilotage. The process of directing a vehicle by reference to recognizable landmarks or soundings, or to electronic or other aids to navigation. Observations may be by any means including optical, aural, mechanical, or electronic.

pip-matching display (navigation). A display in which the received signal appears as a pair of blips, the comparison of the characteristics

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of which provides a measure of the desired quantity.

pitch angle. *See:* **pitch attitude.**

pitch attitude. The angle between the longitudinal axis of the vehicle and the horizontal.

plan position indicator (PPI). A type of radar display format.

platform erection. In the alignment of inertial systems, the process of bringing the vertical axis of a stable platform system into agreement with the local vertical.

plotting chart. A chart designed primarily for plotting dead reckoning lines of position.

plumb-bob vertical. The direction indicated by a simple, ideal, frictionless pendulum that is motionless with respect to the earth; it indicates the direction of the vector sum of the gravitational and centrifugal accelerations of the earth at the location of the observer.

Polaris correction. A correction to be applied to the corrected sextant altitude of Polaris to obtain latitude.

polarization, desired. The polarization of the radio wave for which an antenna system is designed.

polarization error (navigation). The error arising from the transmission or reception of an electromagnetic wave having a polarization other than that intended for the system.

polar navigation. Navigation in polar regions where unique considerations and techniques are applied.

polar regions. The regions near the geographic poles. Definite limits for these regions are not recognized.

position (navigation). The location of a point with respect to a specific or implied coordinate system.

PPI. *See:* **plan position indicator.**

precession. The change in the direction of the axis of rotation of a spinning body, as a gyroscope, when acted upon by a torque.

precision-approach radar (PAR). A radar system located on an airfield for observation of the position of an aircraft with respect to an approach path and specifically intended to provide guidance to the aircraft in the approach.

preset guidance. Guidance in which a predetermined path is set into the guidance mechanism of a craft and is not altered after launching.

pressure altimeter. An altimeter that measures and indicates altitude above a datum plane by means of an aneroid which responds to the change in atmospheric pressure with height.

primary radar. A radar system, subsystem, or mode of operation in which the return signals are the echoes obtained by reflection from the target. Since this is the normal method of radar operation, the word *primary* is omitted unless necessary to distinguish it from *secondary*. *See:* **secondary radar.**

prime meridian. The meridian of longitude 0° almost universally considered as *Greenwich, England.*

proximity-effect error (navigation systems). An error in determination of system performance caused by improper use of measurements made in the near field of the antenna system.

pseudolatitude. A latitude in a coordinate system which has been arbitrarily displaced from the earth's conventional latitude system so as to move the meridian convergence zone (polar region) away from the place of intended operation.

pseudolongitude. A longitude in a coordinate system which has been arbitrarily displaced from the earth's conventional longitude system so as to move the meridian convergence zone (polar region) away from the place of intended operation.

pulse coder. A device for varying one or more of the characteristics of a pulse or of a pulse train so as to transmit information.

pulse decoder. A device for extracting information from a pulse-coded signal. Also called **constant-delay discriminator.**

pulse Doppler (pulse-Doppler radar). A **Doppler radar** that uses pulsed transmission.

quadrantal error (navigation). An angular error in measured bearing caused by characteristics of the vehicle or station which adversely affect the direction of signal propagation; the error varies in a sinusoidal manner throughout the 360° and has two positive and two negative maximums.

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racon. A radar beacon which returns a coded signal providing identification of the beacon as well as range and bearing. Also called **radar transponder beacon.**

radar. A device for transmitting electromagnetic signals and receiving echoes from objects of interest (targets) within its volume of coverage. Presence of a target is revealed by detection of its echo or its transponder reply. Additional information about a target provided by a radar includes one or more of the following: distance (range), by the elapsed time between transmissions of the signal and reception of the return signal; direction, by use of directive antenna patterns; rate of change of range, by measurement of Doppler shift; description or classification of target, by analysis of echoes and their variation with time.

The name radar was originally an acronym for Radio Detection and Ranging.

NOTE: Some radars can also operate in a passive mode, in which the transmitter is turned off and information about targets is derived by receiving radiation emanating from the targets themselves or reflected by the targets from external sources.

radar altimeter. *See:* **radio altimeter.**

radar beacon. A transponder used for replying to interrogations from a radar.

radar bearing. A bearing obtained by a radar.

radar fix. A position fix established by means of radar data.

radar responder beacon. *See:* **racon.**

radial (navigation). One of a number of lines of position defined by an azimuthal navigational facility; the radial is identified by its bearing (usually the magnetic bearing) from the facility.

radial probable error (RPE). *See:* **circular probable error.**

radio-acoustic ranging. Determining distance by a combination of radio and sound. Also called **echo ranging.**

radio altimeter. An altimeter using radar principles for height measurement. Height is determined by measurement of propagation time of a radio signal transmitted from the vehicle and reflected back to the vehicle from the terrain below. Also called **radar altimeter.**

radio-autopilot coupler. Equipment providing means by which electrical signals from navigation receivers control the vehicle autopilot.

radio beacon. A facility, usually a nondirectional radio station, emitting identifiable signals intended for radio direction finding observations. *See also:* **nondirectional beacon.**

radio direction-finder (RDF). A device used to determine the direction of arrival of radio signals. Also called **directional finder (DF).**

radio direction finding. A procedure for determining the bearing, at a receiving point, of the source of a radio signal by observing the direction of arrival and other properties of the signal.

radiolocation. Position determination by means of radio aids for purposes other than those of navigation.

radio magnetic indicator (RMI). A combined indicating instrument which converts omnibearing indications to a display resembling an ADF display, one in which the indicator points toward the omnirange station; it combines omnibearing, vehicle heading, and relative bearing.

radiometric sextant. An instrument which measures the direction to a celestial body by detecting and tracking the nonvisible natural radiation of the body; such radiation includes radio, infrared, and ultraviolet.

radio navigation. Navigation based upon the reception of radio signals.

radiophare. A term often used in international terminology, meaning radio beacon.

radio range. A radio facility which provides radial lines of position by having characteristics in its emission which are convertible to bearing information and useful in the lateral guidance of aircraft.

random errors. Those errors which cannot be predicted except on a statistical basis.

Ray Dist. A radio navigation system used in hydrographic and geophysical surveying.

RDF. *See:* **radio direction finding.**

NOTE: At one time this term was used by the British to mean radio distance-finding, that is, radar.

reciprocal bearing. The opposite direction to a bearing.

reference direction. A direction from which other directions are reckoned; for example, true north, grid north, and so on.

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reference line. A line from which angular or linear measurements are reckoned.

reference modulation (VOR). That modulation of the ground-station radiation which produces a signal in the airborne receiver whose phase is independent of the bearing of the receiver; the reference signal derived from this modulation is used for comparison with the variable signal.

reference test field (direction-finder testing). That field strength, in microvolts per meter, numerically equal to the DF sensitivity.

reflection error. The error due to the fact that some of the total received signal arrives from a reflection rather than all by way of the direct path.

refraction error. Error due to the bending of one or more wave paths by the propagation medium.

REGAL (range and elevation guidance for approach and landing). A ground-based navigation system used in conjunction with a localizer to compute vertical guidance for proper glide-slope and flare-out during an instrument approach and landing; it uses a digitally-coded vertically-scanning fan beam that provides data for both elevation angle and distance.

relative bearing. Bearing relative to heading.

relative grid. Navigation in a relative grid as opposed to an absolute coordinate system (for example, geo-referenced). A relative grid, arbitrarily constructed by designating a point as the origin and constructing a set of axes *U*, *V*, *W* enables members to navigate in this relative grid by virtue of their *U*, *V*, *W* coordinates.

remote magnetic sensor. A magnetic sensor located on a vehicle away from disturbances which provides an electrical signal in synchro format which is proportional to the vehicle heading relative to magnetic north. Often called a flux valve.

reply (transponder operation). A radio-frequency signal or combination of signals transmitted as a result of an interrogation.

reset on inertial navigation systems. Use of external data (for example, position fix) to refine alignment of and to calibrate the inertial navigation system.

resolving time. The minimum time interval by which two events must be separated, to be distinguishable in a navigation system, by the time measurement alone.

responder beacon. *See:* **transponder.**

responsor. The receiving component of an **interrogator-responsor.**

reticle. A system of lines, etc, placed in the focal plane of an optical instrument to serve as a reference.

rho rho. A generic term referring to navigation systems based on the measurement of two distances for determination of position.

rho theta. A generic term referring to polar coordinate navigation systems for determination of position of a vehicle through measurement of distance and direction.

rhumbline. A line on the surface of the earth making the same oblique angle with all meridians.

RMI. *See:* **radio magnetic indicator.**

roll angle. *See:* **roll attitude.**

roll attitude. The angle between the horizontal and the lateral axis of the craft. *See:* **bank.**

roughness (navigational system display). Irregularities resembling scalloping, but distinguished by their random, noncyclic nature; sometimes called **course roughness.**

runway visual range (RVR). The forward distance a human pilot can see along the runway during an approach to landing; this distance is derived from electro-optical instruments operated on the ground and it is improved (increased) by the use of lights (such as high-intensity runway lights).

satellite navigation. Navigation using artificial earth satellites as an aid. Position is computed by determination of either angles, range and range rate, or range and angle measurements of the vehicle relative to the satellite plus satellite ephermeris data received by the vehicle. Satellite ephermeris data can be determined by tracking stations and transmitted to and stored in the satellite's memory for subsequent transmission to vehicle's receivers.

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scalloping (navigation aids). The irregularities in the field pattern of the ground facility due to unwanted reflections from obstructions or terrain features, exhibited in flight as cyclical variations in bearing error. Also called **course scalloping.**

scanning. A programmed motion given to the major lobe of an antenna for the purpose of searching a larger angular region that can be covered with a single direction of the beam, or for measuring angular location of a target; also, the analogous process using range gates or frequency domain filters.

scatterband (interrogation systems). The total bandwidth occupied by the various received signals from interrogators operating with carriers on the same nominal radio frequency; the scatter results from the individual deviations from the nominal frequency.

Schuler tuning (inertial navigation system). The application of parameter values such that accelerations do not deflect the platform system from any vertical to which it has been set; a Schuler-tuned system, if fixed to the mean surface of a nonrotating earth, exhibits a natural period of 84.4 min.

scope. The face of a cathode-ray tube or a display of similar appearance. A colloquial abbreviation of oscilloscope.

search radar. A radar used primarily for the detection of targets in a particular volume of interest.

sea return. The radar response from the sea surface.

secondary radar. (1) A radar technique or mode of operation in which the return signals are obtained from a beacon, transponder, or repeater carried by the target, as contrasted with primary radar in which the return signals are obtained by reflection from the target. (2) A radar, or that portion of a radar, that operates on this principle. *See also:* **primary radar.**

selector pulse. A pulse which is used to identify, for selection, one event in a series of events.

self-contained navigation aid. An aid which consists only of facilities carried by the vehicle.

semiautomatic flight inspection (SAFI). A specialized and largely automatic system for evaluating the quality of information in signals from ground-based navigational aids; data from navigational aids along and adjacent to any selected air route are simultaneously received by a specially equipped SAFI aircraft as it proceeds under automatic control along the route, evaluated at once for gross errors, and recorded for subsequent processing and detailed analysis at a computer-equipped central ground facility.

NOTE: Flight inspection means the evaluation of performance of navigational aids by means of in-flight measurements.

semiactive homing guidance. Guidance in which a craft is directed toward a destination by means of information received from the destination in response to transmissions from a source other than the craft.

sense (navigation). The pointing direction of a vector representing some navigation parameter.

sensing. The process of finding the sense, as, for example, in direction finding, the resolution of the 180° ambiguity in bearing indication; and, as in phase or amplitude-comparison systems such as ILS and VOR, the establishment of a relation between course displacement signal and the proper response in the control of the vehicle.

service area (navigation). The area within which a navigational aid provides either generally satisfactory service or a specific quality of service.

sextant. A double-reflecting instrument for measuring angles — primarily altitudes — of the celestial bodies.

shoran. A radio navigation system which provides circular lines of position. The term is derived from the words short-range navigation.

sideband null (rectilinear navigation system). The surface of position along which the resultant energy from a particular pair of sideband antennas is zero.

sideband-reference glide slope (ILS). A modified null reference glide-slope antenna system in which the upper (sideband) antenna is replaced with two antennas, both at lower heights, and fed out of phase, so that a null

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is produced at the desired glide-slope angle.

NOTE: This system is used to reduce unwanted reflections of energy into the glide-slope sector at locations where rough terrain exists in front of the approach end of the runway, by producing partial cancellation of energy at low elevation angles.

sidelooking radar. A ground mapping radar, used aboard aircraft, involving the use of a fixed antenna beam pointing out of the side of an aircraft either abeam or squinted with respect to the aircraft axis. The beam is usually a vertically-oriented fan beam having a narrow azimuth width. The narrow azimuth resolution can either be obtained with a long aperture mounted along the axis of the aircraft or by the use of synthetic aperature radar processing.

sidereal. Of or pertaining to the stars.

site error (navigation). Error due to the distortion in the electromagnetic field by objects in the vicinity of the navigational equipment.

skip distance. The minimum separation for which radio waves of a specified frequency can be transmitted at a specified time interval between two points on the earth by reflection from the regular ionized layers of the ionosphere.

sky compass. A type of astro compass, designed for use in the arctic during long periods of twilight.

sky-wave contamination. Degradation of the received ground-wave signal, or of the desired sky-wave signal, by the presence of delayed ionospheric-wave components of the same transmitted signal.

sky-wave correction (navigation). A correction for sky-wave propagation errors applied to measured position data; the amount of the correction is established on the basis of an assumed ionosphere height.

sky-wave station-error (sky-wave synchronized loran). The error of station synchronization due to the effect of variations of the ionosphere on the time of transmission of the synchronizing signal from one station to the other.

slant distance. The distance between two points that are not at the same elevation. Used in contrast to ground distance.

slant range. Slant distance between a radar and a target.

slave station (navigation). A station in which some characteristic of its emission is controlled by a master station.

slope angle. *See:* **glide slope angle.**

slot coupling factor (slot-antenna array). The ratio of the desired slot current to the available slot current, controlled by changing the depth of penetration of the slot probe into the waveguide.

slot current ratio (slot-antenna array). The relative slot currents in the slots of the waveguide reading from its center to its end, with the maximum taken as 1; this ratio is dependent upon the slot spacing factor and the slot coupling factor.

slot spacing factor (slot-antenna array). A value proportional to the size of the angle between the slot location and the null of the internal standing wave; this factor is dependent upon frequency.

sofar. A system of navigation providing hyperbolic lines of position determined by shore listening stations.

sonar. A general name for sonic and ultrasonic underwater ranging, sounding and communication systems.

sonic depth finder. A direct reading instrument which determines the depth of water by measuring the time interval between emission of sound and the return of its echo from the bottom.

sonne. A radio navigation aid that provides a number of characteristic signal zones which rotate in a time sequence; a bearing may be determined by observation (by interpolation) of the instant at which transition occurs from one zone to the following zone. *See:* **consol.**

sonobuoy. A buoy with equipment for automatically transmitting a radio signal when triggered by an underwater sound signal. Also called **sono-radio buoy.**

space-referenced navigation data. Data in terms of a coordinate system referenced to inertial space.

specific repetition frequency (loran). One of a set of closely-spaced pulse repetition frequencies derived from the basic repetition frequency and associated with a specific set of synchronized stations.

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specific repetition rate. See: **specific repetition frequency.**

spherical hyperbola. The locus of the points on the surface of a sphere having a specified constant difference in great circle distances from two fixed points on the sphere.

spinaxis. The axis of rotation of a gyroscope.

stabilization (navigation). Maintenance of a desired orientation of a vehicle or device with respect to one or more reference directions.

stabilized flight. That type of flight which obtains control information from devices which sense orientation with respect to external references.

stable element (navigation). An instrument or device which maintains a desired orientation independently of the motion of the vehicle.

stable platform. A gimbal-mounted platform, usually containing gyros and accelerometers, whose purpose is to maintain a desired orientation in inertial space, independent of the motion of the vehicle.

standard-wave error (DF measurements). The bearing error produced by a wave whose vertically and horizontally polarized electric fields are equal and phased so as to give maximum error in the DF, and whose incidence direction is arranged to be 45°.

star chain. A radio navigation transmitting system comprising a master station about which three (or more) slave stations are symmetrically located.

star tracker. *See:* **astrotracker.**

strap-down inertial navigation equipment. Inertial navigation equipment wherein the inertial sensors, (for example, gyros and accelerometers) are directly mounted to the vehicle, (eliminating the stable platform and gimbal system) to sense the linear and angular motion of the vehicle.

NOTES: (1) In this equipment, a computer utilizes gyro information to resolve the accelerations that are sensed along the carrier axes, and to refer these accelerations to an inertial frame of reference. Navigation is then accomplished in the same manner as in systems using a stable platform.

(2) Also called **strapped-down.**

stellar-guidance. Guidance by means of celestial bodies, particularly the stars.

stellar-inertial navigation equipment. *See:* **celestial-inertial navigation equipment.**

suppressed time delay. A deliberate displacement of the zero of the time scale with respect to the time of emission of a pulse.

surface navigation. Navigation of a vehicle on the surface of the earth. *See* **land navigation.**

surface of position. Any surface defined by a constant value of some navigation quantity.

surveillance radar. A search radar used to maintain cognizance of selected traffic within a selected area, such as an airport terminal area or air route.

swinging compass. An accurate, portable magnetic compass used to indicate magnetic headings during aircraft magnetic compass calibration.

synchronization error (navigation). The error due to imperfect timing of two operations; this may or may not include signal transmission time.

synchronous satellite. An equatorial satellite orbiting the earth in a west-to-east direction at an altitude of approximately 35 900 kms. At this altitude the satellite makes one revoluton in 24 h, synchronous with the earth's rotation.

synthetic aperture radar. A radar system that generates the effect of a long antenna by signal processing means rather than by the actual use of a long physical antenna.

tacan (tactical air navigation). A complete ultra-high-frequency (uhf), polar coordinate (rho theta) navigation system using pulse techniques. The distance (rho) function operates as DME and the bearing function is derived by rotating the ground transponder antenna so as to obtain a rotating multilobe pattern for coarse and fine bearing information.

target (radar). (1) Specifically, an object of radar search or tracking. (2) Broadly, any discrete object which reflects energy back to the radar.

target transmitter. A source of radio-frequency energy suitable for providing test signals at a test site.

teleran. A navigation system which employs ground-based search radar equipment along an

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airway to locate aircraft flying near that airway.

terminal guidance. Guidance from an arbitrary point, at which midcourse guidance ends, to the destination.

terrain avoidance radar. A radar which provides assistance to a pilot for navigation around obstacles by displaying obstacles at or above the pilot's altitude.

terrain-clearance indicator. An absolute altimeter using the measurement of height above terrain to alert the pilot of danger.

terrain error (navigation). The error resulting from the use of a wave which has become distorted by the terrain over which it has propagated.

terrain following radar. A radar which works with the aircraft flight control system to provide low level flight following the contour of the earth's surface at some given altitude.

terrestrial-reference flight. That type of stabilized flight which obtains control information from terrestrial phenomena, such as earth's magnetic field, atmospheric pressure, etc.

three-dimensional (3D) radar. A radar capable of producing three-dimensional position data on a multiplicity of targets.

threshold signal (navigation). The smallest signal capable of effecting a recognizable change in navigational information.

tilt (directional antenna). The angle which the antenna axis forms with the horizontal.

tilt angle. The vertical angle between the axis of measurement and a reference axis; the reference is normally horizontal.

tilt error. *See:* **ionospheric tilt error.**

time difference (loran). The difference in the time of reception of the two signals of a loran rate.

time meridian. Any meridian used as a reference for reckoning time, particularly a zone.

time signal. An accurate signal marking a specified time or time interval.

to-from indicator (omnirange receiver). A supplementary device used with an omnibearing selector to resolve the ambiguity of measured omnibearings.

tone localizer. *See:* **equisignal localizer.**

torquing rate (inertial navigation). The angular rate at which the orientation of a gyro, with respect to inertial space, is changed in response to a command.

track (navigation). (1) The resultant direction of actual travel projected in the horizontal plane and expressed as a bearing. (2) The component of motion that is in the horizontal plane and represents the history of accomplished travel.

track angle. Track measured from 0° at the reference direction.

track homing. The process of following a line of position known to pass through an objective.

tracking. The process of following a moving object or a variable input quantity. This process may be carried out manually or automatically. In radar, target tracking in angle, range, or Doppler frequency is accomplished by keeping a beam or angle cursor on the target angle, etc. *See also:* **automatic tracking, tracking radar.**

tracking radar. A radar whose primary function is the automatic tracking of targets. *See also:* **tracking, automatic tracking.**

transceiver. A combination transmitter and receiver in a single housing, with some components being used by both parts. *See:* **transponder.**

transfer alignment. A method of transfer of reference coordinates to an inertial navigation system for initial alignment. Accomplished by way of: structure to structure mating, simultaneous measurement of acceleration patterns, or by optical measurement techniques.

transit. A radio navigation system using low orbit satellites to provide world-wide coverage, with transmissions from the satellites at vhf and uhf, in which fixes are determined from measurements of the Doppler shift of the continuous wave signal received from the moving satellite.

transobuoy. A free floating or moored automatic weather station providing weather reports from the open ocean.

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transponder. A transmitter-receiver facility, the function of which is to transmit signals automatically when the proper interrogation is received.

transponder beacon. *See:* **transponder.**

transponder, crossband (navigation). A transponder which replies in a different frequency band from that of the received interrogation.

transponder reply efficiency. The ratio of the number of replies emitted by a transponder to the number of interrogations which the transponder recognizes as valid. The interrogations recognized as valid include those accidentally combined to form recognizable codes, a statistical computation of them normally being made.

trigger level (transponder). The minimum input to the receiver which is capable of causing the transmitter to emit a reply.

triplet (navigation systems). Three radio stations, operated as a group, for the determination of positions.

true air speed. The actual speed of an aircraft relative to the surrounding air.

true air-speed indicator. An instrument for measuring indicated true air speed.

true bearing. Bearing relative to true north.

true course. Course relative to true north.

true heading. Heading relative to true north.

true north. The direction of the north geographical pole.

two-range Decca. *See:* **lambda.**

ultrasonic depth finder. A direct reading instrument which determines the depth of water by measuring the time interval between the emission of an ultrasonic signal and the return echo from the bottom.

vane. A device to indicate the direction from which the wind blows.

VAR (visual-aural range). A special type of VHF radio range which provides: (1) two reciprocal radial lines of position presented to the pilot visually on a course deviation indicator, and (2) two reciprocal radial lines of position presented to the pilot as interlocked and alternate A and N aural code signals. The aural lines of position are displaced 90° from the visual and either may be used to resolve the ambiguity of the other.

variable modulation (VOR). That modulation of the ground station radiation which produces a signal in the airborne receiver whose phase with respect to a radiated reference modulation corresponds to the bearing of the receiver.

variation. The angle between the magnetic and geographical meridians at any place. *See:* **magnetic variation.**

vehicle. That in or on which a person or thing is being or may be carried.

vehicle-derived navigation data. Data obtained from measurements made at a vehicle.

vertical, gravity. *See:* **mass-attraction vertical.**

visual-aural radio range. *See:* **VAR.**

visual radio range. Any radio range (such as VOR) whose primary function is to provide lines of position to be flown by visual reference to a course deviation indicator.

VOR (very high-frequency omnidirectional range). A navigation aid operating at VHF and providing radial lines of position in any direction as determined by bearing selection within the receiving equipment; it emits a (variable) modulation whose phase, relative to a reference modulation, is different for each bearing of the receiving point from the station.

vortac. A designation applied to certain navigation stations (primarily in the United States) in which both VOR and tacan are used; the distance function in tacan is used with VOR to provide VOR/DME (rho theta) navigation.

warp (loran). Variation of the propagation times for loran signals due to the variations of conductivity over land. Causes errors in the determination of absolute position.

way point (navigation). A selected point on or near a course line and having significance with respect to navigation or traffic control.

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weather vane. *See:* **vane.**

wind speed. The rate of motion of air.

wind velocity. The speed and direction of wind.

yaw angle. (1) The horizontal angular displacement of the longitudinal axis of a vehicle from its neutral position, (2) The angle between a line in the direction of the relative wind and a plane through the longitudinal and vertical axes of the vehicle.

Z (zone) marker. A marker used to define a position above a radio range station.

zone of silence. A local region in which the signals of a given radio transmitter cannot be received satisfactorily.

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