GLOSSARY OF TERMS

The terms listed below are defined mainly to clarify their use in antisubmarine warfare, particularly for the application of oceanography. For the sake of clarity, definitions are brief and do not necessarily reflect an academic description of the term.

ABSORPTION: The loss of sound or light intensity caused by the conversion of sound or light energy into heat as it passes through air or water.

ACOUSTIC SCREEN: A blanket of air bubbles that effectively entraps backscattered sound energy.

ACOUSTIC SIGNATURE: The graphical noise output characteristic and identified with a specific noise source, for example, the noise output of a particular class of submarine.

ADVECTION: The process of the transfer of air or water by horizontal motion.

AFTERNOON EFFECT: Solar heating of the surface water, which results in a reduction of sonar ranges in the afternoon. This heating causes downward refraction of sound rays.

AIR (SWIM) BLADDER: A gas-filled organ in some fishes, believed to have a role in regulating buoyancy and, in some species, is a source and amplifier of sound.

ALGAE: Water plants that differ from land plants in that they lack true leaves, stems, and roots; they range in size from microscopic to the giant kelps (over 100 feet long).

AMBIENT NOISE: The naturally occurring noise in the sea and noise resulting from man's activity; excludes self noise and reverberation.

ANGULAR SPREADING: The swell-producing process, in wave theory, that takes into account the fact that waves in the generating area are traveling in many different directions.

ANOMALY: A deviation from an average value. For example, in comparing any set of observational data (such as geomagnetism) with a computed graph or table the anomaly is the difference between the observed value and the corresponding computed value.

ANTIFOULING PAINT: Any marine paint containing a poisonous substance, such as cuprous oxide, that prohibits attachment and growth of fouling organisms.

APPARENT CONTRAST: The change in contrast that depends upon the distance to an object, the amount of light absorption, and the inclination of line-of-sight to the vertical; expressed as percentage.

ARRAY: A group of two or more hydrophones feeding into a single sonar console or recorder.

ATTENUATION: The reduction in sound or light intensity caused by the absorption and scattering of sound or light energy in air or water.

ATTENUATION, WAVE: The decrease of wave height by loss of energy from friction and gravity (decay); damping by ice floes, crosswinds, and opposing currents also may cause attenuation.

AURORAL ZONE: The region of maximum occurrence of the aurora, a luminous phenomenon resulting from electrical discharges in the upper atmosphere; typically located in polar regions.

BACKGROUND NOISE: All unwanted sounds, other than reverberation, received by a hydrophone; includes ambient and self-made noise.

BACKSCATTERING: That part of the reflected sound energy that returns to the transducer; equivalent to reverberation.

BASEMENT ROCK: The rock produced in the early formation of the earth that underlies all other rock.

BATHYTHERMOGRAPH: An instrument used to obtain a permanent, graphical record of water temperature (°F) with depth (feet) as it is lowered and raised in the sea.

The water temperature versus depth is automatically traced on a slide. Instruments usually are designed to record to depths of 180, 450, or 900 feet.

BEARING STRENGTH: The ability of the bottom sediments to support an object without appreciable deformation or penetration of the bottom

BEAUFORT SCALE: A series of numbers ranging from 0 to 12 that indicate the strength of the wind.

BENTHOS: All plants and animals living on or in the ocean bottom.

BIOLUMINESCENCE (PHOSPHORESCENCE): The production of light without heat in living organisms as a result of a chemical reaction.

BIOLUMINESCENT (LUMINESCENT) DISPLAY: A visible occurrence of bioluminescence, sometimes brilliant in intensity and often extending over a large expanse of the sea surface.

BLOWHOLE: The single or double opening in the upper surface of the head of a whale or porpoise through which the marine mammal breathes on surfacing.

BOTTOM BOUNCE: That form of sound transmission in which sound rays strike the bottom, in deep water, at steep angles and are reflected to the surface; one reflection may attain ranges of about 20,000 yards. Bottom reflected ray paths are defined by the limiting and critical angle rays.

BOTTOM SEDIMENTS (MATERIALS): Marine sediments found on the sea bottom. Sediments include eroded rock material, plant residue, and undissolved animal remains.

BOTTOM TOPOGRAPHY: The vertical relief of the submarine earth-water interface; identical to the term *terrain* as used for land.

BRYOZOANS: Animals that produce either plantlike or encrusting colonies, the individual cells of which usually are covered by hard deposits of calcium carbonate.

BUOYANCY: The amount of ballast that a submarine moving vertically without power must pump or flood to overcome the buoyant force (density) of the water at that depth. For example, a negative buoyancy value indicates that the weight of the submarine exceeds the buoyant force of the water.

BURIAL: The penetration into or the subsequent covering by sediments of an object placed upon the sea bottom.

CAVITATION: The formation of local cavities (bubbles) in a liquid as a result of the reduction of total pressure. This pressure reduction may result from a negative pressure produced by rarefaction or from the reduction of pressure by hydrodynamic flow, such as is produced by high-speed movement of an underwater propeller.

COLLOIDAL PARTICLE: Matter having a size range in diameter of about 0.0002 to 0.000005 mm, that, when mixed with a liquid, goes into suspension.

COLOR, WATER: The apparent color of the surface layers of the sea caused by the reflection of certain components of the visible light spectrum coupled with the effects of dissolved material, concentrations of plankton, and concentrations of other suspended matter. Sea water color ranges from deep blue to yellow and is expressed by various numerical scales. Plankton concentrations may cause the temporary appearance of red, green, white, brown, or other colors.

CONTINENTAL RISE: A gentle slope with a generally smooth surface found at the base of a continental slope.

CONTINENTAL SHELF: A zone adjacent to a continent and extending from the low waterline to a depth at which there is a marked increase of bottom slope to greater depth (usually about the 100-fathom line).

CONTINENTAL SLOPE: A declivity from the outer edge of a continental shelf into greater depths.

CONTRAST: The ratio of the target reflectance (TR) minus the background reflectance (BR) to the background reflectance, that is, $\frac{TR-BR}{BR}$; expressed as percentage.

CONVERGENCE: The sinking of surface water in an area where two currents or water masses of different characteristics come together.

CONVERGENCE, ATMOSPHERIC: The condition existing in the atmosphere when the distribution of winds within an area is such

that there is a net horizontal inflow of air into the area.

CONVERGENCE ZONE: That region in the deep ocean where sound rays, refracted from the depths, arrive at the surface in successive intervals of 30 to 35 miles. The repeated occurrence of these zones to several hundred miles from the sound source depends on the refraction of sound rays at depth and the reflection of these rays at the surface.

CONVECTION CURRENTS: Whenever the surface water undergoes intensive cooling, evaporation, or freezing, the density of the surface water increases beyond that of the underlying water. As this denser water sinks to its level of the same density, currents are produced.

CORIOLIS FORCE: An effect of the earth's rotation whereby water movement (a current) in the Northern Hemisphere is deflected in direction to the right (clockwise) and in the Southern Hemisphere is deflected to the left (counterclockwise).

COUNTERCURRENT: A secondary current setting in a direction opposite or nearly opposite to the predominate flow. A countercurrent may set adjacent to or beneath the predominate flow.

CREST, WAVE: The highest part of a wave.

CRUSTACEANS: In plankton, the weakly swimming shrimplike animals that range in size from microscopic to about 2 inches long; often occur in tremendous numbers.

CURRENT, COASTAL: A current flowing close to and usually parallel with a coastline. Its direction is determined, in large part, by the trend of the coastline and offlying bottom contours.

CURRENT, CONFUSED: Water movements whose directions change rapidly over short distances with no apparent order or pattern.

CURRENT, GEOPOTENTIAL: The relative current that results from two adjacent water columns having different densities. These currents, sometimes called density or dynamic currents, are computed from oceanographic data rather than measured.

CURRENT, HYDRAULIC: A current in a strait or channel that results from a height difference in the water level of the water bodies separated by the strait or channel.

CURRENT, LONGSHORE: A current caused by waves breaking at an angle with the beach. These currents occur shoreward of the surf zone and set parallel to the beach away from the approaching waves.

CURRENT, RIP: The severe agitation of water caused by the meeting of currents or by the rapid flow of a current over an irregular bottom.

CURRENT, ROTARY: A tidal current that flows continually. Its direction changes constantly through all points of the compass during the tidal period of one high water to the next high water.

CURRENT, SUBSURFACE: In general, currents below a depth at which there is a significant change in speed and direction from the current affecting an object floating on or near the sea surface; usually those currents below the thermocline.

CURRENT, SURFACE: A current extending from the sea surface to a depth where the horizontal water movement becomes significantly different in direction and/or speed, usually water movement below the top of the thermocline is not considered a surface current.

CURRENT, TIDAL: Current caused by the tide-producing forces of the moon and the sun, usually floods landward and ebbs seaward with the predominant flow along channels.

DECAY, WAVE: The slow decrease in wave height and increase in wave period and length as the wave moves out of a generating area and gravity tends to reduce the sea surface to a flat condition; usually applies to swell.

DECIBEL: A value that expresses the comparison of sounds of two different intensities. This value is defined as 10 times the common logarithm of the ratio of the two sound intensities.

DEEP SCATTERING LAYER (DSL): A layer or layers in the ocean believed to consist of plankton and fishes, from which sound rays are scattered or reflected back to the sound source.

DEFORMATION, ICE: Alteration of an ice surface by winds, currents, tides, or temperature changes. This process results in rafting, hummocking, and ridging.

DEGREE DAY: A departure of the mean air temperature as measured from the freezing point of water: one degree day for each degree of departure above or below the standard during one day.

DENSITY: The density of sea water is the mass per unit volume. The density of a water sample at the temperature, salinity, and pressure at which it was collected is called the density *in situ*. Density generally is expressed as sigma-t (σ_t).

DENSITY LAYER: The depth at which the rate of density increase is greatest. For submarines, layer depth is the relatively small depth interval within which there is a great increase of density.

DETRITAL MATERIAL: Loose, fragmentary sediments of all sizes (boulders to fine clay) that has been derived from the disintegration and erosion of existing rocks.

DIATOMS: One of a group of microscopic one-celled plants possessing shells of translucent silica. This group comprises a considerable part of the plankton population and generally is considered the basic food supply in the sea.

DIFFRACTION: The phenomenon whereby waves (electromagnetic) traveling in straight paths may bend around an obstacle.

DINOFLAGELLATES: Microscopic or minute plankton, possessing both plant and animal characteristics, that comprise a large fraction of the oceanic plankton. Some types produce bioluminescence or discolored water.

DISPERSION: In wave theory, dispersion is the forward separation of waves with different periods that were formed at the same time in a generating area. This separation progresses in accordance with the wave speed and is proportional to the wave period. Thus, waves with the longest period move ahead of the successively shorter period waves.

DIURNAL CYCLE: A regular daily sequence of events or conditions occurring within each 24-hour day.

DIVERGENCE: The rising of water to the surface in an area where surface currents flow apart.

DOLPHIN: A porpoise.

DOPPLER EFFECT: Whenever the sound source or the sound receiver moves, the frequency of the received sound differs from the frequency of the emitted sound. For example, to an observer the pitch (frequency) rises and then drops suddenly when the sound source moves toward and then rapidly away from a fixed point of listening.

DUCT, ATMOSPHERIC: A layer in the lower atmosphere in which strong downward refraction of electromagnetic waves results in extended transmission ranges.

DYNE: A unit of force in the centimeter-gram-second system of measurement that is defined as the force that gives a 1-gram mass an acceleration of 1 cm/sec^2.

E-VALUE: The average of the sum of the squares of the individual amplitudes of the individual sine waves that make up the complicated irregular pattern of actual wave motion.

EDDY: A circular movement of water of comparatively limited area formed to the side of a predominant current flow.

EXTINCTION COEFFICIENT: A beam of light traversing a given thickness of material will be attenuated by a constant fraction, which is characteristic of the material and independent of the initial intensity. For example, a beam of light traveling through a given distance of water will have an extinction coefficient determined by:

$$\ln I_0 - \ln I = bx$$

where: ln = natural logarithm
I_0 = initial intensity
I = intensity after the given distance
x = the given distance
b = extinction coefficient

EUPHAUSIIDS: Shrimplike plankton crustaceans averaging about one inch in length. These animals are the main food supply for whalebone whales.

FALLOFF: In underwater sound, the decrease in acoustic energy as it travels away from the sound source.

FAUNAL PROVINCES: Geographic areas within which certain broad groups of animals are native.

FAULTING: The breaking or shearing within the earth's crust resulting in a relative dis-

placement of adjacent rock masses along a zone of weakness.

FETCH: The effective distance over which the wind acts on the water surface to produce waves.

FILTERING: The mathematical method of wave forecasting based on the theory that waves having the same direction and wavelength will separate from the complex spectrum of the generating field into uniform patterns of a single wavelength as they progress outward in accordance with their corresponding wavespeeds.

FLOEBERG: A mass of thick, heavily hummocked sea ice resembling an iceberg.

FLOW NOISE: The noise produced by water movement past the transducer or hydrophone array housing, and the noise produced by breaking waves against the hull of a moving ship.

FLUCTUATION, SOUND: Sound pulses that are projected with the same amplitude at intervals of a few seconds will, after transmission, differ from each other in amplitude. The change in average amplitudes of successive pulses is called fluctuation.

FLUKE: One lobe of the tail of a whale or porpoise.

FORECAST: To project present knowledge ahead in time and/or space. Synonymous with prediction or prognosis.

FOULING, MARINE: The attachment and growth of marine plants and animals on submerged objects; usually implies objects of manmade origin such as hulls, piling, buoys, and anchor chains.

FOULING SUCCESSION: The sequence of attachment of different types of fouling organisms on the surface of a submerged object.

FREQUENCY, RESONANT: When a body having a particular natural vibration frequency is acted upon by a force having the same frequency, a large vibratory motion is produced in the body. The frequency at which this phenomenon occurs is the resonant frequency. For example, if the frequency of a series of pushes given a swing equals the natural frequency of the swing, the motion of the swing can become quite large.

FREQUENCY, SOUND: The number of sound waves passing a point in a given time; usually measured as cycles per second (cps).

FREQUENCY, WAVE: The number of waves that pass the point of observation within a designated time interval; the reciprocal of the wave period.

FRONTAL ZONE: The transition zone between two air masses of different densities, that is between a low and a high pressure system.

GEOMAGNETISM: The properties of the earth as a magnet; usually applies to the study of the earth's magnetic field.

GLACIATED COAST: A coast whose major topographic features and the bottom materials in the adjacent sea have been produced by glacial activity.

GRADIENT: The rate of change in a given distance of an environmental variable. For example, in the sea a temperature gradient is the change of temperature with depth; a positive gradient is a temperature increase with depth, a negative gradient is a temperature decrease with depth.

GRAVITY: The resultant force on any body of matter at or near the earth's surface that tends to attract the body toward the earth's center.

GRAZING ANGLE: The angle that the sound ray path forms with the reflecting surface; usually applies to sound rays reflected from the bottom.

GROWLER: A small fragment of floating ice much smaller than an iceberg, usually of glacial origin, and generally greenish in color.

HEAT EXCHANGE: The amount of heat (in kilogram calories/cm^2) that is transferred between the sea surface and the atmosphere.

HOLDING POWER: The ability of the bottom materials to hold an anchor. Normally expressed as the ratio of the holding power of a particular bottom to holding power in firm sand; this ratio varies from 0.0 for rock and stone to 1.5 for stiff, dense clay.

HUMMOCKS: A form of pressure ice resembling mounds or hillocks on the surface of the ice.

HYDROIDS: The attached, plantlike form of many of the free-floating jellyfishes; sometimes mistaken for seaweed.

HYDROLOGICAL RANGE: The distance, measured along the line-of-sight in the water, for which the apparent contrast has a value of 2 percent.

HYDROPHONE: An acoustic device that receives and converts underwater sound energy into electrical energy.

HYDROPHOTOMETER: An instrument that consists of a constant light source placed at a specific distance from a photocell. When placed in the water, the electrical output of the photocell is proportional to the amount of light striking the cell which, in turn, depends upon the transparency of the water. The instrument is calibrated to read 100 percent light transmission in air.

ICE, FAST: All types of ice, either broken or unbroken, attached to the shore, beached, stranded in shoal water, or attached to the bottom of shoal areas.

ICE FOG: A type of fog composed of particles of ice suspended in the air.

ICE, GREASE: A kind of slush formed from the congelation of ice crystals in the early stages of freezing. It gives the sea surface a greasy appearance.

ICE ISLAND: Tabular iceberg confined to arctic regions and consisting of shelf ice calved from the northern coasts of Ellesmere Island and Greenland.

ICE, SHELF: A thick ice formation with a level surface extending seaward from the land but attached thereto.

INSOLATION: The rate of delivery of all solar energy per unit of horizontal surface. This means that as insolation increases, sea surface temperatures also increase.

INSONIFY: The penetration of sound into any particular part of the sea.

INTENSITY, SOUND: Practically, considered as the square of the sound pressure.

INVERSION: A condition of the atmosphere in which temperature increases with height.

IONOSPHERE: That part of the earth's atmosphere above about 45 miles which is characterized by the presence of electrically charged particles that reflect electromagnetic waves of certain frequencies.

ISOSTATIC ADJUSTMENT: In geology, an equilibrium condition between masses of equal density in which elevated masses (continents and mountains) are compensated by a mass deficiency in the crust beneath them.

ISOTHERMAL: Values of temperature are the same in all parts of a given water column; no increase or decrease in temperature with depth.

ISOVELOCITY: Values of sound velocity are the same in all parts of a given water column; no change in sound velocity with depth.

KELP: Any of the large brown seaweeds (algae), which can attain lengths over 100 feet.

LAND SKY: Dark streaks, patches, or grayness that usually appear on the underside of extensive cloud areas when overlying bare ground. They are caused by the absence of reflected light.

LAPSE RATE: The rate of change of temperature with height above the earth.

LARVAE: The young or immature forms of many marine animals.

LAYER DEPTH: The greatest depth in an area to which the maximum temperature occurs. At this depth sound rays are refracted both toward the surface and toward the bottom.

LAYER EFFECT: When sound passes through a layer in which little or no bending of the ray path occurs and then passes into a layer with a strong negative gradient (causing sharp downward bending of the ray), increased spreading occurs with a consequent loss of sound energy.

LEAD: A long, narrow, but navigable water passage in ice of high concentration.

LIMITING RAY: That sound ray which becomes tangent at the depth where the sound velocity is at maximum, and delimits the outer boundary of direct (before reflection) sound rays.

LINE COMPONENT: Ordinarily, machinery produces noise in a spectrum of many frequencies, but occasionally machinery produces a strong noise of a single (line) frequency superimposed on the continuous spectrum.

LUCIFERASE: An enzyme whose presence is necessary for the production of bioluminescence by luciferin.

LUCIFERIN: A heat resistant, simple protein, the oxidation of which produces bioluminescence.

MAGNETIC POLARIZATION: The direction of magnetic force, that is, the trending of magnetic force lines along the axis of the north and south magnetic poles.

MEANDER: In describing ocean currents, an irregular and unpredictable deviation from the mean pattern of flow, usually implies that the current in a particular area is flowing in a convoluted course.

MOLLUSKS: Animals that possess either an outside shell or shells (snails and oysters) or an internal shell or shells (squids and octopuses).

NEKTON: All swimming animals in the sea capable of independent movement for considerable distances.

OCEAN BASIN: A large depression of the sea floor more or less equidimensional in form.

OCEANIC CIRCULATION: The system of permanent currents that make up the pattern of major horizontal water movements in the large ocean basins.

OOZE: A fine-grained deep sea deposit that consists, in large part, of the skeletal remains of plankton. The following are some of the common types of oozes:

Globigerina—limey deposits consisting primarily of shells of the plankton *Globigerina*.

Diatom—soft, siliceous deposits consisting primarily of the skeletal parts of diatoms.

Pteropod—limey deposits consisting primarily of shells of a planktonic snail.

Coccolith—limey deposits consisting primarily of skeltal parts of certain planktonic protozoa.

Radiolarian—siliceous deposits consisting primarily of skeletal remains of certain protozoans.

OPTICAL IMAGE: The counterpart of an object produced by a lens, mirror, or other optical system.

ORGANISMS, MARINE: All plants and animals living in the sea, on the sea floor, or on the sea shores.

PARTICLE, WAVE: An infinitesimal part of a wave considered theoretically in determining the characteristics and effects of waves. Particles within a wave move in an orbital curve in the vertical plane.

PELAGIC: That environment of the sea other than the sea bottom and sea shore.

PERIOD, WAVE: The time interval between the appearance of two consecutive wave crests at a given point, usually expressed in seconds.

PHYTOPLANKTON: The plant forms of plankton.

PLANKTON: All passively drifting or weakly swimming plant and animal life in the sea; usually microscopic or rather small in size.

POLYNYA: Any sizable sea water area, other than a lead, encompassed by ice.

PRESSURE, ACOUSTIC: The difference at a point between the total sound pressure and the hydrostatic pressure.

PRESSURE FLUCTUATION (WAVE): The variations about static water pressure caused by wave action.

PRESSURE LEVEL: The sound intensity, as measured in decibals relative to units of dynes/cm^2, 20 times the common logarithm of the acoustic pressure.

PROPAGATION, SOUND: The transmission of sound energy through a medium.

PROTOZOANS: In plankton these are one-celled, microscopic or minute organisms having mainly animal characteristics; often occur in tremendous numbers in the sea.

QUENCHING: The great reduction in underwater sound transmission or reception resulting from absorption and scattering of sound energy by air bubbles entrapped around the sonar dome. Roll and pitch of the ship in relatively rough water is the primary cause of air bubble entrapment.

QUENCH/PING RATIO: For sound ranging, a measure of the sound lost from quenching. Based on the ratio of the number of echoes received (quench) to the number of pulses emitted (ping).

RADIATED NOISE: The underwater sound energy emitted by ships, submarines, and torpedoes.

RADIO HOLE: A region in the atmosphere where strong fading of radio and radar signals is caused by abnormal refraction of electromagnetic waves.

RAFTING: The deformation process whereby one fragment of ice overrides another.

RAREFACTION: The process that produces, in a sound wave, the portion of the wave where the pressure is lower than the average pressure exerted by the medium surrounding the wave.

RAY PATH: The path that a sound beam (ray) takes as it travels through the water.

RAY PATTERN: A graphic presentation of the course of sound rays in relation to depth and range.

RAY THEORY: The transmission of underwater sound as based on Snell's law. This law describes the change in the sound ray path as it passes through different layers of water.

REFERENCE LEVEL: In underwater sound, the standard to which other sound levels can be related. Two reference levels commonly used are: 1 dyne/cm^2 and 0.0002 dyne/cm^2.

REFLECTANCE: The ratio of light given off by an object to the amount of light striking the object; expressed as percentage.

REFLECTION, SOUND: Sound rays transmitted in the sea eventually reach either the surface or the bottom. As these boundaries are abrupt and very different in sound transmitting properties from the water, sound energy along a ray path striking these boundaries will be returned (reflected) to the water.

REFLECTION, SPECULAR: A mirrorlike or perfect reflection of sound rays from a smooth surface or bottom.

REFRACTION, ATMOSPHERIC: The change in direction of motion of a ray of radiated energy as it passes through layers of the atmosphere in which the transmission speed of the ray differs.

REFRACTION, SOUND: The bending or curving of a sound ray that results when the ray passes from a region of one sound velocity to a region of a different velocity. The amount of ray bending is dependent upon the amount of difference between sound velocities.

REFRACTION, WAVE: When a train of waves approaches a shoreline at an angle, the wave crests are bent (in direction) because the portion of the wave that first reaches shallow water travels more slowly than the portion that is still advancing in deep water.

REVERBERATION: The combined sound of many small echoes returned to the hydrophone by scattering at the surface, at the bottom, and in the volume of the water.

RIDGING: The deformation process whereby ice forms one or more, usually parallel, ridges.

RIME: A white or milky and opaque granular deposit of ice formed by the rapid freezing of supercooled water droplets as they impinge on an exposed surface.

ROSE: A circular bargraph showing the percent frequency of wave heights and wave amounts from eight or more directions. Roses usually are constructed separately for sea and for swell.

ROTATING DIRECTIONAL TRANSMISSION (RDT): A device installed on active sonar equipment whereby sound energy is concentrated into a narrow beam that is rotated rapidly during transmission.

SALINITY: The salinity of sea water represents the total amount of dissolved solid material (in grams) contained in one kilogram (1,000 grams) of water. It usually is expressed in parts per thousand (‰).

SCATTERING, LIGHT: When a beam of light strikes a very small particle suspended in the air or water the particle may reflect a portion of the beam in many directions. Theoretically, in light scattering there is no loss of intensity, but only a redirection of light.

SCATTERING, SOUND: The random dispersal of sound energy after it is reflected off the sea surface or bottom and/or off the surface of solid, liquid, or gaseous particles suspended in the water.

SCOUR: The erosion or removal of sediments around a bottom positioned object, usually caused by water movement.

SEA: Waves caused by a local continuing wind in a particular area. Sea direction approximates that of the generating wind.

SEA, CONFUSED: An irregular pattern of low and high waves caused by the interference of wave trains having different directions arriving simultaneously in an area.

SEAMOUNT: An elevation of the sea floor having a nearly equidimensional plan less than 60 nautical miles across the summit.

SEA RETURN (CLUTTER): Radar echoes from waves and spray may appear on the scope with such a density as to mask areas where normally a target echo appears.

SEA SMOKE: Fog formed during the passage of very cold air across relatively warm water.

SEA STATE: The numerical or written description of ocean surface roughness.

SECCHI DISC: A white, black, or varicolored disc, about 11.7 inches in diameter, used to measure water transparency (clarity). The disc is lowered in the water and the depth (in meters) at which it disappears from sight is averaged with the depth at which it reappears. This average value often is used to represent sea water transparency.

SEISMIC EXPLORATION: The determination of the structure and extent of subsurface geologic strata by measurement of the speed of artificially produced shock waves through the strata.

SEISMICITY: The phenomenon of earth crustal movements, that is, earthquakes.

SET: The direction toward which a current flows.

SHADOW ZONE: A region into which very little sound energy penetrates.

SIGMA-t (σ_t): A space saving method (symbol) for expressing the density of sea water computed at atmospheric pressure using the water sample's *in situ* temperature and salinity.

SKYLIGHT: A former opening that has frozen over.

SLANT RANGE: The diagonal distance between a point at one position and a point at a different position in the vertical plane.

SLUSH: An accumulation of ice crystals which may or may not be slightly frozen together. Slush has no degree of hardness.

SONOBUOY: A free-floating or anchored device that includes a buoy with radio telemetering equipment and a hydrophone suspended beneath. Sound signals received at the hydrophone are transmitted to a nearby receiver for analysis.

SOUND CHANNEL: That region in the water column where the sound velocity first decreases to a minimum value with depth and then increases in value. Above the minimum value sound rays are bent downward, below the minimum value rays are bent upwards resulting in the rays being trapped in this channel. Sound traveling in this channel can be detected thousands of miles from the sound source.

SOUND CHANNEL AXIS: The depth at which minimum sound velocity occurs, usually about 2,000 feet.

SPREADING, SOUND: The phenomenon whereby transmitted sound intensity decreases in a constant relation to distance from the sound source. Three laws govern spreading, these laws all relate sound intensity to a ratio of distance from the sound source. These spreading laws are:

$I = 1/r^2$ (inverse law or spherical spreading)

$I = 1/r$ (cylindrical spreading)

$I = 1/r^4$ (dipolar spreading)

where: I = sound intensity

r = distance from sound source.

SPECTRUM LEVEL, SOUND: The sound level contained in a frequency band 1 cps wide.

STABILITY, ATMOSPHERIC: A condition of the atmosphere in which the vertical distribution of temperature is such that an air particle resists displacement from its level.

STRIDULATORY SOUND: In marine animals a creaking noise usually produced by the rubbing of one hard body part against another.

SUBSIDENCE: A slow downward motion of air extending over a broad area.

SURFACE DUCT: Where the sound velocity at some depth near the surface is greater than at the surface, sound rays are refracted toward the surface where they are reflected. The rays alternately are refracted and reflected along the duct to distances from the sound source.

SWELL: Waves that have departed the area where they were generated by a local wind. The direction of swell is independent of, but may coincide with that of the wind at the time and place of observation.

SYNCHRONISM: The condition when the natural pitching period of a ship coincides with the period of encountering waves.

SYNOPTIC: Oceanographic or meteorological conditions existing at a given time over an extended region. For example, a synoptic sea surface temperature chart, compiled from observations taken simultaneously over the western North Atlantic, gives a general view of the temperature distribution at a particular time for the area concerned.

TEMPERATURE, AMBIENT: The temperature of the surrounding environment at a given time.

TEMPERATURE, SEA WATER: The degree of hotness or coldness of the water measured on a definite scale. The two most commonly used temperature scales are Fahrenheit (°F) and Centigrade (°C); the relation between the two scales is: $°F = 1.8°C + 32$. A surface temperature is measured at or near the sea surface (that is, within the upper 10 feet); a subsurface temperature is measured at any depth greater than 10 feet.

THERMAL EQUATOR: The zone of highest sea surface temperatures. Except for a few areas, the thermal equator lies north of the geographic equator.

THERMAL NOISE: A very low level noise produced by molecular movements in the sea.

THERMAL WAKE: The temperature change that is produced on the sea surface by the passage of a submerged submarine. Although this temperature change is small, it can be detected.

THERMOCLINE: The layer in the sea where the temperature decreases continuously with depth; usually the decrease (gradient) is greater than 2.7°F per 165 feet of depth.

TRAIN, WAVE: A series of waves from the same direction.

TRANSDUCER: A device that converts electrical energy to sound energy or the converse. When sound energy received through the water is converted to electrical energy the device is termed a *hydrophone;* conversely, when electrical energy is converted to sound energy and transmitted through the water the device is termed a *sonar projector* or *echo sounder.*

TRANSMISSION LOSS: The energy lost in the transmission of sound from one point to another, the loss usually is expressed in decibels. In passive sonar the loss is one-way, whereas in active sonar it is two-way (travel from projector and return of echo).

TRANSPARENCY, WATER: The ability of water to transmit light of different wavelengths. Transparency is sometimes measured in the percent of radiation that penetrates a distance of one meter, sometimes it is expressed as the average depth at which a Secchi disc disappears and reappears.

TRANSPONDER: An acoustic device, similar to a sonobuoy, that can be activated upon receipt of a sound or radio signal.

TROUGH, WAVE: The lowest part of a wave between successive crests.

TSUNAMIS: A long-period sea wave produced by a submarine earthquake or volcanic eruption; commonly misnamed a tidal wave.

TUNICATES: Single or colonial, attached or free-floating, sacklike animals possessing a tough protective covering and two or more openings. These marine animals are part of the fouling community; sometimes called sea squirts.

TURBIDITY: A condition of water clarity resulting from the presence of suspended matter. Actually, water is considered turbid when its load of suspended matter is visibly conspicuous, but all waters contain some suspended matter and therefore are turbid.

TURBULENCE, ATMOSPHERIC: Irregular air motion caused by eddies superimposed on a general flow.

UNCONSOLIDATED SEDIMENTS: Marine deposits consisting of uncemented particles of organic or inorganic origin, for example, gravel, sand, or mud.

UPWELLING: An upward movement of subsurface water, usually near certain coasts and associated with offshore winds.

VARIABLE DEPTH SONAR (VDS): A sonar system using a transducer mounted in a housing that can be towed at various depths behind a surface vessel, especially useful in ranging below a layer.

VELOCITY, SOUND: The rate of travel at which sound energy moves through a medium, usually expressed in feet per second.

In sea water, this rate is determined by temperature, salinity, and pressure (depth).

VISIBILITY, METEOROLOGICAL: The maximum distance in a given direction that it is just possible to see a given object with the unaided eye.

WATER SKY: Dark streaks, patches, or grayness that usually appear on the underside of extensive cloud areas when overlying an area of open water in sea ice. Water sky is caused by the absence of reflected light.

WAVE: An oscillatory movement in a body of water seen as the rise and fall of the surface. Normally, a wave means sea or swell, but may mean such phenomena as internal waves, tsunamis, and seiches.

WAVELENGTH, SOUND: The distance between corresponding points of adjacent sound waves; measurement is determined by the ratio of speed to frequency.

WHALEBONE (BALEEN) WHALE: A whale possessing plates of frayed, flexible bone (baleen) in its mouth; these plates strain plankton or small fish as the whale moves through the water.

WHITEOUT: An optical phenomenon occurring at high latitudes during which neither shadows, horizon. nor clouds are discernible. During a whiteout the sense of depth and orientation is lost and only very dark nearby objects can be seen.

ZOOPLANKTON: The animal forms of plankton.

Table 1. Fathoms—Metres

Fathoms	0	1	2	3	4	5	6	7	8	9
0	0·0	1·8	3·7	5·5	7·3	9·1	11·0	12·8	14·6	16·5
10	18·3	20·1	21·9	23·8	25·6	27·4	29·3	31·1	32·9	34·7
20	36·6	38·4	40·2	42·1	43·9	45·7	47·5	49·4	51·2	53·0
30	54·9	56·7	58·5	60·3	62·2	64·0	65·8	67·7	69·5	71·3
40	73·2	75·0	76·8	78·6	80·5	82·3	84·1	86·0	87·8	89·6
50	91·4	93·3	95·1	96·9	98·8	100·6	102·4	104·2	106·1	107·9
60	109·7	111·6	113·4	115·2	117·0	118·9	120·7	122·5	124·4	126·2
70	128·0	129·8	131·7	133·5	135·3	137·2	139·0	140·8	142·6	144·5
80	146·3	148·1	150·0	151·8	153·6	155·4	157·3	159·1	160·9	162·8
90	164·6	166·4	168·2	170·1	171·9	173·7	175·6	177·4	179·2	181·0
100	182·9	184·7	186·5	188·4	190·2	192·0	193·8	195·7	197·5	199·3
110	201·2	203·0	204·8	206·7	208·5	210·3	212·1	214·0	215·8	217·6
120	219·5	221·3	223·1	224·9	226·8	228·6	230·4	232·3	234·1	235·9
130	237·7	239·6	241·4	243·2	245·1	246·9	248·7	250·5	252·4	254·2
140	256·0	257·9	259·7	261·5	263·3	265·2	267·0	268·8	270·7	272·5
150	274·3	276·1	278·0	279·8	281·6	283·5	285·3	287·1	288·9	290·8
160	292·6	294·4	296·3	298·1	299·9	301·7	303·6	305·4	307·2	309·1
170	310·9	312·7	314·5	316·4	318·2	320·0	321·9	323·7	325·5	327·3
180	329·2	331·0	332·8	334·7	336·5	338·3	340·2	342·0	343·8	345·6
190	347·5	349·3	351·1	353·0	354·8	356·6	358·4	360·3	362·1	363·9
200	365·8	367·6	369·4	371·2	373·1	374·9	376·7	378·6	380·4	382·2
210	384·0	385·9	387·7	389·5	391·4	393·2	395·0	396·8	398·7	400·5
220	402·3	404·2	406·0	407·8	409·6	411·5	413·3	415·1	417·0	418·8
230	420·6	422·4	424·3	426·1	427·9	429·8	431·6	433·4	435·2	437·1
240	438·9	440·7	442·6	444·4	446·2	448·0	449·9	451·7	453·5	455·4
250	457·2	459·0	460·1	462·7	464·5	466·3	468·2	470·0	471·8	473·7
260	475·5	477·3	479·1	481·0	482·7	484·6	486·5	488·3	490·1	491·9
270	493·8	495·6	497·4	499·3	501·1	502·9	504·7	506·6	508·4	510·2
280	512·1	513·9	515·7	517·5	519·4	521·2	523·0	524·9	526·7	528·5
290	530·3	532·2	534·0	535·8	537·7	539·5	541·3	543·1	545·0	546·8

Fathoms	0	10	20	30	40	50	60	70	80	90
300	549	567	585	603	622	640	658	677	695	713
400	732	750	768	786	805	823	841	860	878	896
500	914	933	951	969	988	1 006	1 024	1 042	1 061	1 079
600	1 097	1 116	1 134	1 152	1 170	1 189	1 207	1 225	1 244	1 262
700	1 280	1 298	1 317	1 335	1 353	1 372	1 390	1 408	1 426	1 445
800	1 463	1 481	1 500	1 518	1 536	1 554	1 573	1 591	1 609	1 628
900	1 646	1 664	1 682	1 701	1 719	1 737	1 756	1 774	1 792	1 810

Fathoms	0	100	200	300	400	500	600	700	800	900
1 000	1 829	2 012	2 195	2 377	2 560	2 743	2 926	3 109	3 292	3 475
2 000	3 658	3 840	4 023	4 206	4 389	4 572	4 755	4 938	5 121	5 303
3 000	5 486	5 669	5 852	6 035	6 218	6 401	6 584	6 766	6 949	7 132
4 000	7 315	7 498	7 681	7 864	8 047	8 229	8 412	8 595	8 778	8 961
5 000	9 144	9 327	9 510	9 692	9 875	10 058	10 241	10 424	10 607	10 790
6 000	10 973	11 155	11 338	11 521	11 704	11 887	12 070	12 253	12 436	12 618
7 000	12 801	12 984	13 167	13 350	13 533	13 716	13 899	14 082	14 264	14 447
8 000	14 630	14 813	14 996	15 179	15 362	15 545	15 727	15 910	16 093	16 276
9 000	16 459	16 642	16 825	17 008	17 190	17 373	17 556	17 739	17 922	18 105

Table 2. Metres—Fathoms

Metres	0	1	2	3	4	5	6	7	8	9
0	0·0	0·5	1·1	1·6	2·2	2·7	3·3	3·8	4·4	4·9
10	5·5	6·0	6·6	7·1	7·7	8·2	8·7	9·3	9·8	10·4
20	10·9	11·5	12·0	12·6	13·1	13·7	14·2	14·8	15·3	15·9
30	16·4	17·0	17·5	18·0	18·6	19·1	19·7	20·2	20·8	21·3
40	21·9	22·4	23·0	23·5	24·1	24·6	25·2	25·7	26·2	26·8
50	27·3	27·9	28·4	29·0	29·5	30·1	30·6	31·2	31·7	32·3
60	32·8	33·4	33·9	34·4	35·0	35·5	36·1	36·6	37·2	37·7
70	38·3	38·8	39·4	39·9	40·5	41·0	41·6	42·1	42·7	43·2
80	43·7	44·3	44·8	45·4	45·9	46·5	47·0	47·6	48·1	48·7
90	49·2	49·8	50·3	50·9	51·4	51·9	52·5	53·0	53·6	54·1
100	54·7	55·2	55·8	56·3	56·9	57·4	58·0	58·5	59·1	59·6
110	60·1	60·7	61·2	61·8	62·3	62·9	63·4	64·0	64·5	65·1
120	65·6	66·2	66·7	67·3	67·8	68·4	68·9	69·4	70·0	70·5
130	71·1	71·6	72·2	72·7	73·3	73·8	74·4	74·9	75·5	76·0
140	76·6	77·1	77·6	78·2	78·7	79·3	79·8	80·4	80·9	81·5
150	82·0	82·6	83·1	83·7	84·2	84·8	85·3	85·9	86·4	86·9
160	87·5	88·0	88·6	89·1	89·7	90·2	90·8	91·3	91·9	92·4
170	93·0	93·5	94·1	94·6	95·1	95·7	96·2	96·8	97·3	97·9
180	98·4	99·0	99·5	100·1	100·6	101·2	101·7	102·3	102·8	103·3
190	103·9	104·4	105·0	105·5	106·1	106·6	107·2	107·7	108·3	108·8
200	109·4	109·9	110·5	111·0	111·6	112·1	112·6	113·2	113·7	114·3
210	114·8	115·4	115·9	116·5	117·0	117·6	118·1	118·7	119·2	119·8
220	120·3	120·8	121·4	121·9	122·5	123·0	123·6	124·1	124·1	125·2
230	125·8	126·3	126·9	127·4	128·0	128·5	129·0	129·6	130·1	130·7
240	131·2	131·8	132·3	132·9	133·4	134·0	134·5	135·1	135·6	136·2
250	136·7	137·3	137·8	138·3	138·9	139·4	140·0	140·5	141·1	141·6
260	142·2	142·7	143·3	143·8	144·4	144·9	145·5	146·0	146·5	147·1
270	147·6	148·2	148·7	149·3	149·8	150·4	150·9	151·5	152·0	152·6
280	153·1	153·7	154·2	154·7	155·3	155·8	156·4	156·9	157·5	158·0
290	158·6	159·1	159·7	160·2	160·8	161·3	161·9	162·4	163·0	163·5

Metres	0	10	20	30	40	50	60	70	80	90
300	164	170	175	180	186	191	197	202	208	213
400	219	224	230	235	241	246	252	257	262	268
500	273	279	284	290	295	301	306	312	317	323
600	328	334	339	344	350	355	361	366	372	377
700	383	388	394	399	405	410	416	421	427	432
800	437	443	448	454	459	465	470	476	481	487
900	492	498	503	509	514	519	525	530	536	541

Metres	0	100	200	300	400	500	600	700	800	900
1 000	547	601	656	711	766	820	875	930	984	1 039
2 000	1 094	1 148	1 203	1 258	1 312	1 367	1 422	1 476	1 531	1 586
3 000	1 640	1 695	1 750	1 804	1 859	1 914	1 969	2 023	2 078	2 133
4 000	2 187	2 242	2 297	2 351	2 406	2 461	2 515	2 570	2 625	2 679
5 000	2 734	2 789	2 843	2 898	2 953	3 007	3 062	3 117	3 172	3 226
6 000	3 281	3 336	3 390	3 445	3 500	3 554	3 609	3 664	3 718	3 773
7 000	3 828	3 882	3 937	3 992	4 046	4 101	4 156	4 210	4 265	4 320
8 000	4 375	4 429	4 484	4 539	4 593	4 648	4 703	4 757	4 812	4 867
9 000	4 921	4 976	5 031	5 085	5 140	5 195	5 249	5 304	5 359	5 413

Table 3. Feet—Metres

Feet	0	1	2	3	4	5	6	7	8	9
0	0·0	0·3	0·6	0·9	1·2	1·5	1·8	2·1	2·4	2·7
10	3·0	3·4	3·7	4·0	4·3	4·6	4·9	5·2	5·5	5·8
20	6·1	6·4	6·7	7·0	7·3	7·6	7·9	8·2	8·5	8·8
30	9·1	9·4	9·8	10·1	10·4	10·7	11·0	11·3	11·6	11·9
40	12·2	12·5	12·8	13·1	13·4	13·7	14·0	14·3	14·6	14·9
50	15·2	15·5	15·8	16·1	16·5	16·8	17·1	17·4	17·7	18·0
60	18·3	18·6	18·9	19·2	19·5	19·8	20·1	20·4	20·7	21·0
70	21·3	21·6	21·9	22·3	22·6	22·9	23·2	23·5	23·8	24·1
80	24·4	24·7	25·0	25·3	25·6	25·9	26·2	26·5	26·8	27·1
90	27·4	27·7	28·0	28·3	28·7	29·0	29·3	29·6	29·9	30·2
100	30·5	30·8	31·1	31·4	31·7	32·0	32·3	32·6	32·9	33·2
110	33·5	33·8	34·1	34·4	34·7	35·1	35·4	35·7	36·0	36·3
120	36·6	36·9	37·2	37·5	37·8	38·1	38·4	38·7	39·0	39·3
130	39·6	39·9	40·2	40·5	40·8	41·1	41·5	41·8	42·1	42·4
140	42·7	43·0	43·3	43·6	43·9	44·2	44·5	44·8	45·1	45·4
150	45·7	46·0	46·3	46·6	46·9	47·2	47·5	47·9	48·2	48·5
160	48·8	49·1	49·4	49·7	50·0	50·3	50·6	50·9	51·2	51·5
170	51·8	52·1	52·4	52·7	53·0	53·3	53·6	53·9	54·3	54·6
180	54·9	55·2	55·5	55·8	56·1	56·4	56·7	57·0	57·3	57·6
190	57·9	58·2	58·5	58·8	59·1	59·4	59·7	60·0	60·4	60·7
200	61·0	61·3	61·6	61·9	62·2	62·5	62·8	63·1	63·4	63·7
210	64·0	64·3	64·6	64·9	65·2	65·5	65·8	66·1	66·4	66·8
220	67·1	67·4	67·7	68·0	68·3	68·6	68·9	69·2	69·5	69·8
230	70·1	70·4	70·7	71·0	71·3	71·6	71·9	72·2	72·5	72·8
240	73·2	73·5	73·8	74·1	74·4	74·7	75·0	75·3	75·6	75·9
250	76·2	76·5	76·8	77·1	77·4	77·7	78·0	78·3	78·6	78·9
260	79·2	79·6	79·9	80·2	80·5	80·8	81·1	81·4	81·7	82·0
270	82·3	82·6	82·9	83·2	83·5	83·8	84·1	84·4	84·7	85·0
280	85·3	85·6	86·0	86·3	86·6	86·9	87·2	87·5	87·8	88·1
290	88·4	88·7	89·0	89·3	89·6	89·9	90·2	90·5	90·8	91·1

Feet	00	10	20	30	40	50	60	70	80	90
300	91·4	94·5	97·5	100·6	103·6	106·7	109·7	112·8	115·8	118·9
400	121·9	125·0	128·0	131·1	134·1	137·2	140·2	143·3	146·3	149·4
500	152·4	155·4	158·5	161·5	164·6	167·6	170·7	173·7	176·8	179·8
600	182·9	185·9	189·0	192·0	195·1	198·1	201·2	204·2	207·3	210·3
700	213·4	216·4	219·5	222·5	225·6	228·6	231·6	234·7	237·7	240·8
800	243·8	246·9	249·9	253·0	256·0	259·1	262·1	265·2	268·2	271·3
900	274·3	277·4	280·4	283·5	286·5	289·6	292·6	295·7	298·7	301·8

Feet	000	100	200	300	400	500	600	700	800	900
1 000	305	335	366	396	427	457	488	518	549	579
2 000	610	640	671	701	732	762	792	823	853	884
3 000	914	945	975	1 006	1 036	1 067	1 097	1 128	1 158	1 189
4 000	1 219	1 250	1 280	1 311	1 341	1 372	1 402	1 433	1 463	1 494
5 000	1 524	1 554	1 585	1 615	1 646	1 676	1 707	1 737	1 768	1 798
6 000	1 829	1 859	1 890	1 920	1 951	1 981	2 012	2 042	2 073	2 103
7 000	2 134	2 164	2 195	2 225	2 256	2 286	2 316	2 347	2 377	2 408
8 000	2 438	2 469	2 499	2 530	2 560	2 591	2 621	2 652	2 682	2 713
9 000	2 743	2 774	2 804	2 835	2 865	2 896	2 926	2 957	2 987	3 018

Table 4. Metres—Feet

Metres	0	1	2	3	4	5	6	7	8	9
0	0·0	3·3	6·6	9·8	13·1	16·4	19·7	23·0	26·2	29·5
10	32·8	36·1	39·4	42·7	45·9	49·2	52·5	55·8	59·1	62·3
20	65·6	68·9	72·2	75·5	78·7	82·0	85·3	88·6	91·9	95·1
30	98·4	101·7	105·0	108·3	111·5	114·8	118·1	121·4	124·7	128·0
40	131·2	134·5	137·8	141·1	144·4	147·6	150·9	154·2	157·5	160·8
50	164·0	167·3	170·6	173·9	177·2	180·4	183·7	187·0	190·3	193·6
60	196·8	200·1	203·4	206·7	210·0	213·3	216·5	219·8	223·1	226·4
70	229·7	232·9	236·2	239·5	242·8	246·1	249·3	252·6	255·9	259·2
80	262·5	265·7	269·0	272·3	275·6	278·9	282·2	285·4	288·7	292·0
90	295·3	298·6	301·8	305·1	308·4	311·7	315·0	318·2	321·5	324·8
100	328·1	331·4	334·6	337·9	341·2	344·5	347·8	351·0	354·3	357·6
110	360·9	364·2	367·5	370·7	374·0	377·3	380·6	383·9	387·1	390·4
120	393·7	397·0	400·3	403·5	406·8	410·1	413·4	416·7	419·9	423·2
130	426·5	429·8	433·1	436·4	439·6	442·9	446·2	449·5	452·8	456·0
140	459·3	462·6	465·9	469·2	472·4	475·7	479·0	482·3	485·6	488·8
150	492·1	495·4	498·7	502·0	505·2	508·5	511·8	515·1	518·4	521·7
160	524·9	528·2	531·5	534·8	538·1	541·3	544·6	547·9	551·2	554·5
170	557·7	561·0	564·3	567·6	570·9	574·1	577·4	580·7	584·0	587·3
180	590·5	593·8	597·1	600·4	603·7	607·0	610·2	613·5	616·8	620·1
190	623·4	626·6	629·9	633·2	636·5	639·8	643·0	646·3	649·6	652·9
200	656·2	659·4	662·7	666·0	669·3	672·6	675·9	679·1	682·4	685·7
210	689·0	692·3	695·5	698·8	702·1	705·4	708·7	711·9	715·2	718·5
220	721·8	725·1	728·3	731·6	734·9	738·2	741·5	744·7	748·0	751·3
230	754·6	757·9	761·2	764·4	767·7	771·0	774·3	777·6	780·8	784·1
240	787·4	790·7	794·0	797·2	800·5	803·8	807·1	810·4	813·6	816·9
250	820·2	823·5	826·8	830·1	833·3	836·6	839·9	843·2	846·5	849·7
260	853·0	856·3	859·6	862·9	866·1	869·4	872·7	876·0	879·3	882·5
270	885·8	889·1	892·4	895·7	898·9	902·2	905·5	908·8	912·1	915·4
280	918·6	921·9	925·2	928·5	931·8	935·0	938·3	941·6	944·9	948·2
290	951·4	954·7	958·0	961·3	964·6	967·8	971·1	974·4	977·7	981·0

Metres	00	10	20	30	40	50	60	70	80	90
300	984·2	1 017·1	1 049·9	1 082·7	1 115·5	1 148·3	1 181·1	1 213·9	1 246·7	1 279·5
400	1 312·3	1 345·1	1 377·9	1 410·8	1 443·6	1 476·4	1 509·2	1 542·0	1 574·8	1 607·6
500	1 640·4	1 673·2	1 706·0	1 738·8	1 771·6	1 804·5	1 837·3	1 870·1	1 902·9	1 935·7
600	1 968·5	2 001·3	2 034·1	2 066·9	2 099·7	2 132·5	2 165·3	2 198·2	2 231·0	2 263·8
700	2 296·6	2 329·4	2 362·2	2 395·0	2 427·8	2 460·6	2 493·4	2 526·2	2 559·0	2 591·9
800	2 624·7	2 657·5	2 690·3	2 723·1	2 755·9	2 788·7	2 821·5	2 854·3	2 887·1	2 919·9
900	2 952·7	2 985·6	3 018·4	3 051·2	3 084·0	3 116·8	3 149·6	3 182·4	3 215·2	3 248·0

Metres	000	100	200	300	400	500	600	700	800	900
1 000	3 281	3 609	3 937	4 265	4 593	4 921	5 249	5 577	5 905	6 234
2 000	6 562	6 890	7 218	7 546	7 874	8 202	8 530	8 858	9 186	9 514
3 000	9 842	10 171	10 499	10 827	11 155	11 483	11 811	12 139	12 467	12 795
4 000	13 123	13 451	13 779	14 108	14 436	14 764	15 092	15 420	15 748	16 076
5 000	16 404	16 732	17 060	17 388	17 716	18 045	18 373	18 701	19 028	19 357
6 000	19 685	20 013	20 341	20 669	20 997	21 325	21 653	21 982	22 310	22 638
7 000	22 966	23 294	23 622	23 950	24 278	24 606	24 934	25 262	25 590	25 919
8 000	26 247	26 575	26 903	27 231	27 559	27 887	28 215	28 543	28 871	29 199
9 000	29 527	29 856	30 184	30 512	30 840	31 168	31 496	31 824	32 152	32 480

Table 5. Fahrenheit—Celsius

°F.	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
30	−1·11	−1·06	−1·00	−0·94	−0·89	−0·83	−0·78	−0·72	−0·67	−0·61
31	− ·56	− ·50	− ·44	− ·39	− ·33	− ·28	− ·22	− ·17	− ·11	− ·06
32	·00	·06	·11	·17	·22	·28	·33	·39	·44	·50
33	·56	·61	·67	·72	·78	·83	·89	·94	1·00	1·06
34	1·11	1·17	1·22	1·28	1·33	1·39	1·44	1·50	1·56	1·61
35	1·67	1·72	1·78	1·83	1·89	1·94	2·00	2·06	2·11	2·17
36	2·22	2·28	2·33	2·39	2·44	2·50	2·56	2·61	2·67	2·72
37	2·78	2·83	2·89	2·94	3·00	3·06	3·11	3·17	3·22	3·28
38	3·33	3·39	3·44	3·50	3·56	3·61	3·67	3·72	3·78	3·83
39	3·89	3·94	4·00	4·06	4·11	4·17	4·22	4·28	4·33	4·39
40	4·44	4·50	4·56	4·61	4·67	4·72	4·78	4·83	4·89	4·94
41	5·00	5·06	5·11	5·17	5·22	5·28	5·33	5·39	5·44	5·50
42	5·56	5·61	5·67	5·72	5·78	5·83	5·89	5·94	6·00	6·06
43	6·11	6·17	6·22	6·28	6·33	6·39	6·44	6·50	6·56	6·61
44	6·67	6·72	6·78	6·83	6·89	6·94	7·00	7·06	7·11	7·17
45	7·22	7·28	7·33	7·39	7·44	7·50	7·56	7·61	7·67	7·72
46	7·78	7·83	7·89	7·94	8·00	8·06	8·11	8·17	8·22	8·28
47	8·33	8·39	8·44	8·50	8·56	8·61	8·67	8·72	8·78	8·83
48	8·89	8·94	9·00	9·06	9·11	9·17	9·22	9·28	9·33	9·39
49	9·44	9·50	9·56	9·61	9·67	9·72	9·78	9·83	9·89	9·94
50	10·00	10·06	10·11	10·17	10·22	10·28	10·33	10·39	10·44	10·50
51	10·56	10·61	10·67	10·72	10·78	10·83	10·89	10·94	11·00	11·06
52	11·11	11·17	11·22	11·28	11·33	11·39	11·44	11·50	11·56	11·61
53	11·67	11·72	11·78	11·83	11·89	11·94	12·00	12·06	12·11	12·17
54	12·22	12·28	12·33	12·39	12·44	12·50	12·56	12·61	12·67	12·72
55	12·78	12·83	12·89	12·94	13·00	13·06	13·11	13·17	13·22	13·28
56	13·33	13·39	13·44	13·50	13·56	13·61	13·67	13·72	13·78	13·83
57	13·89	13·94	14·00	14·06	14·11	14·17	14·22	14·28	14·33	14·39
58	14·44	14·50	14·56	14·61	14·67	14·72	14·78	14·83	14·89	14·94
59	15·00	15·06	15·11	15·17	15·22	15·28	15·33	15·39	15·44	15·50
60	15·56	15·61	15·67	15·72	15·78	15·83	15·89	15·94	16·00	16·06
61	16·11	16·17	16·22	16·28	16·33	16·39	16·44	16·50	16·56	16·61
62	16·67	16·72	16·78	16·83	16·89	16·94	17·00	17·06	17·11	17·17
63	17·22	17·28	17·33	17·39	17·44	17·50	17·56	17·61	17·67	17·72
64	17·78	17·83	17·89	17·94	18·00	18·06	18·11	18·17	18·22	18·28
65	18·33	18·39	18·44	18·50	18·56	18·61	18·67	18·72	18·78	18·83
66	18·89	18·94	19·00	19·06	19·11	19·17	19·22	19·28	19·33	19·39
67	19·44	19·50	19·56	19·61	19·67	19·72	19·78	19·83	19·89	19·94
68	20·00	20·06	20·11	20·17	20·22	20·28	20·33	20·39	20·44	20·50
69	20·56	20·61	20·67	20·72	20·78	20·83	20·89	20·94	21·00	21·06
70	21·11	21·17	21·22	21·28	21·33	21·39	21·44	21·50	21·56	21·61
71	21·67	21·72	21·78	21·83	21·89	21·94	22·00	22·06	22·11	22·17
72	22·22	22·28	22·33	22·39	22·44	22·50	22·56	22·61	22·67	22·72
73	22·78	22·83	22·89	22·94	23·00	23·06	23·11	23·17	23·22	23·28
74	23·33	23·39	23·44	23·50	23·56	23·61	23·67	23·72	23·78	23·83
75	23·89	23·94	24·00	24·06	24·11	24·17	24·22	24·28	24·33	24·39
76	24·44	24·50	24·56	24·61	24·67	24·72	24·78	24·83	24·89	24·94
77	25·00	25·06	25·11	25·17	25·22	25·28	25·33	25·39	25·44	25·50
78	25·56	25·61	25·67	25·72	25·78	25·83	25·89	25·94	26·00	26·06
79	26·11	26·17	26·22	26·28	26·33	26·39	26·44	26·50	26·56	26·61
80	26·67	26·72	26·78	26·83	26·89	26·94	27·00	27·06	27·11	27·17
81	27·22	27·28	27·33	27·39	27·44	27·50	27·56	27·61	27·67	27·72
82	27·78	27·83	27·89	27·94	28·00	28·06	28·11	28·17	28·22	28·28
83	28·33	28·39	28·44	28·50	28·56	28·61	28·67	28·72	28·78	28·83
84	28·89	28·94	29·00	29·06	29·11	29·17	29·22	29·28	29·33	29·39

Table 5. Fahrenheit—Celsius—contd.

°F.	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
85	29·44	29·50	29·56	29·61	29·67	29·72	29·78	29·83	29·89	29·94
86	30·00	30·06	30·11	30·17	30·22	30·28	30·33	30·39	30·44	30·50
87	30·56	30·61	30·67	30·72	30·78	30·83	30·89	30·94	31·00	31·06
88	31·11	31·17	31·22	31·28	31·33	31·39	31·44	31·50	31·56	31·61
89	31·67	31·72	31·78	31·83	31·89	31·94	32·00	32·06	32·11	32·17
90	32·22	32·28	32·33	32·39	32·44	32·50	32·56	32·61	32·67	32·72
91	32·78	32·83	32·89	32·94	33·00	33·06	33·11	33·17	33·22	33·28
92	33·33	33·39	33·44	33·50	33·56	33·61	33·67	33·72	33·78	33·83
93	33·89	33·94	34·00	34·06	34·11	34·17	34·22	34·28	34·33	34·39
94	34·44	34·50	34·56	34·61	34·67	34·72	34·78	34·83	34·89	34·94

Table 6. Celsius—Fahrenheit

°C.	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
− 2	28·40	28·22	28·04	27·86	27·68	27·50	27·32	27·14	26·96	26·78
− 1	30·20	30·02	29·84	29·66	29·48	29·30	29·12	28·94	28·76	28·58
− 0	32·00	31·82	31·64	31·46	31·28	31·10	30·92	30·74	30·56	30·38
0	32·00	32·18	32·36	32·54	32·72	32·90	33·08	33·26	33·44	33·62
1	33·80	33·98	34·16	34·34	34·52	34·70	34·88	35·06	35·24	35·42
2	35·60	35·78	35·96	36·14	36·32	36·50	36·68	36·86	37·04	37·22
3	37·40	37·58	37·76	37·94	38·12	38·30	38·48	38·66	38·84	39·02
4	39·20	39·38	39·56	39·74	39·92	40·10	40·28	40·26	40·64	40·82
5	41·00	41·18	41·36	41·54	41·72	41·90	42·08	42·26	42·44	42·62
6	42·80	42·98	43·16	43·34	43·52	43·70	43·88	44·06	44·24	44·42
7	44·60	44·78	44·96	45·14	45·32	45·50	45·68	45·86	46·04	46·22
8	46·40	46·58	46·76	46·94	47·12	47·30	47·48	47·66	47·84	48·02
9	48 20	48·38	48·56	48·74	48·92	49·10	49·28	49·46	49·64	49·82
10	50·00	50·18	50·36	50·54	50·72	50·90	51·08	51·26	51·44	51·62
11	51·80	51·98	52·16	52·34	52·52	52·70	52·88	53·06	53·24	53·42
12	53·60	53·78	53·96	54·14	54·32	54·50	54·68	54·86	55·04	55·22
13	55·40	55·58	55·76	55·94	56·12	56·30	56·48	56·66	56·84	57·02
14	57·20	57·38	57·56	57·74	57·92	58·10	58·28	58·46	58·64	58·82
15	59·00	59·18	59·36	59·54	59·72	59·90	60·08	60·26	60·44	60·62
16	60·80	60·98	61·16	61·34	61·52	61·70	61·88	62·06	62·24	62·42
17	62·60	62·78	62·96	63·14	63·32	63·50	63·68	63·86	64·04	64·22
18	64·40	64·58	64·76	64·94	65·12	65·30	65·48	65·66	65·84	66·02
19	66·20	66·38	66·56	66·74	66·92	67·10	67·28	67·46	67·64	67·82
20	68·00	68·18	68·36	68·54	68·72	68·90	69·08	69·26	69·44	69·62
21	69·80	69·98	70·16	70·34	70·52	70·70	70·88	71·06	71·24	71·42
22	71·60	71·78	71·96	72·14	72·32	72·50	72·68	72·86	73·04	73·22
23	73·40	73·58	73·76	73·94	74·12	74·30	74·48	74·66	74·84	75·02
24	75·20	75·38	75·56	75·74	75·92	76·10	76·28	76·46	76·64	76·82
25	77·00	77·18	77·36	77·54	77·72	77·90	78·08	78·26	78·44	78·62
26	78·80	78·98	79·16	79·34	79·52	79·70	79·88	80·06	80·24	80·42
27	80·60	80·78	80·96	81·14	81·32	81·50	81·68	81·86	82·04	82·22
28	82·40	82·58	82·76	82·94	83·12	83·30	83·48	83·66	83·84	84·02
29	84·20	84·38	84·56	84·74	84·92	85·10	85·28	85·46	85·64	85·82
30	86·00	86·18	86·36	86·54	86·72	86·90	87·08	87·26	87·44	87·62
31	87·80	87·98	88·16	88·34	88·52	88·70	88·88	89·06	89·24	89·42
32	89·60	89·78	89·96	90·14	90·32	90·50	90·68	90·86	91·04	91·22
33	91·40	91·58	91·76	91·94	92·12	92·30	92·48	92·66	92·84	93·02
34	93·20	93·38	93·56	93·74	93·92	94·10	94·28	94·46	94·64	94·82
35	95·00	95·18	95·36	95·54	95·72	95·90	96·08	96·26	96·44	96·62
36	96·80	96·98	97·16	97·34	97·52	97·70	97·88	98·06	98·24	98·42
37	98·60	98·78	98·96	99·14	99·32	99·50	99·68	99·86	100·04	100·22
38	100·40	100·58	100·76	100·94	101·12	101·30	101·48	101·66	101·84	102·02
39	102·20	102·38	102·56	102·74	102·92	103·10	103·28	103·46	103·64	103·82
40	104·00	104·18	104·36	104·54	104·72	104·90	105·08	105·26	105·44	105·62
41	105·80	105·98	106·16	106·34	106·52	106·70	106·88	107·06	107·24	107·42
42	107·60	107·78	107·96	108·14	108·32	108·50	108·68	108·86	109·04	109·22
43	109·40	109·58	109·76	109·94	110·12	110·30	110·48	110·66	110·84	111·02
44	111·20	111·38	111·56	111·74	111·92	112·10	112·28	112·46	112·64	112·82
45	113·00	113·18	113·36	113·54	113·72	113·90	114·08	114·26	114·44	114·62
46	114·80	114·98	115·16	115·34	115·52	115·70	115·88	116·06	116·24	116·42
47	116·60	116·78	116·96	117·14	117·32	117·50	117·68	117·86	118·04	118·22
48	118·40	118·58	118·76	118·94	119·12	119·30	119·48	119·66	119·84	120·02
49	120·20	120·38	120·56	120·74	120·92	121·10	121·28	121·46	121·64	121·82

Table 7. Nautical Miles—Kilometres

Nautical miles	0	1	2	3	4	5	6	7	8	9
0	0·0	1·8	3·7	5·6	7·4	9·3	11·1	13·0	14·8	16·7
10	18·5	20·4	22·2	24·1	25·9	27·8	29·7	31·5	33·4	35·2
20	37·1	38·9	40·8	42·6	44·5	46·3	48·2	50·0	51·9	53·7
30	55·6	57·5	59·3	61·2	63·0	64·9	66·7	68·6	70·4	72·3
40	74·1	76·0	77·8	79·7	81·5	83·4	85·2	87·1	89·0	90·8
50	92·7	94·5	96·4	98·2	100·1	101·9	103·8	105·6	107·5	109·3
60	111·2	113·0	114·9	116·8	118·6	120·5	122·3	124·2	126·0	127·9
70	129·7	131·6	133·4	135·3	137·1	139·0	140·8	142·7	144·6	146·4
80	148·3	150·1	152·0	153·8	155·7	157·5	159·4	161·2	163·1	164·9
90	166·8	168·6	170·5	172·4	174·2	176·1	177·9	179·8	181·6	183·5

Table 8. Kilometres—Nautical Miles

Kilometres	0	1	2	3	4	5	6	7	8	9
0	0·0	0·5	1·1	1·6	2·2	2·7	3·2	3·8	4·3	4·9
10	5·4	5·9	6·5	7·0	7·6	8·1	8·6	9·2	9·7	10·3
20	10·8	11·3	11·9	12·4	13·0	13·5	14·0	14·6	15·1	15·6
30	16·2	16·7	17·3	17·8	18·3	18·9	19·4	20·0	20·5	21·0
40	21·6	22·1	22·7	23·2	23·7	24·3	24·8	25·4	25·9	26·4
50	27·0	27·5	28·1	28·6	29·1	29·7	30·2	30·8	31·3	31·8
60	32·4	32·9	33·5	34·0	34·5	35·1	35·6	36·2	36·7	37·2
70	37·8	38·3	38·9	39·4	39·9	40·5	41·0	41·5	42·1	42·6
80	43·2	43·7	44·2	44·8	45·3	45·9	46·4	46·9	47·5	48·0
90	48·6	49·1	49·6	50·2	50·7	51·3	51·8	52·3	52·9	53·4
100	54·0	54·5	55·0	55·6	56·1	56·7	57·2	57·7	58·3	58·8
110	59·4	59·9	60·4	61·0	61·5	62·1	62·6	63·1	63·7	64·2
120	64·8	65·3	65·8	66·4	66·9	67·4	68·0	68·5	69·1	69·6
130	70·1	70·7	71·2	71·8	72·3	72·8	73·4	73·9	74·5	75·0
140	75·5	76·1	76·6	77·2	77·7	78·2	78·8	79·3	79·9	80·4
150	80·9	81·5	82·0	82·6	83·1	83·6	84·2	84·7	85·3	85·8
160	86·3	86·9	87·4	88·0	88·5	89·0	89·6	90·1	90·7	91·2
170	91·7	92·3	92·8	93·3	93·9	94·4	95·0	95·5	96·0	96·6
180	97·1	97·7	98·2	98·7	99·3	99·8	100·4	100·9	101·4	102·0
190	102·5	103·1	103·6	104·1	104·7	105·2	105·8	106·3	106·8	107·4
200	107·9	108·5	109·0	109·5	110·1	110·6	111·2	111·7	112·2	112·8

Table 9. Knots—Metres per Second

Knots	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
0	0·00	0·05	0·11	0·15	0·20	0·26	0·31	0·36	0·40	0·46
1	0·50	0·57	0·62	0·67	0·70	0·77	0·80	0·88	0·93	0·98
2	1·03	1·08	1·13	1·18	1·24	1·29	1·84	1·39	1·44	1·49
3	1·54	1·60	1·65	1·70	1·75	1·80	1·85	1·91	1·96	2·01
4	2·06	2·11	2·16	2·21	2·27	2·32	2·37	2·42	2·47	2·52
5	2·58	2·63	2·68	2·73	2·78	2·83	2·88	2·93	2·99	3·04
6	3·09	3·14	3·19	3·24	3·30	3·35	3·40	3·45	3·50	3·55
7	3·60	3·66	3·71	3·76	3·81	3·86	3·91	3·96	4·02	4·07
8	4·12	4·17	4·22	4·27	4·32	4·38	4·43	4·48	4·53	4·58
9	4·63	4·69	4·74	4·79	4·84	4·89	4·94	4·99	5·05	5·10

Table 10. Metres per Second—Knots

m/sec	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
0	0·00	0·19	0·39	0·58	0·78	0·97	1·17	1·36	1·55	1·75
1	1·94	2·14	2·33	2·53	2·72	2·91	3·11	3·30	3·50	3·69
2	3·89	4·08	4·27	4·47	4·66	4·86	5·05	5·24	5·44	5·63