

## GLOSSARY OF TRAIN CONTROL TERMS

The language of rail rapid transit and train control technology contains many specialized terms that may be unfamiliar to the general reader. This glossary has been prepared as an aid to understanding the terminology used in the report. It is also contemplated that the glossary may be useful as a reference for additional reading on the subject of ATC and transit system engineering. For this reason, the list of terms defined here has been expanded to include some background items not needed for the immediate purpose of reading this report.

The principal source of the definitions presented here is the Lexicon of Rail Rapid Transit Safety-Related Terminology, prepared by the Safety Technology Applied to Rapid Transit (START) Committee of the American Public Transit Association, January 1975. The START Lexicon, in turn, draws extensively on earlier work by the Association of American Railroads and the U.S. Department of Transportation. In addition to START, other sources consulted include General Order No. 127 of the Public Utilities Commission of the State of California, August 1967, and several technical specifications prepared by WMATA. In all cases, however, the responsibility for interpretation and for the accuracy and completeness of the definitions offered here rests with the authors of this report.

**ACKNOWLEDGING DEVICE**—a manual device used by the train operator to forestall automatic brake application on a train equipped with automatic train stop or to silence the sounding of a cab indicator on a train equipped with cab signaling. (See Audible Cab Indicator.)

**ASPECT**—the visual indication presented to an approaching train by a wayside signal; also, the display presented by a cab signal to an operator in the cab. The aspect is said to be “clear” (proceed at civil speed) or varying degrees of “restrictive.”

False Clear Aspect—the aspect of a signal that conveys an indication less restrictive than intended.

False Restrictive Aspect—the aspect of a signal that conveys an indication more restrictive than intended.

**ATTENDANT**—a transit employee on board a train in service whose principal duties are to oversee safety, provide security, and assist in emergency situations (as distinct from a train operator, motorman, who is responsible for running the train).

**AUDIBLE CAB INDICATOR**—an alerting device, on a train equipped with cab signals, designed to sound when the cab signal changes and to continue sounding until acknowledged. (See Acknowledging Device.)

**AUDIO-FREQUENCY TRACK CIRCUIT**—a track circuit energized by an electrical current alternating in the audio-frequency range (15,000-20,000 Hz); also called “high frequency” or “overlay” track circuit.

**AUTOMATIC BLOCK SIGNAL SYSTEM**—a series of consecutive blocks governed by block signals, cab signals, or both, actuated by occupancy of the track or by certain conditions affecting the use of a block; such as an open switch or a car standing on a turnout and blocking the main track. (See also Block and Manual Block Signal System.)

**AUTOMATIC CAR IDENTIFICATION**—a system that automatically provides positive recognition and transmission of individual car numbers as they pass a fixed wayside point.

**AUTOMATIC TRAIN CONTROL**—the method (and, by extension, the specific system) for automatically controlling train movement, enforcing train safety, and directing train operations. ATC includes four major functions:

Automatic Train Protection (ATP)—assuring safe train movement by a combination of train detection, separation of trains running on the same track or over interlocked routes, overspeed prevention, and route interlocking.

Automatic Train Operation (ATO)--controlling speed, programmed station stopping, door operation, performance level modification, and other functions traditionally assigned to the train operator and conductor.

Automatic Train Supervision (ATS)—monitoring of system status and directing traffic movement to maintain the schedule or minimize the effect of delays.

Communication (CS)—interchanging information (voice, data, or video) between system elements separated by distance.

AVAILABILITY—the portion of time that a system is operating or ready for operation; mathematically, the probability that a system or system element will be operational when required, expressed as the ratio of mean time between failure to the sum of mean time between failure plus mean time to restore.  $[A = MTBF / (MTBF + MTTR)]$  (See also Mean Time Between Failure and Mean Time to Restore.)

BASE PERIOD—the nonrush hour period of weekday transit system service. (See also Peak Period.)

BERTH—the space assigned for a train of specified length when stopped at a station platform or in a terminal zone. (See Terminal Zone.)

BERTHING—the positioning of a train in its assigned berth.

BLENDING—the automatic and simultaneous application of dynamic and friction braking, where the effort of each is continuously proportioned to achieve the required total braking effect.

BLOCK—a length of track of defined limits, the use of which is governed by block signals, cab signals, or both.

Absolute Block—a block into which no train is allowed to enter while it is occupied by another train.

Permissive Block--a block into which a train is allowed to enter even though occupied by another train.

BLOCK SIGNAL-See Signal.

BRAKE ASSURANCE—the function provided by a subsystem within the automatic train operation system that will cause the emergency brakes of a vehicle to be applied when the actual braking

rate of the vehicle is less than the braking rate requested by the automatic train control system.

BRAKING—the process of retarding or stopping train movement by any of various devices:

Dynamic Braking—a system of electrical braking in which the traction motors are used as generators and convert the kinetic energy of the vehicle into electrical energy, which is consumed in resistors and, in so doing, exert a retarding force on the vehicle.

Friction Braking—braking supplied by a mechanical shoe or pad pressing against the wheels or other rotating surface; also called “mechanical braking.”

Regenerative Braking—a form of electrical braking in which the current generated by the traction motor is returned to the traction power supply for use in propelling other trains. (In ordinary dynamic braking the generated power is dissipated in resistors.)

There are two methods of controlling brake application:

Closed-Loop Braking—continuous modulation (by means of feedback) under the direction of the automatic train operation system or the human operator. (See Closed-Loop Principle.)

Open-Loop Braking—braking without modulation through feedback from the ATO system.

BRAKING EMERGENCY—irrevocable unmodulated (open-loop) braking to a stop usually at a higher rate than that obtained with a full service brake application.

BRAKING, FULL SERVICE—a nonemergency brake application that obtains the maximum brake rate consistent with the design of the primary brake system. Full service braking can be released and reapplied.

BRAKING, SERVICE—braking produced by the primary train braking system,

CAB SIGNAL SYSTEM—a signal system whereby block condition and the prevailing civil speed commands are transmitted and displayed directly within the train cab. The cab signal system may

- be operated in conjunction with a system of fixed wayside signals or separately. (See also Signal.)
- CATENARY**—the wire or wires above the track (including the messenger, supports, and insulation) that carry electric energy for the propulsion of trains. (See also Contact Rail.)
- CENTRAL CONTROL**—the place from which train supervision and direction is accomplished for the entire transit system; the train command center.
- CIRCUIT, TRACK**—an arrangement of electrical equipment, including the rails of the track, that forms a continuous electrical path used for the purpose of detecting the presence of trains on the rails; the track circuit may also be used to communicate commands or other information between the wayside and the train.
- Check-In/Check-Out**—a track circuit system that detects the entrance of the front end of a train into a block and the departure of the rear end of a train from a block for the purpose of determining block occupancy.
- Coded Track Circuit**—a track circuit in which the feed energy is varied or interrupted periodically for the purpose of transmitting commands or instructions to the train or operating train detection apparatus.
- Fail-Safe Circuit**—a circuit designed to principles which will cause the actuated device to assume its most restrictive position (or a state generally known to be safe) when any element of the circuit or system fails.
- Vital Circuit**—an electrical circuit that affects the safety of train operation.
- CIVIL SPEED**—See Speed Limit.
- CLOSED-CIRCUIT PRINCIPLE**—the principle of circuit design employing a circuit that is normally energized and, on being deenergized or interrupted, causes the controlled function to assume its most restrictive condition.
- CLOSED-LOOP” PRINCIPLE**—the principle of control system design in which the response of a system (feedback) is continuously compared with the controlling signal to generate an error signal.
- CLOSING IN**—running a following train toward a leading train that is either stopped or running slower than the following train. (See also Closing up.)
- CLOSING UP**—running a following train to a position that will allow it to couple with a stopped leading train.
- COAST**—the moving condition of a car or train where the propulsion is inactive and, usually, a certain minimum braking is applied. (See also Freewheeling.)
- CONDUCTOR**—an attendant whose main function is to operate train doors.
- CONSIST** (noun)—the number, type, and specific identity of cars that compose a train.
- CONTACT RAIL**—a rail, mounted on insulators alongside the running rails, that provides electric energy for the propulsion of trains. (Also known as “Third Rail.”)
- CROSSOVER**—two turnouts, arranged to form a continuous passage between two parallel tracks.
- DEADMAN CONTROL**—a safety device that requires continuous pressure or activity to remain activated; used to detect the inattention or disability of a train operator.
- DEPARTURE TEST**—an operational test made in a yard or on a transfer track before permitting the unit to enter revenue service.
- DISPATCH**—to start a train into revenue service from a terminal zone, transfer track, or designated intermediate point.
- DISPATCHER**—a person at central control whose function is to dispatch trains, monitor train operation, and to intervene in the event of schedule disruption or when any change in service or routing is required. (Also called “Line Supervisor” or “Central Supervisor.”)
- DOWNSTREAM**—for a given direction of travel, locations that will be reached after passing a given point (equivalent to the AAR term “in advance of”).
- DWELL** (or **DWELL TIME**)—the elapsed time from the instant a train stops moving in a station until the instant it resumes moving.
- ENTRANCE—EXIT ROUTE CONTROL**—a system of interlocking control that automatically aligns switches and clears signals to form a train route in response to manual inputs designating

- the entrance and exit points of the desired route. (Also called "N-X.")
- FACING MOVEMENT**—the movement of a train over points of a switch which face in the direction in which the train is moving. (See also *Trailing Movement*.)
- FAIL-SAFE**--a characteristic of a system which ensures that a fault or malfunction of any element affecting safety will cause the system to revert to a state that is known to be safe; alternatively, a system characteristic which ensures that any fault or malfunction will not result in an unsafe condition.
- FALSE OCCUPANCY**--an indication of track occupancy when no train is present.
- FREEWHEELING**-a mode of operation in which the train is allowed to roll freely without tractive or braking effort being applied. (See also *Coast*.)
- FREQUENCY SHIFT KEYED (FSK)**--a technique used with high-frequency a.c. track circuits, in which the frequency of the track signal is varied between two or more discrete states to convey information (used as an alternative to rate modulation where the track circuit is turned on and off as an information code).
- FROG**-a track structure, used at the intersection of two running rails, to provide support for wheels and passageway for their flanges, thus permitting wheels on either rail to cross the other. A frog may either be fixed or have movable points like a switch.
- GATE**—the limit of an interlocked route where entry to that route is governed by a signaling device.<sup>102</sup>
- Fixed Gate--the limit of an interlocked route beyond which automatic operation of trains is never permitted.
- HEADWAY**—the time separation between two trains traveling in the same direction on the same track, measured from the instant the head end of the leading train passes a given reference point until the head end of the train immediately following passes the same reference point.
- HOSTLER**-an employee assigned to operate cars or trains manually within the yard or maintenance area.
- Hz (HERTZ)**—the unit of frequency equal to 1 cycle per second.
- IMPEDANCE BOND**-a device of low resistance and relatively high reactance, used to provide a continuous path for the return of propulsion current around insulated joints and to confine alternating current signaling energy within a track circuit.
- INDUCTIVELY COUPLED IMPEDANCE BOND**--an impedance bond in which transmitter energy and receivers are inductively coupled into a track circuit,
- INSULATED JOINT**-a joint placed between abutting rail ends to insulate them from each other electrically.
- INTERLOCKING**--an arrangement of signals and control apparatus so interconnected that functions must succeed each other in a predetermined sequence, thus permitting train movements along routes only if safe conditions exist.
- Automatic Interlocking-an interlocking controlled by logic circuits so that movements succeed each other in proper sequence without need for manual activation or control.
- Manual Interlocking—an interlocking operated manually from an interlocking machine, so interconnected (either mechanically or electrically) that movements succeed each other in proper sequence.
- Relay Interlocking-an interlocking in which locking is accomplished electrically by interconnection of relay circuits.
- INTERLOCKING LIMITS**—the length of track between the most remote opposing home signals of an interlocking.
- INTERLOCKING MACHINE**-an assemblage of manually operated levers or like devices for controlling the switches, signals, and other apparatus of an interlocking. (Also called "Switch Machine,")
- INTERLOCKING ROUTE**-a route between two opposing interlocking signals.
- JERK**—the rate of change of acceleration (the second derivative of velocity), expressed in units of miles per hour per second per second (mphsps, mph/see/see, or mph/sec<sup>2</sup>).
- JUNCTION**-a location where train routes converge or diverge.

<sup>102</sup>These terms are peculiar to the BART system.

**KEY-BY**—the act of lowering a trip stop in order to pass a signal displaying a stop indication; so called because of the use at one time of a key by the train operator to actuate the mechanism for lowering the trip stop. Key-by today operates automatically without a key,

**LOCKING**—establishing an electrical or mechanical condition for a switch, interlocked route, speed limit, or automatic function such that its state cannot be altered except by a prescribed and inviolate sequence of actions.

**Approach Locking**—electric locking effective while a train is approaching within a specified distance a signal displaying an aspect to proceed and which prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the movement of any interlocked or electrically locked switch, movable point frog or derail in the route governed by the signal and which prevents an aspect to proceed from being displayed for any conflicting route.

**Electric Locking**—an electrical circuit arrangement by means of which levers of an interlocking machine, switches, or other signal apparatus is secured against operation under prescribed conditions.

**Indication Locking**—electric locking which prevents actions that would result in an unsafe condition for a train movement if a signal, switch, or other operative unit fails to make a movement corresponding to that of its control.

**Occupancy Detector Locking**—electric locking which prevents the movement of a track switch while the track circuit or circuits surrounding that switch are occupied by a train.

**Route Locking**—electric locking, effective when a train passes a signal displaying an aspect for it to proceed, that prevents the movement of any switch in the route governed by the signal and prevents the clearing of a signal for any conflicting route.

**Time Locking**—electric locking that prevents the operation of any switch in the route (or

for any conflicting route) until expiration of a predetermined time interval after a signal is restored to its most restrictive indication.

**Traffic Locking**—electric locking which prevents the actuation of devices for changing the direction of traffic on a section of track while that section is occupied or while a signal displays an aspect for a movement to proceed into that section,

**Sectional Release Locking**—a route locking so arranged that, as a train clears a section of the route, the locking affecting that section is released. (Also called “Trailing Release Locking.”)

**MAINTAINABILITY**—the property of a system that allows it to be repaired and restored to operating condition after a component malfunction or failure; maintainability is often expressed as mean time to restore (or repair).

**MANUAL BLOCK SIGNAL SYSTEM**—a block signal system operated manually, usually based on information transmitted by telephone or telegraph.

**MARRIED PAIR**—two semipermanently coupled cars that share certain essential components and are usually operated as a unit.

**MASTER CONTROLLER**—a carborne device that generates control signals to the propulsion and braking systems,

**MEAN TIME BETWEEN FAILURES (MTBF)**—the average time that a system or component will operate without failure or malfunction; mathematically,  $MTBF = (\text{operating time}) / (\text{number of failures})$ . MTBF is the measure of reliability.

**MEAN TIME TO RESTORE (MTTR)**—the average time required to restore a system or component to operation after a failure; this time is measured from the time troubleshooting and repair work is begun until the system or component is again operable; mathematically,  $MTTR = (\text{cumulative corrective maintenance time}) / (\text{number of failures})$ . MTTR is the measure of maintainability,

**MODEL BOARD**—a reproduction of the track assemblage (not necessarily to scale) equipped with lights and other indicators, used for the pur-

pose of train supervision and traffic control (Also called "Train Board").

MOTORMAN—See Operator.

MTBF—See Mean Time Between Failures.

MTTR—See Mean Time to Restore.

NORMAL DIRECTION—the prescribed direction of train traffic as specified by the rules; usually, the direction in which all regularly scheduled revenue service operations are conducted.

N-X—See Entrance-Exit Route Control.

OPERATOR—the transit employee on board the train having direct and immediate control over the movement of the train. (Also called "Motor-man.")

OPPOSING TRAIN—a train moving in the direction opposite to another train on the same track.

OVERSPEED CONTROL—that onboard portion of the carborne ATC system that enforces speed limits in a fail-safe manner.

PABX—a designation used in the national telephone system to denote a privately owned telephone system that operates by the use of dialing, such as that used in some transit systems for communication between stations or wayside locations and central control.

PEAK PERIOD—the period during a weekday when system demand is highest; usually 7:30-9:30 a.m. and 4:30-6:30 p.m. (Also called "Rush Hour.") (See also Base Period)

POINT—See Switch Point.

PROPERTY—literally, the right-of-way, track, structures, stations, and facilities owned or operated by a transit agency; but used generally as a synonym for the operating agency itself. (See also Territory.)

RAIL RAPID TRANSIT—a mode of transportation operating in a city or metropolitan area and high-speed speed passenger cars run singly or in trains on fixed guideways in separate rights-of-way from which all other vehicular and foot traffic is excluded. Tracks may be located in underground tunnels, on elevated structures, in open cut, or at surface level. There are very few, if any, grade crossings; and rail traffic has the right-of-way at such intersections. Cars are driven electrically with power drawn from an

overhead electric line by means of pantograph or from an electrified third rail. Rail rapid transit may use steel wheels on steel rails or pneumatic tires on wooden, steel, or concrete guideway.

RELAY—a device operated by variation in the condition of one electric circuit and used to effect the operation of other devices in the same or another circuit; commonly, an electromagnetic device to achieve this function.

Track Relay—a relay receiving all or part of its operating energy through conductors having the track rails as an essential part.

Vital Relay—a relay, meeting certain stringent specifications, designed so that the probability of its failing to return to the prescribed state after being deenergized is so low as to be considered, for all practical purposes, nonexistent.

RELIABILITY—the probability that a system or component thereof will perform its specified function without failure and within prescribed limits; reliability is often expressed as a mean failure rate (MTBF).

REVENUE SERVICE—transportation of fare-paying passengers on main line routes.

REVERSE DIRECTION—train movement opposite to the normal direction. (See Normal Direction.)

REVERSE RUNNING—operation of a train in the reverse direction.

ROUTE—a succession of contiguous blocks between two controlled gates or interlocked signals.

Conflicting Routes—two or more routes (opposing, converging, or intersecting) over which movements cannot be made simultaneously without possibility of collision.

Normal Route—a prescribed route, a route in the normal direction of train travel.

Reverse Route—a route opposite to the normal route.

ROUTE REQUEST—registration at an interlocking of a desired interlocked route.

RUNTHROUGH—intentionally passing a station platform without making a scheduled stop.

**SEMAPHORE**-a wayside signal device by which indications are given by the position of a movable arm in daylight hours and by the color of a light in darkness.

**SHUNT**-a conductor joining two points in an electrical circuit so as to form a parallel or alternate path through which a portion of the current may pass.

**SHUNTING SENSITIVITY**-the maximum impedance that, when placed at the most adverse shunting location, will cause the track circuit to indicate the presence of a train.

**SIDING**—a track auxiliary to the main track, used for meeting, passing, or storing trains.

**SIGNAL**-a means of communicating direction or warning.

**Block Signal**-a fixed signal at the entrance of a block governing trains entering and using that block,

**Cab Signal**--a signal in the train operator's cab that governs the movement of that train by conveying the automatic block aspects and the prevailing speed command.

**Clear Signal**--a signal displaying the aspect indicating to proceed.

**Home Signal**-a fixed signal at the entrance of a route or block governing trains entering and using that route or block.

**Opposing Signals**-wayside signals governing train movements in opposite directions over the same stretch of track.

**Time Signal**-a signal that controls train speed by requiring that a certain time elapse between entering and leaving a block.

**Wayside Signal**-a signal of fixed location along the track right-of-way.

**SIGNAL ASPECT**-See Aspect.

**SLIDE (WHEEL)**—the condition, during braking or deceleration, where the surface speed of the wheel is less than train speed,

**SLIP (WHEEL)**—the condition, during acceleration, where the surface speed of the wheel is greater than train speed. (Also called "Spin.")

**SLIP-SLIDE SYSTEM**-an onboard system for automatically detecting and correcting slip and slide by making compensating adjustments of propulsion and braking to maintain optimum traction (wheel-rail adhesion),

## SPEED

**Civil Speed (Limit)**—the maximum speed allowed in a specified section of track as determined by physical limitations of the track structure, train design, and passenger comfort.

**Safety Speed (Limit)**—the maximum speed at which a train can safely negotiate a given section of track under the conditions prevailing at the time of passage. (Safety speed may be less than or equal to civil speed.)

**Schedule Speed**-the speed at which a train must operate to comply with the timetable; mathematically, the distance from terminal to terminal divided by the time scheduled for the trip (including station stops),

**SPEED PROFILE**-a plot of speed against distance traveled.

**SPEED REGULATOR**-an onboard subsystem, usually part of the automatic train operation (ATO) system, that controls acceleration and braking to cause the train to reach and maintain a desired speed within a given tolerance,

**SPIN**-See Slip.

## STOP

**Emergency Stop**-stopping of a train by an application of the emergency brake, which—after initiation-cannot be released until the train has stopped.

**Full Service Stop**-a train stop achieved by a brake application, other than emergency, that develops the maximum brake rate.

**Penalty Stop**--irrevocable open-loop braking initiated by an onboard automatic system or by a wayside trip stop as a result of a block violation or uncorrected overspeed.

**Programed Stop**-a train stop produced by closed-loop braking such that the train is stopped at a designated point according to a predetermined speed-distance profile.

- Stop Signal--a signal indication requiring a train to stop and stay stopped and permitting no exceptions such as running at reduced speed, movement within restricting limits, or similar alternatives.
- Train Protection Stop-a train stop initiated by the automatic train protection (ATP) system.
- SWITCH—a device that moves rails (switch points) laterally to permit a train to transfer from one track to another. (See also Frog,)
- Facing Point Switch-a track switch with points facing toward approaching traffic.
- Trailing Point Switch-a track switch with points facing away from approaching traffic.
- SWITCH POINT-a movable tapered track rail, with the point designed to fit against the stock rail.
- TERMINAL ZONE-a length of track, within which the prescribed running direction can be reversed while it is occupied by a train,
- TERRITORY—that portion of a route or route network characterized by a particular mode of operation or type of equipment, e.g., cab signal territory, multiple track territory,
- THIRD RAIL-See Contact Rail.
- TRACK
- Double Track—two parallel tracks, usually with each reserved for running in one direction only.
- Main Track-a track extending through yards and between stations, upon which trains are operated in revenue service or the use of which is governed by signals.
- Reversible Track--a section of track on which the prescribed direction of running can be reversed if it is unoccupied and the opposing home signals are at stop.
- Single Track--a main track on which trains are operated in both directions.
- Transfer Track-a track in a yard area where transfer between main track and yard modes of operation takes place.
- TRACK CIRCUIT—(See Circuit, Track,)
- TRAFFIC REGULATION--a train supervisory function making use of changes in dwell time, performance level, acceleration rates, or other train performance characteristics to maintain intended traffic patterns and system stability,
- TRAIN-a consist of one or more cars combined into an operating unit, (See also Consist.)
- TRAIN BOARD—(See Model Board.)
- TRAIN DETECTION EQUIPMENT—the track circuits and associated apparatus used to detect the presence of trains in blocks,
- TRAIN IDENTIFICATION-a method of designating trains by means of such information as train number, destination, or length; may be accomplished automatically for functions such as routing or dispatching.
- TRAIN ORDERS—instructions used to govern the movement of trains manually, usually written and hand-delivered,
- TRANSFER ZONE-a zone where changeover from manual to automatic operation, or vice versa, may be made. (See also Transfer Track, under Track.)
- TRIP STOP-a mechanical arm, located on the wayside, that can initiate a penalty brake application on a train that passes it by engaging a brake-triggering device (trip cock) on the train. Trip stops may be fixed, i.e., permanently positioned in the tripping position; or they may be raised and lowered in response to signal indications,
- TURNBACK POINT-a point along the track, not at a terminal, where a train may reverse direction if allowed by the train control system, (See also Terminal Zone,)
- TURNOUT-an arrangement of switch points and frog with closure rails that permits trains to be diverted from one track to another,
- UPSTREAM—track locations that, for a given reference point and direction of travel, lie behind the train and have been passed by it.
- YARD-a network of tracks for making up trains and storing cars.