

GENERAL ORDER NO. 127

Public Utilities Commission of the
State of California

REGULATIONS, GOVERNING THE CONSTRUCTION, RECONSTRUCTION, MAINTENANCE AND OPERATION OF AUTOMATIC TRAIN CONTROL SYSTEMS WITH RESPECT TO TRAIN DETECTION AND SEPARATION, ROUTE INTERLOCKING, SPEED ENFORCEMENT AND RIGHT-OF-WAY HAZARD PROTECTION ON RAPID TRANSIT SYSTEMS.

Adopted August 15, 1967. Effective September 15, 1967. (Case No. 8670)

IT IS ORDERED that the following regulations governing the construction, reconstruction, maintenance and operation of automatic train control systems with respect to train detection and separation, route interlocking, speed enforcement and right-of-way hazard protection on rapid transit systems shall hereafter be observed in this state unless otherwise authorized or directed by the Commission.

DEFINITIONS

Section 1

- 1.1 *Rapid Transit System*—An electrified railroad operating on an exclusive grade separated right-of-way for the transportation of passengers and their incidental baggage.
 - 1.2 *Automatic Train Control (ATC)*—The system for automatically controlling train movement, enforcing train safety, and directing train operations.
 - 1.3 *Emergency Braking*—Irretrievable open-loop braking to a stop.
 - 1.4 *Open-Loop Braking*—Braking at the maximum effort permitted by the traction system without continuous direction from the ATC system.
 - 1.5 *Vital Circuit*—Any circuit, the function of which affects the safety of train operations.
 - 1.6 *Closing-In*—Running a following train toward a leading train which is either stopped or running slower than the following train.
 - 1.7 *Closing-Up*—Running a following train to a position that will enable it to couple to a leading train which is stopped.
 - 1.8 *Control Limit*—The extent of route over which a gate is controlled.
 - 1.9 *Departure Test*—Test made on complete train at transfer track before permitting train to operate in automatic mode.
 - 1.10 *Fail-Safe*—A characteristic of a system which ensures that any malfunction affecting safety will cause the system to revert to a state that is known to be safe.
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- 1.11 *Gate*—The limit of an interlocked route where entry to that route is governed.
- 1.12 *Fixed Gate*—The limit of an interlocked route past which automatic operation of trains is never permitted.
- 1.13 *Interlocking*—An arrangement of gates and control apparatus so interconnected that functions must succeed each other in predetermined sequence permitting train movements over controlled routes only if safe conditions exist.
- 1.14 *Locking*—The electrical or mechanical establishment of a condition for a switch, interlocked route, speed limit, or automatic function so that its state cannot be altered except by a prescribed and inviolate sequence of unlocking.
- 1.15 *Indication Locking*—Electrical locking, effective when a route is requested, which prevents the opening of a gate if a switch, another gate, or other operative unit is not detected as locked in a correct position corresponding to the requested route.
- 1.16 *Route Locking*—Electrical locking, effective when a train passes an open gate, which prevents the movement of any switch in the route governed by that gate and prevents the opening of a gate for any conflicting route.
- 1.17 *Time Locking*—A method of locking which, after a gate is opened, prevents, until after the expiration of a predetermined time interval after the gate has been closed again, the operation of any switch in the route governed by that gate, and which prevents a gate from being opened for any conflicting route for the same time interval.
- 1.18 *Reception*—The process of receiving a train at a terminal zone, station, or yard.
- 1.19 *Redundancy*—The existence in a system of more than one means of accomplishing a given function.
- 1.20 *Route*—A specified succession of contiguous zones over which trains operate between two controlled gates that are capable of stopping the train under automatic operation.
- 1.21 *Interlocking Route*—A route controlled by interlocking; equipped with gates to prevent conflicting movements.
- 1.22 *Normal Route*—A route established in the normal direction of train travel.
- 1.23 *Reverse Route*—A route in which trains run opposite to the normal direction.
- 1.24 *Route Request*—A control at an interlocking, immediately preceding the interlocking functions, that requests a desired interlocked route.

- 1.25 *Sectional Release (Of Locking)*—The partial release of route locking behind a train as it proceeds through an interlocked route, and unoccupies successive train detection zones, to expedite the establishment of subsequent routes.
 - 1.26 *Civil Speed Limit*—The maximum safe speed allowed in a specified zone as determined by the physical limitations of the track structure.
 - 1.27 *ATC Speed Limit*—The upper limit of a train speed as enforced by the train protection system.
 - 1.28 *Absolute Stop*—A train stop which permits no exceptions such as reduced speed running, movement within restricting limits, or similar alternatives.
 - 1.29 *Zero Speed*—A speed not greater than 1.0 miles per hour, for 1.0 second, and which shall include the condition that the traction control has been open-looped for 1.0 second after 1.0 miles per hour or less was detected.
 - 1.30 *Switch and Lock Movement*—A device which performs the sequential functions of unlocking, operating, and locking a track switch.
 - 1.31 *Normal Switch Position*—The designation for the position of a track switch and its controls when the switch's position corresponds to the defining track plan.
 - 1.32 *Reverse Switch Position*—The designation for the position of a track switch and its controls when the switch's position is opposite to that shown in the defining track plan.
 - 1.33 *Reaction Time*—Time from the occurrence of a step change of control signal to the first attainment of the new, steady-state value of the controlled variable, within a designated accuracy.
 - 1.34 *Main Track*—A track that normally is under control of the automatic train control system, including leads into yard areas but excluding transfer tracks.
 - 1.35 *Reversible Track*—A section of track on which the prescribed direction of running can be reversed if all its zones are unoccupied.
 - 1.36 *Transfer Track*—A track in a yard area where the transfer between automatic main line and manual yard modes of operation takes place.
 - 1.37 *Train Protection*—A subsystem which may be included within automatic train control, which enforces safe operation, including speed restriction and separation of trains running on the same track and over interlocked routes.
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- 1.38 *Block Zone*—A length of track between two interlocking zones, between a terminal zone and an interlocking zone, or between two terminal zones, within which track occupancy and direction of trains must be detected.
- 1.39 *Gate Control Zone*—That portion of track extending between a controlled gate and the point on its approach side where gate control can affect the movement of trains.
- 1.40 *Interlocking Zone*—A zone in an interlocked route containing one or more track switches.
- 1.41 *Speed Limit Zone*—A zone in which maximum authorized train speed is defined by the physical limitations of the track structure or surrounding structures.
- 1.42 *Station Stop Zone*—A zone at a station platform within which controls and indications are transferred between train and station.
- 1.43 *Terminal Zone*—An interlocked zone within which the prescribed direction of running can be reversed while the zone is occupied by a train.
- 1.44 *Transfer Zone*—A zone in which transfer may be made from automatic to manual operation, or vice versa.

GENERAL REQUIREMENTS

Section 2

2.1 *Plans and Construction Shall Be Approved*

- (a) No train protection equipment or circuits in such equipment, which is part of an automatic train control system, shall hereafter be constructed, nor shall any changes be made in such equipment or circuits, that affect the original operational concept, until plans and specifications for such construction and changes have been filed with and approved by the Commission. Changes made to improve performance that do not affect the basic concept may be made by the carrier without formal authorization by the Commission, if revised plans of such changes are submitted to the Commission within thirty days after the changes are made.
- (b) When fixed equipment, cable, or other fixtures of the automatic train control system are replaced, repaired, or reconstructed such that the fixed equipment, cable, or other fixtures have the same prior design and function, such replacement, repair, or reconstruction shall not be considered as construction or a change for the purpose of this order.
- (c) When an equipment has been replaced as a modular or plug-in unit of which it is a part, or a circuit is temporarily

changed, for maintenance or testing purposes, the replacement or change shall not be considered as a change for the purpose of this order.

- (d) When the plans are submitted to the Commission for its approval, the request for such approval shall be signed by the General Manager of the carrier. The general track plan shall be signed by the General Manager or a responsible officer of the carrier. The request shall state the carriers' representative who will be in charge of the work, or portions of the work for which request is made.

2.2 *Plans To Be Filed*

Two copies of the following plans shall accompany each copy of the application of the carrier for approval of construction, of train protection equipment and vital circuits in an automatic train control system:

- (a) Function Description and Functional Block Diagram of the Work which applies to train protection.
- (b) Schedule for the progress and completion of the work.
- (c) Elementary schematic diagrams of equipment and circuits which affect train protection in the work.
- (d) Equipment Arrangement and Outline Drawings.
- (e) Track Plan. This plan shall be drawn to a scale of not more than 200 feet per inch and shall show civil plan and profile, the extent of control zones, and the arrangement and nomenclature of zones, gates and switches, on a schematic track plan separate from the indicated civil plan and profile. In addition, the track plan shall convey a control limit diagram covering the full extent of the work. On every sheet of the track plans, these shall appear on the print, in any location most convenient with respect to the subject matter of the print, a white space which will have a vertical dimension of at least two inches and a horizontal dimension of at least three inches.

Note—All plans shall be furnished with the minimum number of folds to bring them with filing size, 8½" x 13", and so folded that title and drawing number appear on the outside. Drawings reduced to half size, whose reduced dimension shall be not less than 8½" x 13", may be furnished.

2.3 *Preparation of Exhibits*

In preparing exhibits, symbols shall conform to standards of the following organizations:

- (a) American Standards Association
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- (b) Association of American Railroads—Signal Section
- (c) Institute of Electrical and Electronic Engineers
- (d) National Electrical Manufacturers Association

2.4 *Commission Shall Approve Plans*

- (a) When plans are approved by the Commission, a copy so marked will be sent to the carrier.
- (b) If the work is not commenced within one year after date of approval, a new approval shall be obtained.

2.5 *Request for Inspection*

- (a) When the plans for the work have been approved by the Commission, and its construction, has been completed, the carrier shall request by letter or telegram to the Commission for inspection. The request for inspection shall be accompanied or preceded by a corrected copy of the plans on which any change has been made from those originally submitted.
- (b) Request for inspection by letter or telegram shall be made by the carrier not less than ten days prior to the date of initial operation. After receipt of this request, the Commission shall notify applicant of the date of inspection. There shall be furnished to the Commission's representative, at a central location on the work site on the date set for inspection, a complete set of updated plans submitted to the Commission, a complete set of circuit plans, and tables showing route locking logic, and switch locking logic.

2.6 *Approval*

The representative of the Commission inspecting the work may, at his discretion, for what appears to him to be good cause, recommend changes necessary for the safe operation of the completed work and direct that the completed work be not operated until such changes are made.

If the inspection discloses the completed work to be in compliance with the general order, and changes shown to be necessary at the time of inspection have been made, the carrier will receive the written approval of the Commission for the operation of the completed work.

2.7 *Test and Inspection Records*

The carrier shall establish and maintain on file for at least one year the records of inspections and tests it makes of train protection equipment and vital circuits and equipment. Said records shall be made available on request to this Commission or its duly authorized representative.

GENERAL SPECIFICATIONS

Section 3

- 3.1 Every rapid transit carrier shall operate all revenue trains, and all trains which operate on track used for revenue service, under a system which shall automatically protect against:
- (a) Rear end collisions which may result from one train overtaking another;
 - (b) Head-on or sideswipe collisions which may result from admission of trains upon conflicting routes;
 - (c) Derailment or collision which may result from a track-switch(s) being moved immediately ahead of or under a train;
 - (d) Derailment or collision which may result from excessive speed for track conditions;
 - (e) Such right-of-way hazards as may be detectable.
- This system shall be subject to the approval of the Commission and may be integrally a part of an ATC system.
- 3.2 The train protection features shall subordinate all other features of the automatic train control system and possess fail-safety.
- 3.3 Trains shall be detected continuously. The maximum length of a train detection zone shall not exceed 5,000 feet. If the train detection equipment becomes incapable of detecting the presence of a train in a zone or zones, the effect shall indicate that zone or zones as occupied.
- 3.4 Whenever a condition arises in which the sole relief necessitates the operation of a train or trains without benefit of the train protection system, the carrier may employ immediately such relief, as an emergency measure, as the Commission will have approved.
- 3.5 The safe distance separating operating trains shall be not less than the maximum stopping distance of the following train. The maximum stopping distance shall be determined and make allowances for the effects of grade, propulsion and braking characteristics, equipment reaction time and the pertinent controls effecting the protection stopping distance.
- 3.6 Route interlocking shall provide for the alignment and locking of protected routes wherever trains may diverge, converge, cross, or conflict in any way. Standards of the Association of American Railroads-Signal Section shall govern the design and construction of all interlocking equipment.
- (a) The interlocking circuits shall employ devices arranged to ensure that specified functions succeed each other in a pre-determined order. The interlocking control logic shall be de-

signed according to route logic tables as submitted by the carrier.

- (b) Control circuits shall be arranged so that an aligned and locked indication cannot be signaled until each switch point in the route is indicated to be in proper position through circuit controllers operated directly by the switch points and by the switch locking mechanism. The position of the closed points and locking of each switch controlled by the interlocking shall be detected.
- (c) Interlocking shall receive one fail-safe signal of occupancy from each separate detection zone within the routes it controls and from each separate approach detection zone which effects time locking protecting the routes it controls. In addition, interlocking shall receive one fail-safe signal of gate closure for each gate that controls entry into the zones protected by the interlocking.
- (d) Gates shall be located at each limit of all interlocking routes and shall control entry to all interlocking routes. When a gate is closed, the train movement control signal, normally transmitted to approaching trains, shall ensure that any approaching train in automatic mode will stop before the gate. Under the condition of a closed gate, the train movement control signal shall enforce a progressive reduction in train speed from the maximum speed allowed by the operating speed restriction to zero speed so that, if the gate remains closed, the approaching train will stop without violating the gate. When a gate is open, the train movement control signals shall be transmitted to an approaching train. Gate control circuits shall open a gate only when a route aligned and locked signal is established in the interlocking for the route controlled by the gate.
- (e) Interlocking shall include time locking. The time settings for time locking shall be not less than the maximum time taken for a train to stop from the highest authorized speed approaching the gate controlling the entrance of the protected route. Time locking shall remain in effect after a gate closes regardless of the location or speed of the approaching train unless route locking is in effect.
- (f) Interlocking shall include route locking. Route locking shall release time locking after detection of the train in two consecutive and separate detection zones and the train is clear of the interlocking zone. The route locking shall be protected against the effect of inadvertent momentary loss of train

detection. Route locking shall prevent the movement of any switches in the route, and prevent the opening of any gates for train movement to conflicting routes while a train is in the protected zone. When the rear of a train leaves the interlocked zone, electric locking on the switches that have been passed over and entrance gates that are no longer conflicting may unlock behind the train.

- 3.7 The automatic train control system shall provide a fail-safe method of limiting the speed of trains according to the track and wayside structure characteristics. The speed limit, which shall be determined according to the track and wayside characteristics, shall apply to the full length of the longest train it may govern throughout the entire length of the zone.
- 3.8 The train protection system shall ensure that the speed of trains never exceeds a safe speed-distance profile over the entire system.
- (a) If the speed of a train broaches the safe speed-distance profile, the system shall immediately and automatically cause an open-loop brake application which shall be maintained at least until the train speed reduces to a value below the safe speed-distance profile.
 - (b) The safe speed-distance profile shall be a curve based on the track and wayside structure requirements and shall apply to each track throughout the length of the system. The profile transition from a lower speed limit to a higher speed limit shall not rise from the lower value until the rear of a train clears the lower speed limit. The profile transition from a higher speed limit to a lower speed limit shall be continuous curve beginning at a point preceding the entrance to the lower speed limit by a distance at least equal to the sum of the maximum open-loop braking distance and the distance traveled in 3.0 seconds at the higher speed limit, and the equipment reaction time distance at the higher speed limit, and ending at a point preceding the entrance to the lower speed limit by a distance at least equal to the sum of the distance traveled in 3.0 seconds at the lower speed limit, and the equipment reaction time distance at the lower speed limit.
 - (c) If the ATC speed limit is zero mph, the train protection system shall maintain an open-loop brake call after the train stops and until the train protection system changes the ATC speed limit.
 - (d) For purposes of train speed detection, the measurement of speed shall continuously represent true train speed within plus or minus 0.5 mph and independent of wheel wear.
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- (e) Zero speed shall be detected and used to prevent door operation and direction reversal when a train is moving.
 - (f) The train protection system shall initiate emergency braking in the event a train is detected to be rolling back. The emergency braking shall be applied before roll-back speed exceeds 1.0 mph, or before roll-back distance exceeds 20 inches.
- 3.9 All signals that govern train movements shall be continuous. The interruption of any such signal for longer than 1.0 second shall automatically initiate open-loop braking.
- 3.10 Wherever protection shall be provided against right-of-way hazards, the protection shall effect a zero speed limit at a distance at least equal to maximum stopping distance from the hazard area. The protection area circuits shall be continuously energized through normally closed contacts of detector control circuit switches, relays, and circuit controllers, as applicable. When the detector is actuated, the control circuit shall open and remain open, producing a zero speed limit until manually reset.
- 3.11 If the train protection governing train movement does not interface with an automatic train operation of the traction system, the carrier shall apply for approval by the Commission to install and manually operate such vehicles. Such vehicles shall be at least equipped with a visual speed limit indicator to advise the vehicle operator of the speed limit and direction authorized. The control of this indicator shall comply with the train protection functions specified in this order.
- 3.12 *Security For Equipment*
Security shall be provided within an equipment room, or for any cases, or enclosures, for all train control equipment related to the operational safety of trains. Access to this equipment shall be prevented by use of a key to prohibit persons other than those authorized by possession of the key.
- 3.13 *Cross and Ground Protection*
All circuits shall be designed and arranged, as far as practicable, to prevent the operation of apparatus by crosses or grounds. The carrier shall make periodic tests for crosses and grounds and report their results in the quarterly reports required by Section 4.1 of this order.
- 3.14 *Materials and Workmanship*
Materials and workmanship shall be first class throughout, and the system constructed in every way to warrant the safe and expeditious performance of the functions for which it is designed.

3.15 Maintenance and Operation

The train control system shall be maintained and operated in accordance with rules which the carrier shall submit for the Commission's approval. Such rules shall include emergency procedures which shall be instituted whenever portions of the system become inoperative.

- 3.16 No portion of the automatic train control system shall be abandoned nor its operation discontinued without the permission of this Commission.

REPORTS TO THE COMMISSION

Section 4

4.1 Quarterly Reports of Performance

Reports of the complete and operating automatic train control performance shall be prepared by the carrier for the quarter ending March 31, June 30, September 30, and December 31 of each year. Such reports shall be filed within thirty days after the end of the quarter for which they are made and shall be prepared in a manner prescribed and upon the forms provided by the Commission.

4.2 Reports of Accidents and Investigations

Within a period of fifteen days after the occurrence, a complete copy of the testimony given at all investigations conducted in connection with derailments or collisions, except those in yards and outside of the limits of the automatic train control system, must be forwarded to the Commission. In the event of serious personal injury, or property damage exceeding \$1,000, occurring as a result of such accidents, the Commission shall be immediately notified by telephone or telegraph. Such accident report and transcript of testimony in accident investigations shall not be open to public inspection.

EXEMPTIONS

Section 5

- 5.1 Requests for deviations from these rules shall contain a full statement of the reasons justifying the requested deviations. Any deviation or exemption so granted shall be limited to the particular case covered by the request.

This order shall be effective on and after the 15th day of September, 1967.

Approved and dated at San Francisco, California, this 15th day of August, 1967.

**PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA**
By WILLIAM W. DUNLOP, *Secretary*

