

The GCOR Signaling System

General Overview

The signaling system regulated by the General Code of Operating Rules (GCOR) represents the operational backbone of Western and Central American railroads, distinguishing itself clearly from the logic commonly used in Europe. The main difference lies in the nature of the message sent to the Engineer: while European standards inform about the occupancy status of the next block and/or the route using additional panels, the United States employs "Speed Signaling." In this context, the signal aspect does not necessarily communicate which switch will be engaged, but precisely defines the maximum authorized speed for that section, such as Medium Speed or Limited Speed. A further divergence is found in the management of non-signaled areas, known as Dark Territory, which is very common across the vast American distances but has entirely disappeared in Europe, where movement is guaranteed by formal authorizations known as Track Warrants, transmitted via radio instead of visual signals.

The history of the GCOR is a chronicle of necessity and standardization born to overcome the chaos of the early 20th century, when each railroad company used its own proprietary rulebook. Starting in the 1980s, the major Western companies, such as Union Pacific and Burlington Northern, decided to unify these norms into a single common code, which today is updated periodically to integrate modern technologies like Positive Train Control (PTC). Despite its widespread use, the GCOR is not the only American standard; indeed, NORAC exists and is used primarily in the Northeast Corridor. The difference between the two often lies in the names of the aspects and the philosophy of visualization: NORAC tends to be more complex in its variety of light and color combinations to manage the extremely high density of passenger traffic in the New York and Washington areas, while the GCOR is optimized for long-haul freight and large transcontinental routes.

In the context of American signaling regulated by the GCOR, the distinction between Absolute and Intermediate signals is not just a matter of safety, but of movement management. In a bidirectional line with directional signaling regulated by a CTC system, the "clear" state of the line (in the absence of set routes) typically sees intermediate signals set to red or, in many modern Union Pacific (hereafter referred to as UP) installations, completely dark to optimize energy consumption. These signals "come to life" only when the Dispatcher opens an Absolute Signal (Home Signal) at the end of a stretch between two service locations: at that moment, the system establishes the direction of travel, activating the intermediate signals in the chosen direction in a cascade and locking those in the opposite direction at red to guarantee head-on protection.

The fundamental difference compared to European standards is that there are no automated permissive block signals; instead, there are only intermediate signals which are, by their very nature, "permissive." When these signals display a red aspect, they do not just dictate a permanent halt. Operating rules allow the locomotive engineer, after bringing the train to a complete stop, to immediately proceed at Restricted Speed, moving with the caution necessary to stop within half the range of vision—the so-called *Stop-and-go* rule. In this regard, the behavior is similar to the automatic block signals we are accustomed to in Europe.

In short, within the GCOR framework and North American railroading in general, the concept of a "constantly green" signal (meaning a fixed clear aspect even in the absence of trains), as known in European automatic block systems, does not exist. On American railroads, tracks do not have a predefined, permanent direction of traffic. If intermediate signals were constantly green in one direction, the system would have to preemptively lock out the opposing direction for hundreds of miles, drastically reducing the operational flexibility available to the Dispatcher (DCO). Therefore, a red or dark aspect serves as the neutral state, ensuring that the line is ready to be "activated" at any moment in either direction.

It is also very common in real-world American operations with Absolute Permissive Block (APB) that when the line is entirely clear of traffic, signals actually display a green (*Clear*) aspect in both directions simultaneously.

However, there are specific areas where an "European-style" automatic block system is utilized; these are territories characterized by high-density commuter and transit traffic, now operated via ATC (Automatic Train Control), such as the Chicago suburban lines managed by Metra, the regional transit agency.

The GCOR System

The Philosophy of Speed Signaling

Unlike "Route Signaling" systems, where the signal graphically or via codes indicates which direction the train will take, the GCOR is based on **Speed Signaling**.

- The signal communicates exclusively the maximum authorized speed and the conditions of the next block.
- Simplify the operation of heavy trains; the Engineer does not have to worry about where the switch is taking them but only needs to obey the speed indicated by the aspect to transit safely.
- If you receive a **Diverging Clear** aspect, you know you will travel through a turnout at the established speed (e.g., 30 MPH), regardless of whether you are going left, right, or into a freight yard.

The Regulatory Hierarchy: GCOR and SSI

The operation of a Union Pacific train is not regulated by a single book, but by a hierarchy of documents that every employee must consult:

1. GCOR (General Code of Operating Rules): This is the base code defining common operating rules for almost all Western railroads. It establishes signal names and standard safety procedures.
2. SSI (System Special Instructions): These are the specific instructions of the Union Pacific. They can modify or supplement the GCOR, defining, for example, the exact speeds for terms like "Medium" or "Limited" that the general code leaves flexible.
3. Timetable: Contains the geographical information of the subdivision (e.g., the Kearney Sub), maximum line speeds, and local restrictions.

Key Signal Definitions

It is essential to immediately distinguish between the two types of signals you will encounter:

A. Absolute Signal

- Recognized by the absence of a numerical plate (Milepost) on the mast.
- Protects a Control Point (CP) or an interlocking. It commands movements that may conflict with other trains.
- If it is at Red (Stop), the stop is mandatory and impassable. You cannot proceed without verbal or digital authorization from the Dispatcher.

B. Intermediate Signal

- Always features a numerical plate (indicating the railroad mile) attached to the mast.
- Serves exclusively for spacing trains between two service locations (line blocks).
- If it is at Red (Stop and Proceed), its nature is permissive. The Engineer must stop and can then resume travel at Restricted Speed without contacting the Dispatcher, as the system ensures there are no trains in the opposite direction.

Train Director Simulator Note: Please note that due to an inherent limitation within Train Director's AI processing, a true *Stop-and-go* rule into an occupied block cannot be faithfully simulated. Consequently, within this simulation, a Red aspect must always be treated as an absolute stop until the downstream block section is physically cleared by the preceding train. At that exact moment, the intermediate signal will automatically clear and assume the appropriate headway aspect. Furthermore, since Train Director cannot display green aspects in opposing directions simultaneously without causing software conflicts, the neutral state of the line within the simulator is explicitly forced to Red until a route is actively lined by the operator.

The Control Point (CP)

In the CTC system, the Control Point is the physical perimeter managed by the Dispatcher. Within the limits of a CP (interlocking), the safety logic ensures that switches are locked before the signal becomes favorable. Once a train has passed the exit signal of a CP and is between intermediate signals, it enters a "line travel" phase where spacing is automatic.

Table of Aspects and Speeds

Standard GCOR Aspects (Base)

Visual Aspect	Aspect Name	Operating Indication (GCOR)
Green (Single or on top head)	CLEAR	Proceed at Maximum Authorized Speed (MAS) .
Flashing Yellow	ADVANCE PROACH AP-	Proceed prepared to stop at the second following signal.

Visual Aspect	Aspect Name	Operating Indication (GCOR)
Yellow (Single or on top head)	APPROACH	Proceed prepared to stop at the next signal. Do not exceed 30 MPH once past the signal.
Yellow over Yellow	APPROACH SLOW	Proceed prepared to pass the next signal at Slow Speed (15 MPH).
Red over Green	DIVERGING CLEAR	Proceed through the turnout at the established speed for the switch, then resume MAS.
Red over Yellow	DIVERGING APPROACH	Proceed through the turnout at the established speed, prepared to stop at the next signal.
Red	STOP	Absolute stop (if Absolute signal) or Stop & Proceed (if Intermediate with plate).

Specific UP Aspects (System Special Instructions - SSI)

To manage heavy trains on triple or quadruple track lines, Union Pacific has introduced additional aspects that extend the braking distance over multiple blocks.

- **APPROACH FOURTH (YF/G - Flashing Yellow over Green):** Proceed. The train will encounter a sequence of approach signals. It is the "fourth signal" before a potential stop. Used to initiate the smooth slowing of loaded convoys (e.g., coal).
- **APPROACH THIRD (YF/Y - Flashing Yellow over Yellow):** Proceed prepared to encounter the next signal with an *Advance Approach* or *Approach Slow* aspect. It is the "third signal" before the stop.

Engineer's Quick Reference Logic

To avoid confusion during train operations, UP crews apply three mnemonic mental rules:

- **The Top Head Rule:** If the colored light (non-red) is on the highest signal head, the train is staying on the main track (Straight route).
- **The Diverging Rule:** If the colored light is on the second or third head, the train is making a Diverging movement. Speed will be limited (30 or 40 MPH).
- **The Flashing Rule:** In almost all cases, a flashing light is less restrictive than the same light when solid. For example, an Advance Approach (Flashing Yellow) provides one extra block of spacing compared to an Approach (Solid Yellow).

Speed Definitions (UP Standards)

In a "speed signaling" system, every signal aspect is tied to an absolute limit. For Union Pacific, these definitions are standardized within the System Special Instructions (SSI).

Line and Maneuvering Speeds

- **MAXIMUM AUTHORIZED SPEED (MAS):** The maximum speed allowed for that stretch of line, indicated in the Timetable or by fixed signs along the track. It is the limit the Engineer must never exceed, even with a "Clear" (Green) signal.
- **RESTRICTED SPEED:** This is the most important and frequent rule in the GCOR.
 - It is not just a number, but a behavior.
 - It is the speed that allows stopping within half the range of vision, paying attention to trains, improperly lined switches, broken rails, or track interruptions.
 - In no case should 20 MPH (32 km/h) or 15 MPH (24 km/h) be exceeded within yards or specific areas indicated by UP.
 - It is used after a Restricting signal or after a Stop and Proceed.

Speeds Linked to Diverging Aspects

When the signal indicates a diverging movement, the speed is determined by the geometry of the interlocking switches. Unless the signal specifies otherwise, the following categories apply:

- **LIMITED SPEED:**
 - 40 MPH (64 km/h) for freight trains or 45 MPH (72 km/h) for passenger trains.

- Applies when the signal shows aspects like Limited Clear.
- Typical of high-speed switches on main corridors.
- MEDIUM SPEED:
 - 30 MPH (48 km/h).
 - Standard speed for most turnouts and crossovers between main tracks. Required by Diverging Clear, Diverging Approach aspects, or when passing an Approach signal.
- SLOW SPEED:
 - 15 MPH (24 km/h).
 - Applies in railroad yards, secondary tracks, or very tight turnouts.

Engineer's Summary Table

GCOR Term	UP Limit (Freight)	Operating Condition
Normal Speed	MAS (e.g., 60-70 MPH)	Track clear, Clear signal.
Limited Speed	40 MPH	High-speed turnouts, indicated by "Limited" aspects.
Medium Speed	30 MPH	Standard turnouts or after passing an "Approach" signal.
Slow Speed	15 MPH	Movements in yards or industrial sidings.
Restricted Speed	20 MPH max	Movement at sight, stopping within half the range of vision.

Control and Management Systems (CTC and PTC)

The Absolute Permissive Block (APB) System

The APB (Absolute Permissive Block) system is one of the most ingenious headway and spacing frameworks in North American signaling, designed specifically to manage single-track lines with total safety in the absence of centralized CTC control. The core philosophy of APB is encapsulated in its name: it acts as an Absolute block for trains traveling in opposing (head-on) directions, but converts into a Permissive block for trains traveling in the same direction (following moves).

1. Opposing Trains: The "Tumble-Down" Mechanism (Absolute)

Imagine a single-track line between two stations (Station A and Station B), punctuated by 3 or 4 automatic intermediate signals for each direction.

- When the line is clear of traffic: All intermediate signals physically display a Green (*Clear*) aspect in both directions simultaneously.
- As soon as a train clears the absolute departure signal at Station A to enter the single-track territory toward Station B, an electrical cascading sequence known as the Tumble-Down is instantly triggered.
- Every single intermediate signal governing the opposing direction (those that would allow a train from Station B to advance toward Station A) immediately drops to a solid Red (Absolute Stop), one after the other, along the entire stretch of track up to the next station.

Through this logic, the line is locked out in a single direction, and the APB mathematically prevents two trains from entering the single-track bottleneck head-on.

2. Following Trains: Tail-to-Tail Spacing (Permissive)

While the opposing signals are securely locked at red, the signals behind the advancing train dynamically update their aspects as the train moves forward.

- Behind the first train, the system behaves exactly like the European automatic block spacing we are accustomed to.
- The block section currently occupied by the train drops to Red (*Stop and Proceed / Restricting*), the preceding block displays Yellow (*Approach*), and the block before that returns to Green (*Clear*).
- A second train traveling in the same direction can therefore depart Station A and follow the leader at close range, taking advantage of the **permissiveness** of the intermediate signals (utilizing the *Stop-and-go* rule if it encounters a red aspect).

Train Director Simulator Note: While real-world American intermediate signals can sit at clear in both directions when the line is empty, this behavior cannot be replicated within Train Director. To avoid routing conflicts and guar-

antee the safety of opposing movements, the neutral state of the line within Train Director is explicitly configured so that all intermediate signals remain at Stop. The line is "activated" in a single direction only when the operator (DCO) clears the absolute station signal, forcing a cascading opening sequence *only* for the specific intermediate signals required by the train's direction of travel.

CTC: Centralized Traffic Control

The CTC is the backbone of the Kearney Subdivision. Thanks to this system, the entire management of the line is centralized.

- The Dispatcher (Dispatcher) does not "command" individual signals, but sets a route from one Control Point (CP) to another. If the interlocking logic confirms that the track is clear and the switches are locked, the signals clear automatically.
- The CTC allows for train movements in both directions on any track (2-main or 3-main tracks) with the same level of safety. It is the system that decides which direction is "active," lighting the corresponding intermediate signals and turning off the opposing ones.

Automatic Block and Track Circuits

The system "senses" the presence of the train through track circuits:

- When the metal wheels of a train shunt the two rails, they close an electrical circuit signaling occupancy.
- Block occupancy does not only set the immediately preceding signal to red, but automatically modifies the aspects of upstream signals (Yellow, Flashing Yellow, etc.) to create the necessary braking distance.

PTC: Positive Train Control

PTC is the predictive safety system mandated by law in the USA, acting as a safety overlay on top of visual signaling.

- Satellite and Radio Monitoring: The train knows its exact position, the track gradient, the train consist, and, most importantly, the status of the signals ahead through wireless communications with the CPs.
- Active Protection: If the Engineer does not slow down sufficiently when approaching a red signal or exceeds the speed limit, the PTC displays a warning on the onboard display. If the error persists, the system automatically activates the emergency brakes to stop the train before the point of danger.
- Integration with the GCOR: PTC does not replace visual signals but enforces their compliance. If a signal is "dark" (off), the PTC will still treat it as the most restrictive signal possible to protect the train.

Special Operating Procedures

In railroading, the absence of clear information must always be interpreted as the most restrictive condition. This chapter defines how to act in the face of ambiguous signals or when it is necessary to cross the "red line" under strict control.

Passing a Red Signal (Stop)

The procedure varies drastically depending on the nature of the signal:

- Intermediate Signals (Permissive):
 - Procedure: The Engineer must bring the train to a complete stop. After stopping, the train may re-start immediately at Restricted Speed without requesting authorization from the Dispatcher (Dispatcher).
 - Logic: It is assumed that the block is occupied by a preceding train or that there is a circuit failure. The responsibility for spacing passes from the system to the Engineer.
- Absolute Signals (Home Signals):
 - Procedure: The train must stop and cannot move. The Engineer must contact the Dispatcher via radio.
 - Authorization: After verifying there are no conflicts, the Dispatcher issues a verbal authorization (e.g., "UP 4014 East, you have authority to pass the Stop indication at CP Gibbon Junction on Track 1"). Only then may the train proceed at Restricted Speed until the entire consist has cleared the interlocking limits.

"Shoving" Movements and Switching

Freight trains often need to reverse or push cars onto industrial tracks (Shoving).

- Point of Observation: Since the Engineer cannot see where the train is going (the locomotive is pushing), a ground employee (Switchman) must "protect the point," communicating distances via radio.

- **Switching Signals:** In these areas, travel is almost exclusively at Restricted Speed, regardless of the signal aspect, as the destination track is often already occupied by other cars.

Additional Resources on North American Signaling:

- **The Signal Page** (<https://thesignalpage.nl/en/index.php>): A global repository containing documentation and visual schematics on railway signaling systems implemented worldwide.
- **Al Krug's Railroad Facts - Signals (Archived Database):** A highly detailed and comprehensive analytical breakdown explaining the operational meaning, physics, and philosophy behind US railroad signal indications. Available via the Wayback Machine at: <https://web.archive.org/web/20160313144451/http://alkrug.vcn.com/rrfacts/signals/signals.htm>

Technical Glossary GCOR - Union Pacific

A. Authority and Movement

- **Track Warrant:** A formal written authorization, transmitted via radio by the Dispatcher (Dispatcher), which grants a train the authority to occupy a segment of track in non-signaled territory (Dark Territory) or under ABS rules.
- **Track Power:** In a CTC system, this is the authority granted by the Dispatcher to trains or maintenance equipment to occupy a track within defined limits for a specific period of time.
- **Bona Fide (Movement):** A movement made with the genuine intent of traveling the line, as opposed to switching movements.
- **Pilot:** A qualified employee who guides or assists an Engineer who is not fully acquainted with the territory or the regulations of that specific segment.

B. Infrastructure and Tracks

- **Main Track:** The primary track, extending between stations, upon which train movement is governed by signals, rules, or Dispatcher authority.
- **Siding:** An auxiliary track connected to the main line, used for meeting or passing trains. In GCOR territory, sidings are often non-signaled or governed by restricted speed.
- **Crossover:** A pair of switches that allows a train to move from one track to an adjacent one.
- **Dual Control Switch:** A motorized switch that can be operated either remotely by the Dispatcher or manually by ground personnel (after switching the selector lever).

C. Signaling and System States

- **Aspect:** The visual appearance of the signal (colors, light positions, or flashes).
- **Indication:** The operating meaning of the aspect (e.g., "Proceed at Medium Speed"). The aspect is what you see; the indication is what you must do.
- **Dark Signal:** A signal that should be lit but is completely off. It must be treated as the most restrictive signal (Stop).
- **Overlap:** A segment of track beyond a signal that must be clear in order for the preceding signal to display a favorable aspect.

D. UP Operating Jargon

- **Highball:** A green signal or authorization to proceed at maximum speed. Derived from old ball signals where the "high ball" indicated a clear path.
- **Shoving:** A maneuver where the locomotive pushes the cars instead of pulling them. Requires constant protection at the leading end of the consist.
- **Consist:** The technical makeup of the train (number of locomotives, number of cars, total weight, and length in feet).
- **Dynamic Braking:** A system that uses the locomotive's electric motors as generators to slow the train without using air brakes, preventing wheel overheating.

E. Essential Acronyms

- **MOW (Maintenance of Way):** Personnel or equipment intended for infrastructure maintenance (tracks, switches, signals).
- **DED (Drag Detector):** A trackside sensor that detects dragging or derailed train components, alerting the Engineer via radio.
- **SSI (System Special Instructions):** The supplement to the GCOR containing specific rules for the Union Pacific network.