

# Rail Signal Aspects and Indications

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## ABSTRACT

Wayside rail signaling practice in the U.S. is a nightmarish web of operating rules, signal types, aspects, aspect names, and indications, differing between the different roads and even their individual divisions and locations. Much of the “vocabulary” involved is extremely curious and counter-intuitive, a result of the long historical evolution of this field and of the industry.

This article begins with a review of the evolution of the actual “signals” themselves. Then a consistent (if tortured) thread of syntax is identified for the mainstream of current practice, and its principles and most common application are discussed at length. An appendix illustrates, with extensive charts, the majority of the vocabulary with explanatory notes under two widely-used “dialects”.

## 1. INTRODUCTION

Wayside rail signaling<sup>1</sup> practice in the U.S. is a nightmarish web of operating rules, signal types, aspects, aspect names, and indications, differing between the different roads and even their individual divisions and locations. Much of the protocol involved is extremely curious and often counter-intuitive, a result of the long historical evolution of this field and of the industry.

Canadian practice, although for many years generally paralleling U.S. practice, currently follows a somewhat different (and more rational!) practice.

In this article, I begin with a discussion of the evolution of rail signaling and the various signal devices used in it.

Then, I describe some principles that run through most of the syntax used in the area. Next I give examples of the syntax used by an

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<sup>1</sup> *Wayside signaling* operates through the use of visible signals placed alongside the track which give indications intended for observation by the locomotive engineer. It is distinguished from *cab signaling*, in which the indications appear inside the locomotive cab, and from various forms of *automatic train control*, in which the indications actually govern train operation (either through the engineer or directly).

illustrative signaling protocol. Then I discuss various “variations” we may encounter.

There are of course numerous subtleties to the various matters I present which are beyond the scope of this paper. And I must emphasize that often what I describe for each situation is only one of many possibilities—usually the most common, and hopefully the most illustrative.

An appendix gives, in “glossary” form, illustrated, a more extended definition of the syntax of two “standardized” signaling protocols,

Readers having need to further pursue the wide range of possibilities and the various subtleties of the field are referred to the section of the paper entitled “References”, where URLs to Web sites having an almost obscene amount of scope and detail may be found.

Finally, note that, consistent with our practice with respect to telephone signaling, we spell “signaling” that way, with one “L”. The spelling with two L’s is of course quite common and wholly proper.

## 2. DEFINITIONS

These terms will be widely used in this paper. Words in bold here have their own entries.

Signal (wayside)—A **head** or array of heads placed alongside, or over, the track that shows, at any particular time, a single visual **aspect** to the train crew.

Head—A signal element that can exhibit any one of a small number of visual messages. Called “arm” if implemented by a semaphore, and often colloquially called “arm” even if implemented with lights (out of nostalgic respect for the earlier implementation).

Aspect—The visual appearance of a **signal** at a particular time, often described verbally. Examples: “Red”, “Yellow over green over red”.

[Aspect]Name—The formal name of the **aspect**. It is essentially a short form of the **indication** conveyed by the **aspect**. Example: for the **aspect** Green, the name is often Clear. An **aspect** may be given different names in the signal protocols of different railroads, and in a given protocol, there may be multiple alternative **aspects** that have the same name.

Indication—The operational mandate given by an **aspect**. Example, for the aspect Green, the name may be Clear, and the indication may be: “Proceed not exceeding Normal Speed”.

Rule—A numbered provision of a recognized set of operating rules (see section 3) that defines a particular **aspect**, its **name**, and the associated **indication**. Example: “NORAC Rule 282”.

### **3. STANDARDIZATION**

#### **3.1 Caveat**

The information in this section was gathered for Issue 1 of this article, in 2002. It has not been generally updated, and so may well be out-of-date at this writing.

#### **3.2 NORAC**

Many northeastern U.S. railroads subscribe to a model set of operating rules promulgated by the Northeastern Operating Rules Advisory Committee (NORAC). The NORAC Operating Rules document covers many aspects of railway operation, including defining a set of signal aspects and indications.

#### **3.3 GCOR**

Many railroads in the western part of the United States adhere today to a set of rules known as the General Code of Operating Rules (GCOR), developed by an industry committee. Like the NORAC rules, it covers many facets of railway operation. In its initial edition (1985, substantially amended 1986), GCOR defined a set of signal aspects, names, and indications. However, as of the 1989 edition, GCOR no longer defines signal aspects, names, and indications, now leaving that up to the individual railroads.

Many railroads that follow GCOR as their overall operating rules continue to follow signal aspect and indication definitions very similar to those earlier prescribed by GCOR itself. Sometimes these are spoken of as “GCOR aspects and indications”, but in light of the current scope of GCOR, that is not fully apt.

#### **3.4 UCOR and CCOR**

At one time, many railroads followed one of three sets of standard operating rules: The NORAC Operating Rules (already mentioned), the Uniform Code of Operating Rules (UCOR), or the Consolidated Code of Operating Rules (CCOR). GCOR in effect superseded both UCOR and CCOR, in an attempt to broaden the uniformity of practices.

Both UCOR and CCOR defined sets of signal aspects, names, and indications. Reference to UCOR and CCOR aspects, names, and indications are still encountered in the literature, but these references are essentially “nostalgic”.

### 3.5 CROR

In Canada, railroads are governed by the Canadian Rail Operating Rules (CROR). Among other things, It defines a set of signal aspects, names, and indications. This document is largely based on the UCOR rules.

### 3.6 Common western U.S. practice

Many western U.S. railroads have sets of aspects/names/indications drawn from, or evolved from, those once promulgated by GCOR. Each railroad may have a different subset of the entire GCOR repertoire, but when the same aspect appears in the list of two or more railroads, the names and indications are usually harmonious (if not identical).

I will refer to the joint collection of such aspect/indication definitions as "Common Western Practice" (CWP).

### 3.7 Rule numbers

In the various standard sets of operating rules that define sets of signal aspects and indications, the various aspects/indications are each usually identified as a numbered "rule". Thus, it is common, in writing about one or more of these aspects, to refer to them by "rule number", as: "In such an instance, the signal shall display the aspect of Rule xxx", or even, more explicitly, "In such an instance, the signal shall display the aspect of NORAC Rule xxx".

By way of reference, the rule numbers for aspects/indications prescribed by NORAC, UCOR, CCOR, and the first issue of GCOR are all typically in the "upper 200s" and/or "300s".

In the current GCOR, Rule 9.1 states that the aspects and indications are to be found in the Special Instructions, a term used to refer to a railroad-specific "addendum" to the railroad's version of the GCOR.<sup>2</sup> Accordingly, railroads adhering to the GCOR as their basic set of operating rules will often number their own signal aspects/indications as "Rule 9.1.x".

In the current CROR, the aspects/Indications are denoted as rules 405 through 430.

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<sup>2</sup> Often this information will actually appear in the System Timetable (which is not a timetable at all but rather a compendium of rules)..

## 4. SIGNAL CATEGORIES

In U.S. practice, most wayside signals may be classified as either *automatic block signals* or *interlocking signals*. Their respective roles are as follows.

### 4.1 Automatic block signals

Basically, the purpose of automatic block signals is to prevent a train from running into the train ahead. This is done by dividing the track into a series of blocks and controlling the entrance of a train into each. The presence of a train (or even a single errant car) in a block is usually detected by an electrical arrangement called a *track circuit*. When the track circuit determines that a block is occupied, a wayside signal at the beginning of the block gives an indication requiring the engineer to stop the train.

Stop indications given by an automatic block signal are usually *permissive*; that is, after the train has been brought to a stop, it may resume movement at a very low speed (often called the "restricted" speed), assuming that there is adequate visibility of the track ahead. The presumption is that the engineer would be able to see the train (or other obstruction) ahead in ample time to come to a stop before hitting it. Such an indication is sometimes called "Stop and proceed". (See a further discussion of this matter in section 10)

### 4.2 Interlocking signals

An *interlocking* (more completely, *interlocking plant*) is a location in which a train encounters, for example, (a) switches (turnouts), which allow the train to move onto a siding, cross from one track to another, or follow either of two routes; (b) a crossing at grade over another track, essentially at right angles; (c) a drawbridge or other such potential disruption to the continuity of the track; or (d) a situation where the train could foul another train (such as where two separate tracks are unnaturally close together due to space limitations).

The term *interlocking* itself comes from the fact that the controls operating the signals are mechanically or electrically interlocked among themselves, with the controls for the switches, and with track circuits detecting the presence of a train (or car) in various locations, such that a signal cannot be made to give an indication that would authorize an unsafe or infeasible movement.

Today, a location of this type is most often called a "control point" (CP) rather than an "interlocking". I will however in some cases use the term "interlocking" for continuity.

Interlocking signals are in modern times generally controlled within a concept known as Centralized Train Control (CTC). In this concept, signal operators working at control centers, which may be responsible for a rather large geographic area, control the movement of trains within that area by setting the various switches and signals, of course under the "interlocking" concept.

An *interlocking signal* is found at the entrance to an interlocking, but in fact usually also marks the beginning of, and governs, an entire block, often extending well beyond the far end of the interlocking proper. Thus it must also perform the duties of an *automatic block signal*. Forcing both these duties on a single signal has led to some of the more curious facets of syntax.

Stop indications given by interlocking signals are usually *absolute*: the train must stop and remain stopped until the signal changes to a more favorable indication. The reason is that the conflict might be a switch setting that the train could not possibly traverse, or the conflict might be "dynamic", such as the rapid approach of another train on a crossing or conflicting track. Such an indication is sometimes called "Stop and stay".

#### **4.3 Signals for switchyard and siding operation**

Special parts of the signal protocol described herein are often used to govern movements within switchyards or onto sidings elsewhere. They often utilize smaller signals, placed on or near the ground, known as "dwarf" signals. We will not cover this branch of signal protocol in this article.

#### **4.4 Distinguishing block and interlocking signals**

In many cases, the implications of a particular aspect will depend on whether the signal is in an automatic block or interlocking situation, and it is thus important that the two can be distinguished.

One convention widely followed is that automatic block signals all carry on the mast a plate with the block number; no such plate will appear on interlocking signals.

Another convention sometimes used with multiple-head signals (especially with color light signals, either searchlight or vertical three-lens) is that the heads are staggered on alternating sides of the mast for automatic block signals (typically right, left, right) but are placed on the same side for interlocking signals.

## 5. SPEED LIMIT CATEGORIES

In our discussion of signaling, we will often make reference to various speed limits. Many present signaling protocols involve the following named speeds, listed from the highest to the lowest:

Normal	Varies with road and location
Limited	Typically 40-45 mph
Medium	Typically 30 mph
Low	Typically 15 mph
Restricted	Speed such that train could stop in "half the visual range", typically not over 15-20 mph in any case
[Stop]	[Listed as a speed to make certain syntax conventions work]

## 6. SIGNALS

### 6.1 Introduction

In the next sections, I will describe the important physical types of signals, discussing for each the basic historical syntactic principles pertaining to its use. These syntactic principles are largely creatures of the physical implementation, and the overall syntax developed progressively (by accretion) in parallel with the introduction of new signal implementations.

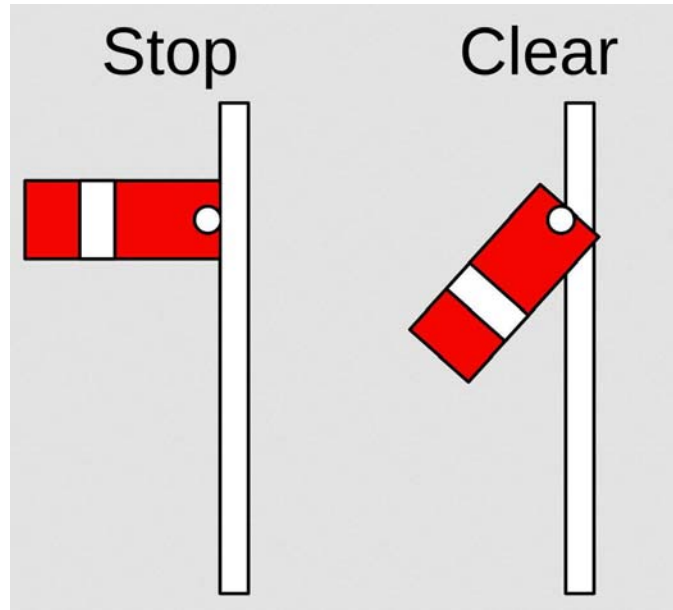
### 6.2 Semaphore signals

#### 6.2.1 *Basic principle*

Many different techniques were utilized during the earliest days of railway signaling. One which came into widespread use was the semaphore, a moving arm mounted on a mast, whose position conveyed information regarding the status of the track ahead.

A common arrangement was to have the semaphore arm hanging down (but not usually quite vertical) when the track ahead was clear, and to raise it to a horizontal position to indicate that the track ahead was not clear (and that therefore the train should stop). It has been suggested that this convention was evocative of a human "signalman" raising his arm to order the train to halt.

Typically the semaphore arm was square at the end, and carried a stripe of a contrasting color across its width near the end, to enhance visibility in different "sky background" situations. Figure 1 illustrates this arrangement in fanciful style.



**Figure 1. Early rail signal semaphore**

Eventually, to allow the signal to be read at night, the “hub” of the semaphore arm was fitted with a frame<sup>3</sup> carrying two glass lenses,<sup>4</sup> behind which was placed a lamp (initially an oil lamp, later an electric lamp). The lamp was seen through a different lens for each of the two positions of the semaphore arm. Originally, the lens through which the lamp was seen with the arm down (Proceed) was clear (giving a white light), and the lens through which the lamp was seen with the arm horizontal (Stop) was red.

This convention raised the risk that, were the red lens to crack and fall out of place, with the signal at Stop a white light would be seen, erroneously indicating Clear. To avert this, the standard color of the Clear aspect was eventually changed to green.

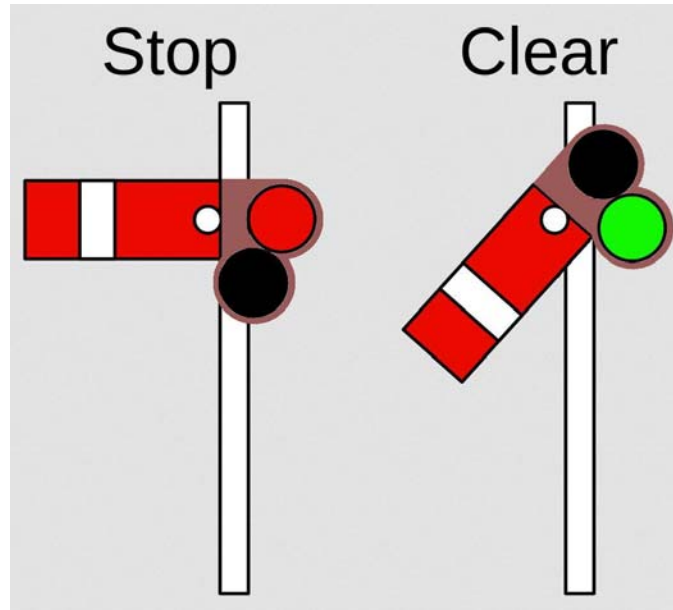
Figure 2 shows this arrangement, in the same fanciful style we saw in figure 1.

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<sup>3</sup> The frame was colloquially called a “spectacle”, a term which is still used, even though today the frame may carry three lenses.

<sup>4</sup> Formally called, today, *roundels* (pronounced “ron-DELS”), but most frequently still called “lenses” in description of signal types.





**Figure 2. Early rail signal semaphore, with lights**

A common early application of a signal like this was at a small station, where the signal (set by the stationmaster) would tell the engineer whether the train should stop, as there were passengers there (or freight, or mail), in case the train did not already plan to stop there to discharge passengers (or unload freight, or mail). It could also be used to have the train stop because it was known (perhaps by telegraph communication) that another train was unexpectedly on the track ahead.

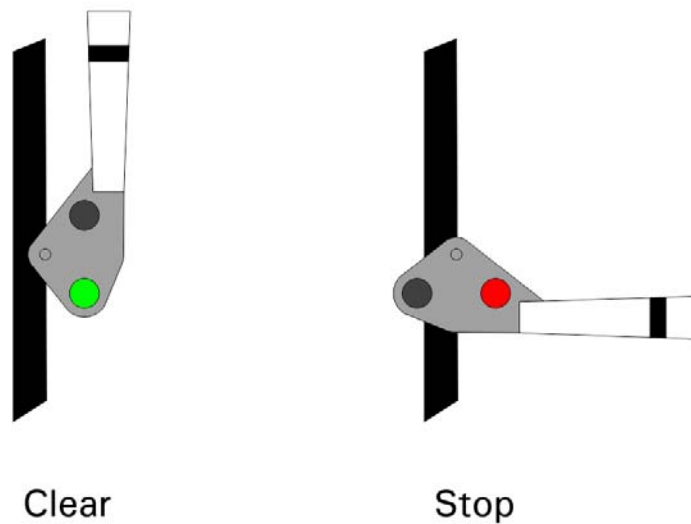
Typically the semaphore arm was lifted (to the Stop position) by an iron wire, pulled by a lever at the base of the semaphore mast.

If that wire were to become disconnected, or rusted in two, or if an accumulation of snow or ice were to weigh down the arm (breaking the wire), then when the arm was supposed to be raised (Stop) it might remain in the down position, again giving an erroneous indication of Clear.

To avert this, most railroads eventually converted to “upper-quadrant operation”. Here, the Stop aspect was still with the arm horizontal<sup>5</sup>, but the Proceed aspect had the arm raised to an **upward** (and in fact vertical) position. Figure 3 illustrates this (with a slightly more “realistic” portrayal).

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<sup>5</sup> This choice was intended to make sure that an engineer would always properly recognize the stop aspect during a time of change of schemes.



**Figure 3. Upper quadrant signal semaphore**

The original mode, then called “lower-quadrant operation”, was retained for quite a while by some roads (notably Southern Pacific).

#### 6.2.2 *The distant signal*

Especially if the track were curved, the engineer might not be able to see a signal in time to bring the train to a halt at a signal that showed Stop. To deal with this, the practice was introduced of having a “distant” signal: another semaphore, following the position of the “main” semaphore but located some distance earlier in the track. The distant signal arm typically had a notched (“fishtail”) end, and the stripe across the arm was replaced with a chevron (matching the contour of the arm end), allowing the nature of the signal to be recognized.

With the adoption of the *distant signal* concept, the “regular” signal at the entrance to the block was given the name *home signal*.

With the “regular” semaphore arm for a block horizontal (Stop), the associated distant signal also had its arm horizontal, but the indication this conveyed was not Stop but rather, “approach the upcoming signal at reduced speed, prepared to stop” (the modern indication name being just Approach). The associated lens color on a distant signal (for the arm horizontal) was yellow.<sup>6</sup>

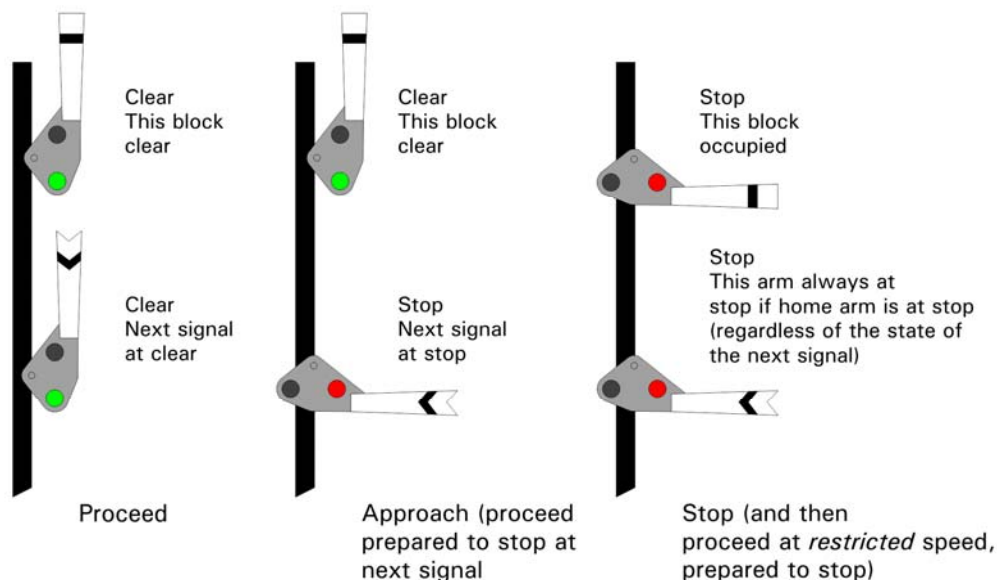
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<sup>6</sup> During the earlier era in which white was the color for “proceed”, green was often used in the distant signal for “approach” (the arm horizontal aspect).

As the blocks controlled by signals became shorter (to provide more efficient operation), it was often practical to have a single mast carry both a home signal for the block beginning there and (beneath it) the distant signal for the next block. The two signals could be distinguished both by their relative positions on the mast and by the difference in the shapes of the arm tips and the stripe/chevron across the arm.

In the initial practice, if the block immediately ahead were occupied (or otherwise unsuited for entry) but the next block were clear, the home signal would show Stop (red) and the distant signal for the next block (on the same mast) would show Proceed (green). There was concern that in this situation the engineer might act upon this inviting apparent Proceed aspect and continue at full speed into the current block (there to collide with its occupant).

To mitigate this concern, it became common to arrange the mechanism such that if the upper (home) arm showed Stop (horizontal, red) the lower (distant) arm would be forced to show Approach (horizontal, red) regardless of the position of the downline home signal that it nominally mimicked. This was called, as a result of the mechanical arrangement used for the purpose, "slotted operation". We see this complete arrangement in figure 4.

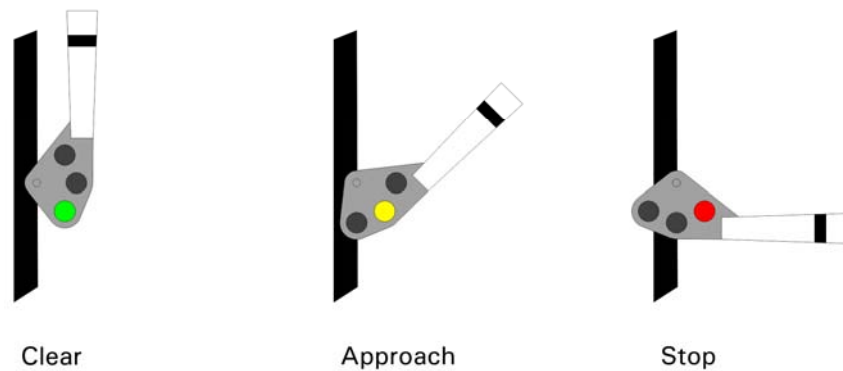


**Figure 4. Home and distant semaphore signal**

**6.2.3 Three-aspect semaphore signals**

With "slotted operation", a set of two semaphore arms (one home, one distant) could only take on three states (as we saw in figure 4). It was realized that a single semaphore arm, with three positions

(‘aspects’), could convey this same repertoire. Figure 5 shows this arrangement.



**Figure 5. Three-aspect semaphore signal**

The light color yellow came to be associated with the “Approach” aspect.

#### 6.2.4 *Names for semaphore positions*

It is common to speak of the various positions of a semaphore in terms of the corresponding light color: red, yellow, or green.

#### 6.2.5 *Slang*

Because of the early history of the signal semaphore, in railroad slang a signal (even if given by a colored light only) is often called a “board” (“Yesterday Harry had an unexpected red board at Pistol Hill that made him late into Springfield by half an hour”).

#### 6.2.6 *Automatic block vs. interlocking semaphores*

Sometimes “automatic block” and “interlocking” semaphores are distinguished by having the interlocking semaphore arms have a pointed end, rather than a square end (and a chevron, rather than a stripe, on the arm, oriented the same way as the pointed end.)

We won’t see that here, since as we get into interlocking signals, we will shift to examples using the more modern “light signals”.

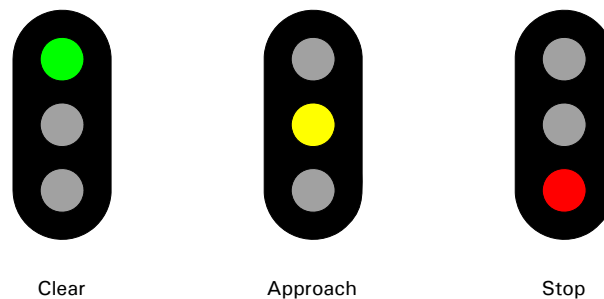
### 6.3 Light signals

#### 6.3.1 *The color light signal*

Semaphores, being overtly mechanical devices, required considerable maintenance, and were subject to problems from ice and snow. Over time, as electric lighting came into wider use, many railroads moved from the 3-aspect semaphore to a 3-aspect color light signal. In its

classical form, this signal has an oval background plate (or “target”) having three lenses, each with a lamp, ordinarily arranged in a vertical column.

The arrangement of the lenses is normally, from top to bottom: green, yellow, red.<sup>7</sup> This matches the sequence of arm positions in the upper-quadrant 3-aspect semaphore. Only one lens is illuminated at a time. The aspects and corresponding indications are the same as for the 3-aspect semaphore. Figure 6 shows the standard arrangement.



**Figure 6. The basic color light signal**

When one signal carries multiple “heads” of this type, some or all may not follow this standard sequence of colors (see section 0).

Despite being thought of as “old-fashioned”, this is in fact probably still the most commonly-used signal head type in the U.S. today. In fact some railroads, having for some while use other types of signal heads, have converted to this type.

### 6.3.2 *The triangular cluster light signal*

In this variation of the three-lens theme, the three lenses are arranged in a triangular pattern on a (usually) circular background, usually with yellow and green at the top (usually in that order, left-to-right) and red centered below. We see a typical one in figure 7 (showing “green”).

“Triangular cluster light” is my name for this style—there is no consistent “official” name. It is sometimes called a “tri-light” signal (“tri” not for “three” but rather for “triangular”). It is sometimes called a “Type G” head, based on the nomenclature for the corresponding General Railway Signal product type.

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<sup>7</sup> Note that this is the opposite order from that customarily used for road traffic signals. In addition, in road traffic signal work “yellow” is formally called “amber”.



**Figure 7. Cluster light signal**

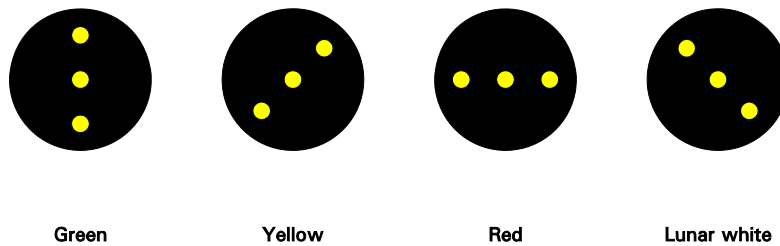
#### *6.3.3 The searchlight color light signal*

A variation of the traditional 3-aspect color light signal, commonly called a “searchlight” signal, has only one lens and lamp, mounted at the center of a relatively-large circular background. Electromechanical apparatus in the signal head moves colored filters so that the light shown is either red, yellow, or green. An advantage is that it takes up less vertical space than a three-lens signal for a given lens diameter.

In its basic use, the aspects and indications of this type of signal are the same as for the three-lens color light signal. Some searchlight heads are also equipped to produce a “lunar white” aspect (produced by a diffusing white lens), typically used to explicitly indicate *restricted* speed.

#### *6.3.4 The position light signal*

The position light signal may be thought of as a semaphore without moving parts. It consists of a (usually) round background within which are set several lenses, all of the same color (usually yellow). For the Clear (or Proceed) aspect, three yellow lights in a vertical row are lit. For an Approach aspect, three yellow lights in a diagonal row, upward to the right, are lit. For a Stop aspect, three yellow lights in a horizontal row are lit. Often there is provision for a fourth aspect, used to indicate *restricted* speed: three lights in a diagonal row, downward to the right. A single light serves as the center of all three patterns. Figure 8 shows the arrangement.



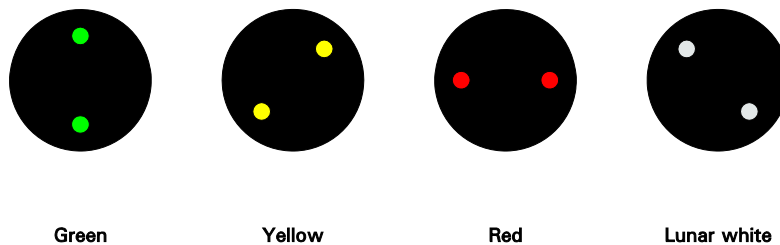
**Figure 8. Position light signal**

For convenience, when speaking of position light signals, we often call the four visual aspects “green”, “yellow”, “red”, and “lunar white” (often just “lunar”), respectively, even though those colors are not actually involved. The figure is labeled this way.

*6.3.5 The color-position signal*

The color-position signal is similar to the position light signal, but the lights that are lit for the different aspects have different colors as well as being in different positions, generally the same colors as for the corresponding aspects of the basic three-lens signal. For the Clear (or Proceed) aspect, two green lights in a vertical row are lit (there is no center light<sup>8</sup>). For an Approach aspect, two yellow lights in a diagonal row, upward to the right, are lit. For a Stop aspect, two red lights in a horizontal row are lit. To indicate *restricted* speed, two yellow lights in a diagonal row, downward to the right, are lit.

Figure 9 shows the arrangement.



**Figure 9. Color position signal**

As with the position light signal, when speaking of color position signals, we often call these visual aspects simply “green”, “yellow”,

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<sup>8</sup> The reason that there are two, rather than three, lamps lit for each aspect is that no single light could serve as the midpoint of all three patterns, as it would have to have a different color in each.

“red”, and “lunar white”, respectively. The figure is labeled in those terms.

## 7. SIGNAL PLACEMENT

In the basic situation of a single track (for a given direction of running), signals are commonly mounted on a mast at the side of the track—typically the right side (corresponding to the engineer’s side of the cab in usual U.S. practice).

When there is more than one track for a particular direction of running, rather than place signals for each on their own masts, there may be a column (usually again on the right of the track group) with a platform on the top from which arise separate short masts for each track, carrying the corresponding signals. (This is sometimes called a “bracket post” arrangement, the name coming from an earlier implementation, in which there was not a real “platform” but rather brackets extending to one or both sides of the mast itself to hold the additional signals.)

But for greater clarity in such cases, a short gantry extending from a column at the right side of the overall roadbed may be used (called a “cantilever bridge” or just “cantilever”). The signals (on short masts arising from the gantry) are not centered over the tracks to which they pertain, but are slightly offset to the right side (as they would be if on trackside masts).

If there is no signal for one track (perhaps it is a siding), then commonly, to avoid any misunderstanding about which signal goes with which track (especially if the tracks are curved so as to distort the engineer’s view of which signal is “almost over” each track), there may be in its signal mast position a small mast with no signal on it (called a “doll arm”<sup>9</sup>)—a “mast placeholder”. Sometimes, for clarity of the situation at night, the doll arm will carry an unchanging blue or purple light.

In some cases, especially where there are several active tracks, a gantry (then called a “signal bridge”) may be built over the whole set of tracks, supported by a column at each side.

If there is only one signaled track and one unsignaled, and a bridge or cantilever is not used, the signal may be placed on a conventional

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<sup>9</sup> “Doll” is old British slang for a signal on a mast. The term “doll arm” for an empty mast is apparently a curious development from that. Sometimes “doll post” is used.



mast at the right of both tracks, with the short doll arm on a bracket off to its side (following the traditional concept of a “bracket post”).

## 8. APPROACH ASPECT NAMES

As maintained earlier, an aspect named just “Approach” means that the train should proceed (usually at some implied maximum speed), prepared to stop at the next signal.

If “Approach” is followed by a speed name (as “Approach Slow”) the train should prepare to approach the next signal at not over that stated speed, rather than being prepared to stop there.

Sometimes an aspect name will include “Approach” preceded by a speed name. That speed name pertains to the speed limit applicable to movement through the switch (if this is an interlocking signal) or through the block itself. If there is also a speed name after “Approach”, the implication described just above also comes into play.

## 9. ADVANCE APPROACH

Many railroads have adopted a protocol in which there are two types of Approach indication. The first indicates that the signal at the following block is at Stop; the second indicates that the signal at the block **after the following block** is at Stop. This protocol gives the engineer better information for controlling the train’s deceleration to meet the upcoming Stop signal.

Many sets of signal rules recognize this mode with the “advance Approach” indication. Its indication is typically to proceed at no more than *limited* speed, prepared to stop at the **second** signal ahead (the one currently known to be at Stop). The basic visual aspect used is flashing yellow (on the top head if a multi-head signal).

## 10. ABSOLUTE AND PERMISSIVE STOP INDICATIONS

As I mentioned at various places, a Stop indication at an automatic block signal is usually permissive, and a Stop indication at an interlocking signal is usually absolute, although the visual aspects are identical. Thus, an engineer arriving at a signal showing a Stop aspect must be able to determine the category of signal to properly determine the indication. A typical hint is that a block signal will have a block number plate, while an interlocking signal will not.

In some cases, unambiguous indication of this difference is provided. For a position light or color-position signal, a single lunar white light below the basic head (in Amtrak protocol; elsewhere, yellow or white above or below) indicates that the Stop indication is permissive.

Absence of such an auxiliary light indicates that the Stop indication is absolute.

## 11. SPEED LIMIT SIGNALING

### 11.1 Introduction

There are two basic situations in which it is appropriate to convey an explicit speed limit (or speed limits) with the signal.

- At an interlocking, the signal is often the signal for a block that begins with the interlocking but extends far beyond it. It is often necessary to impose a limit on the speed of the train while passing through the interlocking trackwork proper, especially when a diverging route has been set through a switch (which divergence the train may be unable to negotiate safely at normal speed).

And/or, it may be appropriate to impose a speed limit (different from that which would ordinarily apply) for movement through the block after the interlocking has been negotiated. Thus, the signal at the entrance to an interlocking may need to express either or both such speed limits.

- At a signal (automatic block or interlocking) **just prior to** a signal (of either category) that currently imposes an immediately-applicable speed limit, or is at Stop, it may be appropriate to impose a speed limit applicable to the approach to that following signal.<sup>10</sup>

The syntactic principles by which these limits are typically conveyed will be described later.

### 11.2 “Speed” vs. “route” signaling

Signal protocols, particularly for interlocking signals, generally follow one or both of two concepts regarding speed limits, which in their idealistic forms are:

- Speed signaling: in schemes of this type, speed limits are explicitly conveyed by conventions presented by multiple head signals. Interlocking signals do not explicitly indicate whether the route to be encountered is “diverging” or not—that is, the position of the switch (turnout) is not explicitly revealed, although it may be intimated by the speed limit indicated.

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<sup>10</sup> The “approach” and “advance approach” indications, already discussed, are special cases of this; they carry inherent speed implications.

- Route signaling: in schemes of this type, at interlocking signals, the route that is set (through or diverging) is explicitly indicated. The applicable speed limit through the interlocking, for either the through or diverging route, is given for the particular interlocking by the employee timetable, and is not part of the signal indication.

In reality, most signaling protocols do not strictly exemplify either of these concepts, but follow different blends of the two.

The NORAC signaling protocol is strictly of the speed signaling variety. The signaling protocol formerly specified by GCOR is generally of the route signaling variety. The CROR (Canadian) signaling protocol is generally of the speed signaling variety.

## 12. BASIC ASPECTS AND INDICATIONS

### 12.1 Introduction

These aspects are given by a single-head signal, a situation most often found for a block signal. They are listed by visual aspect “description”. The customary aspect name is given underlined, followed by the indication.

### 12.2 Green

Clear—proceed at *normal* speed.

### 12.3 Yellow

Approach—reduce speed to *medium* and approach next signal preparing to stop.

### 12.4 Red

#### 12.4.1 *At an automatic block signal*

Stop—stop, then proceed at *restricted* speed, prepared to stop (when a train or car is seen).<sup>11</sup>

#### 12.4.2 *At an interlocking signal* (although such are rarely single-head)

Stop—stop (and stay).

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<sup>11</sup> But a variation on that is found in some signal practices, as discussed in section 14.3.

## 13. MULTIPLE-HEAD SIGNALS

### 13.1 Introduction

Signals providing for speed limit indication (whether block or interlocking) typically have two or three heads arranged vertically.

It is perhaps easiest when visualizing this type of signal to think of the heads being of the searchlight color light type, although most of the aspects can be presented equally well on other types (sometimes with some special considerations). When we illustrate the various aspects with figures, they will be based on the searchlight signal form.

### 13.2 The unique nature of red lights

Almost invariably, If all (lit) heads on a multi-head signal show red lights, the indication is **Stop (Stop and stay or Stop and proceed**, as appropriate to the type of signal).

If, however, some but not all of the lit heads show red lights, in most cases the red lights do not mean Stop, nor do they directly mean anything at all.<sup>12</sup> They are merely placeholders.

A cute phrase used to remind us of this is, "If it isn't all red, it isn't red at all".

### 13.3 Flashing lights

When a certain color light implies a speed limit, in general, if that light is flashing, the next higher speed limit applies (the indication is said to be "promoted" by the flashing of the light). If it does not imply a speed limit, when flashing it implies a "less restrictive" indication than otherwise.

## 14. A TYPICAL SIGNAL PROTOCOL

### 14.1 Introduction

Here I will describe the central themes of a hypothetical railroad's signal protocol, which uses both "speed" and "route" signaling concepts.

### 14.2 Number of heads

The portion of the protocol I will discuss here can be performed by signals with two heads, and I will assume two-head signals in my

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<sup>12</sup> We will see one exception to that in section 14.4.

discussion. When a syntax with further aspects is used, three-head signals may be needed (see section 15). In that case, for the aspects discussed here, the lower head shows red ("not significant").

### 14.3 Basic aspects

The basic aspects in the syntax are:

- Red on both ("all") heads means Stop.
  - At an interlocking signal this means "stop and stay"
  - At a block signal, this means "stop and then proceed at Restricted speed" (so that the train could stop when the train or car in the block ahead is seen).
  - In some protocols, at a block signal this means "proceed at Restricted speed" (no stop first required), the proviso being that the train must already be at restricted speed before passing the signal. (It would have been alerted to this need by the prior signal, which would have shown Approach.)
- Green on the top head means Clear. The train may proceed at not over Normal speed without further qualification.
  - The second head will always show red ("no significance")
- Yellow on the top head means the basic type of the aspect is Approach.
  - Red on the 2nd head means "no significance to this head"
  - Green on the 2nd head advises of a speed limitation different from that inherent in an Approach aspect. Why green? No significance to the color. It is just a different color from the yellow on the top head for ease of visual recognition of its role.
  - If the green is flashing, the speed limit implied is one step higher than otherwise.

### 14.4 When a diverging route is set

- Red on the top head only (this will only happen if the signal is at a switch) shows that the switch is set for the "diverging" route. Now the **second** head will show the basic type of the aspect, Clear or Approach.

- If the second head shows green, the basic type of the aspect is Clear. The train may proceed at not over Normal speed without further qualification.
- If the green is flashing, there is a speed limit through the switch (but none thereafter).
- If the second head shows yellow, the basic type of the aspect is Approach. The train may proceed, prepared to stop at the next signal. In some cases a speed limit is imposed on top of that requirement.
- If the yellow is flashing, this is an Advance Approach aspect: The train must prepare to stop at the **second** following signal.

#### **14.5 Subtleties**

In an actual protocol, often the formal indications include subtleties not discussed here.

#### **14.6 Further aspects and indications**

A complete signal protocol may have many more aspect/name/indication "rules" (the NORAC protocol has 24 altogether). Of the ones beyond what I describe above, many have "irregular constructions", not formed from the basic syntactic principles.

### **15. WITH THREE HEADS**

When three signal heads are used, for interlocking signals that, when a diverging route is set, show red on then top head, then the presence of green or yellow on either of the lower heads denotes the basic type of the aspect, Proceed or Approach, respectively, essentially the same as for the two-head protocol described above.

But here, the position of the green or yellow light, on the second vs. bottom head, conveys the speed limit. Then, also as we saw above, if the light is flashing, this denotes the next higher speed limit. Thus, four different speed limits can be conveyed.

This is one of the refinements allowed by the use of a three-head signal.

## **16. HEAD VARIATIONS**

### **16.1 Approach lighting**

In some cases, so as to conserve energy, at a block signal the entire signal is dark until an approaching train occupies the preceding block. The term "approach" used in this connection is not at all related to an Approach aspect.

### **16.2 Dark heads**

If for a certain aspect on a two-head signal the lowest head (or the two lowest heads on a three-head) would show red (which would of itself be meaningless), those heads may actually be dark. (They contribute nothing to the aspect.)

Thus for example (in a typical syntax) a Clear aspect would appear to an approaching train as just a single green light (just as if the signal were of the single-head type).

This is done in the interest of saving energy and, to some extent, for visual clarity.

This does not contribute to any dangerous ambiguity in the even of a lamp failure in one or more heads; if the only thing showing on a signal is red, or if the entire signal is dark, this is to be interpreted as Stop.

Nevertheless, when the "dark head" plan is used, it is sometimes not followed for the Stop aspect, which then still shows red on all heads.

### **16.3 Hybrid position-family signals**

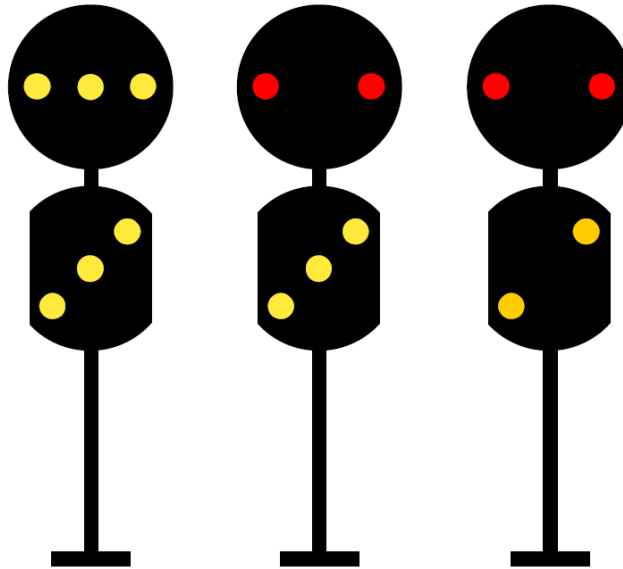
In some protocols (including one flavor of the NORAC protocol) a two-head position-family signal may use one scheme on the top head and the other on the lower head. Quite common is to use the color position scheme on the top head and the position light scheme on the bottom head. I am not in a position to explain the rationale for this.

### **16.4 Narrow background heads**

Very often, on a position-family signal with two heads, the background of the lower head is cut back on the sides, leaving a sort-of oval shape. This helps to visually distinguish the lower head from the upper one.

This is often done in combination with the "hybrid" scheme described just above.

We see this first in figure 10, which shows (in schematic form) three possible implementations of NORAC Rule 288. Slow Approach. The visual aspect for all of these implementations can be spoken of as “red over yellow”.<sup>13</sup> The lower head in each case has a narrow background.



**Figure 10. Narrow background 2nd head—NORAC Rule 288**

- In the leftmost example, both heads use the position light scheme. The upper head visual aspect is “red” (horizontal); the lower head visual aspect is “yellow” (diagonal upward to the right).
- In the center example, the upper head uses the color-position scheme, and the lower head the position light scheme.
- In the rightmost example, both heads use the color-position scheme.

As we can imagine from these figures, a “narrow” lower head of either style cannot exhibit the “red” visual aspect (which would have the lights in a horizontal row). But red on the lower head would mean, of itself, “not significant” (see section 13.2), and so here in such cases the lower head is just dark.

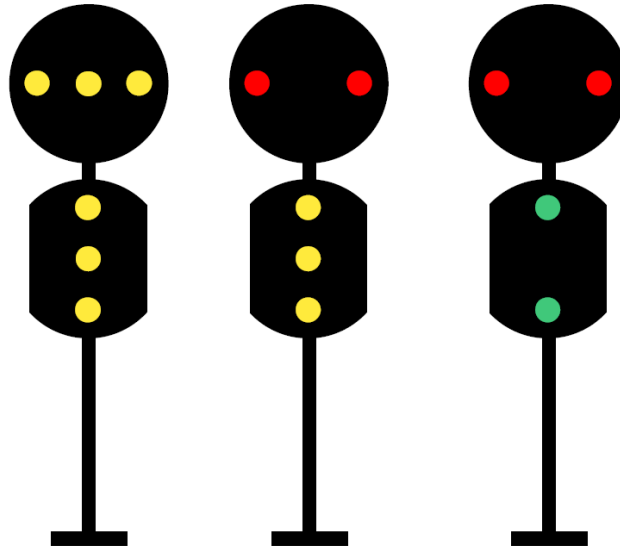
We get further insight into how this works from Figure 11, which shows three implementations of NORAC Rule 283, Medium Clear, using “position family” heads.

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<sup>13</sup> Oddly enough, implementation of this rule with color light or searchlight signals usually uses three heads, the visual aspect being red over red over flashing yellow. Red on the top head, but not all does not here signify “diverging route”, a convention not used in the NORAC protocol.



In this case, the visual aspect for all of these implementations can be spoken of as “red over green”<sup>14</sup>.



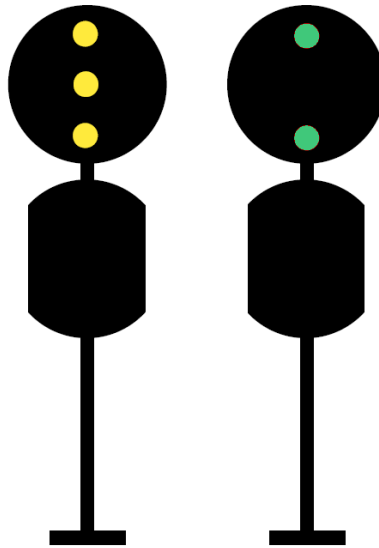
**Figure 11. Narrow background 2nd head—NORAC Rule 283**

For the top head, the leftmost example uses the position light scheme; the center and rightmost use the color position scheme. For the bottom head, the leftmost and center examples use the position light scheme; the rightmost uses the color position scheme.

As we can imagine from these figures, a “narrow” lower head of either style cannot exhibit the “red” visual aspect (which would have the lights in a horizontal row). But red on the lower head would mean, of itself, “not significant” (see section 13.2), and so here in such cases the lower head is just dark.

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<sup>14</sup> And in fact here, implementation with color light or searchlight signals can use two heads, the visual aspect being red over green.



**Figure 12. Narrow background 2nd head—NORAC Rule 281**

We see an example in figure, 12 for position light and color position signals showing NORAC Rule 281, "Proceed". On a two head signal where the lower head can display "red" (such as a typical color light signal), that aspect would be "green over red". But here, it is just "green".

## **16.5 Limited aspect heads**

### **16.5.1 *Semaphore signals***

For a semaphore signal, if a head always exhibits one visual aspect, that arm will not even be equipped with a motor mechanism, and there will be only one lens in the spectacle.

### **16.5.2 *Light signals***

If the repertoire of aspects to be given does not ever utilize all possible colors on a certain head, that head may have only one or two (sets of) lenses. In some such cases, for a position light or color position signal, the background is usually cut back to a shape that only embraces the light pattern(s) that are used. This gives an additional visual cue to the state of that head.



**Figure 13. Color position signal with “yellow only” lower head**

Photograph by Larry Evans  
Used under the doctrine of “fair use”

Figure 13 shows a nice example of that on a color position signal on the former Norfolk and Western Railway (N&W).

Here, the lower head can only exhibit the color position aspect “yellow”. For overall signal aspects where, on other signal types, the lower head would show red for “not significant”, this head will be dark.

Note that the lower head has a center light, not needed for its (only) color position aspect (see figure 9). This is a red light, and it is the only light lit on the lower head in one of the more odd aspects in the N&W syntax: Stop and Stay (“red over little red”).

### **16.6 Implementation on vertical three-lens heads**

In a two- or three-head signal using vertical three-lens color light heads, the position sequence of colors in the 2nd and 3rd heads is not necessarily the same as in the upper head, and the upper head may itself not follow the normal arrangement. Two arrangements used are (shown for three-head signals):

G	R
Y	Y
R	G
Y	Y
G	G
R	R
R	R
Y	Y
G	G

These arrangements are intended to improve the ability of an engineer to visually recognize certain aspects in the repertoire. I am not prepared to further discuss the rationale for this.

**16.7 LED-based heads**

Today, it is common for heads of various layouts to be implemented with LEDs rather than incandescent lamps. This of itself usually has no affect on the syntax that is employed, but might affect some of the details that are based on the conservation of energy or lamp life.

**17. APPENDIXES**

Appendix A gives two tables showing principal signal aspects of two schemes in graphic form along with the corresponding aspect name, indication (not in the official form, but paraphrased for clarity) and perhaps an explanation of how the aspect is constructed and interpreted. The aspects illustrated are from the NORAC scheme and the scheme (based on the former GCOR definitions) followed by many western U.S. railroads.

Appendix B describes the unique B&O Railroad color-position light signaling scheme.

**18. ACKNOWLEDGEMENTS**

The detailed information in this paper comes mostly from a collection of over 300 pages of wondrous, encyclopedic reference documents found on the Web. These documents reflect the great love of railway signaling and its history by the respective authors as well as their extraordinary patience, diligence, and attention to detail. Without in any way slighting the many other contributors to this body of work, I would like to particularly recognize the following:

Mark A. Bej, M.D., of the Department of Neurology, Cleveland Clinic, Cleveland, Ohio (one of the world’s finest hospitals, by the way). Mark’s special interest is the Pennsylvania Railroad, but his collection of works on signaling overall is wondrous.

Clive D. W. Feather of Thus, PLC in the UK. Clive's *oeuvre* also extends to many other fascinating fields. He is the author of many papers and standards in the field of computer science.

James P. G. Sterbenz of GTE Laboratories, Waltham, Massachusetts, author of a large body of (large) Web pages covering signaling practice around the world. As you might expect, his range of interests is quite extensive, and covers many forms of transportation beyond rail.

Special thanks to Dave White, retired locomotive engineer with the Disneyland Railroad, for his insight into "Common Western Practice", and to Dennis Yachechak of the Federal Railway Administration for his help on the evolution of the General Code of Operating Rules.

Thanks to Larry Evans for his nice photo used as figure 13.

## 19. REFERENCES

For those interested in a much larger and deeper look at the extensive landscape of railway signaling (and other railway technical matters as well), I suggest the following Web sites as starting points (the links are all seemingly operative as of February, 2018):

Railway Technical Web Pages—Home Page and Index  
<http://www.railway-technical.com>

Railway Signalling and Operations FAQ (the starting point for access to Mark Bej's monumental work in this field):  
<http://broadway.pennsyrr.com/Rail/Signal/index.html>

This link takes one to a wonderful interactive graphic signaling simulator (Java) developed by Henry J. Sundermeyer:  
<http://raildata.railfan.net/java/DivRte/NORAC.htm>

It is predicated on the NORAC rules, and includes the use of the "Approach limited" aspect to provide the "advance approach" function.

His home page on matters related to New Jersey railroads can be reached at:  
<http://raildata.railfan.net>

Click on any railroad logo at the left and you will go to a page listing many items about all these railroads, in many cases including detailed signaling information (often with Java-based interactive displays). The New York Central area has an especially nice graphic table of signal aspects and indications, directly accessible at:  
[http://raildata.railfan.net/nyc/signals/nyc\\_signals.html](http://raildata.railfan.net/nyc/signals/nyc_signals.html)

A very nice resource on U.S. signaling practice is provided by, of all things, a Danish rail signal engineer, Carsten S. Lundsten, accessible here:

[http://www.lundsten.dk/us\\_signaling](http://www.lundsten.dk/us_signaling)

From the North East Rails site; includes a nice summary of signal aspects and indications:

[http://www.northeast.railfan.net/pro\\_faq1.html](http://www.northeast.railfan.net/pro_faq1.html)

Joseph Hoebet has prepared very nice charts concisely showing the aspects, names, and indications for many railroad practices in a consistent format. They are indexed here:

<http://signals.jovet.net/rules>

## **20. RELEASE NOTES**

### **20.1 This issue (Issue 6)**

The detailed description of the Union Pacific signal syntax is removed and the discussion of a generic syntax expanded. The signal chart for The Full Bucket line is removed. The photo of a complex control point and the ensuing discussion is removed. Additional figures are added, especially in the section on narrow lower heads for position-family signals.

### **20.2 Issue 5**

This issue primarily adds further information on absolute vs. permissive Stop aspects and some related matters. The signal chart for a imaginary/virtual railroad, the Full Bucket Line, is added in an Appendix. The photo of a complex control point is added, with some discussion. Figure captions have been added to conform to our editorial style. A number of editorial adjustments have been made.

### **20.3 Issue 4**

This issue adds a number of figures, especially in the section on semaphore signaling. The description of multi-head signaling (in sections 13 and 14) has been completely rewritten, hopefully for greater clarity, now revolving around the example of the Union Pacific Railroad (UPRR) protocol. The list of external references has been updated. Many editorial adjustments have been made.

## Appendix A

### NORAC and CWP protocols—Selected Aspects and Indications

The tables that follow give illustrative aspects with their name and indication. Two protocols are represented:

- That defined by the NORAC Operating Rules. This generally follows the “speed signaling” protocol.
- What I call “Common Western Practice” (CWP). This is a joint collection of aspect/indication definitions from the sets of several western U.S. railroads, all drawn from, or evolved from, the definitions once included in GCOR. This generally follows the “route signaling” protocol.

Under any of the standards or railroad protocols, a given aspect name/indication may be attached to multiple visual aspects (even for the same type of signal, such as “searchlight”). In general, these are all obvious variants of one another (e.g., **yellow** vs. **yellow over red** vs. **yellow over red over red**). In this table, the visual aspects shown are usually the “most common” searchlight implementation. If the defined alternate visual aspects include ones that are not obvious variations of one another, two or more may be shown as the basis of separate items in the table.

For automatic block signals, I show schematically both a number plate and the convention of “staggered heads”, even though the latter is infrequently found in practice.

A cross across the lens symbol indicates that the light flashes.

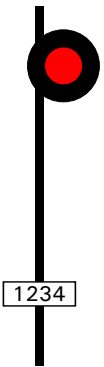
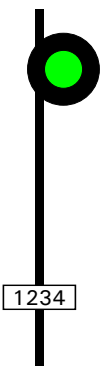
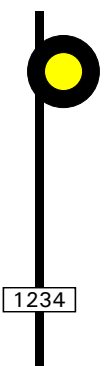
The very light blue color indicates “lunar white”.

All aspects may appear on a signal with more heads than shown. In such a case, the additional (lower) heads generally show red (placeholder). In certain cases, such lower heads may be dark.

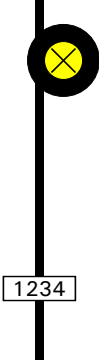
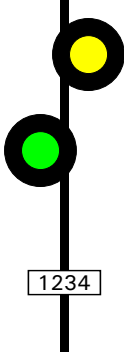
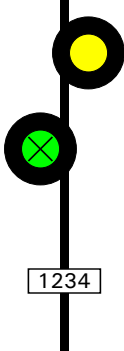
Aspects shown with red on the lower head(s) may appear on signals with fewer heads.

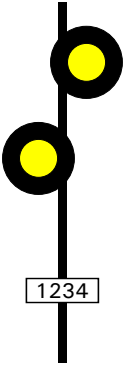
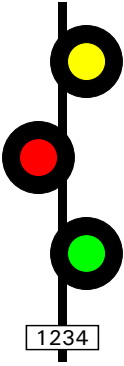
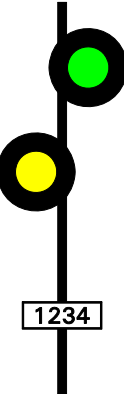
The NORAC indication descriptions are paraphrased (not necessarily verbatim). The CWP indication description is generic, and is only included if substantially different in its implications from the NORAC indication description.

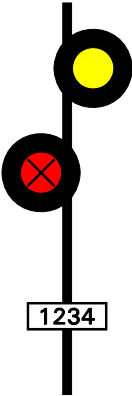

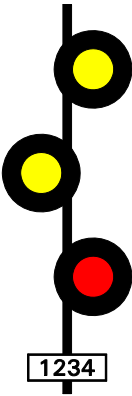
**Table A-1 – Automatic block signal aspects**

Aspect	<u>NORAC aspect name</u> <b>CWP aspect name</b>  NORAC indication CWP indication	Explanation
Basic indications		
	<u>Stop and proceed</u> <b>Stop and proceed</b>  Stop; then proceed if appropriate at restricted speed.  <b>Stop; then proceed at restricted speed.</b>	The stop is permissive since this is an automatic block signal (number plate present).
	<u>Clear</u> <b>Clear</b>  Proceed at normal speed.  <b>Proceed.</b>	Basic clear indication.
	<u>Approach</u> <b>Approach</b>  Reduce to medium speed and approach next signal at that speed, prepared to stop.	Basic approach indication.  It is assumed that the next signal will be at "stop".



Indications with approach speed limits (In aspect name, speed limit stated after "approach")		
	<p><u>Advanced approach</u>  <b>Approach medium</b></p> <p>Reduce to limited speed, and proceed preparing to stop at second following signal. (It is assumed that the next signal will be at "approach".)</p> <p><b>Proceed not exceeding prescribed speed, prepared to advance on diverging route at next signal at prescribed speed through turnout.</b></p>	<p>Flashing yellow is an arbitrary "code" for this indication.</p>
	<p><u>Approach medium</u></p> <p>Proceed at normal speed but approach the next signal at medium speed.</p>	<p>Yellow: approach</p> <p>Presence of green implies "but not prepared to stop".</p> <p>Green on second head: approach speed medium.</p>
	<p><u>Approach limited</u>  <b>Approach limited</b></p> <p>Proceed at normal speed, but approach the next signal at limited speed.</p> <p><b>Proceed prepared to pass next signal not exceeding 60 MPH.</b></p>	<p>Same as above, but flashing "promotes" the approach speed from medium to limited.</p> <p>This is often used to implement the "advance approach" function.</p>




	<p><u>Approach slow[1]</u> <b>Approach diverging</b></p> <p>Reduce to medium speed and approach the next signal at low speed.</p> <p><b>Proceed prepared to advance on diverging route at the next signal at prescribed speed through turnout.</b></p>	<p>This is an arbitrary "code" to allow this indication to be displayed on a two-head signal. Following the "normal" pattern would require a three-head signal (see next aspect).</p>
	<p><u>Approach slow[2]</u></p> <p>Reduce to medium speed and approach the next signal at low speed.</p>	<p>Here is the orthodox, three-head version.</p> <p>Yellow present: approach</p> <p>Presence of green implies "but not prepared to stop".</p> <p>Green on 3rd head: approach speed slow.</p> <p>The fact that the approach speed is "slow" reduces the proceed speed.</p>
<p>Aspects used in CWP only</p>		
	<p><b>Advance approach</b></p> <p><b>Proceed prepared to pass next signal not exceeding 50 MPH</b></p>	<p>CWP only</p> <p>Yellow present: approach</p> <p>Assumes next signal will be at "approach".</p> <p>Irregular construction.</p>



	<p><b>Approach restricting[1]</b></p> <p><b>Proceed prepared to pass next signal at restricted speed.</b></p>	<p>CWP only.</p> <p>Yellow present: approach</p> <p>Irregular construction.</p> <p>See alternate form below.</p>
	<p><b>Approach restricting[2]</b></p> <p><b>Proceed prepared to pass next signal at restricted speed.</b></p>	<p>CWP only.</p> <p>Alternate form.</p> <p>Yellow present: approach</p> <p>Lunar white present: restricted speed</p>
	<p><b>Approach diverging</b></p> <p><b>Proceed prepared to advance on diverging route at the next signal at prescribed speed through turnout.</b></p>	<p>CWP only.</p> <p>Yellow present: approach</p> <p>Irregular construction.</p>




**Table A-2—Interlocking signals**




**Three head signal form shown (unless aspect not defined that way)**



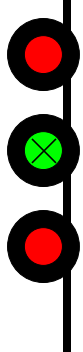
(Aspects shown with red on the 3rd head may be utilized on two-head signals.)

Aspect	<u>NORAC aspect name</u> <b>CWP aspect name</b>  NORAC indication CWP indication	Explanation
	<u>Stop</u> <b>Stop</b>  Stop and stay.	Basic stop indication—“It’s red because its all red”.  The stop is absolute since this is an automatic block signal (heads in line, no number plate present).
	<u>Clear</u> <b>Clear</b>  Proceed at normal speed.  Through route set.	Green only: clear  Since the signal is not “all red”, the red lights are only placeholders, and have no meaning.
	<u>Approach</u> <b>Approach</b>  Reduce to medium speed and approach next signal at that speed, prepared to stop.  Through route set.	Yellow only: approach (prepared to stop)  The reduction to medium speed is inherent in the “approach prepared to stop” indication.  The red lights are placeholders.




Indications with speed limits through the interlocking (in name, interlocking speed stated before "approach" or "clear", approach speed stated after "approach").		
	<p><u>Medium approach</u>  <b>Diverging approach</b></p> <p>Reduce to medium speed and approach next signal at that speed, prepared to stop.</p> <p><b>Proceed on diverging route not exceeding prescribed speed through turnout prepared to stop at next signal.</b></p>	<p>Red on top head (but not all heads: diverging route set.</p> <p>Yellow present: approach.</p> <p>Yellow on second head: medium speed through interlocking (also).</p> <p>The bottom red light is placeholders.</p>
	<p><u>Slow approach</u>  <b>Diverging approach medium</b></p> <p>Slow speed through interlocking [on diverging route], then medium speed and approach next signal at that speed, prepared to stop.</p> <p><b>Proceed on diverging route not exceeding prescribed speed through turnout prepared to stop at second signal unless signal is clear.</b></p>	<p>Red on top head (but not all heads: diverging route set.</p> <p>Yellow present: approach</p> <p>Yellow on 3rd head: slow speed through interlocking. [Yellow on the 3rd head would indicate "restricted", but is promoted to "slow" by flashing.]</p>



	<p><u>Limited clear</u> <b>Diverging clear limited</b></p> <p>Limited speed through interlocking [on diverging route], then proceed at normal speed.</p> <p><b>Proceed on diverging route not exceeding 40 MPH through turnout.</b></p>	<p>Red on top head (but not all heads: diverging route set.</p> <p>Green present, no yellow: clear</p> <p>Green on second head, flashing: limited speed through interlocking. [Green on the 3rd head would indicate "medium", but is promoted to "limited" by flashing.]</p>
	<p><u>Medium clear</u> <b>Diverging clear[1]</b></p> <p>Medium speed through interlocking, then proceed at normal speed.</p> <p><b>Proceed on diverging route not exceeding prescribed speed through turnout.</b></p>	<p>Red on top head (but not all heads: diverging route set.</p> <p>Green present: clear</p> <p>No yellow, green on second head: medium speed through interlocking</p>
	<p><u>Slow clear</u> <b>Diverging clear[2]</b></p> <p>Slow speed through interlocking[on diverging route], then proceed at normal speed.</p> <p><b>Proceed on diverging route not exceeding prescribed speed through turnout.</b></p>	<p>Red on top head (but not all heads: diverging route set.</p> <p>Green present, no yellow: clear</p> <p>Green on 3rd head: slow speed through interlocking</p>

	<p><u>Medium approach medium</u></p> <p>Medium speed through interlocking, then approach next signal at that speed.</p>	<p>Red on top head (but not all heads: diverging route set.</p> <p>Yellow present: approach</p> <p>Yellow on second head: medium speed through interlocking.</p> <p>Green on 3rd head: approach next signal at medium speed. [Special construction].</p>
	<p><u>Restricting Restricting</u></p> <p>Proceed at restricted speed until a more favorable signal.</p> <p>(There are several alternative aspects.)</p>	<p>Lunar white: proceed at restricted speed.</p> <p>[Arbitrary: doesn't really fit any pattern.]</p> <p>The red lights are placeholders.</p>
<p>Aspects used in CWP only</p>		
	<p><b>Approach limited</b></p> <p><b>Proceed prepared to pass next signal not exceeding 60 MPH.</b></p>	<p>CWP only.</p> <p>Yellow present: approach</p> <p>Flashing green on second head: approach next signal at "limited" speed (traditional syntax).</p>

	<p><b>Advance approach</b></p> <p><b>Proceed prepared to pass next signal not exceeding 50 MPH</b></p>	<p>CWP only.</p> <p>Green over yellow: next signal yellow.</p> <p>Yellow on second head: "medium" speed through interlocking (traditional syntax).</p>
	<p><b>Approach medium</b></p> <p><b>Proceed past next signal not exceeding prescribed speed, prepared to advance on diverging route at next signal at prescribed speed through turnout.</b></p>	<p>CWP only</p> <p>Yellow present: approach</p> <p>Arbitrary construction.</p>
	<p><b>Diverging clear limited</b></p> <p><b>Proceed on diverging route not exceeding 40 MPH through turnout.</b></p>	<p>CWP only</p> <p>Red on top head: diverging route set</p> <p>Green present, no yellow: proceed</p> <p>Flashing green on second head: through interlocking at "limited" speed (traditional syntax).</p>



	<p><b>Approach restricting[3]</b></p> <p><b>Proceed prepared to pass next signal at restricted speed.</b></p>	<p>CWP only</p> <p>Yellow present: approach</p> <p>Lunar white: restricted speed</p> <p>Arbitrary construction.</p>
	<p><b>Approach diverging</b></p> <p><b>Proceed prepared to advance on diverging route at the next signal at prescribed speed through turnout.</b></p>	<p>CWP only.</p> <p>Yellow present: approach</p> <p>Irregular construction.</p>
	<p><b>Approach restricting[4]</b></p> <p><b>Proceed prepared to pass next signal at restricted speed.</b></p>	<p>CWP only</p> <p>Yellow present: approach</p> <p>Irregular construction.</p>

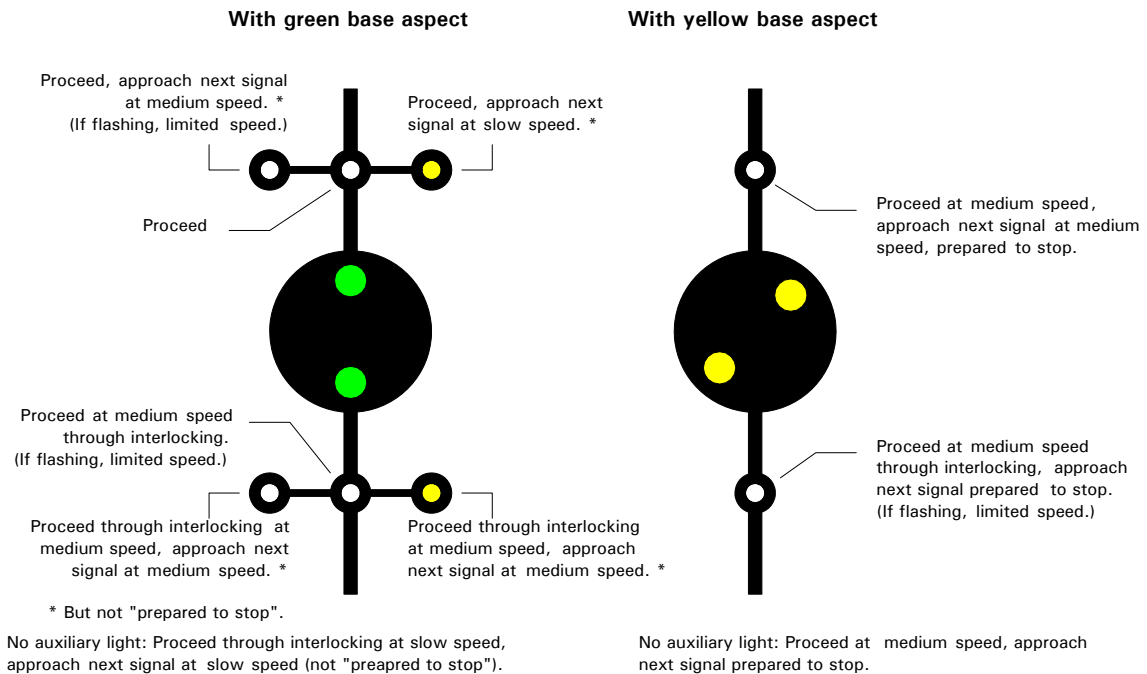
	<p><b>Diverging approach diverging</b></p> <p>Proceed on diverging route not exceeding prescribed speed through turnouts, prepared to advance on diverging route at next signal.</p>	<p>CWP only</p> <p>Irregular construction.</p>
	<p><b>Approach thirty</b></p> <p>Proceed; approach next signal not exceeding 30 MPH, prepared to enter diverging route at prescribed speed.</p>	<p>CWP only</p> <p>Irregular construction.</p>

## Appendix B B&O Color-position signal conventions

### Introduction

The former B&O railroad widely utilized an interesting convention based on a single color-position head accompanied by auxiliary lights (on individual circular backgrounds) above and/or below the head proper. Although this practice has largely been superseded, it is fascinating, and so I describe it here.

The syntax is quite direct. The signal layout and the basics of the syntax are shown in this chart:



### Auxiliary light syntax

There are three auxiliary light positions above the color-position head proper and three below. Only one auxiliary light is illuminated for any aspect (a few involve no auxiliary light).

An auxiliary light above denotes a signal of the automatic block type (or one that is functionally equivalent); one below denotes an interlocking signal.

The center lights in either group essentially denote the "basic" form of the indication given by the aspect of the head proper. The left and

right lights, used mainly in connection with a green base aspect, indicate that the indication is of the speed-limited approach type (that is, not "prepared to stop" at the next signal), and indicate the speed limit for approach.

### **Green base aspect**

With a green base aspect:

An auxiliary light above indicates that this is an automatic block signal, and

- A left light indicates proceed and approach to the next signal be at *medium* speed.
- A flashing left light indicates proceed and approach the next signal at *limited* speed.
- A right light (yellow) indicates proceed and approach the next signal at *slow* speed.
- A center light indicates proceed.

An auxiliary light below indicates that this is an interlocking signal, and

- A left light indicates proceed at *medium* speed and approach the next signal at *medium* speed.
- A right light (yellow) indicates proceed at *medium* speed and approach the next signal at *slow* speed.
- A center light indicates proceed through the interlocking at medium speed and proceed at normal speed.
- A flashing center light indicates proceed through the interlocking at *limited* speed and the proceed at *normal* speed.

### **Yellow base aspect**

With a yellow base aspect:

- A light above at the center indicates that this is an automatic block signal: proceed at *medium* speed and approach the next signal prepared to stop.
- A light below at the center indicates that this is an interlocking signal: proceed through the interlocking at *medium* speed and approach the next signal prepared to stop.

- A light below at the center indicates that this is an interlocking signal: is proceed through the interlocking at *limited* speed and approach the next signal prepared to stop.

### **Red base aspect**

A red base aspect indicates Stop ("and stay), unless one of the following conditions obtains, in which case it indicates Stop and Proceed:

- There is a block number plate on the mast (denoting an automatic block signal)
- The center auxiliary light, above or below, is illuminated.

### **Lunar white aspect**

A lunar white aspect (there will be no auxiliary light) indicates proceed at *restricted* speed.

### **Alternative to flashing**

For any of the aspects that involve a flashing auxiliary light, an alternative is to have the light steady and a triangular yellow plate in the lower right auxiliary light position. (The plate essentially indicates, "limited speed".)

### **Flashing green aspect**

A flashing green base aspect (there will be no auxiliary light) indicates *slow* speed through the interlocking, then proceed at *normal* speed. (This is an irregular construction.)

### **No auxiliary light**

With no auxiliary light, the indication is highly restrictive (a "fail-safe default" situation). With a green base aspect, the indication calls for slow speed through the interlocking (if applicable) and approach to the next signal at slow speed. With a yellow base aspect, the indication calls for slow speed through the interlocking (if applicable) and approach to the next signal prepared to stop.

As already mentioned, with a red base aspect and no auxiliary light, the Stop indication is absolute ("Stop and Stay") unless a number plate is present (denoting that the signal is of the automatic block type), in which case the indication is Stop and Proceed.