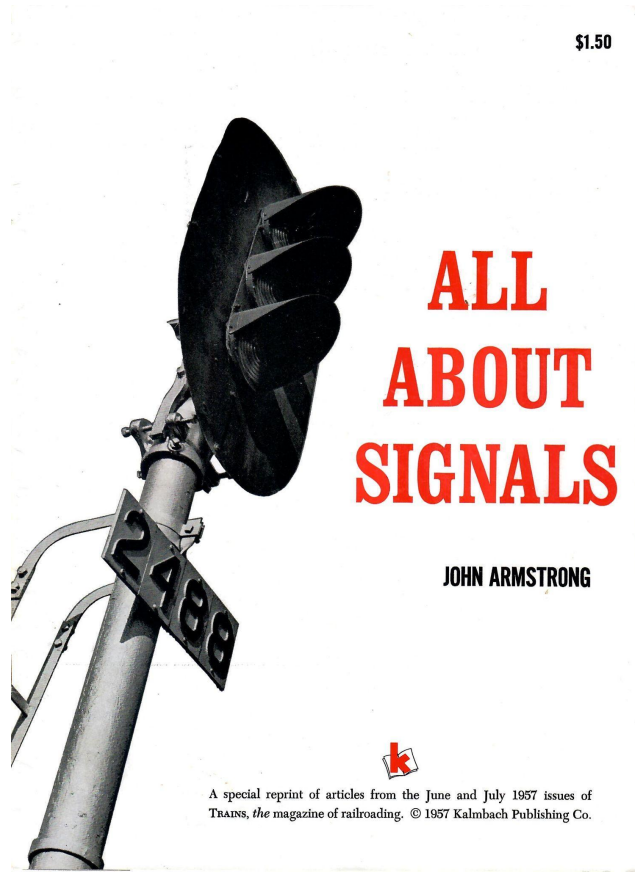


Something About Signals

NMRA MER Division 11 Clinic Sept. 19, 2026

In case you don't recognize the pun in the clinic's title ...



Tell them what you're going to tell them ... (a.k.a. outline)

- I. What is a signal?
- II. Physical fixed signal types
 - A. Early - ball, banner, disk, Hall (banjo)
 - B. Semaphore - upper, lower quadrant
 - C. Color light - inline, triangular, searchlight
 - D. Position light
 - E. Color position light
- III. Aspect/name/indication
 - A. Absolute vs. permissive
 - B. Route vs. speed signaling
 - C. NORAC standard vs. others (with a DL&W digression)
- IV. Signal systems
 - A. Manual - block, train-on-branch
 - B. Automatic block signals (ABS)
 - C. Absolute permissive block (APB)
 - D. Centralized traffic control (CTC)
- V. A few notes on modeling fixed signals
- VI. Q&A

What we're not covering (at least not outside of the Q&A):

How to build or operate a CTC panel

Model railroad occupancy detectors

TT&TO operation (though that doesn't preclude the use of fixed signals)

Positive train control

I. A signal is ...

Any indicator (sounds, lights, motions, symbols, mechanical devices, or signs) that are used to direct, govern, or control the operation of a railroad

Crossing signals

Fixed signals

Cab signals

Whistle/horn signals

Hand signals

Class lights / markers

II. Physical fixed signal types - A. Early types

Ball

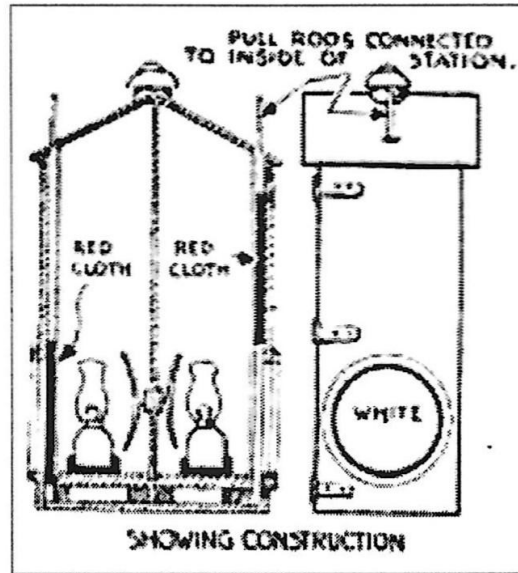


II. Physical fixed signal types - A. Early types

Banner Box



Banner box signal installed in 1863 between Philadelphia, Pa., and Trenton, N. J. First type of manual block signal put in service in the United States



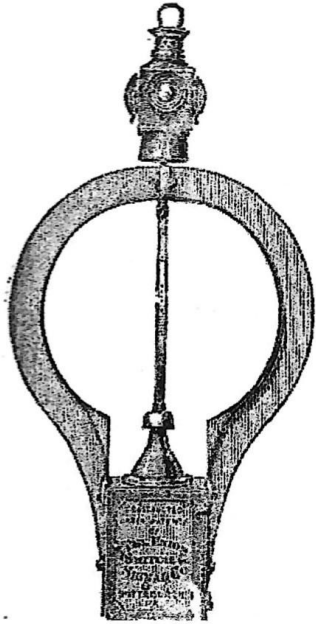
Which is not the same as what the British call a banner signal

It is used even today as a "repeater" signal, to show the position of a signal ahead which might be obscured by station buildings or a bridge.

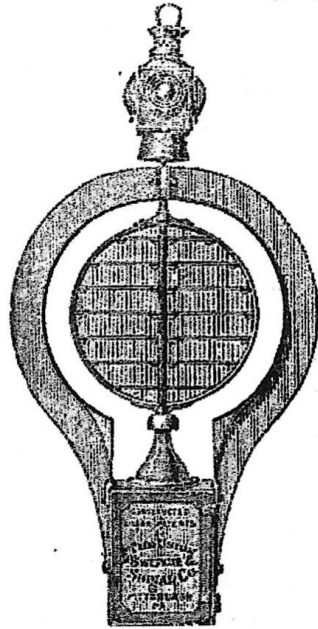


II. Physical fixed signal types - A. Early types

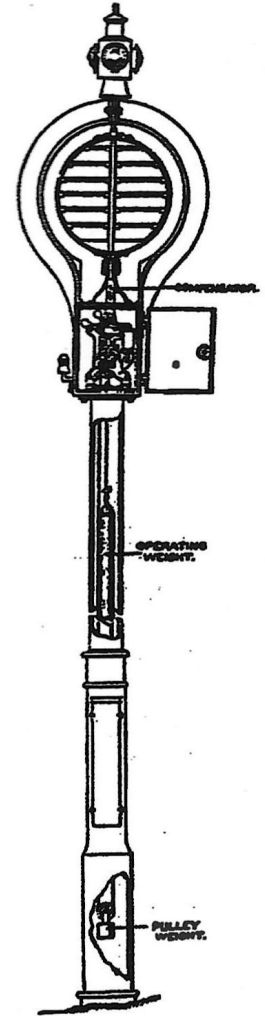
Disk (Exposed clockwork)



Clear

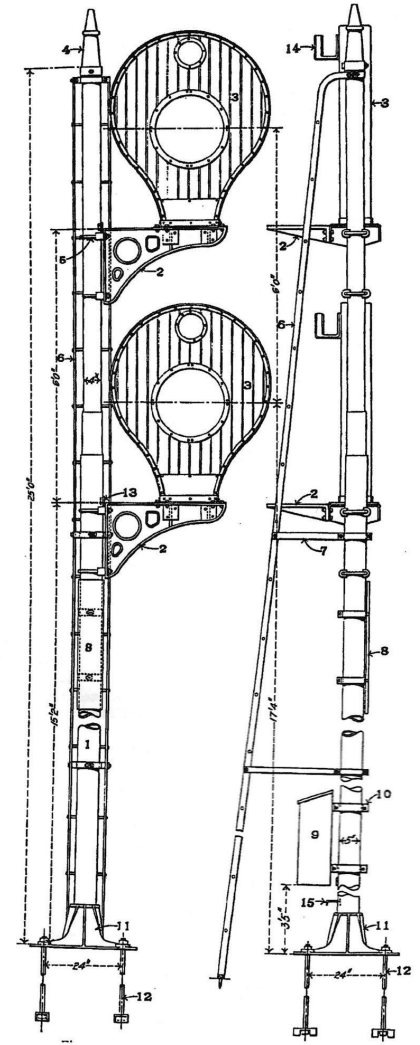
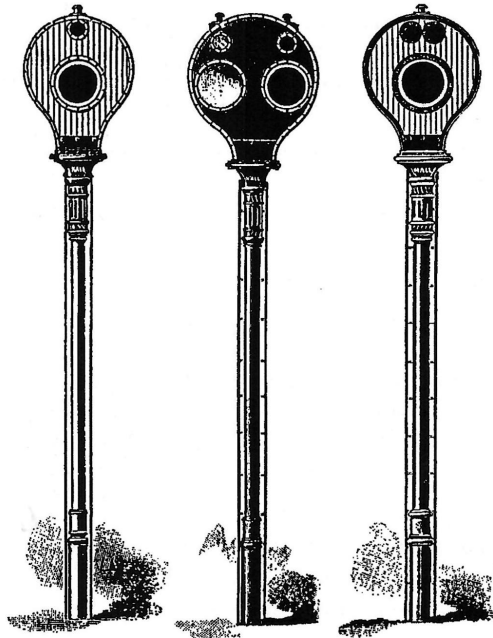


Danger



II. Physical fixed signal types - A. Early types

Hall (Banjo)



Hall signals were also used as crossing signals



From the
Reading
Railroad
Heritage
Museum
collection

II. Physical fixed signal types - B. Semaphores

Lower Quadrant



Donald Wise

Notes on Lower Quadrant Semaphore

Earlier type than upper quadrant

Generally 2 positions - Horizontal “danger”, 45° Down “clear”

Required counterweights to “fail safe” (blade horizontal)

Upper arm indicated condition of the next block, lower arm for block after that, but the lower arm was also raised to the danger position if the upper arm was at “danger”.

Middle roundel if present on a 2 position was generally red though it only affected the light as the blade was being moved.

II. Physical fixed signal types - B. Semaphores

Upper Quadrant



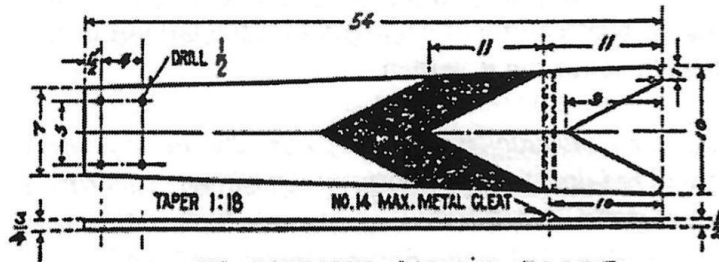
Notes on Upper Quadrant Semaphores

ARA Standard Code of 1912 made upper quadrant signal meanings more uniform

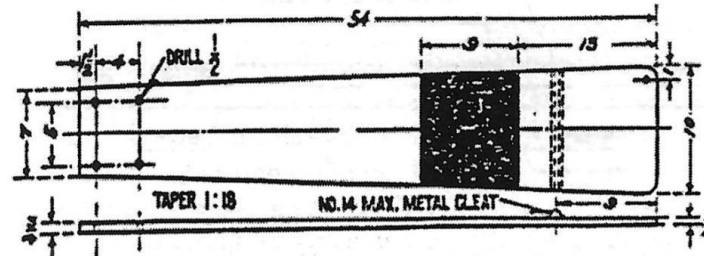
Generally 3 positions - Horizontal “danger”, 45° Up “caution”, Vertical “clear”

No need for counterweights as gravity pulled the arm to the “danger” position in the event of a power failure

Semaphore Blade Shapes and Colors (generally)

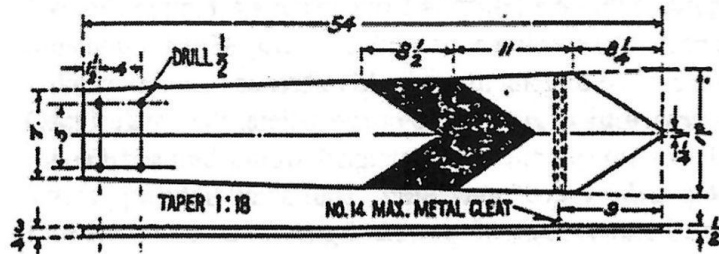


101 DISTANT SIGNAL BLADE
 PAINT FRONT YELLOW WITH BLACK STRIPE
 PAINT BACK AND EDGES BLACK.

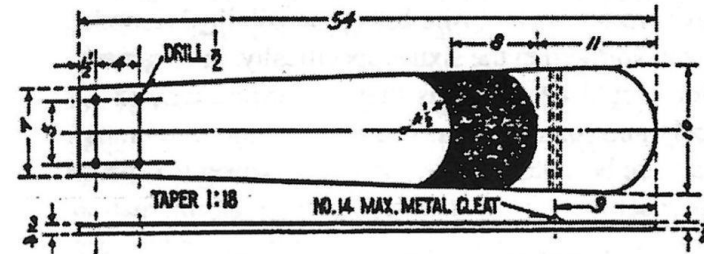


102 INTERLOCKING SIGNAL BLADE
 PAINT FRONT RED WITH WHITE STRIPE.
 PAINT BACK AND EDGES BLACK.

0 3 6 9 12
 SCALE AND ALL DIMENSIONS GIVEN IN INCHES



103 AUTOMATIC BLOCK SIGNAL BLADE
 PAINT FRONT RED WITH WHITE STRIPE.
 PAINT BACK AND EDGES BLACK.



104 MANUAL BLOCK SIGNAL BLADE

PAINT FRONT RED WITH WHITE STRIPE.
 PAINT BACK AND EDGES BLACK.

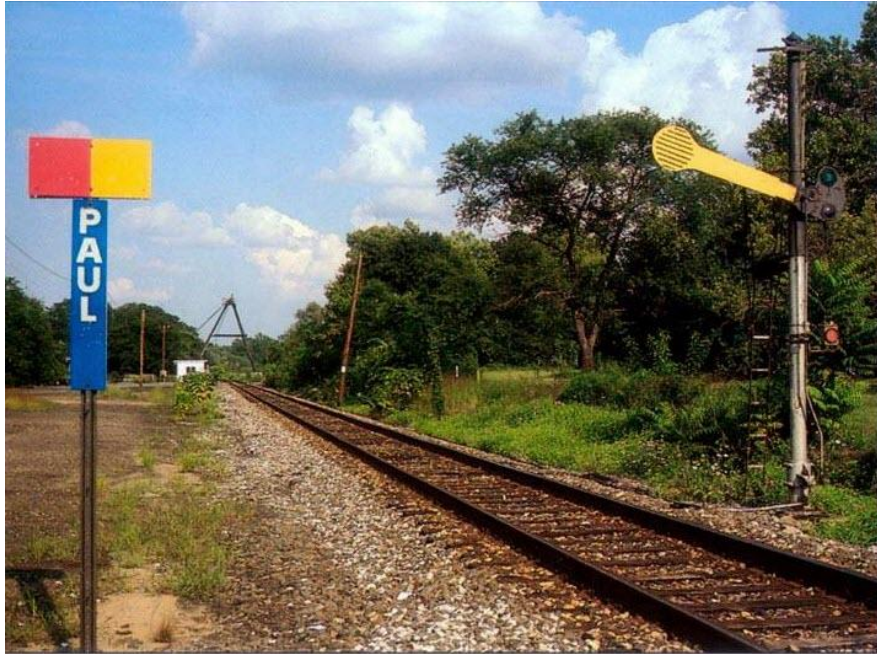
Semaphore Blade Sizes

Highly variable - from a few inches to speaker-sized



Specialized Semaphores

Smashboard



OLD FASHION SMASHBOARDS protects both ends of Paulsboro Movable Bridge.
Railpace Magazine, April 2001, p. 23

Flag Stop



Train Order



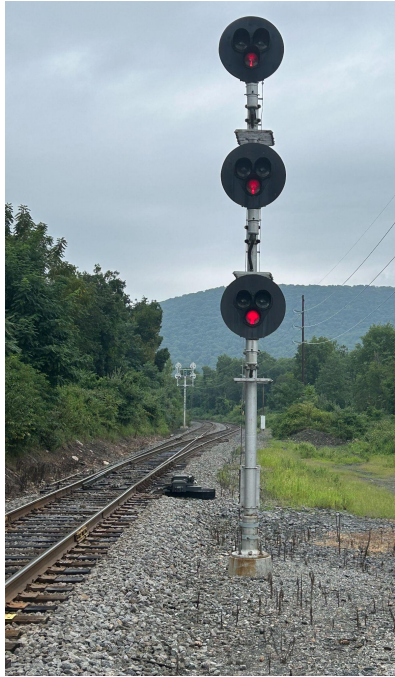
II. Physical fixed signal types - C. Color light

Inline - e.g. US&S types P-5 & R-2; GRS type D



II. Physical fixed signal types - C. Color light

Triangular - e.g. US&S type G



Type G Signals at CP Wall (Lebanon PA)



II. Physical fixed signal types - C. Color light

Searchlight - GRS type SA, US&S types H2 & H5



A few more examples



Mast Searchlights on the Reading



Signal V242



Closeup of V242 Head



A 2-Head Dwarf Searchlight Rising from the Ballast



Digression - Dolls

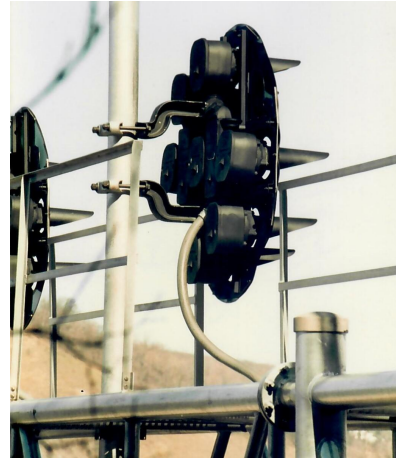
When there are one or more tracks between a signal and the track it is for, dolls are used to mark the unsignalled track(s).



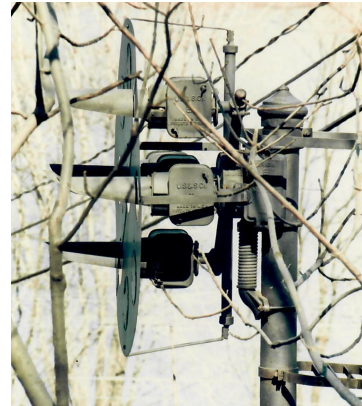
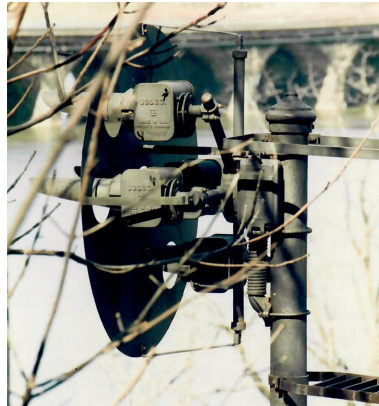
II. Physical fixed signal types - D. Position light



“Modern” position lights on cantilever bridge



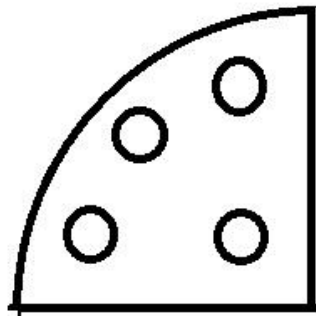
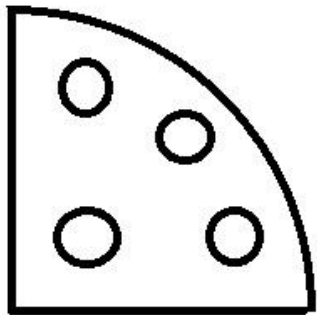
Compare head support
with that of “old style”
mast signal near it



The changing of the guard at Lewistown



PRR Dwarfs - which is the right shape?



PRR Dwarfs



Position Light Dwarfs Are All Gone Except At Museums - right?



II. Physical fixed signal types - E. Color position light



CPL Dwarf and Bracket Post



Where's Waldo - How many CPL signals can you spot?

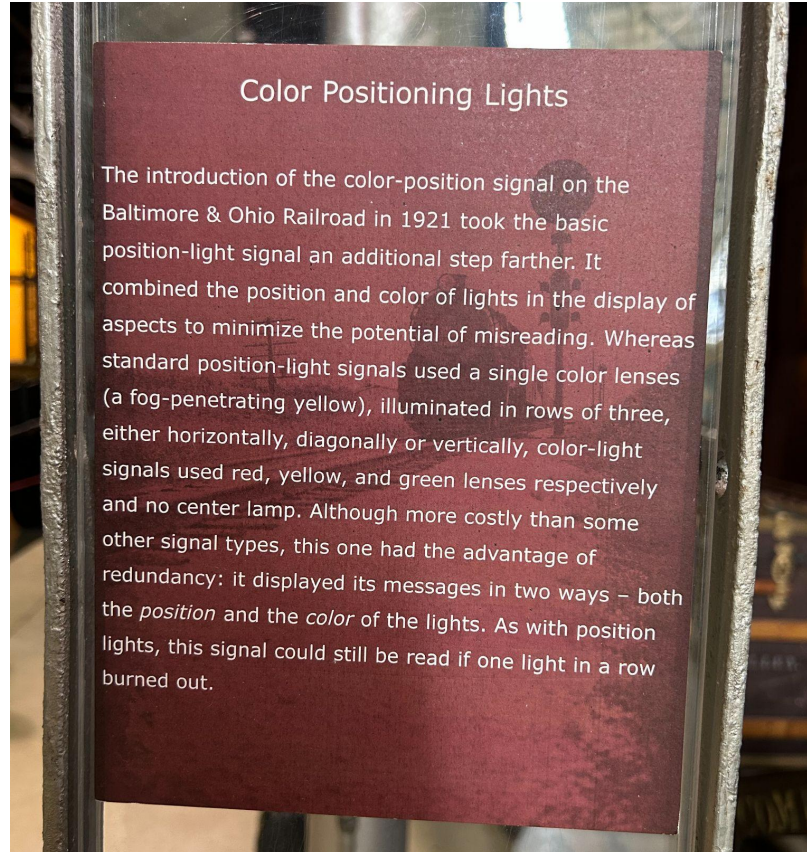


Darby Creek Yard was the Reading's main freight yard on its Chester Branch, which was isolated from the rest of the Reading's system, and accessed via 4 miles of trackage rights over the Baltimore & Ohio Railroad between Park Junction and Eastwicks in Philadelphia. In this view from the Reed Street footbridge over the B&O taken on June 8, 1976, we see a Conrail train from Darby Creek, led by ex-Reading U30C #6301, passing by the B&O's Eastside Yard. The trailing diesel, ex-Erie-Lackawanna Railroad SD45 #3632, is still in its Bicentennial paint scheme. *Richard W. Jahn photo.*

N&W - Used to be position light but color was added



Railroad Museum of Pennsylvania has a CPL signal



Well, they think they do



III. Aspect/name/indication

Aspect is the physical appearance of a signal - red/yellow/green (over red/yellow/green over ...) including any heads that are flashing

Name is the identifier in the rulebook for that aspect - e.g. Clear, Restricting. There is a rule number for every name, e.g. 281, 290.

Indication is the meaning given in the rulebook - e.g. Proceed, Proceed at restricted speed.

Indication descriptions may use terms defined elsewhere in the rulebook. E.g. “restricted speed” may be defined as “A speed that will permit stopping short of another train, or an obstruction, or switch not properly lined, and to look out for broken rail, but not exceeding 15 miles per hour.”

III. Aspect/name/indication - A. Absolute vs. permissive

Both of these signals have a red-over-red aspect, but the indication is different - why?



Is a signal absolute or permissive or very permissive?

Absolute signals are stop-and-stay, and may not be passed without an order from the DS. They control the approach to converging routes or crossings. Absolute signals will not have a number plate. If there are multiple heads they will be aligned vertically. An absolute signal with a single head may have a red marker below the functional head, or a “A” plate on its mast, to help differentiate it at a distance from a permissive signal.

Permissive signals have a number plate, and if they have multiple heads their alignment may be staggered. Permissive signals allow a train to pass at restricted speed once the train stops. If there is a grade indicator on the signal, trains exceeding a certain tonnage (as a percent of what their locomotive(s) can haul) may pass such a signal displaying stop-and-proceed at restricted speed without stopping, to prevent the inability to restart on the grade. Some railroads, to conserve fuel, allow all (freight) trains to pass a stop-and-proceed signal at restricted speed without stopping, thereby turning stop-and-proceed into restricting.

PRR position light with grade marker

Some roads
use a triangle
instead of the
letter G.

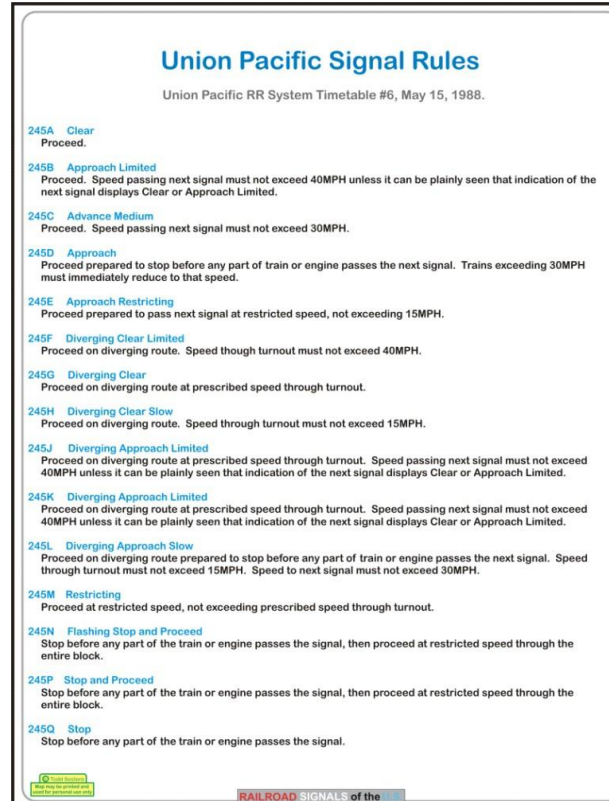
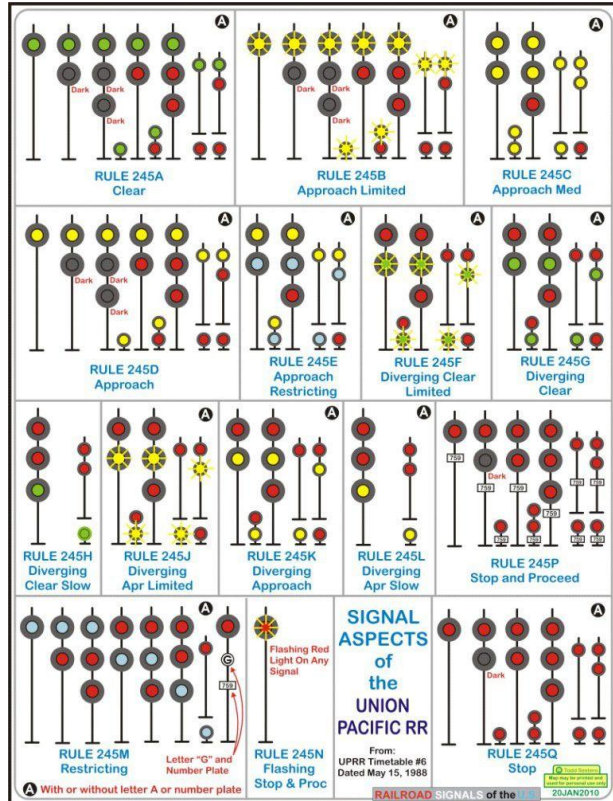


III. Aspect/name/indication - B. Route vs. speed signaling

Western (and British) railroads generally use route signaling. In pure route signaling there is a signal head for every route. Signal names for aspects where one of the lower heads is other than red generally include the word “diverging”. It is up to the engineer to know the territory well enough to take reversed switches at no more than their prescribed speed. As the number of routes through a complex interlocking may make for a ridiculous number of heads, the second head is used for all medium-speed routes, and the third head for all low-speed routes, thus becoming a hybrid of route and speed signaling.

Eastern (and Canadian) railroads generally use speed signaling. Signal indications do not (theoretically) imply which route the train is to travel, only the maximum speed at which it is to go.

UP signal chart - example of hybrid route signaling



III. Aspect/name/indication - C. NORAC standard vs. others

[illegible]

NORAC

RULE 280A. NAME: CLEAR TO NEXT INTERLOCKING

INDICATION: Trains without operative cab signals must proceed on next signal indication, not exceeding 79 MPH, and approach next interlocking signal prepared to stop.

RULE 280B. NAME: APPROACH NORMAL

INDICATION: Trains without operative cab signals must proceed on next signal indication not exceeding 79 MPH.

RULE 281. NAME: CLEAR

INDICATION: Proceed next interlocking Normal Speed.

RULE 281A. NAME: CAB SPEED

INDICATION: Proceed in accordance with cab signal indication. Reduce speed to not exceeding 80 MPH when Cab Speed cab signal speed is received. Reduce speed to not exceeding Limited Speed when Approach Medium Speed cab signal is received. Trains not equipped with operative cab signals must proceed 79 MPH.

RULE 281B. NAME: APPROACH LIMITED

INDICATION: Proceed approaching the next signal at Limited Speed.

RULE 281C. NAME: LIMITED CLEAR

INDICATION: Proceed at Limited Speed until enter train clears all interlocking or spring switches, then proceed at Normal Speed. In CSS territory with fixed automatic block signals, trains not equipped with operative cab signals must approach the next signal at Limited Speed.

RULE 282. NAME: APPROACH MEDIUM

INDICATION: Proceed approaching next signal at Medium Speed.

RULE 282A. NAME: ADVANCE APPROACH

INDICATION: Proceed prepared to stop at the second signal. Trains exceeding Limited Speed must begin reduce to Medium Speed as soon as the engine passes the Approach Signal.

RULE 283. NAME: MEDIUM CLEAR

INDICATION: Proceed at Medium Speed until enter train clears all interlocking or spring switches, then proceed at Normal Speed. In CSS territory with fixed automatic block signals, trains not equipped with operative cab signals must approach the next signal at Medium Speed.

RULE 283A. NAME: MEDIUM APPROACH MEDIUM

INDICATION: Proceed at Medium Speed until enter train clears all interlocking or spring switches, then approach the next signal at Medium Speed.

RULE 284. NAME: APPROACH SLOW

INDICATION: Proceed approaching the next signal at Slow Speed. Trains exceeding Medium Speed must begin reduce to Medium Speed as soon as the engine passes the Approach Signal.

RULE 285. NAME: APPROACH

INDICATION: Proceed prepared to stop at the next signal. Trains exceeding Medium Speed must begin reduce to Medium Speed as soon as the engine passes the Approach Signal.

RULE 286. NAME: MEDIUM APPROACH

INDICATION: Proceed prepared to stop at the next signal. Trains exceeding Medium Speed must begin reduce to Medium Speed as soon as the Medium Approach Signal is clearly visible.

RULE 287. NAME: SLOW CLEAR

INDICATION: Proceed at Slow Speed until enter train clears all interlocking or spring switches, then proceed at Normal Speed. In CSS territory with fixed automatic block signals, trains not equipped with operative cab signals must approach the next signal at Medium Speed once they have all interlocking limits.

RULE 288. NAME: SLOW APPROACH

INDICATION: Proceed prepared to stop at the next signal. Slow Speed applies until enter train clears all interlocking or spring switches, then Medium Speed applies.

RULE 289. NAME: RESTRICTING

INDICATION: Proceed at Restricted Speed until the entire train has:

1. Passed a more favorable fixed signal.
2. Entered non-signalized OSS territory or
3. Passed a location where a more favorable cab signal was received.

RULE 291. NAME: STOP AND PROCEED

INDICATION: Stop. Then proceed at Restricted Speed until the entire train has:

1. Passed a more favorable fixed signal or
2. Entered non-signalized OSS territory or
3. Passed a location where a more favorable cab signal was received.

Where a letter (G grade marker) or a letter R (restricting marker) is displayed in additional number plate as part of these signals, freight trains may observe the signal as though Restricting, Rule 290, were displayed.

RULE 292. NAME: STOP SIGNAL

INDICATION: STOP.

RULE 293. NAME: SWITCH CLOSED SIGNAL

INDICATION: Proceed.

RULE 294. NAME: SWITCH OPEN SIGNAL

INDICATION: Proceed prepared to stop short of open switches.

RULE 295. NAME: APPROACH CLEAR

INDICATION: Proceed. Note: Do not convey block or track information.

RULE 296. NAME: APPROACH RESTRICTING

INDICATION: Proceed prepared to stop at hand-operated switches and at the next signal. Trains exceeding Medium Speed must begin reduce to Medium Speed as soon as the engine passes the Approach Restricting Signal.

NOTE: Do not convey block or track information.

RULE 297. NAME: CLEAR SLOW DETECTOR SIGNAL

INDICATION: Proceed, slow detector not actuated.

RULE 298A. NAME: SLOW DETECTOR SIGNAL

INDICATION: Approach actuated slow detector prepared to stop short of slow detector.

RULE 299. NAME: APPROACH PERMANENT SLOW LIMIT SIGNAL

INDICATION: Proceed prepared to stop short of signal based upon permanent speed restriction.

NOTE: In classified territory, this sign will be mounted in the category signal. In non-classified territory, this sign will be mounted on an overhead bridge or on a pole approximately 12 to 20 above the top of the rail.

RULE 299A. NAME: APPROACH SPEED LIMIT SIGN

INDICATION: Proceed at Medium Speed until at a speed not exceeding the speed posted on the Approach Speed Limit Sign. Where a sign with two sets of numbers is posted, the higher speed applies to passenger trains, and the lower speed applies to freight trains.

RULE 299B. NAME: SPEED LIMIT SIGN

INDICATION: Proceed at speed posted on the Approach Speed Limit Sign until the entire train has passed the Resume Speed Sign.

RULE 299C. NAME: RESUME SPEED SIGN

INDICATION: Proceed after the entire train has passed the Resume Speed Sign.

RULE 299D. NAME: APPROACH STOP

INDICATION: Proceed prepared to stop at the Stop Sign. Trains exceeding Medium Speed must begin reduce to Medium Speed as soon as the engine passes the Approach Signal.

RULE 299E. NAME: STOP SIGN

INDICATION: Stop unless permission is received as prescribed by Rule 105.

RULE 299F. NAME: RESTRICTED AREA SPEED LIMIT SIGN

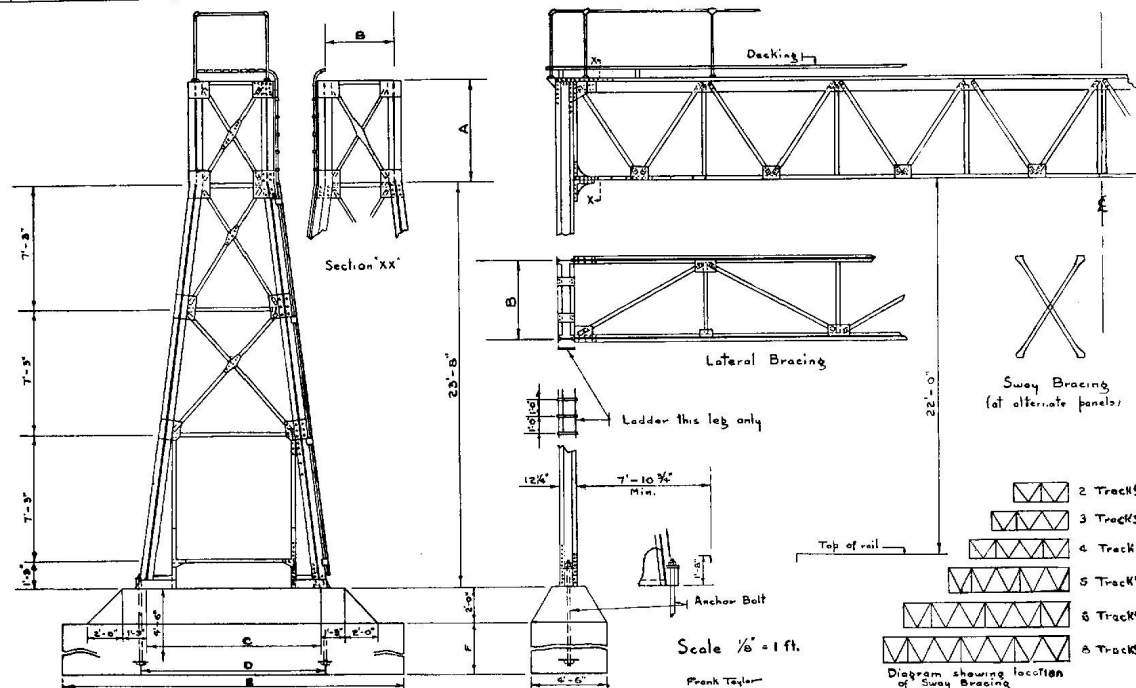
DL&W digression - remember this bridge?



	NUMBER OF TRACHS							18" - 0" C to C of TRACH
	2 TRACHS	3 TRACHS	4 TRACHS	5 TRACHS	6 TRACHS	7 TRACHS	8 TRACHS	
A	6'-0"	6'-0"	6'-0"	7'-0"	7'-0"	8'-0"	8'-0"	
B	6'-0"	6'-6"	6'-6"	6'-6"	8'-0"	8'-0"	6'-6"	
C	10'-5"	10'-5"	10'-5"	10'-11"	11'-11"	11'-11"	12'-9"	
D	11'-0"	11'-0"	11'-0"	11'-6"	11'-6"	12'-6"	13'-0"	
E	20'-0"	20'-0"	20'-0"	21'-0"	21'-0"	23'-0"	23'-0"	

	NUMBER OF TRACHS							18'-0" C to C of TRACH
	2 TRACHS	3 TRACHS	4 TRACHS	5 TRACHS	6 TRACHS	7 TRACHS	8 TRACHS	
A	6'-0"	6'-0"	6'-0"	7'-0"	7'-0"	8'-0"	8'-0"	
B	6'-0"	6'-6"	6'-6"	6'-6"	8'-0"	8'-0"	6'-6"	
C	10'-5"	10'-5"	10'-5"	10'-11"	11'-11"	11'-11"	12'-9"	
D	11'-0"	11'-0"	11'-0"	11'-6"	11'-6"	12'-6"	13'-0"	
E	20'-0"	20'-0"	20'-0"	21'-0"	21'-0"	23'-0"	23'-0"	

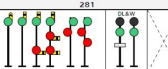
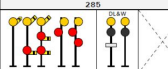
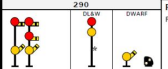
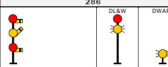
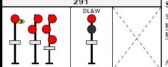
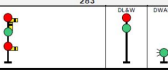
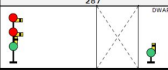
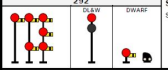
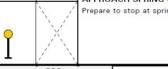
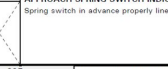
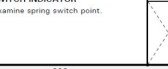
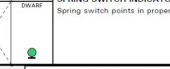
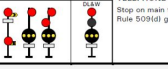
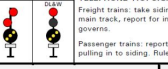
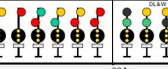
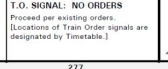
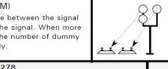
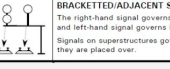
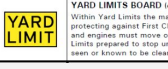
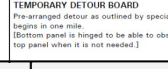
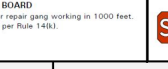
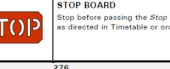
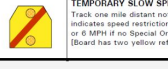
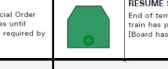
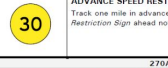
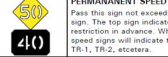
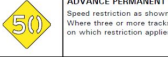
STANDARD SIGNAL BRIDGE



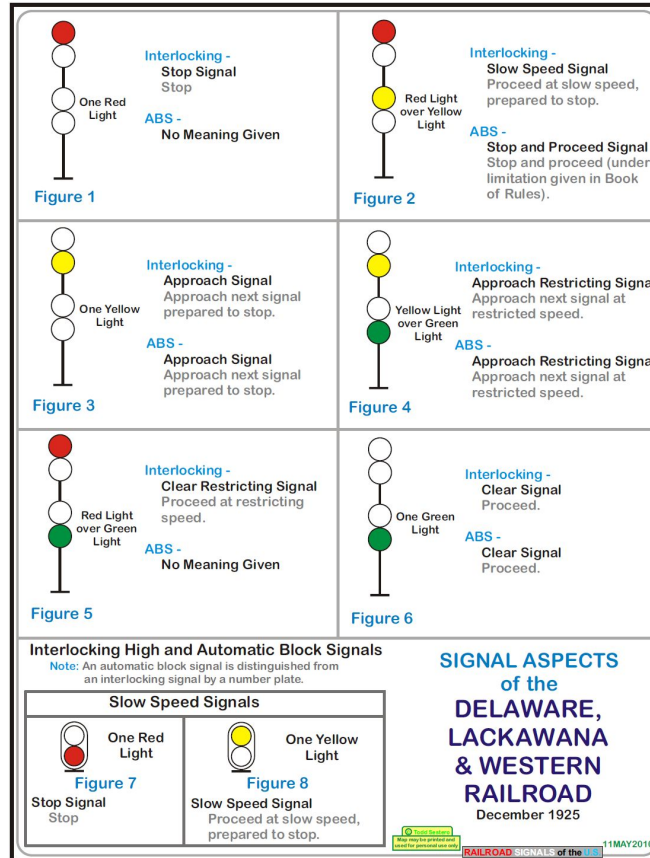
But the paired two indication signals are DL&W



EL signal rules from 1964 - see “DL&W” entries

ERIE LACKAWANNA RAILROAD – SIGNAL RULES									
 281 CLEAR Proceed.		 285 APPROACH Prepare to stop at next signal. Train exceeding Medium speed must at once reduce to that speed.		 290 RESTRICTING Proceed at Restricted speed.					
 282 APPROACH-MEDIUM Approach next signal at not exceeding Medium speed.		 286 MEDIUM APPROACH Proceed at not exceeding Medium speed prepared to stop at next signal.		 291 STOP AND PROCEED Stop; then proceed at Restricted speed. See Rule 509(b) and 509(d). NOTE: When Yellow disk at letter "O" is provided, see Rule 509(c). NOTE: Signals where main restrictive indication is more favorable than Stop are provided with a Number Plate, when the signal must be in a location adjacent thereto as seen from an approaching train except as otherwise provided. <i>Require Number Plate, as shown.</i>					
 283 CLEAR-MEDIUM Proceed through crossovers or turnout with entire train at not exceeding Medium speed, then resume Normal speed to next signal.		 287 CLEAR-SLOW Proceed through crossovers or turnout with entire train at not exceeding Slow speed, then resume Normal speed to next signal.		 292 STOP Stop. See Rule 509.					
 284 APPROACH SLOW Approach next signal at not exceeding Slow speed.		 289 PERMISSIVE Block occupied, proceed prepared to stop short of train ahead.		 509-C GRADE PLACARD (example) The presence of this sign on or near a permissive signal allows trains to proceed upon a Stop and Proceed indication without stopping. See Rule 509(c).					
 278A APPROACH SPRING SWITCH INDICATOR Prepare to stop at spring switch.		 279B APPROACH SPRING SWITCH INDICATOR Spring switch in advance properly lined.		 280A SPRING SWITCH INDICATOR Stop and examine spring switch point.		 280B SPRING SWITCH INDICATOR Spring switch points in proper position.			
 296 TELEPHONE T.O. SIGNAL: STOP Stop on main track and report for instructions. Rule 509(d) governs.		 297 TELEPHONE T.O. SIGNAL: TAKE SIDING Freight trains: take siding, and when clear of main track, report for instructions. Rule 509(d) governs. Passenger trains: report for instructions before pulling in to siding. Rule 509(d) governs.		 298 TELEPHONE T.O. SIGNAL: PROCEED Proceed as directed by block signal indication regardless of following superior trains. Rule 509(d) governs.					
 293 T.O. SIGNAL: TRAIN ORDERS Slow or stop to receive orders as required per Timetable, Order, or Special Instructions. [Locations of Train Order signals are designated by Timetable.]		 294 T.O. SIGNAL: NO ORDERS Proceed per existing orders. [Locations of Train Order signals are designated by Timetable.]		 295 DUMMY MAST (DOLL ARM) One or more tracks intervene between the signal and the track governed by the signal. When more than one track intervenes, the number of dummy arms is increased accordingly.		 296 BRACKETTED/ADJACENT SIGNALS The right-hand signal governs right-hand track, and left-hand signal governs left-hand track. Signals on superstructures govern the track that they are placed over.			
 93 YARD LIMITS BOARD (example) Within Yard Limits the main track may be used, protecting against First Class trains. All other trains and engines must move on main track within Yard Limits prepared to stop unless the main track is seen or known to be clear. Rule 93 is not relieved.		 277 TEMPORARY DETOUR BOARD Pre-arranged detour as outlined by special order begins in one mile. [Bottom panel is hinged to be able to obscure the top panel when it is not needed.]		 278 WORK AREA BOARD Expect track or repair gang working in 1000 feet. Sound whistle per Rule 14(b).		 279 STOP BOARD Stop before passing the Stop Board and proceed as directed in Timetable or order.			
 274 TEMPORARY SLOW SPEED BOARD Track one mile distant not in condition for regular speed. Special Order indicates speed restriction. Do not exceed speed specified in Special Order, or 6 MPH if no Special Order known or seen, in one mile. [Board has two yellow reflectors.]		 275 TEMPORARY SPEED RESTRICTION STARTS BOARD Proceed not exceeding speed specified in Special Order. If Special Order has not been seen, 6 MPH must be observed. Restriction applies until entire train has passed. Resume Speed Board. Sound whistle as required by rule 14(m). [Board has one yellow reflector.]		 276 RESUME SPEED BOARD End of temporary speed restriction at this point. Resume speed once entire train has passed this sign board. [Board has one green reflector.]					
 271 ADVANCE SPEED RESTRICTION SIGN (ERIE) Track one mile in advance restricted to speed indicated. Pass Speed Restriction Sign ahead not exceeding the speed indicated.		 272 SPEED RESTRICTION SIGN (ERIE) Pass this sign not exceeding speed previously indicated on Advance Speed Restriction Sign. Sound whistle as required by rule 14(m).		 273 RESUME SPEED SIGN (ERIE) Resume speed once the entire train has passed this sign.					
 270A PERMANENT SPEED RESTRICTION SIGN (LACKAWANNA) Pass this sign not exceeding the speed indicated on the lower sign. The top sign indicates the permissible speed at the next restriction in advance. Where three or more tracks are in service, speed signs will indicate track on which restriction applies as TR-1, TR-2, etcetera.		 270B ADVANCE PERMANENT SPEED RESTRICTION SIGN (LACKAWANNA) Speed restriction as shown starts 2500 feet past this sign. Where three or more tracks are in service, speed signs will indicate track on which restriction applies as TR-1, TR-2, etcetera.		STANDARD SPEEDS Maximized Authorized Speed (MAS) – The maximum speed authorized by timetable, or by Special Order, for a Division or Sub-Division. Medium Speed – A speed not exceeding 30 MPH unless otherwise provided. Slow Speed – A speed not exceeding 15 MPH unless otherwise provided.		RESTRICTED SPEED Proceed prepared to stop short of train, obstruction, or anything that may require the speed of the train to be reduced.			

Note that rules and their names, aspects, and indications were added since 1925



DL&W signals not needing more than 3 aspects omitted lower yellow



Aspects involving flashing lights

Flashing lights were added to increase the number of available aspects/indications without adding more colors or heads (though at the cost of increased circuit complexity).

An aspect with a flashing light is always less restrictive than the same colors held steady. That's so that, if the flashing circuit gets stuck in the "on" position, it is "failing safe".

Flash rate is between 50 and 65 Hz - about one cycle per second.

Normally only one head flashes at a time, but ...

CN and CP have some where two heads flash (alternately)

TIME TABLE No. 86 — APRIL 27th, 1975			
BLOCK AND INTERLOCKING SIGNALS			
The following block and interlocking signal indications will supersede signal indications shown in the Uniform Code of Operating Rules only where authorized in the Subdivision footnotes, bulletins or train orders. Lights may be to either side of signal mast and number plates may be provided for the purpose of identifying location. Indications may be on dwarf signals, high signals or bridge structures.			
RULE		NAME	INDICATION
294		Clear Signal	Proceed.
294A		Clear to Limited	Proceed, approaching next signal at limited speed.
294B		Clear to Medium	Proceed, approaching next signal at medium speed.
294C		Clear to Slow	Proceed, approaching next signal at slow speed.
294D		Clear to Stop	Proceed, preparing to stop at next signal.
295		Limited to Clear	Proceed, limited speed within interlocking limits or through turnouts.
295A		Limited to Limited	Proceed, limited speed within interlocking limits or through turnouts approaching next signal at limited speed.
295B		Limited to Medium	Proceed, limited speed within interlocking limits or through turnouts approaching next signal at medium speed.
295C		Limited to Slow	Proceed, limited speed within interlocking limits or through turnouts approaching next signal at slow speed.
295D		Limited to Stop	Proceed, limited speed within interlocking limits or through turnouts preparing to stop at next signal.

TIME TABLE No. 86 — APRIL 27th, 1975			
296		Medium to Clear	Proceed, medium speed within interlocking limits or through turnouts.
296A		Medium to Limited	Proceed, medium speed within interlocking limits or through turnouts approaching next signal at limited speed.
296B		Medium to Medium	Proceed, medium speed within interlocking limits or through turnouts approaching next signal at medium speed.
296C		Medium to Slow	Proceed, medium speed within interlocking limits or through turnouts approaching next signal at slow speed.
296D		Medium to Stop	Proceed, medium speed within interlocking limits or through turnouts preparing to stop at next signal.
297		Slow to Clear	Proceed, slow speed within interlocking limits or through turnouts.
297A		Slow to Stop	Proceed, slow speed within interlocking limits or through turnouts preparing to stop at next signal.
297B		Restricting Signal	Proceed at restricted speed.
298		Stop and Proceed Signal	Stop, then proceed at restricted speed.
298A		Grade Signal	Trains handling fifty per cent or more of ruling grade tonnage approaching a grade signal indicating "stop, then proceed at restricted speed" may pass it without stopping and proceed at restricted speed.
299		Stop Signal	Stop.
300		Take (or leave) Siding Signal	Be governed by signal indication. Take (or leave) siding when "S" lighted or light flashing. NOTE: Lighted "S" or flashing light is used in conjunction with a block or interlocking signal.

IV. Signal systems - A. Manual - block, train-on-branch

Prior to the invention of automatic block occupancy detection, signals at block limits were set manually. In cases where no telegraph lines existed between stations signals were cleared based on the time since the last train passed. With telegraphy, blocks were cleared when the next block's operator noted the train's passage.

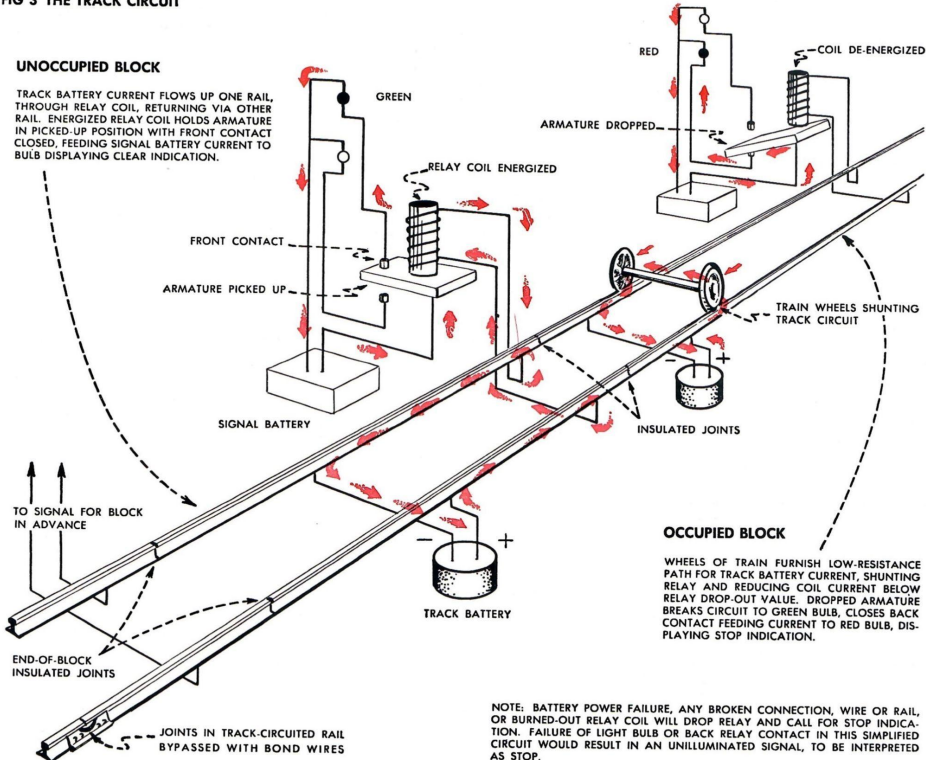
A special case of this is the train-on-branch signal, where only one train is allowed on a branch at a time. In this case the signal is set to stop when the train enters the branch by the train's crew, and cleared by the crew when it leaves the branch.

Train-on-branch semaphore



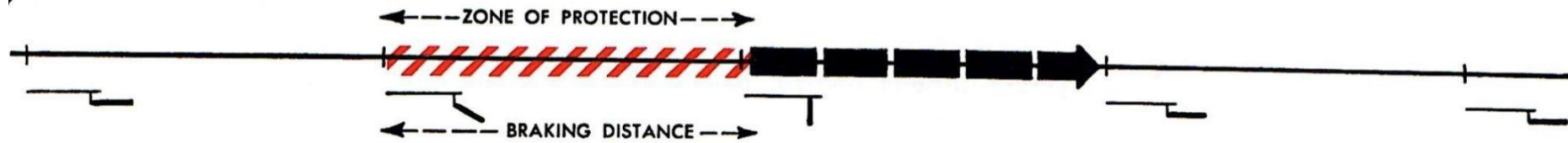
IV. Signal systems - B. Automatic block signals (ABS)

FIG 3 THE TRACK CIRCUIT



NOTE: BATTERY POWER FAILURE, ANY BROKEN CONNECTION, WIRE OR RAIL, OR BURNED-OUT RELAY COIL WILL DROP RELAY AND CALL FOR STOP INDICATION. FAILURE OF LIGHT BULB OR BACK RELAY CONTACT IN THIS SIMPLIFIED CIRCUIT WOULD RESULT IN AN UNILLUMINATED SIGNAL, TO BE INTERPRETED AS STOP.

Basic R-Y-G signal with ABS provides only 1 block braking distance



But with increasing train speeds comes increasing braking distance, requiring longer blocks

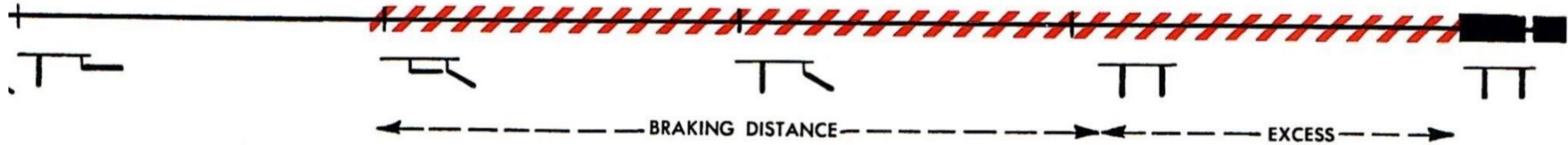


This reduces track capacity, as there's wasted space when a train nears the end of a long block



Solution - add more aspects to allow braking in advance

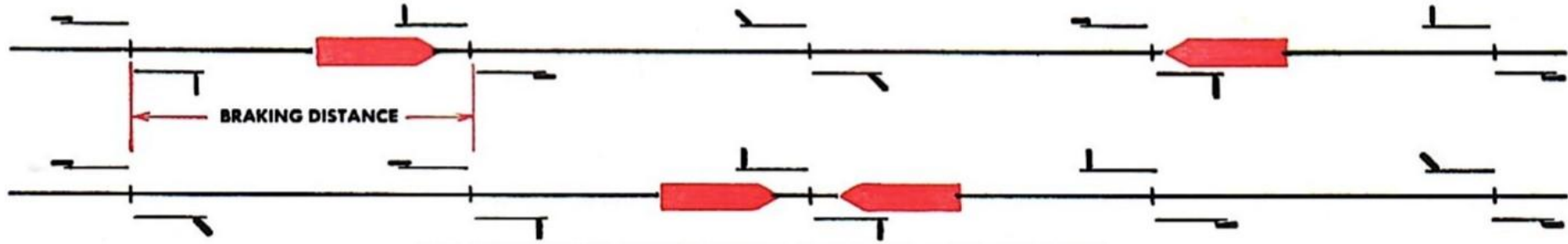
Approach medium displayed in the rear of the approach signal allows 2 blocks of braking.



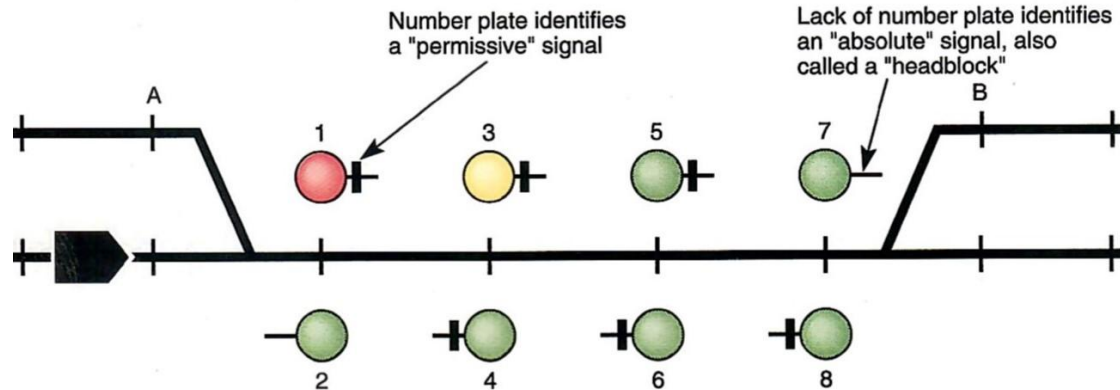
This reduces the wasted braking distance behind a train that's approaching the end on a block, because the blocks are shorter. They can be shortened further by adding another signal displaying a fifth aspect, advance approach, between the signals displaying approach medium and approach.

Basic 3 aspect ABS doesn't prevent cornfield meets

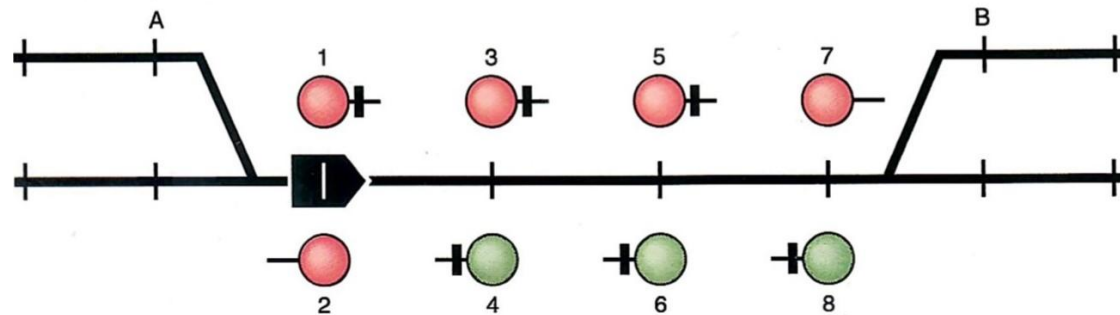
And even 4 or 5 aspect ABS only reduces their severity. If two trains approach the same block simultaneously neither will see a stop aspect. And even if two trains approach adjacent blocks from opposite directions simultaneously they won't encounter a stop signal till they're about to enter the block with the opposing train. Since they can't stop immediately they'll overrun the stop and likely collide.



IV. Signal systems - C. Absolute permissive block (APB)



Single track not occupied



Train enters single track

Do signals grant authority for trains to move?

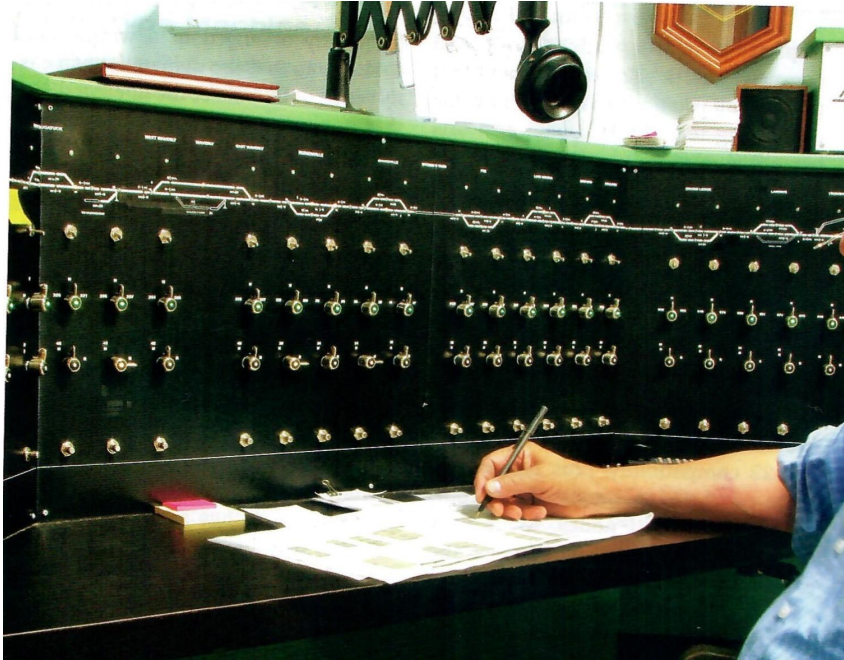
No, generally train orders (written or by radio, which can take the form of Direct Traffic Control or track warrants) are required in either ABS or APB territory for a train to move. The exception is rule 251, where if a direction of travel is established for a track, trains may move when ABS signals allow.

IV. Signal systems - D. Centralized traffic control (CTC)

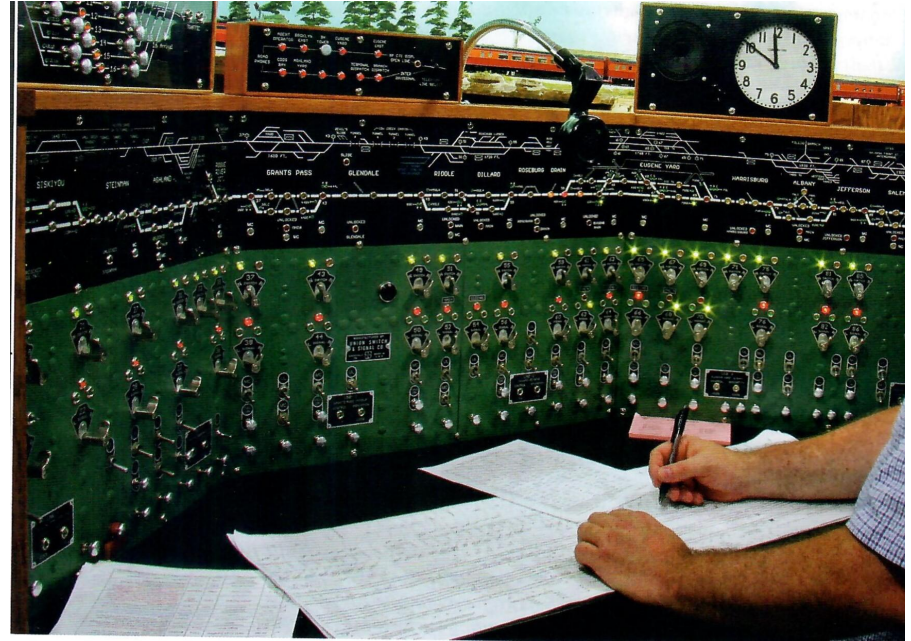
Strictly speaking, CTC is just one form of a Traffic Control System (TCS). A TCS allows operators to request that signals be set a certain way, and if the field circuitry allows, signals in that case do confer the right for a train to move.

CTC doesn't control every signal on a railroad, just those at control points. Intermediate signals are generally APB. All signals at control points are absolute. Control points are the ends of sidings, crossings, crossovers, and converging/diverging routes (i.e. junctions).

Example CTC Machines



GRS



US&S

V. A few notes on modeling fixed signals

1. Our model railroads generally have little track between one siding or junction to the next. 4 or 5 aspect ABS is not generally realistic. In fact most signals on a model railroad would be absolute.
2. LEDs when used as signal lights tend to be much more visible from the side than real signals, but that's not necessarily a bad thing as we generally view them from the side on our model railroads. If using a bicolor LED, the red and green dies should be aligned vertically as the color shift when both are on (to make yellow). The up-down viewing range is smaller than in the side-to-side direction. Usually that means aligning the two leads vertically rather than horizontally.

VI. The End - Time for Q & A



Credits by slide number (other than author's pictures)

2,58-61: "All About Signals" by John Armstrong, Copyright 1957 Kalmbach Publishing Co.

6: <https://www.american-rails.com/highball.html>

7: "Banner Box Signal" by Al Buchan & Bill Strassner, Clear Block Winter 2000

7: <https://railroadsignals.us/early/bannerbox/index.htm>

8: <https://old.signalbox.org/signals/bannersignals.htm>

9: "Of Banjos and Mandolins or What Do You Call a Disc Signal" by Don Ball, Clear Block Winter 2002

10: "The Banjo Signal and the Hall Disk Signal" by Don Ball, Clear Block Fall 1988

10: <http://www.railroad-signaling.com/semaphores/29.html>

12: <http://www.railroad-signaling.com/semaphores/8.html>, .../10.html, and .../28.html

14: <http://www.railroad-signaling.com/semaphores/4.html>

14: <https://railroadsignals.us/signals/sem/index.htm#TypesOf>

16. provided by Kevin Kohls, Clear Block, Winter 1997

17. <https://www.railroadsignals.us/rulebooks/NH25/index.htm>

18. <https://railroadsignals.us/early/smashboard/index.htm>

18. <https://www.irm.org/player/flag-stop-semaphore/>

Credits by slide number, continued

37: Richard W. Jahn photo, from RCT&HS 2026 calendar

46: <https://railroadsignals.us/rulebooks/up88/index.htm>

48: <https://www.ebay.com>

49: http://www.trainweb.org/s-trains/photos/projects/signal_b.gif

50: <https://rrmodelcraftsman.com/building-signals-for-the-lackawanna-in-ho/> (RMC 11/22)

51: <https://signals.jovet.net/rules/ELRR%20Signal%20Rules.pdf>

52: <https://railroadsignals.us/rulebooks/dlw25/dlw25.pdf>

53: <https://www.rrpicturearchives.net/showPicture.aspx?id=2149736>

55: <https://railroadsignals.us/rulebooks/CN75/index.htm>

62: "Absolute-Permissive Block signals: 1" by Jay S. Boggess, Model Railroader November 1991

65: "Understanding Railroad Signals Part 10" by Dr. Bruce Chubb, Railroad Model Craftsman October 2016