

**SYDNEY LIVE STEAM LOCOMOTIVE SOCIETY
CO-OP LTD.**

GROUND LEVEL RAILWAY

SIGNALLING SYSTEM

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REVISED 1996

1 Introduction

Visitors to our railway are always impressed by the efficient way that the ground level railway operates. The running of 4 six car trains with a capacity of up to 30 people per train and the giving of over 2000 rides in an afternoon requires train operations to be reliable and safe.

An important part in this efficient operation is played by the Signalling System and those who operate it.

In response to requests for information, as an aid to encourage new signalmen, and to document its principles and limitations, this small publication has been prepared based on past newsletter articles, amended and expanded where necessary.

I hope it helps to permit members to further enjoy the running of our miniature railway.

2 Description of the Signals

Signals are based on NSW Railway practice and are one quarter full size.

The indications displayed are the same as in full sized practice for single light signals except that no marker light is fitted to any signal. Marker lights are fitted so that drivers will not miss a signal if the main lamp is out. As this is unlikely on our railway (and the consequences are not as severe,) they are not fitted to our signals. Queensland and British Rail don't fit marker lights anyway, so even in full size there are differing opinions as to their necessity.

So that all are aware of the indications; the attached diagram shows the indications that drivers will encounter.

Although signals will drop back to stop as the train passes, they in no way indicate the state of the track ahead, except that they are operated by the signalman, so always watch out for the other train.

However being fully interlocked, they do indicate that points are in the correct position and locked and that no opposing signals have been cleared.

All the colour light main signals are fitted with correct lenses. An 18w 24 volt globe is used for each aspect except the turnout and shunt signals which are a miniature 24v lamp. No reflectors are fitted to avoid "phantom" indications (i.e. the lens lighting up due to the sun shining into them).

Main line signals are post or signal bridge mounted while the shunt signals are mounted low on the ground.

The platforms are provided with guards indicators to advise the guard at the rear of the train when the starting signal has been cleared and the train can depart. These show a white light.

Three full size railway banner signals are also installed.

The small electric banner on the Outer Main platform came from Gordon where it was mounted on the post of the down home signal. The banner authorised movements from the down main to the local platform and was replaced by a colour light shunt signal on 11th February 1987. The banner was designed for operation on 120v AC but works OK at 24v DC, which is our system's main voltage.

At Gordon the signal was mounted horizontally off the side of the post, so to suit our situation, during restoration, it was reassembled to sit on top of a vertical post. The main casting, which is aluminium, was badly distorted and warped but some professional work to correct this means that we now have the best assembled banner in the state. Typically railway, it was covered in plenty of paint (railway painters only

apply it, not remove it!) which caused the sand blasters to grimace. While the age is uncertain, it would date from the 1920's or 30's.

The banner, which is situated near the ground level locomotive depot is electro-pneumatic. 120v AC magnet valves control air to the mechanism which operated the arms quite smartly.

This signal was decommissioned at Hornsby on 15th February 1987 (old 126/128 signal) and again was replaced by a colour light. If the signal is original it would date from the 1920/30's, but obviously considerable work has been done on it during its life as the wiring in it is most modern.

The third banner is a wrong road banner from St. Mary's (ex No.20 signal). This is a 120v AC mechanism. This is a more modern unit than the Gordon banner, and contains mercury tilt switches within the mechanism to provide indications back to the signal box.

The number plate fitted to main line signals carries letters to indicate the line it applies to and the control lever number. The letters are as follows:

O Outer **OL** Outer Loop **I** Inner **IL** Inner Loop

A typical number plate would thus be 0 45.48 which means the signal applies to the outer and is controlled by two levers, numbers 45 and 48 (in this case 45 is for the turnout and 48 the main line).

Main line signals return to stop as the train passes, but shunt signals are not fitted with this feature.

3 The Signal Box

3.1 General Description

The ground level railway Signal Box consists of 48 miniature Westinghouse type levers, similar to Sydenham (now replaced) and Newcastle signal boxes. Behind these levers are lever name plates. These show the number of the lever and indicating lights relevant to that lever, as well as the name of the function it operates. A drawing of the lever nameplate arrangements is provided.

Above the windows is a "Box Diagram" showing the naming of the tracks, and all signal and point numbers. The signal numbers are in red and relate to the red levers, the points being black. The two closing levers are blue and spare levers are white.

The levers are *normal* when they are back in the frame and *reverse* when pulled toward you. All the points in the "Box Diagram" are drawn in the *normal* position.

For safety, all functions are electrically interlocked, however there is no point to point interlocking.

The indicating lights behind the levers show whether that function has responded to the lever movement. These lights mean the following (see the attached diagram).

Signal Levers: A green repeater light illuminates when the signal is cleared.

Points Levers: Yellow *normal* light indicates when the points are *normal* (i.e. lying the same way as shown in the diagram).

Yellow "Reverse" light indicates when the points are reverse.

Red "Transit" light flashes when point detection is lost, to attract the signalman's attention.

Green "Free" light indicates when no locking is applied to the points by other functions and that they will respond to movement of the lever.

3.2 Operation

It is always best to start with all levers normal.

To clear a signal, first pull over any points required to be reverse for that signal. In doing this, first check that the *free* light is illuminated. This indicates that the locking is free. Then pull the lever right over. The *normal* light will go out and while the points are moving the *transit* light will flash. When the points have completed their travel the *reverse* light will illuminate. Only then, and not when in transit, operate the signal lever. The green repeater illuminating behind this lever verifies the signal has cleared.

Note that when the signal lever is pulled, the points *free* light goes out indicating that they are now locked.

When the train is completely past that signal, put the levers back in the reverse order, i.e. signal levers first, then the points.

Note that if the signal lever is pulled before the points have completed their travel, they will stop mid stroke (the signal, of course, will stay at red).

All main running signals will go to red when the train passes. To reclear the signal, simply put the lever normal and then

THE SYDNEY LIVE STEAM LOCOMOTIVE SOCIETY

SIGNAL INDICATIONS

RUNNING SIGNALS



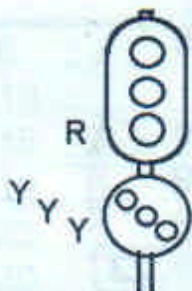
STOP



CAUTION
NEXT SIGNAL
AT STOP

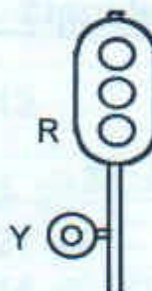


CLEAR
PROCEED



CAUTION
TURNOUT

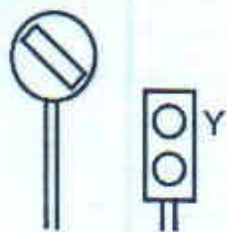
PROCEED THROUGH
TURNOUT TO THE LEFT.
NEXT SIGNAL
MAY BE AT STOP



SHUNT

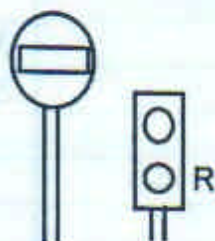
PROCEED THROUGH TURNOUT
TO THE LEFT, BEING PREPARED
TO STOP SHORT OF
ANY OBSTRUCTION

SHUNTING SIGNALS



SHUNT

PROCEED, BUT BE PREPARED
TO STOP SHORT OF
ANY OBSTRUCTION



STOP

GUARD'S INDICATOR



WHITE LIGHT DISPLAYED
WHEN THE SIGNAL AT THE
END OF THE PLATFORM IS CLEARED

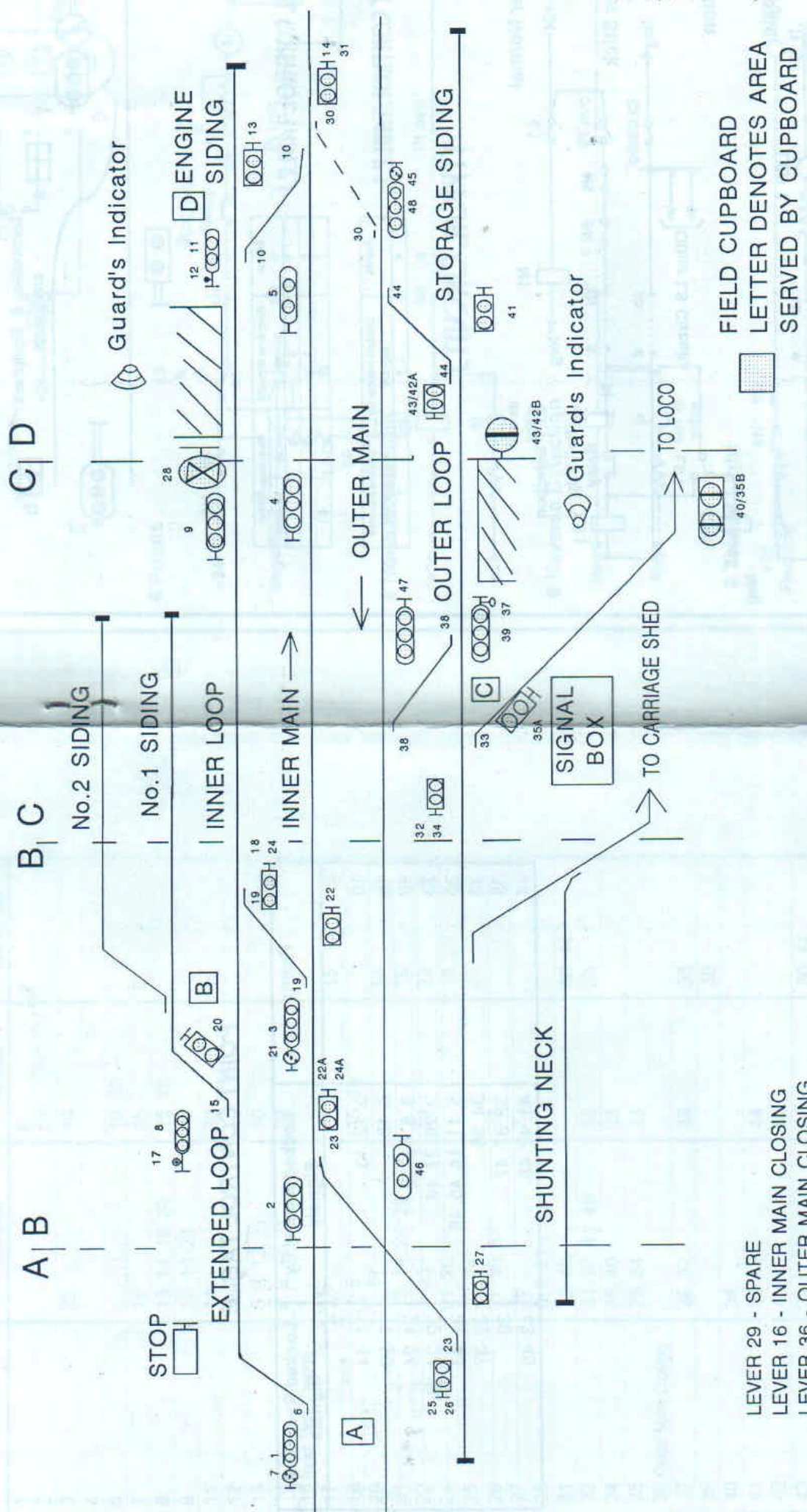
SIGNAL CONTROL TABLE

Signal	Requires Signals Normal	Requires Points	
		Normal	Reverse
1		6	
2		23	
3	22	19	
4			
5		10. 30	
7	18	15	6
8	13. 14. 18. 28	15. 19	
9	13. 14. 28		
11	14	30	10
12	13	10	
13	8. 9. 12. 21	10	
14	8. 9. 11. 21	30	
16 Inner Main Closing			
17	20		15
18	7. 8	15. 19	
20	7. 17		15
21	13. 14. 24. 28		19
22	3. 25	19	23
24	21. 25		19. 23
25	22. 24		23
26	27. 35. 37	23	
27	26	23	
28	8. 9. 21		
31	32. 43		30. 44
32	31. 37. 41. 45	38	33
34	35. 40	33	
35	26. 34	33	
36 Outer Main Closing			
37	26. 32	38	33
39			38
40	34		
41	32. 42	44	
42	41	44	
43	31		30. 44
45	32		44
46		23	
47		38	
48		44	

POINT CONTROL TABLE

Points	Locked Normal By Signals	Locked Reverse By Signals
6	1	7
10	5. 12. 13	11. 14
15	8. 18	17. 20
19	3. 8. 18. 22	21. 24
23	2. 26. 27. 46	22. 24. 25
30	5. 11. 14. 45. 48	31. 43
33	34. 35	32. 37
38	32. 37. 47	39
44	41. 42. 48	43. 45

SLSLS GROUND LEVEL RAILWAY SIGNALLING



LEVER 29 - SPARE
 LEVER 16 - INNER MAIN CLOSING
 LEVER 36 - OUTER MAIN CLOSING

FIELD CUPBOARD
 LETTER DENOTES AREA
 SERVED BY CUPBOARD

SAMPLE SIGNALLED LAYOUT



Termination & Equipment cupboards



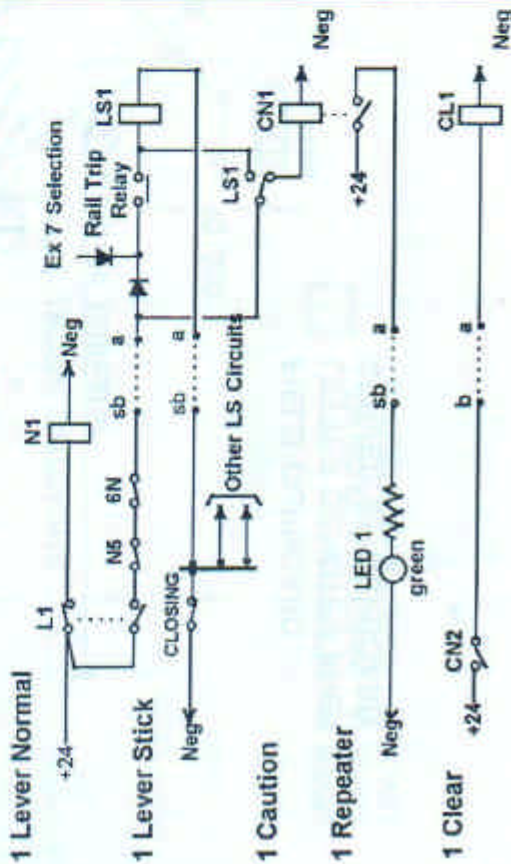
Signal	Requires Signals		Requires Points	
	Normal	Reverse	Normal	Reverse
1	5	0	0	6
6	1	6	6	0
7	1	6	6	0

SIGNAL CONTROL TABLES

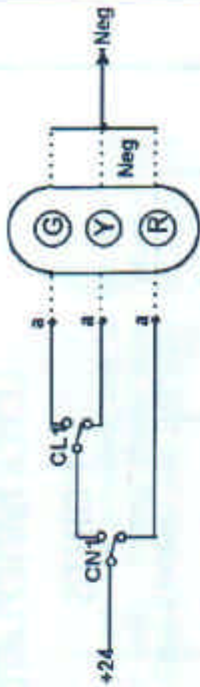
Points	Locked Normal By Signals		Locked Reverse By Signals	
	1, 0	6	7	0
6	1, 0	6	7	0

POINT CONTROL TABLES

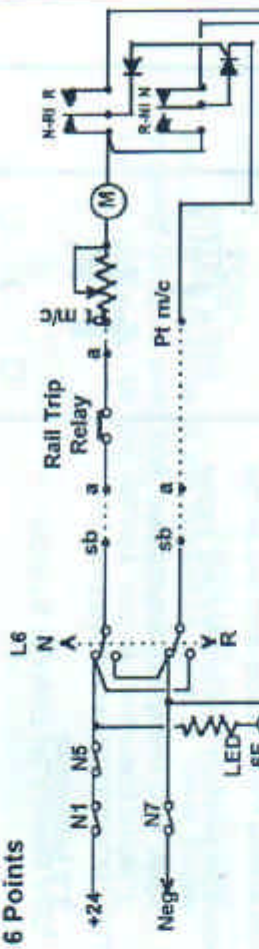
TYPICAL CIRCUITS



1 Signal



6 Points



6 Normal Detection



6 Reverse Detection



6 Transit Light



GLOSSARY

N-Normal; R-Reverse; L-Lever; LS-Lever Stick; CL-Clear; CN-Caution; CL-Clear F-Free; T-Transit
N-Rl, Made except when reverse; Nl-R, Made except when normal; sb-Signal Box

LEVER NAMEPLATES

POINTS



POINTS FREE (*GREEN*)

POINTS REVERSE (*YELLOW*)

POINTS TRANSIT (*FLASHING RED*)

POINTS NORMAL DETECTION (*YELLOW*)

LEVER NUMBER

ABOVE THE LINE: ROUTE WHEN POINTS NORMAL

BELOW THE LINE: ROUTE WHEN POINTS REVERSE

SIGNALS



REPEATER LIGHT (*GREEN*)

LEVER NUMBER

SIGNAL NAME & FUNCTION

NUMBERS OF OTHER LEVERS THAT NEED TO BE PULLED BEFORE THIS ONE CAN

reverse again.

Two blue "closing levers" are provided, one for the inner and one for the outer main. Pulling these levers reverse will disable this feature (useful when only one train running on the relevant track).

3.3 Problems

If, when operating the box, you get tied up, i.e. signals will not clear, and points will not operate, you have probably pulled a wrong lever, or done something out of sequence. Simply put back all levers and start again.

If when operating the points they go over but do not make detection, the point motor will continue to work. If this occurs put the point lever in the centre position (this cuts power to the machine and prevents anything burning out). The most likely cause is dirty points, or some obstruction in the blades such as a leaf. The point machines are set to detect the blade within about 20 thou. of the stock rail to ensure wheels do not split the points.

It is good practice to inspect and oil all the points prior to operation, particularly if they have not been operated for some time. Any other problems will require chasing through the circuitry.

The signals can be dimmed for night running by operating the HI-LO switch on the main supply transformer under the left hand side of the console, to LO. This changes the transformer tapping, dropping the lamp voltage from 23V to about 17V.

A complete set of up to date circuit diagrams is available in the signal box for fault finding. These documents include interlocking charts which detail the actual interlocking applied in the electrics.

4 Track Locking

The equipment that places the signals to stop on passage of a train is utilised to provide additional protection by cutting power to the points. The incorporation of a timer of about 7 seconds and additional rail trips ensures that the main line points cannot be moved while a train is passing over them. (Note that this is not provided for the shunt signals).

This feature prevents the accidental operation of points under the train with the consequential risk of derailment, damage to the point blades, or damage to the loco or rolling stock.

5 Electrical Infrastructure

The system is comprised of relays, terminals and wiring.

Beneath the lever frame is a large terminal board, and relay banks. These relays are old post office type working on 24v. DC and perform three main functions: signal lever normal, points normal detectors; and points reverse detectors. All the interlocking is done by wiring through the contacts on these relays.

Automotive style cables run from the signal box to one of four trackside termination boxes. These boxes contain local control relays and any local apparatus is wired out of these boxes.

The relays in these boxes include signal control relays (for shunt and turnout signals), signal caution relays (for the yellow aspect on main signals) and signal clear relays (for the green aspect).

When points are double ended, one end operates local detection relays which in turns cut the detection circuits for the other end enroute to the main detection relays in the signal box.

Also included in the local termination boxes is a lever stick relay. This is the function that returns the signal to stop (in conjunction with the track trips) and keeps it at red until the lever is restroked. (The 'stick' refers to a function that self holds once initiated).

All relays in the termination boxes are plug in cradle types except the track trips which are reed switch relays operated by 555 timer integrated circuits. These IC's are capacitor coupled to sleeper mounted wheel trip wires. When a wheel passes across a trip the timer is triggered by a voltage pulse which then operates the lever stick relay via the reed switch relay. The timer also cuts the point motor circuits. This ensures that the points cannot be operated with a train passing by.

All wiring is numbered with a system that relates that particular part of the circuit to the control number. This helps in fault finding.

The Signal Box also houses a variety of power supplies. The major transformer powers 2 rectifiers which each supplies 2 of the trackside termination boxes. A second transformer provides the Signal Box 24 volt. Two other supplies are provided; one for the telephones, and a regulated supply for the electronics. A small 555 timer circuit provides a flashing supply for the point transit lights Total supply is around 30 amps.

All the supplies are unearthed, however, the electronic supply has its negative connected to the rails for operation of the rail trips. This actually occurs via a "power-on" relay which ensures that the system is isolated from the track when turned off to prevent electrical surges (lightning) from entering and damaging the electronics.

Dual power supply indicator lamps (centre earthed to rail) are provided across the signal box supply. When all is in order these glow equally but should a defect occur (such as a diode shorting to frame) one light becomes considerably brighter than the other. These faults can then be relatively easily tracked down before a second fault causes problems.

The diagram showing the typical circuit arrangements gives an idea of the philosophy employed in the design.

All the point machines have heaters fitted to limit condensation problems. These are permanently on and are powered from a specially fireproofed transformer mounted in the carriage shed.

6 Some Fundamental Principles

Railway signalling systems are quite unlike road traffic signals. For the system to be effective it is essential that drivers must have faith in the system. It is very easy for a system to become an encumbrance rather than an asset if it is not reliable, or shows conflicting aspects, etc.

The key elements are:

- a) consistent signal indications
- b) appropriate signal locations so that drivers always know which signal refers to their train
- c) correct design principles so the system "fails safe" and cannot show irregular aspects
- d) high reliability.

As far as drivers are concerned, railway signals should only step up their aspects (i.e. from red to yellow to green). Should a signal change to red in face of a train, the driver is quite entitled to treat it as an emergency situation.

So an important element in this system is the signalman.

7 DO'S AND DON'TS FOR SIGNALMEN

The basic interlocking and track locking provided in our system protects us against most signalmen's errors. However, the following points should ensure the best operation.

DO

- ◆ clear signals for the next train as early as possible.
- ◆ protect any risks by keeping two signals at stop, until you are sure the driver is aware of the risk and has reduced his speed.
- ◆ advise drivers if they go through stop signals (politely!)
- ◆ give priority to trains with passengers.
- ◆ be patient.

DON'T

- ◆ tempt fate by operating point levers while trains are travelling over or approaching points.
- ◆ alter any route for which a signal has been cleared until you are sure the driver is responding correctly to the replaced signal indication.
- ◆ operate signal levers until points operated first have indicated detection.
- ◆ put signal levers back until the train has cleared the points the signal protects.
- ◆ try and drive the train by stopping it where you think is best. Leave the driving to the driver.
- ◆ rush any lever movements - look and think first.
- ◆ be distracted.

8 DO'S AND DON'TS FOR DRIVERS

DO

- ◆ stop at red signals
- ◆ be vigilant
- ◆ use the telephones to communicate your intentions to the signalman
- ◆ be familiar with the signals that apply to your train movements

DON'T

- ◆ assume the signal is at stop because you have been forgotten
- ◆ anticipate you have the road; drive on the signals
- ◆ pass a red signal unless instructed to do so
- ◆ surprise the signalman; plan any shunts with him in advance.