4 SIGNALLING AND TELECOMMUNICATIONS

4.1. SAFEGUARDING OF TRAIN MOVEMENTS

Principle 4.1 Safeguarding of train movements

Systems are required to ensure that trains are authorised to proceed only when and to the extent it is safe for them to do so, to minimise risk of collision and, so far as the system can reasonably control it, also to minimise the risk of derailment.

4.1.1. Signalling Safety Objectives

4.1.1.1. The primary safety objective of any signalling system is to:

(a) prevent collision between trains;

(b) prevent derailment of trains at incorrectly set points or inadequately locked facing points;

(c) give an authority to proceed which does not conflict with the route set;

(d) protect level crossings (section 5 level crossings); and

(e) protect moveable bridges.

4.1.1.2. A signalling system may be enhanced by the provision of an advisory warning system (e.g. CAWS) which alerts drivers to cautionary signal aspects, and provides an indication of the aspects of lineside signals. The signalling system may be enhanced further by the provision of Automatic Train Protection (ATP) to prevent danger from trains passing signals at which they are required to stop, or exceeding permitted speeds. Automatic Train Operation (ATO) systems may be introduced to Light Railways to permit operations without supervision and control by drivers.

4.1.1.3. A signalling system may be further enhanced to:

(a) give indications that enable the safe maximum speed relative to:

(i) track condition and geometry;

(ii) distances to signals or obstructions to be known and not exceeded;

(b) detect and protect against failures of, or damage to, structures, track or the railway formation;

(c) detect and protect against trespass by people, vehicles or (adjacent to airports) aircraft onto the railway;

(d) detect and protect against derailed or dragging equipment from trains, or other train monitoring equipment such as ‘hot box’ detectors; and

(e) provide protection to people working on or near the track.

4.1.1.4. With some railway operations, very simple forms of train operation and signalling systems may be satisfactory. Where the railway operates at a relatively low speed and safety of operation can be ensured by a system of driving on-sight, no signalling system, as such, may be required.

4.1.1.5. However, the majority of railways will require a signalling system. Types of signalling system will depend upon the type of line and the speed and frequency of trains on the line. The process of choosing a signalling system and the key factors which may influence the choice are illustrated by Figure 1.

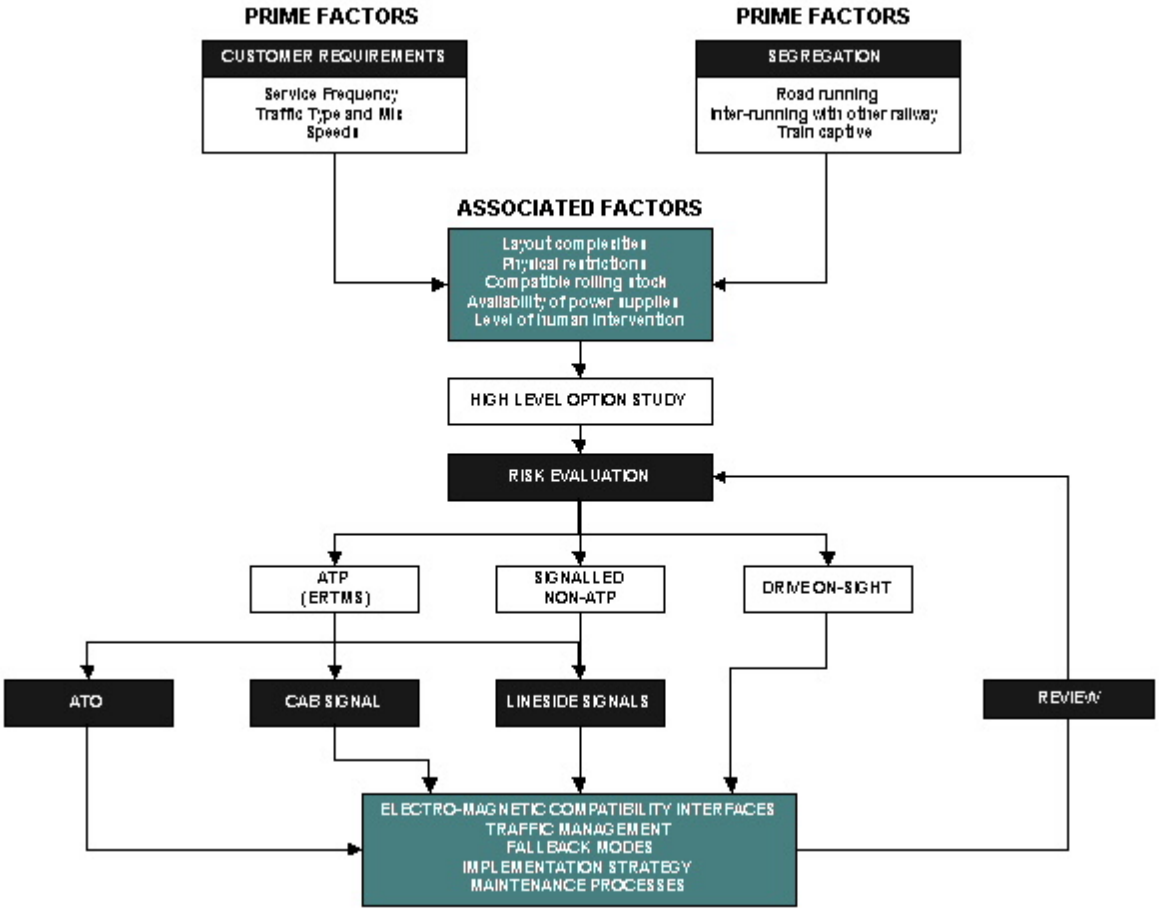

Figure 1 : Choosing a Signalling System

4.1.1.6. When choosing a signalling system, the balance between automatic technology and the level of human input into the safe operation of the railway should be considered to reduce the opportunity for human error. The choice of signalling system should be supported by an appropriate risk assessment.

4.1.1.7. All aspects of the signalling system should be designed with the provision of practical maintenance and operational diagnostics in mind. Particular factors to consider for diagnostics are:

(a) Security of access.

(b) Security to the safety integrity of the signalling systems itself.

(c) Provision of remote access or automatic dial up to improve availability.

(d) Speed in identifying failures.

4.1.1.8. Programmable electronic signalling systems which contain site specific data should be demonstrated to have an adequate configuration management system.

4.2. DETECTION OF TRAINS

Principle 4.2 Detection of trains

Appropriate means should be provided to detect and record the passage of trains on the system.

Note: The term 'record' may be considered as a paper record such as a Train Register, or the acknowledgment of its passage by automatic interlocking controls

4.2.1. Train detection

4.2.1.1. A train location system with an accuracy which is appropriate to the method of separation and the signalling system is required. The level of integrity of the train location system should be consistent with the overall safety of the signalling system. Train location measures may range from the visual observation of trains to fully automatic means of detection (e.g. track circuits). The appropriate method will depend on the type of signalling system employed. In some instances, it may be necessary to establish accurately the position of both ends of the train at the same time.

4.2.1.2. Compatibility between trains and the detection system is required for automatic train detection using either track circuits which detect the presence of axles, axle counters which detect the movement of wheels or other technology such as satellite positioning and radio transmission. The factors to be taken into account should include interference from electric traction systems, under both normal and fault conditions, and the condition of wheel and rail surfaces.

4.2.1.3. Where moving block systems such as ERTMS Level 3 are to be employed the availability of the radio system and its compatibility with the environment should be demonstrated to be sufficient to support the signalling system.

4.2.1.4. The train detection system is required to be sufficiently precise to ensure that the position of the train in relation to the point to be protected is known with an accuracy necessary to ensure safety (see section 6 Trains). Unless it can be shown that the risk of a train becoming divided is acceptably low, the train detection system should be capable of identifying and safeguarding against the effects of train division.

4.2.1.5. Train detections systems which rely on volatile memory devices to record the presence of a train (e.g. axle counters systems), should incorporate a safe means of bringing them back into use following any maintenance or other disruption or failure.

4.2.2. Detection by axle movement (Axle Counters)

4.2.2.1. Opportunities provided by axle presence detection which are lost when using axle counters should be analysed and the risk controlled, particular consideration should be given to:

(a) Use of emergency protection (e.g. Track Circuit Operating Clips).

(b) Detection of Rail Breaks.

(c) Ability to establish the presence of a rail vehicle or obstruction prior to restoring the axle counter section to clear.

(d) Human error and equipment failure within the restoration process.

4.2.2.2. When a technician takes possession of the axle counter section, the system should protect against the technician or the signalman restoring the axle counter section back into service without co-operation between both parties (known as "co-operative reset")

4.2.2.3. Where multiple section axle counter systems are introduced the following additional controls should be provided:

(a) The system should protect against restoration of a section when the last movement was into the section (known as "conditional or preparatory reset").

(b) Before restoring a section the system should enforce a sequential two-step restoration process by the signalman. The steps should employ different types of action and should force a conscious action each time.

(c) The restoration process should be completed within a predetermined time once initiated otherwise the system should cause the restoration to fail and the process restarted.

(d) The system should provide sufficient information to allow the signalman to undertake the action safely.

(e) The signalman should have the facility to replace any signal which protects an axle counter section to danger.

4.3. SEPARATION OF TRAINS

Principle 4.3 Separation of trains

The signalling system should have sufficient logic (interlocking) to provide for the safe routing, spacing and control of trains and it should behave in a safe manner in the event of malfunction.

4.3.1. Train separation

4.3.1.1. The guidance in this section deals primarily with the safe spacing of the permitted traffic.

4.3.1.2. Train separation should be ensured by spacing trains according to their speed and rated braking performance. There are two main types of system used:

(a) a fixed space interval system where the line is divided into a series of 'fixed blocks'; or

(b) a 'moving block' system where a safe space is maintained ahead of a moving train commensurate with its speed relative to other trains.

4.3.1.3. Unless permissive working is allowed, the signalling system should not authorise a train to enter a block section until that section is proved to be clear.

4.3.1.4. The relationships between different types of block system are illustrated by Figure 2.

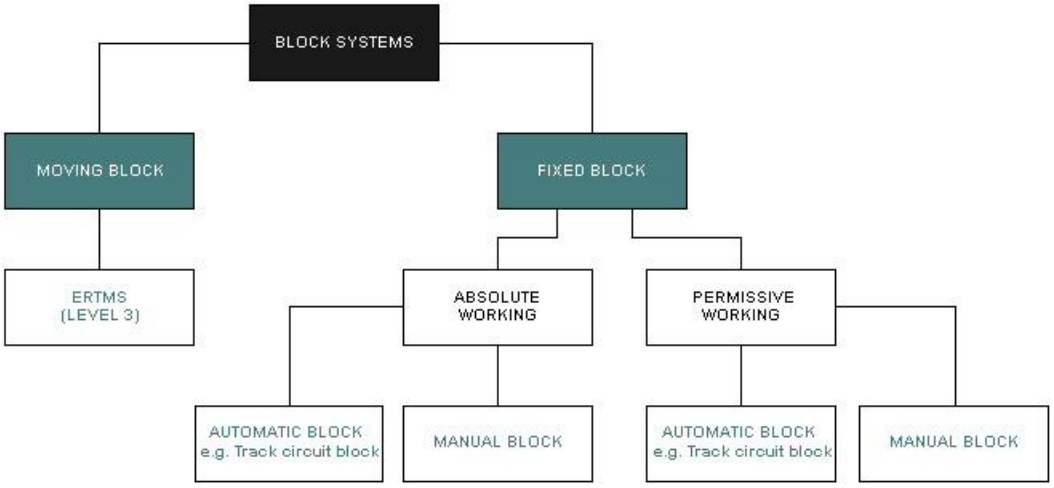

Figure 2 : Different Block Systems

4.3.1.5. A safe train separation distance should consist of:

(a) braking distance from the allowed maximum (and safe) speed; and

(b) a margin for safety.

4.3.1.6. The safety margin should be determined according to such factors as the maximum train speed, the type of train and braking system, and the presence or otherwise of automatic train protection.

4.3.1.7. A safe train separation distance in 'fixed block' systems may be assured by:

(a) maintaining one or more unoccupied intervening block sections;

(b) providing an 'overlap' beyond the end of the block section; or

(c) by controlling the entry speed into a block section by the 'delayed clearance' of a signal where a full (or any) overlap is not available.

4.3.1.8. The number and length of the intervening block sections and overlaps should take into account:

(a) the frequency of trains;

(b) the braking performance of the trains using the line;

(c) the topography of the line;

(d) the permissible train and line speed;

(e) the level of supervision provided by the signalling system on the driving of the train; and

(f) a margin for variation in the equipment or human performance.

4.3.1.9. Permissive working under which more than one train is permitted into a block section may be appropriate for:

(a) entering platforms at stations to enable passenger trains to be coupled or divided, or for locomotives to be exchanged; or

(b) low speed, driving on line-of-sight operations on freight only lines and loops.

Note: Permissive working is not considered appropriate for allowing two trains access to a platform for reasons other than to couple or uncouple.

4.3.2. Interlocking

4.3.2.1. The guidance in this section deals with safe routing, spacing and control of the permitted traffic.

4.3.2.2. Interlocking is required to ensure that the signalling system can authorise a train to proceed only when it is safe to do so, and to maintain the integrity of the route once authority to proceed has been given.

4.3.2.3. Point and signal controls must be interlocked so that no agency can clear a signal for the movement of a train unless the points are set and locked in the proper position. It must not be possible to clear at the same time any signals which may lead to a collision between trains.

Note: The terms 'authorise a train to proceed' and 'cancel the authority to proceed' may be considered as equivalent to 'clear a signal' and 'replace a signal'.

4.3.2.4. Interlocking controls are required for all regular train movements within the interlocking area.

Note : Movement of trains without the protection of the interlocking should only be undertaken following equipment failure and following predetermined safety arrangements.

4.3.2.5. Once the route has been set and locked, and the signals cleared, the interlocking must not permit any points on the route to be moved or conflicting signals to be cleared until the train has used it, or until it has been established that the train will not use it. Points should also be set to avoid the risk of collision.

4.3.2.6. The interlocking should allow colour light signals to display a Proceed aspect only for so long as the conditions which allowed it to display that aspect are maintained.

4.3.2.7. Interlocking may be implemented by, for example, the mechanical interlocking of signal and point levers, the use of electro-mechanical relays, or programmable electronic devices. Design and construction of mechanical or relay interlocking to inherently 'fail-safe' criteria are required. Programmable electronic interlocking should be designed to composite or reactive fail-safe criteria, using techniques such as redundancy, diversity and self-testing as described in European standards.

4.3.2.8. The interlocking logic should be documented in a form which is understandable by designers, railway operators, and signalling testing and maintenance staff.

Note: This may be achieved by expressing the logic conditions in a tabular form known as a 'control table'.

4.3.2.9. In the design of the interlocking, the factors which should be taken into account include:

(a) position ('lay') of points;

(b) track occupancy;

(c) overlaps;

(d) clearance points;

(e) moveable bridges;

(f) conflicting train movements;

(g) signal aspects;

(h) the enforced control of speed of trains at junctions, where the line speed is restricted, or on entering a terminal station or platform; and

(i) protection of people working on or near the track by staff warning systems.

4.3.3. Position of points

4.3.3.1. The interlocking should establish that the position of each switch blade is correct and the locking mechanism of points is properly engaged for train movements in the facing direction. Facing points should be locked in both 'normal' and 'reverse' positions unless specially agreed otherwise.

4.3.3.2. Where train detection is by an automatic means, the movement of points should be prevented when the section of track up to and through the points is occupied. This arrangement prevents the risk of derailment caused by points moving beneath a train. In some circumstances, on lines where train detection is not by an automatic means, other means of detecting the presence of a train up to and on the points may be required. E.g. locking and clearance bars.

4.3.3.3. The interlocking must prevent any signal from being cleared for any route for which the conditions for the lay, detection or locking have not been met. The loss of the necessary conditions after a signal has been cleared should result in the signal being automatically replaced to Stop. Mechanical signals will still need to be replaced manually, though loss is less likely other than those actions controlled by the signalman.

4.3.3.4. In areas of low density traffic and with a maximum linespeed of 40 km/h, trailable points may be introduced. For movements over the points in the facing direction detection should be provided, which is indicated to the driver by suitable means to ensure safe passage through the junction.

4.3.4. Track occupancy

4.3.4.1. Unless the signalling system permits permissive working, the interlocking is required to prevent a train from being signalled into an already occupied block section until that section is cleared.

4.3.4.2. On the railways worked on the 'absolute block' system, interlocking which links the block instruments with any train detection system and the control of the points and signals should be provided. This interlocking should prevent the signals being cleared for the entry of a second train into the block section until the signalling controls and block instruments have been operated.

4.3.4.3. Where automatic train detection systems are employed, route locking and route release should be engineered in such a way that transient conditions or faults in the train detection system do not allow conflicting routes to be set or routes to be prematurely released.

4.3.4.4. The interlocking should not be released until there is assurance that the train has completely travelled over the route. This may be achieved by the correct sequential occupation and clearance of the train detection system through the signalled route or by delaying the release for an appropriate period of time. To improve operational flexibility, progressive release of the interlocking with the passage of the train may be employed.

4.3.5. Overlaps

4.3.5.1. For the purposes of interlocking, the overlaps beyond the end of the signalling section should be considered as part of the section. The interlocking should not permit entry to the section unless the overlap is also proved to be clear (with the exception as described in 4.3.1.7 (c)). Where points are in the overlap they may be realigned unless the train enters the overlap when the guidance given in paragraphs 4.3.3.1 to 4.3.3.3 on the position of points applies. Depending on the lay of the points, different conditions may need to be applied by the interlocking.

4.3.6. Converging tracks

4.3.6.1. A clearance point is located where two converging tracks come sufficiently close together for vehicles on one track to be separated by the minimum passing clearance from vehicles on the other. It is the clearance point which should be protected by the interlocking rather than the

actual place at which the tracks intersect.

4.3.7. Conflicting train movements

4.3.7.1. To ensure that conflicting movements cannot be signalled, the interlocking should ensure that the signals protecting against conflicting or opposing train movements are established to be exhibiting a Stop aspect before the signal for the selected route is cleared. Should another train pass a signal at Stop, which is providing protection from a conflicting route, the interlocking should replace signals to Stop for the selected routes.

4.3.7.2. The interlocking should protect against a conflicting route being selected in the event of a route which has been selected and signals cleared for an approaching train being cancelled. Before the conflicting route can be selected, it should be proved that the approaching train has not entered the route and has stopped or will be able to stop.

4.3.7.3. The signalling and permanent way layout should be assessed for the risk of collisions due to trains passing signals at danger, and appropriate controls put in place to reduce this to As Low As Reasonably Practicable (ALARP).

4.3.8. Signal aspects

4.3.8.1. The interlocking is required to ensure that signals can exhibit aspects only in a correct sequence. A subsidiary aspect should be free to clear only when the main aspect is at Stop and other relevant conditions have been satisfied.

4.3.8.2. The interlocking should establish that the next signal is displaying an appropriate aspect before any signal is cleared. At junctions, a proceed route indication aspect should be displayed before the signal showing an appropriate speed aspect.

4.3.9. Stop signals

4.3.9.1. The interlocking should ensure that all signals, other than those which apply to a route which has been set, are maintained at Stop. It may permit more than one route to be selected, provided they are not in conflict.

4.3.9.2. The interlocking should not prevent a Stop signal being manually replaced to and maintained at Stop. Where it allows some signals to operate in an automatic mode controlled by the passage of trains, it should be possible to replace those signals to, and maintain them at, Stop from the signal cabin.

4.3.9.3. Where devices, such as trip wires, are installed to guard against obstruction of the railway, the interlocking may be used to return the signals to Stop when they are operated.

4.3.10. Distant signals

4.3.10.1. It should not be possible to clear a Distant signal unless all the associated Stop signals have been cleared.

4.3.10.2. Where a Distant signal is controlled from one signal cabin but mounted on the same post as a Stop signal controlled by the previous signal cabin, the interlocking should prevent the Distant signal being cleared when the Stop signal is not displaying a Proceed aspect.

4.3.11. Speed regulation

4.3.11.1. Interlocking may be used to control the speed of trains on the approach to junctions, speed restrictions or terminal platforms by delaying the clearance of a signal.

4.3.11.2. ATP and in-cab advisory systems should be used where the likelihood of trains passing signals protecting conflicting routes at danger is unacceptable.

4.4. INFORMATION TO DRIVERS

Principle 4.4 Information to drivers

The outputs of the control system should be presented to train drivers in a clear and safe manner.

4.4.1. Introduction

4.4.1.1. The guidance in this section deals with safe routing, spacing and control of the permitted traffic.

4.4.1.2. Trains should only be given an indication or instruction to move from a stationary position if the proposed route is safe. Regular or time-tabled train movements should only be signalled using appropriate interlocked routes.

4.4.1.3. Signals may include visual indications displayed to the train crew by means of coloured lights, semaphore positions, fixed markers, coloured flags (or similar manual operations), or may be automatically detected by the train and then indicated in the cab to the driver.

4.4.1.4. The indications and meanings of signals (both lineside and on-board systems) should be clear and without ambiguity. Mixing of different types of lineside signalling on the same section of line should be avoided. Where one type of lineside signalling changes to another (e.g. semaphore to colour light), or where on-board signalling starts or ends, particular care is required to avoid the risk of confusion.

4.4.2. Lineside signals

4.4.2.1. Colour-light signals are the preferred form of lineside signals. Semaphore signals may be used on lines which are operated at lower speeds and with a limited level of traffic.

4.4.2.2. The design of the signalling scheme should ensure that the driver does not see a lineside signal revert to danger following correct operation of the signalling system, as may occur with first wheel replacement.

4.4.3. Cab signalling

4.4.3.1. The cab signalling (e.g. ATP) or advisory warning system (e.g. CAWS) should provide a display of the next aspect or the permitted speed for the section. It should where possible be compatible with ERTMS which specifies the form of cab signalling that should be adopted.

4.4.3.2. Where it is appropriate within the route, the in cab signalling should be replaced to reflect a Stop signal when a train on a conflicting route passes a signal at danger. Judgements should be made during the design as to when this in cab signalling should be replaced to danger, so as not to increase the risk of collision.

4.4.4. Spacing

4.4.4.1. The signals should be spaced at intervals appropriate to the frequency, speed and braking performance of all trains using the line. Distant signals located on the approach to a Stop signal should be at a sufficient distance from the Stop signal to allow a train to be brought to a stand at or before the Stop signal using a normal ‘service’ brake application. Distant signals should not be at an excessive distance from the Stop signal.

4.4.5. Location

4.4.5.1. The layout of signals should be consistent and not likely to lead to confusion. They should be located so that their aspects will not be obscured, open to misreading or against a background which will make the sighting of the aspect difficult.

4.4.5.2. For railways which operate with left-hand running, signals should be positioned to the left of the track to which they apply. On multi-track lines, signals for movements in the same direction should be parallel. On bi-directional signalled lines, signals should be located as appropriate for the direction of movement.

Note: Where automatic train protection systems are provided, some flexibility in the location of signals may be acceptable.

4.4.6. Sighting

4.4.6.1. Signal aspects should be visible for an adequate length of time on the approach to the signal, and when stopped at the signal. Where an adequate sighting of a signal cannot be obtained, another signal which repeats the first signal's main aspects may be provided on the approach to that signal.

4.4.6.2. In a scheme where additional infrastructure is being installed other than signalling (e.g. overhead lines, bridges) a full assessment of their impact on signal sighting should be undertaken.

4.4.7. Subsidiary

4.4.7.1. There should be full aspect ('running') signals at the exit from sidings onto main lines unless a signal is provided at the limit of the shunting movement. 'Shunting' or 'subsidiary' signals of a different appearance to running signals may be used for the entry to sidings or for reverse direction moves.

4.4.7.2. Running signals used for entry to terminal platforms, where the final signal is on the buffer stop, should be able to show only Stop or Caution aspects.

4.4.7.3. Where permissive working is employed, a separate aspect from the main Proceed aspect(s) of the running signal is required for use when the section is already occupied. Shunting indications at running signals should not be cleared as authority to pass a Stop aspect unless it is to allow permissive working.

4.4.7.4. Where shunting movements are permitted along main lines, there should be a distinctive 'limit of shunt' lineside signal if there is no other lineside signal to serve the purpose.

4.4.8. Colour-light signals

4.4.8.1. The most restrictive aspects of colour-light running signals should be positioned at the eye-level of the driver of the train. Exceptionally, they may be mounted at ground level where the sighting of a signal at the normal height would be severely restricted.

4.4.8.2. The main aspect of colour-light running signals may provide some or all of the following indications:

Aspect	**Meaning**
Red	Stop at or before the signal
Yellow	Caution, be prepared to stop at the next signal
Double yellow	Caution, be prepared to stop at the next-but-one signal
Green	No signalling requirement to slow down and line speed is permitted to at least the next signal.

Note 1: The meanings given to the different aspects have been recognised as standard. Different meanings to these aspects are unlikely to be acceptable.

Note 2: The aspects of a double yellow should be separated by another aspect on the signal head

Note 3: White lights are not suitable for main aspects because of the risk of a white light being displayed by an aspect with a damaged lens.

4.4.8.3. The display of a subsidiary signal should be different from that of a running signal.

Note 1: If white lights are used as a Proceed aspect for subsidiary or shunting signals, at least two are required for a Proceed aspect.

Note 2: The use of two white lights has been recognised as a standard for railways to guard against failures of a single unproven red aspect of a shunting signal.

4.4.9. At junctions

4.4.9.1. Signals on the approach to junctions should give a clear indication of the route to be taken.

Means of controlling or indicating the safe speed through a junction should be provided.

4.4.9.2. Where a signal protects a junction with diverging routes, a positive and clear indication is required of the route to be taken when the signal changes to the Proceed aspect. The route to be taken may be indicated by the use of a row of white lights or by a display of letters or numbers. Where junction indicators are provided, they should be provided for all the diverging routes from the junction. The signal preceding the one at the junction may also need to provide an indication of the route to be taken.

4.4.9.3. Stop signals on the approach to junctions may be duplicated with separate signals for each diverging route.

Note 1: The forms of display should be appropriate to the speed of approach to the signal.

Note 2: Similarly, route indications may be required at subsidiary signals.

4.4.10. Semaphore signals

4.4.10.1. A semaphore signal conveys an indication by the position of the arm and its colour and shape. If the line is used during the hours of darkness, a light signal which gives a corresponding indication to the semaphore arm is required. Failure of the operating mechanism of a semaphore signal should cause the arm to return to or remain in the most restrictive position and any light signal to display its most restrictive aspect.

Note: If all the trains are equipped with headlights, reflective signals may be acceptable.

4.4.10.2. Two types of semaphore running signals are required:

Stop signals	A flame red arm with a white band and signal red tip, with light signals capable of displaying red or green aspects.
Distant signals	A flame red arm with a fish-tail-shaped end and a similarly shaped white band and saturn yellow tip, with light signals capable of displaying yellow or green aspects.

Note 1: The reverse of semaphore signals should normally be white, with an appropriately shaped black band.

Note 2: The colour and design of the arm of semaphore signals given above has been recognised as standard for railways in the Republic of Ireland.

Note 3: For left-hand running, the signal arm should project to the left of the post.

4.4.11. Signal display

4.4.11.1. For a Stop signal displaying a Stop aspect, the arm is required to be horizontal and a red signal light displayed. For a Proceed aspect, the arm is required to be moved 45^{o} from the horizontal to avoid doubt as to the aspect being displayed. The recommended Proceed aspect is with the arm moved into the lower quadrant. A green signal light is required for a Proceed aspect.

4.4.11.2. For a Distant signal displaying a Caution aspect, the arm is required to be horizontal and a yellow signal light displayed. To indicate that all the related Stop signals are displaying a Proceed aspect, the arm of the Distant signal is required to be moved 45^{o} from the horizontal to avoid doubt as to the aspect being displayed. The recommended Proceed aspect is with the arm moved into the lower quadrant. A green light is required for a Proceed aspect.

4.4.11.3. Distant signals may be mounted on the same post as Stop signals with the Distant arm positioned lower than the Stop arm. Distant signals should be interlocked with the Stop signals to which they refer.

4.4.12. Subsidiary

4.4.12.1. Subsidiary or shunting signals are required to be different in character or with a clearly different

size of signal arm. Subsidiary signals may be mounted on the same post as a Stop signal with the subsidiary signal positioned lower than the Stop signal or on a separate post. Shunting signals may be located at track level or post mounted.

4.5. DEGRADED CONDITIONS

Principle 4.5 Degraded conditions

The signalling system should facilitate continued operation in safety in specified degraded conditions.

4.5.1. System Safety in failure mode

4.5.1.1. The guidance in this section deals with the safe passage of permitted traffic under degraded conditions of the signalling system.

4.5.1.2. Failure of the signalling system should not result in an unsafe situation being created. However, consideration should be given to the actions necessary to allow the passage of trains to continue while the failure condition is rectified.

Note 1: The 'fail-safe' concept which underlies the design of signalling systems requires that a failure of any part of the equipment employed should cause the system to remain in its present state, if it is safe to do so, or to revert to a more restrictive condition to avoid an unsafe condition arising.

Note 2: A failure may result in trains being stopped which not only disrupts the transport system, but may also lead to secondary situations which introduce an increased risk. For example, the failure of a single part of the train detection system may result in all trains having to proceed through the affected signalling section by verbal instruction and driven on line-of-sight.

4.5.1.3. The signalling system should be able to be configured so that failed equipment can be isolated and, once the nature of the failure is confirmed, the other parts of the system, which are working correctly, can then be used.

Note: The more complex the signalling system, the more important it is that the signalling system should have a modular capability.

4.6. CONTROL

Principle 4.6 Control

Appropriate management and communications facilities should be provided to maintain safety in normal, abnormal, degraded and emergency situations.

4.6.1. Signalling Control

4.6.1.1. The guidance in this section deals with the control function of the signalling system, whether located in a signal cabin or control centre.

4.6.1.2. The design of signal cabins should provide a working environment which minimises distraction, fatigue and stress, to avoid the risk of error by the signalman.

4.6.2. Location of signal cabins

4.6.2.1. Signal cabins for the control of 'manual block' signalling systems are required to be located adjacent to the railway with access to the line. The signal cabin should provide for the best possible view of the signals controlled and the lines for all operations supervised. In so far as is reasonably practicable, the view should not be interrupted by the passage of trains. A signal cabin which does not have an elevated operating position may be built only by prior agreement with the RSC.

4.6.2.2. The signal cabin name should be prominently displayed on the outside in a position visible to train crew.

4.6.2.3. Signal cabins for signalling systems other than 'manual block' systems are not required to be located adjacent to the railway. Provision of unified control centres incorporating the signal cabin functions should be considered.

4.6.3. Signal cabin and control centre facilities and equipment

4.6.3.1. Arrangements to prevent unauthorised access to the signalling controls or the interlocking should be provided. Where the major interlocking facilities are located away from the signalling control position, intruder alarms connected to the control position are required with appropriate security measures in place.

4.6.3.2. The function of all signalling controls should be clearly and unambiguously indicated. Immediate and unimpeded access is required to all controls which may have to be operated to protect trains in an emergency, including replacing every Stop signal to stop.

4.6.3.3. The integrity of controls and indications should be appropriate to the extent to which safety depends on their correct operation. Both normal and degraded modes of operation should be taken into consideration in assessing the risks and the level of safety required.

4.6.3.4. In so far as is reasonably practicable, signalling control and interlocking systems should be protected from the consequences of electrical supply failures. Any loss of power, or change-over between the diverse power sources, should not cause a loss of the protection provided by the signalling system.

4.6.3.5. A means of reminding a signalman of any temporary limitations to the use of track or signals should be provided. Any such reminder should prevent the operation of any signals or points to which it applies. The removal of the reminder should require positive action on the part of the signalman.

4.6.3.6. The stop or proceed state of the aspects of colour-light signals should be indicated in the controlling signal cabin. If the aspect of a semaphore signal is not clearly visible from the signal cabin, an indication of the aspect state being displayed should be provided in the signal cabin. Where a Distant signal is interlocked with a Stop signal controlled from another signal cabin, indication should be given as to whether the Distant signal is free or locked.

4.6.3.7. All indications should be clearly visible from the signalman's normal working position. Care should be taken to avoid positioning diagrams, control panels, display screens etc in a way that is likely to lead to confusion. The signalman should be able to use any means of communication provided while keeping all indications clearly in view. All signal cabins should be equipped with an accurate clock, clearly visible to the signalman.

4.6.3.8. A signalling diagram is required showing:

(a) the lines controlled from the signal cabin, their identities and direction (where necessary);

(b) adjacent signal cabins;

(c) all signals, points and any level crossings or moveable bridges;

(d) station platforms, tunnels or long viaducts; and

(e) gradients as appropriate (which may be provided separately in the cabin).

4.6.3.9. The signalling diagram may be enhanced to display the locations and identities of trains, the aspect of signals etc as appropriate. The signalling diagram and indications should be clearly visible to the signalman from the normal operating position.

4.6.3.10. Where any lines are electrified, the limits of electrification should be indicated on the signalling diagram. Places where there are means of sectioning the electric traction power supply should also be shown on the signalling diagram. These limits or places should be related to the positions of signals.

Note: Other information and indications necessary for the control and management of the electric traction system may be displayed separately.

4.6.3.11. Where display screens and VDU's are used as part of the control system, information necessary for the signalman to control the system safely should be continuously displayed. Switching between displays in the course of an operation with a consequent need to remember the status of relevant items, would not be acceptable.

4.6.3.12. VDU layouts should be designed to provide clarity and consistency of indication to the signalman and avoid screen clutter.

4.6.3.13. An Ergonomic study should be undertaken for the design of all control systems to ensure clarity and ease of use to reduce the risk of human error.

4.6.3.14. A simple and quick means of rapidly replacing signals to Stop or cancelling authorities to proceed is required.

4.7. TELECOMMUNICATIONS

Principle 4.7 Telecommunications

Appropriate and reliable systems of communication both for railway operations and emergency services should be provided.

4.7.1. Communication Facilities

4.7.1.1. All communications facilities should have an appropriate level of priority, availability, reliability and safety integrity. Also all such facilities should be resistant to unauthorised intrusion.

4.7.2. Between signal cabins and control centres

4.7.2.1. Communication between adjacent signal cabins is essential to the efficient and safe operation of a railway and may employ any appropriate communication system. Communications which form a critical part of the signalling system may require high integrity, discrete links.

4.7.2.2. Communication between signal cabins and other control rooms, such as electrical controls, should be provided with an appropriate level of priority and reliability. A means of isolating the electric traction supply or causing it to be isolated is required by this communication.

4.7.3. With emergency services

4.7.3.1. Means of summoning the emergency services should be provided with an appropriate level of availability at signal cabins and other control offices.

4.7.4. Between signal cabins or control centres and trains

4.7.4.1. An effective means of communication should be provided between the signalman and the driver of any train held at a signal or marker board. On ‘manual block’ systems, where there are few signals, and they are located adjacent to the controlling signal cabin, face-to-face contact between the train driver and the signalman may be possible and sufficient.

4.7.4.2. Where radio is used as a means of communication, it should have a high level of availability and an appropriate level of integrity.

Note 1: This system should provide for oral communication but may be supported by a data transfer system.

Note 2: The implications of any gaps in radio coverage and black spots should be assessed and taken into account in the signalling operation.

4.7.4.3. The system of communication should automatically identify to the signalman the signal and/or the train from which the communication originates. The signalman should be able to selectively communicate with specific trains or signals. General broadcast facilities, available to the signalman, may also be provided. The communication system should give priority to emergency calls.

4.7.4.4. Where instructions are to be given to a train driver over the communication system for the movement of trains, either as part of the normal signalling operation or in a degraded mode of operation, a discrete system which allows only the train driver concerned to receive the instruction, is required.

4.7.5. Recording of communications

4.7.5.1. All oral communications employed in the control of the signalling should be recorded. In large signal cabins where more than one signalman is normally employed and decisions affecting safety may be made orally, it may be appropriate to record conversations between people working in the signal cabin. This may be done in writing or by means of a voice recorder.

4.8. COMPATIBILITY

Principle 4.8 Compatibility

Neither the signalling nor the telecommunications equipment should generate nor be at risk from dangerous interactions with other systems.

4.8.1. Environment

4.8.1.1. Any signalling system chosen to be designed and developed for operation within the Republic of Ireland should be compatible with the environment and existing infrastructure, including signalling and telecommunications systems already in place.

4.8.1.2. The use of materials within a signalling scheme should be assessed for the compatibility with both the environment to which they are to be installed and their compatibility with the other products present at the site.

4.8.2. EMC

4.8.2.1. All systems should meet the electromagnetic compatibility requirements laid down in European standards, as well as demonstrate no interference or susceptibility to systems that pre-date European standards present on the infrastructure.

4.9. STAFF PROTECTION

Principle 4.9 Staff protection

The signalling system may be used to protect workers on the line from being struck by a train.

4.9.1. Staff Protection Systems

4.9.1.1. In areas where it is unsafe for staff to work whilst trains are running, facilities may be provided to lineside workers to prevent signal routes being cleared, e.g. station platforms.

4.9.1.2. On reversible signalled lines, facilities may be provided to lineside workers to inhibit reverse direction working.

4.9.1.3. In areas of high risk (e.g. limited visibility), signalling facilities may be provided to allow connection of fixed or portable warning to lineside workers at risk. The staff protection system may have audible, vibrating or visual alarm or any combination of warning and should be considered to be external to the signalling system.

4.10. DEFINITIONS

Absolute working	A signalling system that allows only one train to be in the Block Section at the same time.
ERTMS	European Rail Traffic Management System.
Permissive Working	Permissive working is a way of train working that allows movements into an occupied section of track.
Subsidiary signal	A subsidiary signal allows a train to enter an occupied section, for example for shunting purposes. The driver passes the signal at extreme caution and must be prepared to stop at the first red signal or any other obstruction.
Multiple section axle counters	Axle counting system which has the ability to monitor and control more than one section within a single processor or evaluator.

4.11. GUIDANCE ON SPECIFIC SIGNALLING SYSTEMS

4.11.1. Introduction

4.11.1.1. This section gives further guidance for specific forms of train separation systems. They are based on arrangements which can be regarded as proven. Alternatives or variations to these systems should be able to provide an equivalent level of safety. There should be appropriate safeguards at the transition between different systems.

4.11.2. Absolute block systems

4.11.2.1. In the 'absolute block' system, trains are signalled from signal cabin to signal cabin. The respective signalmen are required to communicate with one another to:

(a) control the entry of trains to the section of line between them; and

(b) advise one another of the passage of trains between them.

4.11.2.2. In addition:

(a) a record should be kept of the passage of all trains; and

(b) a means of passing emergency messages is required.

4.11.2.3. Block instruments which function in a way that requires the co-ordination of actions by the signalmen should be provided.

Note: Block instruments incorporating bells and capable of showing the status of the line, whether or not it is occupied by a train, are a proven and acceptable method of communication between signal cabins.

4.11.2.4. The visual observation of the passage of trains may be assisted by the provision of track circuits or other train detection technology. Interlocking between the block instruments, any train detection system and the signals should be provided.

4.11.2.5. The traffic capacity of an 'absolute block' signalling system may be increased by the provision of an 'intermediate block' section.

4.11.2.6. Where semaphore signals are used in conjunction with the block system of working, Stop signals are required to control the entry to each block section of the line. Additional Stop signals may be provided on the section of the line between block sections.

4.11.2.7. A worked Distant signal is required on the approach to the outermost Stop signal of an 'absolute block' signal cabin. Exceptionally, an unworked Distant signal may be provided. The Distant signal should be located at least a full service braking distance from the Stop signal.

Note: Use of the sighting distance of the Distant signal to provide part of the braking distance is not acceptable.

4.11.3. Track circuit block systems

4.11.3.1. The block section for 'track circuit block' is between two Stop signals or block markers and not necessarily between two signal cabins. Many 'track circuit block' sections may be controlled from one signal cabin. The system requires the block section and the overlap (which may be a complete block section depending on the type of train separation used) to be proved clear by an automatic train detection system before a train is permitted to enter the block section.

4.11.3.2. Although 'track circuit block' normally uses track circuits for train detection, other methods of train detection may be used. The system requires the signals to be fully interlocked with the train detection system. Where other methods of train detection are used, additional precautions may be necessary.

4.11.4. Moving block systems

4.11.4.1. A 'moving block' system compares the position of trains, their direction of travel and speed to determine the safe space ahead of and behind each train. To compute the position, direction and speed, a system of continuous, or near continuous, train detection or reporting is required. 'Moving block' signalling systems will require the trains to be equipped with cab signalling (see Note 2). Automatic train protection will also be required.

Note 1: 'Moving block' signalling systems will inevitably be complex and special care is required to ensure that all parts of the system have a level of integrity appropriate for safety critical signalling.

Note 2: 'Moving block' signalling systems require trains to be equipped with in-cab signalling unless they are automatically controlled. The latter may require in-cab indications for occasions when they are crew operated.

Note 3: Those intending to install 'moving block' systems will be required to demonstrate how the integrity of the system has been established for both normal and degraded modes of operation.

4.11.5. Single Line Working

4.11.5.1. The guidance in this section is applicable to bi-directional working on multi-tracked railways as well as to single-line railways.

4.11.5.2. As well as maintaining a space interval between following trains, it is important to ensure that opposing movements are prevented.

4.11.5.3. Where the single line is provided with automatic train detection, for example, it is fully track circuited (or equipped with an equivalent train detection system) and the whole of the line is within the control of one signal cabin, no extra safeguards over and above those provided by normal interlocking are required. Where the single line is controlled from two signal cabins and is fully track circuited, provision of interlocked directional controls is acceptable.

4.11.5.4. In both cases, permission to enter the single line is given by the clearance of the relevant Stop signal. The signals for entering the section should be interlocked with the train detection system to ensure the line is clear. Directional controls are to be similarly interlocked. There should be a control to ensure the signals are restored to Stop behind each departing train.

4.11.5.5. Special consideration should be given to the positioning of signals protecting single lines to reduce the risk of driver error.

4.11.5.6. Precautions against disregard of signals which could result in trains entering the single line may be necessary. Where the design assessment indicates additional precautions are necessary, this should be provided by directing any train overrunning a signal away from the single line.

Note 1: Allowance may be made in the assessment and on the precautions provided for other safety measures such as automatic train protection systems or the provision of SPAD (Signal Passed At Danger) indicators.

Note 2: It is preferable that any train overrunning should be directed away from the single line by providing alternative routes within the track layout. Only where this is not reasonably practicable should the provision of trap points be considered.

4.11.5.7. Where the above type of signalling is not available for the operation of a single line, a number of alternative methods are acceptable to the RSA.

Method 1 - One-train-on-line

4.11.5.8. With this method, one train and one train only may be permitted free movement on the single line not connected to any other railway. Block instruments are not necessary and signals are not required unless needed for the protection of level crossings or to indicate that points are correctly set.

4.11.5.9. Where the single line has a connection to another part of the railway system or access to the line is possible from sidings or depots, one-train-on-line may be used as an appropriate method of working as long as appropriate arrangements are made to prevent a second train from gaining access to the line.

Method 2 - Train-staff

4.11.5.10. With this system a train-staff and, where appropriate, a set of train-tickets of paper or permanent

material, are required as tokens for each section. No train may enter the single line, except for the purpose of shunting within the protection of signals, unless the train-staff for the section through which it is about to travel is at the place of departure. The train may only enter the single line with the train-staff, or if the train-staff has been seen by the driver at the entry point.

4.11.5.11. So long as movement through a section takes place alternately in opposite directions, the driver of each train is required to carry the train-staff as their authority. However, if two or more trains are to travel in succession through a section in the same direction, the driver of each train except the last is required to be shown the train-staff and be given a train-ticket as authority to proceed. The last train of the series is required to carry the train-staff through the section before any train passes through it in the reverse direction.

4.11.5.12. The train-tickets are to be kept in the signal cabin or booking office in a locked box which can only be opened by a key forming part of the appropriate train-staff. Removal of the train-staff is required to relock the ticket box.

4.11.5.13. The 'absolute block' system with suitable block instruments is required to ensure a proper space interval between trains. A single-line section may be divided into two or more block sections by intermediate block posts with the necessary signals, to increase its capacity for following movements.

4.11.5.14. Long section tokens may be used to combine two or more sections.

Method 3 - Electric Train Staff (ETS)

4.11.5.15. This method employs a number of tokens which are kept in token machines at either end of the single line. The two machines are interlocked electrically to release one token at a time to authorise movement onto the single line. The first token is required to be returned to a machine before a second token can be issued.

4.11.5.16. Exceptionally, auxiliary token instruments may be provided at remote locations to avoid delay in obtaining or surrendering a token to one of the two main instruments.

4.11.5.17. Long section tokens may be used to combine two or more sections, with appropriate interlocking to maintain the requirements of 4.11.5.15.

4.11.6. European Rail Traffic Management System (ERTMS)

4.11.6.1. The guidance in this section applies to ERTMS and includes for transmission of information between the trackside and signalling system and the train, and the interfacing of the train-borne equipment with the train driver and the train braking system.

Note : ERTMS is under development at the time of writing this guidance and therefore the information provided should be read in conjunction with current ERTMS requirements (i.e. at the time of applying the guidance).

4.11.6.2. Signalman control interface, the signalling interlocking and trackside elements are outside the scope of the ERTMS other than balises.

4.11.6.3. All levels of ERTMS provide ATP functionality by continuous supervision of the train speed on board the train.

Level 1

4.11.6.4. Use of this method provides an ATP system that interfaces to the electronic signaling interlocking and transmits to the train by the use of balises mounted between the rails. The train uses the position data along with the aspect of the signal ahead that it receives to output to the driver the correct linespeed. This requires safety integrity information to be held on board the train.

4.11.6.5. Level 1 is an overlay to lineside signalling and can be used for mixed traffic and mixed working of lineside and in cab signalling. The detection of train position and the proving of train integrity is by conventional means (e.g. Track circuits)

4.11.6.6. Level 1 performance may be improved by introducing in-fill loops or balises to improve the performance of the train service by communicating the signalling status at an earlier opportunity than lineside signalling can achieve.

Level 2

4.11.6.7. While still utilising the equipment in place for Level 1, Level 2 improves performance by the used of Radio (GSM-R) to transmit information to the train for display in cab whilst still utilising the fixed block working and the train detection system of the signalling interlocking.

4.11.6.8. Level 2 is an overlay to lineside signalling when it is used for mixed traffic and mixed working of lineside and in cab signalling. The detection of train position and the proving of train integrity is by conventional means (e.g. Track circuits). Movement authority can be provided for ERTMS fitted trains via Radio.

4.11.6.9. The use of radio transmission of control at Level 2 allows for the removal of lineside signals where all traffic is ERTMS fitted.

Level 3

4.11.6.10. The trainborne system provides train integrity, and detection of position. Transmission is primarily by the GSM-R radio system.

4.11.6.11. Movement authority is conveyed to the driver via a cab display and there is no requirement for lineside signals.

4.11.6.12. The use of balises and on board integrity for train positioning at level 3 allows for the removal of train detection systems such as track circuits and axle counters.