Guidance on Category ‘A’ SPAD Investigations

Synopsis
This document supports the process of investigating category ‘A’ SPADs as set out in GO/RT3252 Signals Passed at Danger (SPADs). As most category ‘A’ SPADs are subject to formal investigation, the document is written in this context. In general, it will also be relevant where it has been determined that a formal inquiry should be convened.

Submitted by

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Part A

A1 Issue Record

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<th>Issue</th>
<th>Date</th>
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<tr>
<td>One</td>
<td>October 2003</td>
<td>Original document supporting GO/RT3252, Signals Passed at Danger (SPADs)</td>
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This document will be updated when necessary by distribution of a complete replacement.

A2 Implementation of this document

The publication date of this document is 4 October 2003.

This document does not supersede any other Railway Group Guidance Notes.

A3 Responsibilities

Railway Group Guidance Notes are non-mandatory documents providing helpful information relating to the control of hazards and often set out a suggested approach, which may be appropriate for Railway Group* members to follow.

* The Railway Group comprises Network Rail Infrastructure Limited, Rail Safety and Standards Board Limited, and the train and station operators who hold railway safety cases for operation on or related to infrastructure controlled by Network Rail Infrastructure Limited.

Network Rail Infrastructure Limited is also known as Network Rail.

Rail Safety and Standards Board Limited is also known as RSSB.

A4 Health and safety responsibilities

In issuing this document, RSSB makes no warranties, express or implied, that compliance with all or any document published by RSSB is sufficient on its own to ensure safe systems of work or operation. Each user is reminded of its own responsibilities to ensure health and safety at work and its individual duties under health and safety legislation.

A5 Technical Content

The technical content of this document has been approved by:

Richard Evans, Principal, Operations, RSSB

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A6 Supply

Controlled and uncontrolled copies of this document may be obtained from the Industry Safety Liaison Dept, Rail Safety and Standards Board, Evergreen House, 160 Euston Road, London NW1 2DX or e-mail enquiries@rssb.co.uk.
Part B

B1 Purpose

This document supports the process of investigating category ‘A’ SPADs as set out in GO/RT3252 Signals Passed at Danger (SPADs). As most category ‘A’ SPADs are subject to formal investigation, the document is written in this context. In general, it will also be relevant where it has been determined that a formal inquiry should be convened.

B2 Application of this document

B2.1 To whom the guidance applies

This document contains guidance that is applicable to RSSB and duty holders of the following categories of Railway Safety Case:

a) infrastructure controller

b) train operator.

B2.2 Documents supported by this Guidance Note

GO/RT3252 Signals Passed at Danger (SPADs).

B3 Definitions

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<tr>
<td>Conflict point</td>
<td>The conflict point is the first point along the track beyond the signal at which a collision could occur.</td>
</tr>
<tr>
<td>Consequences</td>
<td>The number of fatalities, major injuries and minor injuries or damage to infrastructure or trains resulting from the occurrence of a particular hazardous event outcome.</td>
</tr>
<tr>
<td>Overrun distance</td>
<td>The distance travelled by the train beyond the SPAD signal before coming to a stop.</td>
</tr>
<tr>
<td>Permissible speed</td>
<td>For the purposes of this Standard the highest permitted speed (including any enhanced permissible speed) of a train on the approach to a signal.</td>
</tr>
<tr>
<td>Platform starting signal</td>
<td>A signal is classed as a platform starting signal under either of the following conditions:</td>
</tr>
<tr>
<td></td>
<td>a) where the longest passenger (or empty coaching stock) train authorised to use the platform would, if stopped at the signal, still have a portion of the passenger accommodation alongside the platform</td>
</tr>
<tr>
<td></td>
<td>b) where the leading end of the train passes over the automatic warning system (AWS) equipment associated with the signal before it is dispatched from the station.</td>
</tr>
<tr>
<td>For the purposes of the SPAD risk ranking, other signals classed as remote platform starting signals are not to be considered as platform starting signals.</td>
<td></td>
</tr>
<tr>
<td>Probability</td>
<td>The likelihood of an event occurring over a specified period of time or on demand (when an individual component or system is called upon to operate).</td>
</tr>
<tr>
<td>Risk</td>
<td>Risk in the context of SPADs is a measure of the average number of injuries, fatalities or equivalent fatalities that could result following a SPAD due to the occurrence of a train accident. It can be calculated as the product of probability of a train accident and the consequences should that SPAD occur.</td>
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Safety management information system
Safety management information system (SMIS) is a computer database containing details of events (including SPADs) reported by, or on behalf of, Railway Group members.

Signal
A visual display device which conveys instructions or provides prior warning of instructions regarding the driver’s authority to proceed.

Signal passed at danger
Signal passed at danger (SPAD) is the term used to describe an event when any part of a train has passed a stop signal at danger without authority or where an in-cab signalled movement authority has been exceeded without authority.

If the vehicles involved are being propelled and run away because the movement was not controlled in compliance with GO/RT8000, the event is treated as a category ‘A’ SPAD.

Stop signal
A signal capable of displaying a stop aspect or indication. Additionally, for the purpose of this document, it includes:

- end of in-cab signalled movement authority
- stop boards or indicators
- limit of shunt indicators
- position light and shunting signals where the normal aspect means ‘stop’ and (where applicable) the movement is in the direction for which the signal can be cleared
- possession limit boards
- marker boards at the entrance to or exit from a worksite within a possession
- stop indications given by authorised handsignallers or by a signaller.

Train
For the purposes of this document a train includes a light locomotive, self-propelled rail vehicle or road-rail vehicle in rail mode.

Train driver
For the purposes of this document a train driver includes the operator of a light locomotive, self-propelled rail vehicle or road-rail vehicle in rail mode.

Visual acuity
The visual acuity test measures the smallest letters that you can read on a standardised chart at a distance of 20 feet.

Other defined terms are set out in GK/RT0002.

B4 Introduction

B4.1 Introduction to guidance in document
Railway Group Standard GO/RT3252, Signals Passed at Danger (SPADs), sets out the requirements for managing SPAD incidents and reducing the risk of recurrence. Integral to this Standard is a requirement that each SPAD is investigated to establish the causes. This Standard needs to be considered in the context of GO/RT3473, Formal Inquiries, Formal Investigations and Local Investigations; and the supporting Guidance Note GO/GN3673, which is essential reading for those tasked with arranging and conducting the investigation of category ‘A’ SPADs, as these are normally subject to at least a formal investigation.

This document has been written specifically to support the process of investigating category ‘A’ SPADs. As most category ‘A’ SPADs are subject to formal investigation, the text that follows is written in this context.
However, in general, it should also be relevant where it has been determined that a formal inquiry should be convened.

Appendix 1 shows a diagrammatic representation of the sequence of steps taken in a signal sighting investigation. Appendix 2 provides a series of case studies intended to clarify the scope and nature of the investigation in a range of scenarios. Appendix 3 provides background information on human factors as the cause, or as a contributor to the cause, of a SPAD. This information is relevant for consideration in the investigation that follows a SPAD incident. It is structured in a way to support the inputting of basic cause data into the SPAD Data Collection Forms in GO/RT3252 for use in updating SMIS.

B4.2 SPAD investigation remit

The remit set by the designated competent person (DCP) for investigation should be tailored to the individual SPAD and take account of the outputs of the initial gathering and collation of evidence, including an assessment of collision potential and any other particular circumstances. In setting remits for SPAD investigation, there should be a recognition that even a low-risk SPAD can provide the opportunity to learn much about the integrity of management systems and therefore make improvements before a further SPAD with higher consequences occurs.

A SPAD investigation based on a generic remit often leads to an investigation that is neither proportionate to the potential consequences of the SPAD, nor to the risk associated with SPADs at that location.

There are occasions when a train driver’s initial reaction to his train having passed a signal at danger is an immediate oral admission that he made an error. The significance of such an admission should not automatically be allowed to lead to a narrowly defined remit that does not, for example, lead the investigation team to consider an unmitigated SPAD trap that has resulted in several SPADs in recent years. Remits should therefore be written in a manner that encourages the team to consider all relevant issues, including the caution signals on the approach to the signal involved in the SPAD. This encouragement should lead to the team retaining an open mind and a healthy scepticism when considering any early preconceptions as to the causal model lying behind the SPAD in question.

When developing the remit, the DCP should involve the other parties to the investigation so that collectively they agree the extent to which similar incidents, past or related events involving the same signal, personnel or rolling stock and changes to standards, management systems and organisations should be specifically referenced within the remit.

The DCP should discuss the remit with the person appointed to lead the formal investigation to ensure that the remit and scope of the investigation is understood and accepted. Additionally, the person appointed to lead the investigation should ensure that all other team members similarly understand the scope of the investigation.

The need for a Signal Sighting Committee (SSC) should be considered whilst the remit for the investigation is being developed. Where signal sighting is necessary, the investigation remit should specifically require the investigation team to consider the findings of the SSC as an input to, rather than output from, the investigation process.

B4.3 The investigation team

In identifying the lead investigator and other team members, it is important to ensure that those appointed are sufficiently independent of the event and local management of the equipment and people involved. Too often the closeness of one or more of the investigation team to the factors for consideration has proved a limiting factor and could lead to a failure to consider the possibility that local or company management systems could have failed. Accordingly the signaller's...
manager for the location and / or the driver standards manager responsible for
the driver should not be considered as members of the panel.

Appropriate specialist advice may need to be available to an investigation team
not only in railway operations and signalling disciplines but also in human error
analysis, as this is a factor in nearly all SPADs. The engagement of specialist
human factors support can assist investigation teams to understand the systemic
context within which an individual is more or less likely to make errors.

B4.4 Statements, reports and interviews
All SPAD investigations draw heavily on the RT3189 form completed at the time
of the SPAD and statements and initial interviews of those directly involved in the
SPAD. The investigation team should not rely solely on these reports; it should
always consider the benefits to be gained by the team interviewing witnesses to
complement the initial evidence of the individual.

Interviewing key witnesses enables benefits to be gained from an iterative
approach within the context of a formal investigation. A specific example of good
practice relates to a more detailed examination of the factors lying behind fatigue.
These may not have been willingly disclosed to the immediate line manager who
would not necessarily have been equipped to ask the appropriate diagnostic
questions.

B4.5 Risk
It is important that the potential for a catastrophic collision is considered, rather
than just the actual consequences of the SPAD in question. The initial
assessment of collision potential included in the SPAD report should be taken as
guidance only and reviewed alongside all other evidence. Where high potential
consequences are identified, these should be taken into account in framing the
recommendations. This is of particular importance where the SPAD is at a signal
at which there have been multiple SPADs.

The significance of the outputs of risk ranking should be considered in the body of
the report with the risk ranking form itself reproduced in full as an appendix to the
investigation report. If necessary, the panel should seek assistance to ensure that
the maximum benefit is gained from the evidence provided by use of the risk-
ranking tool.

B4.6 Multi-SPAD status
When a signal has acquired multiple SPAD status it is likely that there are
location specific special cause factors in play. The panel should investigate what
these might be. When a signal has been passed at danger for the third time in
five years, or four times in total, it is a strong indicator that infrastructure related
features are contributing to the occurrence of SPADs.

It is important that investigations into SPADs at multiple SPAD signals, in
particular those where it is the signal’s third or more SPAD, are structured to
explore the similarities (and differences) between the latest event and those that
have occurred in the past. Where, as a result of an earlier SPAD, additional
mitigation measures have been installed, investigations should assess the
efficacy of these measures and consider how they might be further developed in
light of the new knowledge generated by the SPAD investigation in hand.

The above principles should be extended to the consideration of SPADs
associated with a single gantry, or pairs and groups of signals where there is a
history of signals being misread.

The approach to the SPADED signal (from the first caution signal) and, where
there is a possibility of reading through, the signals in advance, should always be
considered.

Where a driver, signaller or other person involved in the SPAD has a substantive
history of safety of the line incidents or other factors, the investigation should
consider the adequacy of any special monitoring arrangements introduced earlier.
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Where such arrangements are found not to have been applied, the reasons for this should be considered.

Previous Railway Group investigation reports relevant to the SPAD in question by virtue of location or other factors should also be consulted. Further relevant additional material may be available within the reports HMRI generate as a result of their targeted programme of SPAD investigations. Consideration of previous reports should extend to their recommendations, the progress made in discharging them, and how, in light of the investigation of a subsequent SPAD, they should be developed further if the risk of recurrence is to be further reduced.

B5 Factors to be considered by the investigation panel

B5.1 Introduction

The investigation of a SPAD should consider the following risk factors to determine the extent to which they are or are not relevant to the event.

B5.2 Health – screening and examination

Generally the post-incident testing is focused on prescribed drugs and alcohol. However, it is also often necessary to arrange for post-event screening to look for prescription and over-the-counter medication that could lead to degraded performance. Antihistamines taken to combat hay fever and painkillers taken when toothache is severe are typical examples of self-prescribed medication. Post-incident screening procedures should also be used to explore the possibility that an age related, undetected diabetic or other health condition may be material. Where a decision is taken not to test for other than prescribed medication, the reasons for this should be stated within the investigation report. Similarly, where there are factors suggestive of eyesight concerns (for example failure to locate or respond to a signal) an appropriate medical examination should be arranged. Additionally, interviews of those involved should always seek to establish if they have had any change in the prescription of their glasses/contact lenses since they were last medically assessed. If so, it is always necessary to arrange for eyesight to be assessed. As sunglasses can impact on the ability to differentiate colours, it should be established if these were being worn. If so, arrangements should be made for this factor to be assessed. This approach should enable the extent to which visual acuity was a factor to be determined.

Likewise, where there are factors suggestive of hearing impairment an appropriate medical examination should always be arranged.

Sleep apnoea (partial or complete blockage of the throat during sleep leading to fragmented sleep), narcolepsy (a condition characterised by sudden episodes of sleep), insomnia and other sleep disorders are recognised medical conditions. Where there is evidence that these are factors, medical examination should be arranged as a matter of course.

Medical screening and examination should not be seen as applying solely to drivers and should be extended, as appropriate, to signallers and other staff involved in the SPAD in question. All staff should be treated equally, particularly when miscommunication is a possible cause.

Initial interviews with staff should be structured in a diagnostic manner. This means that the sequence of questions should be logical, one naturally leading to another. The aims of this approach are to enable early decisions to be taken as to the appropriate level of medical screening and examination to be applied and identify other areas where it is necessary to gather evidence.
B5.3 Loss of concentration and fatigue

SPAD investigations should include detailed consideration of factors associated with roster patterns, travel to work times, sleep patterns, sleep deficits, blood sugar levels, dehydration and lifestyle issues that may generate fatigue and a resultant loss of concentration.

Investigators should go beyond considering whether or not the staff concerned were off duty for 12 hours or more before the shift in question and whether or not the staff member had worked more than 72 hours in the previous seven days and / or 13 shifts in the last 14. Initial interviews should be structured to explore lifestyle issues, including those that can relate to voluntary activity and second jobs (for example as a retained fireman or member of the armed forces volunteer reserve).

Particular attention should be paid to gathering and considering evidence pertaining to shift systems and roster patterns, as these are directly within the control of railway businesses and workplace representatives. The following components of a shift system should be considered:

a) start times (particularly before 0700 hrs, late in the day or at night)

b) recovery time (particularly from night to day shifts)

c) shift length

d) rotation (early – late – nights is generally a better arrangement than nights – late – early)

e) availability and pattern of rest periods, including grouping of rest days within the roster cycle

f) timing and duration of breaks within the turn of duty.

The shift system needs to be seen in the context of other job factors relating to, for example, workload, which may result in issues relating to either an underload or overload of those involved in a SPAD.

In turn, consideration should also be given to factors more directly related to the individual and social context in which he or she operates. Those most likely to be significant include:

g) body clock / circadian rhythm

h) age

i) personality

j) fitness.

The investigation should explore the extent to which these factors are systemic and indicative of wider managerial issues (for example, the authorising of voluntary shift swaps in a way that destroys the integrity of a roster designed to minimise the risks associated with fatigue).

Voluntary shift exchanges can be an indication of domestic factors that should be considered. A compassionate approach should be adopted when exploring if there are any domestic, family illness, bereavement and financial issues that are affecting the concentration of the driver or other involved person. An assurance should be given that confidential information will not be included in the SPAD report. However, this should not mean that the investigation process and reporting is so sanitised that it does not allow the significance of the underlying issue to be considered and reported.
Specialist assistance may be required to interpret the significance of evidence pertaining to fatigue and loss of concentration. Where there are indications that there are loss of concentration issues unrelated to fatigue, it may be appropriate to consider arranging for a deeper specialist assessment of the issue in advance of any decision to allow the individual concerned to resume safety-critical duties.

As the benefits of post-incident psychometric testing are not yet clear, care should be taken to understand the limitations of the output of these tests which should be progressed with the consent of the person concerned.

**B5.4 Technical deficiencies**

The initial ‘on the day’ investigation should include an inspection of driving-cab condition, including cleanliness of the windscreen and in-cab temperature. Additionally, where there are any allegations made concerning the braking performance of a train, it is good practice for brake testing to be carried out immediately, even if this is not operationally expedient. Where there is no on-train monitoring recorder (OTMR) it is essential that such a test be conducted immediately. Whenever a driver suggests that wheels have ‘locked up’ or there is excessive wheel slip protection, the initial investigation needs to look for evidence. In addition, all rolling stock involved in a SPAD should be inspected on its next diagrammed return to depot; details of any deficiencies should be made available as evidence for consideration by the panel.

The initial ‘on the day’ investigation should be structured so as to provide for a non-intrusive visual inspection, with a view to identifying hazards associated with other factors affecting the conspicuity or readability of the signal (for example, inadequate vegetation management, light sources swamping the signal, low sun and line-side distractions). This visual inspection should also consider issues pertaining to the signals on the approach to the SPADed signal. These ‘on the day’ inspections should be used to inform the need for a Signal Sighting Committee (SSC) to be convened.

Photographs should be taken in support of the initial ‘on the day’ investigations as they provide an effective way of both recording evidence and showing the generality of the environment within which the SPAD occurred.

The SPAD investigation needs to be conducted in a manner that allows for the output of all technical investigations to be considered as evidence and therefore an input to the SPAD investigation.

Reports should not be finalised in advance of the panel having considered the significance of the findings of all relevant technical investigations, including signal sighting.

Where either an initial or subsequent more detailed technical inspection demonstrates that a particular factor was not material to a SPAD, this should be seen to have been considered in the body of the SPAD investigation report, rather than left as the conclusion of the supporting technical report.

**B5.5 Signal sighting**

Signal sighting should not be confined to consideration of the red aspect of the SPAD, rather it should also consider the sighting of adjacent signals and those on the approach on which cautionary aspects have been experienced by the driver. Implicit in this is that any four to three and three to four aspect or other transitions should have been considered. All fundamental parameters should be measured and recorded, including alignment, height and offset of signal aspects and signal spacing (further guidance is provided in section B6 of this document).

Signal sighting and evaluation of the options to improve signal sighting should be used to identify how best to achieve the maximum sighting that is reasonably practicable. The remit for the investigation should make clear that signal sighting is not required solely to check compliance with Standards, rather it is to identify...
scope for improvement and recommend reasonably practicable measures to the panel investigating the SPAD.

It is important that SSCs are convened quickly, as their conclusions and recommendations are essential inputs to the wider SPAD investigation. The SPAD investigation should not be concluded in advance of the SSC results being available for consideration by the panel.

As with the panels constituted to investigate SPADs, the infrastructure controller, train operators and infrastructure maintenance contractors should consider how best to commit resources in a manner that enables all necessary SSCs to be convened in a timely manner.

B5.6 Starting against signals
Continuing analysis of all category ‘A’ SPADs provides solid evidence that there are groups of SPADs with common characteristics. Investigating panels should look beyond the individual SPAD, the SPAD history of the staff involved and the signal itself to explore parallels and lessons learned. This is of particular benefit when considering starting against signal SPADs (SASSPAD) and the recently identified issue of SPADs that have occurred following a start from a station against a single yellow aspect (SOYSPAD).

Distraction factors and the appropriateness of train dispatch arrangements should always be considered. Benefit can be gained from the analysis of closed circuit television (CCTV) surveillance tapes. Accordingly, these should be secured and considered as evidence when investigating SASSPADs at platforms. Note, however, that not all SASSPADs occur at stations.

When it has been established that the driver’s reminder appliance (DRA) was not used prior to a SASSPAD, it is necessary to establish why it was not used. In establishing why DRA was not used or not used correctly, it is necessary to consider the significance of both immediate and underlying distraction factors. Similarly, systemic issues relating to the way in which the company has trained and/or briefed drivers as to the correct use of DRA and the benefits that arise from such correct use should be considered.

B5.7 Perturbed operation and unusual moves
When investigating SPADs that are associated with abnormal and perturbed operation, investigations should look beyond the SPAD itself and explore the underlying reasons for the event that had led to the abnormal or perturbed operation.

In so far as unusual moves are concerned, the causal component relating to inadequate route knowledge should be identified as a matter of course. The extent to which there are systemic failures in the processes by which the necessary knowledge is acquired and retained should be investigated within the context of the company’s competence management system.

Where an unusual move is one that a driver could be expected to make in the context of an accepted company contingency plan addressing out of course working, and the planned response to handling defective vehicles and defective on-train equipment referenced in section H2 of the Rule Book, the adequacy of instructions given and the plan itself should be considered. This consideration should in turn lead to a further assessment of the need for individual and possibly systemic supplemental route learning requirements.

Interaction between a signaller and the driver faced with an unusual move or perturbed operation should always be investigated. Managerial and staff attitudes to issues such as whether it is appropriate and necessary for a signaller to talk a driver through an unfamiliar move should be explored.

SPADs arising from train operations in association with T(iii) possessions too often expose that the event has arisen because a driver was willing to take instructions to pass a signal at danger from a source other than the signaller. The
wider reasons lying behind the event, including performance pressures that might be perceived as making it acceptable to take short cuts, custom and practice diverging from the requirements of the Rule Book and poor planning should be explored. There are very few occasions on which it is appropriate to conclude solely that there was an on the day miscommunication or failure to follow the rules, as there are generally systemic factors that should be considered and identified as underlying causes. These systemic factors may extend to the rules and standards themselves.

B5.8   Expectation

When performing the same task regularly, a particular mental model is developed that can lead to an expectation that the same thing will happen each and every time. This can lead to a train being driven in a way that anticipates, for example, that an approach released signal will clear and therefore an expectation that there will be no need to stop at the signal may have been created. A further example of where a false mental model may be pertinent is where a driver has misread his diagram and drives as if he were a through service rather than stopping service, while the signaller is operating a level crossing on the basis that the train is booked to stop. These examples illustrate the need to consider the mental model held by the driver at the point where a processing error has been made.

As with fatigue it may be necessary to call on specialist human factors support to the investigation in order that the influence of expectancy, reliance on inappropriate cues and related matters can be considered. As these influences are linked to loss of attention, it may be appropriate that specialist support is employed to establish the extent to which there are wider ‘loss of attention’ issues to consider.

B5.9   Mobile telephones

It is now clear that mobile telephones have been a significant factor in a number of SPADs. The call record of company mobile telephones should be checked to identify if they were making a call or text message at the time of the SPAD or in the time leading up to it. It is unlikely that the call record will be able to identify calls/messages received by a mobile phone, therefore only a partial record of the use of the phone is provided by this source.

The reasons for the company issued mobile telephone having been used to make or receive calls/messages should be established and considered in the context of the adequacy of any company protocol covering their use.

When considering issues relating to company issued mobile telephones, it is important that equal attention is applied to consideration of the reason and need for calls/messages made by the company itself, for example in respect of rostering or altered duties, as is given to calls/messages made by the driver.

Additionally, the use of personal mobile telephones may have been a factor. Again, this needs to be in the context of the applicable protocol. Consideration should be given to asking the involved staff members to obtain and provide as evidence the mobile telephone provider’s record of calls/messages made from a personally sourced mobile telephone.

Similar consideration should also be given to the need for and appropriateness of any message sent or received by way of the train radio networks. Voice recordings of these calls should be identified and analysed by the investigation panel.

B5.10   Personal preoccupation

An analysis of SPAD investigations shows that in some organisations as a whole, or in part, there is a climate within which the staff relationship with their managers enables them to declare when they need help in balancing the demands of work with those in their personal life. Conversely, other investigations expose that either in other places within a company or across a company as a whole the
sharing of confidences relating to, for example, health worries, bereavement, child care and divorce is not well developed.

Investigations should not only explore the extent to which personal preoccupations are present but also the nature of the company response to them or what more the company might do to develop an environment within which staff were more willing to discuss sensitive personal issues with the potential to impact on their performance at work.

**B5.11 Competence management systems**

Diagnostic investigation of limitations and failures of competence management systems needs to be handled with care and may require specialist support to be made available to ensure that the panel only makes recommendations that are both practical and proportionate. The learning that can arise from this approach should be significant, as it relates not just to the further development of the staff directly involved in the particular SPAD but to staff in general, thereby further increasing the potential for SPAD reduction.

When considering the efficacy of the competence management system, specifically including any application (or, in some cases, non-application) of special monitoring arrangements, investigation panels should always consider the relationship between expected and evidenced behaviour. This consideration should extend to:

a) underpinning competence in rules and regulations
b) driving technique and traction knowledge
c) company professional and defensive driving protocols
d) safety-critical communications
e) route knowledge, including frequency and pattern of working over the infrastructure in question.
f) initial and recurrent training
g) briefing arrangements, including awareness of multiple SPAD signals
h) understanding of late notices etc.
i) wider interaction with line managers and those tasked with developing and assessing competence.

In exploring each of these dimensions of the wider competence model, the panel should always be looking for underlying systemic weaknesses. Accordingly, a panel should not draw conclusions based solely on ‘immediate’ human errors and, in a few cases, violations.

The above approach should be applied in an equivalent and parallel manner to the consideration of the competency management system, within which other involved persons such as signallers, shunters, train despatch staff and hand-signallers are operating.

As safety-critical communication involves the interaction of more than one person investigation panels should explore this holistically and explore both the standard of verbal communication and the appropriateness of the method by which it has been effected (for example, face-to-face, signal post telephone, mobile telephone, cab secure radio, back-to-back radio).

Whenever available, voice tapes should always, and quickly, be secured as evidence to be considered by the panel conducting the investigation. Likewise, where an on-train monitoring recorder (OTMR) data download is possible it should always be done so in a timely manner and interpreted by a competent.
person, for consideration by the panel. Where possible, the panel should review the evidence provided by routine monitoring of OTMR downloads to identify and analyse recurrent factors that may be present.

B5.12 Train protection systems
Investigators should be alert to the risks associated with drivers developing an over-reliance on TPWS leading to any degradation of driving techniques.

Similar issues may exist where differences are noted in a driver’s technique when operating over an automatic train protection (ATP) equipped route compared with the approach to driving when off the route equipped with ATP.

B6 Factors to be considered by the Signal Sighting Committee

B6.1 Introduction
Whilst the SSC investigation is a self-contained activity, it forms an integral part of the formal investigation convened in response to the incident. The SSC report provides a considerable amount of information to assist the investigation panel in their consideration of the factors that may possibly have contributed to staff error. In this context, basic data regarding the signalling and other aspects of the infrastructure, as well as the findings in respect of the visibility and readability of the signals, are of great significance. The conclusions from the SSC report also provide an essential input to the investigation panel's consideration of error mechanisms. The SSC recommendations also should be considered by the investigation panel.

At the SSC level, as with any sort of investigation, a methodical approach to the collection and analysis of evidence is essential. The normal sequence of steps that can be applied to any signal sighting investigation is shown in diagrammatic form in Appendix 1 to this document. A detailed description of each of the steps is as follows:

B6.2 Establish the initial facts
Before any technical investigation work commences, those involved should obtain as much information as possible regarding the circumstances of the incident. This is essential for the correct scoping of the work that is to follow.

As much information as possible should be sought in relation to the following questions:

B6.2.1 Why did it happen?
There are two key questions to be asked:

a) Did the driver realise that the SPAD signal was controlling the movement being made?

b) Did the driver see the signal at red at any time during the approach?

B6.2.2 What actually happened?
There are four possible scenarios relating to the driver’s state of mind approaching the red aspect:

a) The driver passed the signal at danger unaware that it was controlling the movement being made.

b) The driver passed the signal at danger in the belief that he/she had authority to do so.

c) The driver passed the signal knowing that it had been at danger but in the belief that it had cleared.
d) The driver intended to obey the signal at danger but did not succeed in doing so. (This category describes all cases where the driver has attempted to stop in response to the red aspect. Depending on the circumstances, such cases could include situations where the driver has not reacted correctly to the previous cautionary aspect, or has anticipated the clearance of the red aspect.)

B6.2.3 Who was involved?
Establish a list of those people who directly contributed to the scenario above. Were there any factors present that might have affected their ability to perform to the normal standard?

B6.2.4 Where did the error (or errors) occur?
Establish the contribution of factors local to the signal where the SPAD occurred. Consider the relevance of the aspect sequence leading to the signal and the pattern and type of signalling encountered before the first cautionary aspect. The possible relevance of other factors such as gradients, station stops, speed restrictions, AWS, DRA and engineering possessions should also be considered. A helpful tactic is to examine the incident from the driver's viewpoint:

a) What was the driver doing?
b) What was in the driver's field of view?
c) What was the driver looking at within the field of view?

B6.2.5 When did it happen?
Establish any time-dependent factors (such as light conditions and weather conditions) which may have contributed to the likelihood of the SPAD occurring at the time it did.

B6.2.6 Why did it happen?
Establish any unique trigger factors which occurred, or special circumstances that applied at the time and in the vicinity of the SPAD.

Much fine detail on these points should emerge during the course of the technical investigation itself, and also the formal investigation of which the technical investigation is part. It therefore may be helpful to review the answers to these questions as the work progresses; if significant new information emerges during the investigation, then it is essential to do so.

In supplying much of the basic information, reference to documentary sources is essential, especially at the beginning of an investigation. Relevant sources include:

a) management information systems (for example SMIS)
b) the zonal/regional log and daily incident log
c) reports from those directly involved in the incident, those who witnessed it, and records of subsequent management interviews with staff
d) the signalling plan
e) the zonal/regional sectional appendix
f) other infrastructure records such as signal sighting forms
g) operating notices, including signal box instructions
h) records relating to previous SPADs at the signal and other signals in the vicinity. This includes previous SSC reports, and reports of formal inquiries and investigations.
When sourcing some of this information, liaison with the person leading the formal investigation may be helpful.

**B6.3 Determine the scope of the investigation**

Having established as much of the background detail as possible, the committee is now in a position to agree the scope of its investigation, in terms of the number of signals and the extent of the infrastructure to be examined.

It is important to reiterate that all possible contributory causes should be considered. Therefore, it is standard practice to undertake a detailed examination of all cautionary signals in the sequence leading to the signal at red, as well as the SPAD signal itself. Since it is important to understand the driver's perspective of events, this means that the normal boundary of the committee's investigation is the point at which the outermost cautionary aspect became visible. From this point onwards, all significant features of the infrastructure, as well as any significant features outside the Network Rail boundary that could have had a material effect on the driver's actions, should be examined. Where the signal previous to the SPAD signal was a shunting signal, then the investigation should extend back at least as far as the point at which the shunting signal became visible.

Wherever it is possible for a driver to see the aspects of other signals, apart from those immediately applicable to the train, then misreading error (because of cross-reading one or more parallel signals, or reading-through to a signal ahead) is a possibility. In such cases the committee should consider the likelihood of such an error occurring. The scope of the investigation should therefore be expanded to take in such signals.

When agreeing an exact scope for the signal sighting investigation, the committee should beware of applying a rigid formula: No two SPAD incidents are ever exactly the same. A full examination of the SPAD signal itself should always be undertaken. Beyond that, the scope of the exercise should take in all factors that could possibly have had a bearing on the incident. The committee should always consider the possibility that the conditions for an error to occur were set up before the first cautionary aspect came into view. For example, it is possible that irregular spacing between green aspects, a change between two, three, or four aspect signalling systems, or even the presence of a significant landmark contributed to a SPAD at some distance ahead.

In certain cases, examination of the full aspect sequence may not be necessary. However, this only applies in cases where it is safe to take the view that the signals (or other infrastructure) in question could not possibly have contributed to the incident. In areas of four-aspect signalling it may only be necessary to go back as far as the point at which the single-yellow became visible, if any of the following scenarios apply:

a) the signal on the approach to the SPAD signal was subject to approach release from red, and the train was being controlled correctly at that point

b) the train was detained at a signal which then changed to single-yellow, and after the train started away, a SPAD occurred at the next signal ahead

c) the train had stopped in a properly controlled fashion for any reason (such as a station stop) within the cautionary aspect sequence

d) the SPAD occurred when the train started away against the red aspect, having previously made a properly controlled stop.

In the course of the SSC investigation, a considerable amount of detailed information should emerge. After the evidence has been collected it should be a matter of routine to consider whether or not the initial planned scope of the investigation was sufficient. Sometimes during an investigation, the emerging facts indicate that the scope of the work should be extended. For example, the potential for misreading error (due to cross-reading or reading-through to other
.signals) may not be immediately obvious until a detailed site examination is carried out. Review of the scope of the investigation is shown in Appendix 1 as a separate decision process.

The SSC also has a duty of care to consider potentially sub-standard conditions that lie strictly outside the narrow confines of the incident itself. For example, where more than one route leads to the SPAD signal, and the committee has doubts about its approach view, then the view from all other directions should be checked. The adequacy and effectiveness of all aspects and indications at the SPAD signal should always be examined, even though it is only the red aspect that will have strict relevance in the circumstances of the incident.

Appendix 2 to this document contains a number of case study examples showing how these scoping guidelines are applied in practice, and how the emphasis of an investigation should reflect the likely human error modes.

B6.4 Collect basic data
The following basic data should be collected in all circumstances when a SSC is required. Some of this may have already been established during ‘on the day’ investigations described in section B5.4. Relevant information (which should be recorded throughout the area within the scope of the exercise) is as follows:

a) the form of each signal (as set out in GK/RT0037)
b) the permitted speeds
c) signal spacings
d) aspect sequence (the designed aspect sequence leading to the signal at red; the usual sequence of aspects encountered by the train service in question; the actual sequence presented to the train involved)
e) gradients
f) distances at which aspects become readable
g) misreading possibilities
h) the positions of any signs relevant to the driver (for example, permitted speed indicators, permitted speed warning indicators, cab secure radio signs).

In all cases where a train has started at or in view of a signal (either in the cautionary aspect sequence or at the SPAD signal itself), then additional basic data is required:

i) The starting position of the driving cab should be established. In locations where ‘stop marks’ are provided, the position of the cab in relation to these should be noted.
j) This information should then be used to deduce where the signal was in the driver’s field of view, or even if the signal was visible at all from the normal driving position. This assessment should take into account the limitations imposed by the sightlines of the type of driving cab in question.
k) Where the train has started away from a platform against a red aspect, then the method of train despatch should be recorded.

B6.5 Other evidence
B6.5.1 Collecting additional information
For each signal within the scope of a SSC investigation, the following additional information should be obtained:

a) the height and offset of the most restrictive aspect
b) the beam alignment

c) the orientation of any close-up viewing device (for example 'hot strip')

d) the state of the interior and exterior cleanliness

e) the condition of any sighting boards, hoods and blinds

f) the distances from the signal to the track equipment for any associated protection systems (for example AWS, TPWS, ATP)

g) distances to any conflict points ahead of the SPAD signal.

If poor light output from the signal is suspected, then the following additional evidence should be obtained:

h) the lamp voltages

i) the apparent accuracy of the optical focus of the lamp units

j) the condition and security of the lamp holders or other relevant internal components.

The SSC investigation should take account of any special lighting conditions (such as bright sunlight, or darkness) that prevailed at the time of the incident. It should not be necessary to carry out an examination under similar conditions, unless the committee have reason to believe that the readability of the signals under particular lighting conditions may have been a contributory factor.

B6.5.2 Photographic evidence

The above evidence should be supplemented by an appropriate number of photographs of each signal. There should be one photograph of each signal taken close enough to show all the signal elements clearly. There should also be a further view of the SPAD signal taken from the start of the required reading distance, or in the case of a signal with restricted approach view, the achievable reading distance. Additional photographs should be taken to illustrate any potential problem; this applies especially where the committee has formed the view that there are readability issues with a signal, or there is a condition that constitutes a non-compliance with standards.

Photographic evidence should meet the following standards:

a) Photographs should be taken in colour.

b) The exposure, focus, and resolution should be such that distant objects are clear and sharply defined on hard copy when printed at approximately half A4 size.

c) Ideally each photograph should illustrate the aspect that was displayed to the driver at the time of the incident.

d) Photographs should normally be taken from as close to the driver’s perspective as possible. In rare cases it may be possible to take photographs from the driving seat of a test-train; otherwise, photographs should be taken as close as is practicable to the driver’s seated position from within a train cab, or a person standing on the ballast with the camera over, or just to the right of, the left-hand rail.

e) Where it is helpful to use wide-angle or telephoto focal length settings, care should be taken to avoid giving a false impression of perspective. Wide-angle (short focal length) lenses tend to exaggerate the distance of remote objects; telephoto (long focal length) lenses tend to make objects at different distances look closer together than in reality. Accordingly, a telephoto shot of a signal head shown full-frame against a sky background may be useful.
in depicting all the elements of the signal. However, the same signal taken
from further back with rails in the foreground should normally be taken using
a standard focal length setting.

f) A record should be made of the date and time at which each photograph
was taken. If the date and time are automatically recorded on the
photographic medium by the camera itself, then care should be taken to
verify the calibration of this feature.

g) For each photograph, the distance of the camera from the principal object in
question (usually a signal) should be recorded. This value should be stated
in metres and should be obtained by physical measurement.

B6.5.3 Supplementary observations
In addition to taking a thorough set of static observations and measurements from
the ground at least one member of the committee should make supplementary
observations from the driving cab of a train. Wherever practicable, the cab-ride
should take place in similar stock to that involved in the SPAD incident. The
purpose of this exercise is to observe the situation from the driver's perspective,
with particular emphasis on problems of visibility, readability and timing that may
not be evident from static, ground-based observation. The observer should also
be alert to visibility limitations imposed by the driving-cab design, and should also
be careful to note routine driving tasks that take the driver's attention away from
the signals. Where relevant to the investigation, the observer should take the
opportunity to gain intelligence from the driver by asking about particular
problems posed by the locality in question. Persons performing the cab-ride
should have proper authorisation to do so, and should take care to observe
correct driving-cab protocol, avoiding any actions that could possibly disturb the
driver's concentration.

B6.6 Consider compliance issues
Having collected basic data and other evidence, the committee should be in a
position to consider compliance issues. In practice this step should be carried out
in parallel with the evidence collected.

Signals that are the subject of a SPAD investigation should be assessed for
compliance against GK/RT0037. To seed this process the SSC should undertake
the following assessments:

a) A minimum reading time (MRT) calculation for each signal along the route
taken by the train, within the scope of the investigation.

Calculations should be based on a structured assessment of the problem
factors associated with each signal, and should be performed using an
approved method.

b) An assessment of the interruptions to the view of each signal along the
route taken by the train. The results of these assessments should be
presented as obscuration diagrams in an approved format.

The compliance of all the collected data against the parameters and other
measures set out in GK/RT0037 should now be considered.

The committee should also consider compliance matters in respect of several
other factors. Relevant issues (all of which are subject to current standards)
include but are not limited to:

c) the suitability and sufficiency of signals and signs
d) the correct form and positioning of signs
e) signal spacing
f) aspect sequence
g) provision and positioning of AWS equipment

h) provision and positioning of equipment associated with TPWS, ATP or any other train protection system

i) provision and positioning of telephones.

B6.7 Consider the effectiveness of the signalling arrangements

Beyond compliance issues, the committee should also consider whether or not the totality of the situation is as effective as it could be. The compliance of the individual factors does not necessarily guarantee an effective end result. In this respect the committee should be particularly alert to situations of marginal compliance with standards, especially where there are several problem factors present. GK/RT0037 requires such situations to be avoided on the grounds that they could present intolerable risk.

In considering the effectiveness of the arrangements, the SSC should think about the situation from the driver's perspective. The consistency of the situation, compared with what the driver had become accustomed to (over several signal sections back), is always worth examining. Changes between two-, three- and four-aspect signalling systems introduce the possibility of driver confusion. Significant changes in the signal spacing, especially where there is a change from near maximum to near minimum over consecutive signal sections, has the potential to cause misjudgment errors.

Error arising from anticipation is a possibility if the signalling system behaves in a way that is outside the driver's normal experience. This can be a particular problem at signals subject to approach release. In such cases one always should consider the time that was available to the driver to assimilate and react to the unusual circumstance.

GI/GN7606, Appendix D, Items L1 to L17, is a list of ‘Factors Affecting the Likelihood of an Overrun Occurring’. The committee should use this as a checklist and prompt on matters of effectiveness.

The committee should also consider the readability of the signals within the scope of the exercise. The ease with which the signal can be read is always a matter of professional judgment, and is one of the most important factors for the committee to agree upon. In deciding whether or not a signal has acceptable readability, the following issues are relevant:

a) Preconditioning: before the error (or errors) occurred what was the driver's expectation based on his normal experience and the pattern of signalling previously encountered?

b) Identification: How easy was it for the driver to identify the signal applicable to the train?

c) Interpretation: How easy was it for the driver to translate the visual message being given by the signal into a course of action?

d) Conflicting messages: Were there any signs in the vicinity or other stimuli that may have suggested a different action on the part of the driver? (For example, an increase in the permitted speed just before the SPAD signal.)

e) Distractions: What factors in the situation had the potential to divert the driver’s attention away from the signals?

Where the signal in question has been the subject of previous remedial action to reduce the probability of a SPAD occurring or mitigate the consequences, the committee should consider some further questions:

f) Were the previous remedial actions relevant to the circumstances of the incident under investigation?
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b) If so, how effective were the previous remedial actions?

c) Is there any evidence that previous remedial actions have increased the likelihood of the current incident occurring? For example, a platform starting signal may have previously been lowered to reduce the probability of a start-away SPAD. Such action might impair the distant view of the signal, thus increasing the possibility of a misjudgment SPAD.

B6.8 Evaluate remedial actions

Having considered matters of compliance and effectiveness, the SSC is now in a good position to make a careful determination of remedial actions.

As regards compliance with standards, the situation should have been assessed against the requirements of standards currently in force. In many cases the infrastructure will have been installed to previous standards, and the current related standard will often not require retrospective action. Nevertheless the SSC should consider the reasonable practicability of achieving compliance with current standards. In making this decision, the SSC should take into account the seriousness of the incident itself, the previous SPAD history of the signal, and the consequences of a ‘worst-case scenario’. It is unsatisfactory just to assert that ‘the current standard does not require retrospective action’ without giving any other justification for continued non-compliance.

Where the SSC has concerns about the effectiveness of the situation (as distinct from compliance matters) then a variety of supplementary remedial measures may be appropriate. Here a careful separation should be drawn between measures that will reduce the probability of a future overrun occurring (prevention), and measures that should reduce the consequence of an overrun (mitigation).

GI/GN7606, Appendix E, ‘Overrun Risk Reduction Measures’, sets out approved measures that could be applied. These have been divided into two main categories: ‘Overrun Prevention Measures’ and ‘Overrun Mitigation Measures’. Since the primary objective should be to prevent SPADs occurring in the first place, the SSCs first priority should be to consider suitable preventive measures, only moving on to consider mitigation measures as a last resort.

Before any measures are applied, there needs to be a clear understanding of the likely causation factor, or chain of causation factors, underlying the incident. The mechanism by which it is expected that the proposed measures will reduce the risk of the signal being passed at danger should also be clearly understood. The justification for applying a preventive measure is that it should be appropriate for reducing the type of error that has been made. For example, ‘countdown signs’ may be helpful in the case of a misjudgment at the SPAD signal, but would be inappropriate where there has been a misread of the distant signal. For each measure listed in GI/GN7606 Appendix E, an entry headed ‘Benefits’ gives guidance on the purpose and suitability. The SSC should also be mindful that application of one preventive measure, whilst achieving its intended effect, may inadvertently increase the likelihood of other types of the driver error, or move the same problem elsewhere on the layout. The entries in GI/GN7606 also include reference to the possible disadvantages of each measure.

The SSC may find that reference to the latest issue of Network Rail’s ‘Anti-SPAD Toolkit’ is also very helpful. This publication contains a series of case studies of some of the more common infrastructure problems. For each problem, potential solutions are suggested, applicable standards are listed, and commentary and guidance is given. As a matter of routine, the ‘Anti-SPAD Toolkit’ should be checked for relevance to the particular circumstances of the SPAD incident under investigation.

Whatever remedial measures are considered for adoption in any particular case, the chosen application should be planned in such a manner as to maximise its effect in reducing the overall level of risk. The temptation to ‘tinker’ or to ‘do
something for the sake of doing something, without understanding clearly how it is going to improve matters, should be resisted, since ineffective measures are likely either to confuse drivers or subject them to a clutter of superfluous information.

B7 Signal Sighting Committee report

B7.1 Introduction
The purpose of the SSC report is to provide technical evidence and expert judgment to the formal investigation into the incident. Besides any technical recommendations that the SSC may have, it is important that the overall inquiry or investigation is suitably informed about the infrastructure factors that could possibly have contributed to the incident and to what extent the infrastructure can be considered (or ruled out as) a contributory element. This information is an essential input to their consideration of the event, and is particularly helpful in gaining a complete understanding of the error mechanisms that were possibly involved. The SSC report should therefore take the form of a report that is self-contained and self-explanatory, drafted in free text format.

The inclusion of a newly produced signal sighting form should be discouraged where an existing form is available. The sighting form is a design record and as such the production of a second form is likely to introduce confusion.

Appendix 1 illustrates the nature of the required information flow from the SSC report to the formal investigation. The report should contain a number of subsections, which should normally be as follows:

B7.2 Remit
The date and place of the signal sighting should be recorded, together with the reason for holding the signal sighting. Where a formal remit has been issued, this should be included, preferably as an Appendix.

B7.3 List of attendees
The names and affiliations of those attending should be recorded, together with their area of expertise or accredited competence. The person in the role of chairman should be identified; where a person attends the SSC as an observer, then this should be made clear.

B7.4 References
References to any Standards cited in the report should include their issue number and date of publication. It is not normally necessary to list other documents that the committee has consulted.

B7.5 Scope of the investigation
A brief description of the signalling within the scope of the committee's investigation should be given. This should contain all relevant information classified in this document as 'basic data' (refer to clause B6.4). With the aim of making the report self-contained, a diagram of the signalling (which may be a suitable extract from the signalling plan) should be included.

B7.6 The SPAD incident
A brief summary of the committee's understanding of the basic facts of the SPAD incident should be given. This should describe the driver's reported actions, with special attention to the points at which those actions were taken.

B7.7 Previous SPAD history
Any previous SPAD incidents should be briefly described and points of commonality with the current circumstances highlighted. Where previous remedial measures to prevent or mitigate the effects of SPADs have been applied in the locality, then these should be listed and the rationale for applying them outlined.
B7.8 The visibility and readability of the signals
This section should contain all the relevant data classified in this document as ‘other evidence’ (refer to clause B6.4). As each signal is dealt with, the committee’s findings in respect of compliance and effectiveness issues should be included (refer to clauses B6.6 and B6.7). To avoid disrupting the flow of the text, MRT calculations, obscuration diagrams and any other detailed numerical analysis should be placed in an Appendix to the report.

Where the SPAD signal in question has been the subject of previous remedial measures, then the report should comment on their relevance and effectiveness in the particular circumstances of the current incident.

B7.9 Overrun consequences
In this section the report should outline the possible consequences of a SPAD in less favourable circumstances (see clause B6.8). It is possible that such consideration reveals weaknesses in operating practices or interlocking arrangements. The two issues are sometimes closely connected in circumstances where a SPAD is related to a change in the operational use of a layout (that is the layout is being used in a way that was not originally intended or foreseen in the design). Such considerations may in their own right give rise to a recommendation to modify the interlocking, even if only at the level of aspect sequence. However, in most cases the analysis of overrun consequence should serve to put the conclusions and recommendations that follow into a proper context.

B7.10 Conclusions
As stated in B7.1 the conclusions from the SSC report provide essential input to the formal investigation as it considers all of the circumstances of the event, and in particular, the possible human error mechanisms. (Appendix 1 illustrates how the conclusions from the SSC report feed into the formal investigation.) Therefore, it is absolutely essential that the ‘Conclusions’ section should contain a clear statement of the committee’s opinion regarding the contribution of any infrastructure factors to the SPAD incident in question. Absence of comment is not acceptable; it should be clear from reading this section whether or not the committee considered any of the infrastructure factors to have been a possible contributory cause of the incident. For example, an investigation may have discovered that a signal was misaligned and a ‘hot strip’ incorrectly oriented. Correcting these matters will rightly be the subject of recommendations in the report.

However, it is possible that these issues did not play a significant part in the circumstances of the incident, in which case the report should say so. Just from reading the recommendations on their own, it is often not possible to judge the seriousness or the significance of a problem.

As previously stated that the immediate cause of every category ‘A’ SPAD is human error. Citing an infrastructure factor as a contributory cause, simply means that the committee consider that there could have been a contribution to the error from that particular source. It is not the job of the SSC to apportion blame: since the committee will seldom be in possession of all the significant facts of the case, a full causal analysis should be left to the formal investigation. In the past there appears to have been a mistaken belief that identifying an infrastructure factor as a contributory cause absolved the driver from all responsibility. The typical SPAD arises from several factors all coming into combination at once: seldom is driver error the only ingredient; seldom is the infrastructure the only underlying cause.

At those signals that have been passed at danger three or more times, there is only a 4% probability that the SPADs are entirely due to random causes; where there have been four or more SPADs that probability becomes effectively zero. It is therefore reasonable to presume that at those multi-SPAD signals there are factors involving the infrastructure or environment that contribute to and significantly increase the likelihood of drivers making errors. Therefore, when
coming to conclusions in the case of such signals, the SSC needs to take careful account of these statistics and, if necessary, look harder at the situation with a view to discovering underlying problem factors.

Where the committee’s investigation has exposed compliance or effectiveness issues, then this section should contain the rationale for any remedial action. Where the committee has considered alternative possibilities before agreeing remedial action, then the substance of the arguments should be outlined.

B7.11 Recommendations
A list of the committee’s recommendations should be given. These should each be traceable to relevant content in the ‘Conclusions’ section.

Where recommendations are of an urgent nature, then this should be clearly stated. Should urgent interim action be required ahead of a final recommendation being implemented, then this should be made plain. In this case care should be taken to stipulate the required sequence of remedial actions. Where committee members obtain confirmation that urgent action had been implemented before publication of the report, then this should be recorded.

B7.12 Photographs
Photographs are best placed in an Appendix to the report since the reader may wish to reference them from any point in the text. Quality issues associated with obtaining photographic evidence are addressed in B6.5 of this document. Within the report, photographs should be reproduced in colour at approximately half A4 size, or larger. Each photograph should be provided with a descriptive caption that includes amongst other things, the date and time that the photograph was taken, and the distance of the camera from the principal feature (usually a signal).

B7.13 Validation
The report should be signed by the principal members of the committee (those who are competent to pass professional judgment on the visibility and readability of signals). This means that as a minimum the report should be signed by signal engineering, operations, and driving standards specialists. Those who have attended the committee to give expert advice on matters other than visibility and readability of signals (such as civil engineering, electrification or human factors issues) should only sign the report if significant action within their field of expertise arises as a consequence of the recommendations.

The date of issue of the report, and the organisation responsible for its preparation and issue, should be clearly stated.

B8 SPAD investigation report
A SPAD investigation report should contain distinct sections that describe the event, set out all of the evidence to be considered, analyse the evidence and only then draw conclusions as to why the SPAD occurred. Then the immediate and underlying causes should be stated in a manner that will be seen as just rather than blame-driven. In turn, this should lead to the recommendations arising from the investigation being expressed in a way that leads to SMART (specific, measurable, achievable, realistic and timebound) actions being taken. Recommendations should always be both relevant and proportionate.

Evidence should not be introduced within either the factors for consideration or the conclusions, and there should be a clear linkage of the recommendations to the evidence, factors for consideration and conclusions.

The lead investigator should write the report, mindful of the context within which the investigation report will be read.
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The following questions should be asked before a report is finalised:

a) Does the report clearly identify and consider the immediate and underlying causes of the SPAD?

b) Does the report show the panel to have too much of a focus on the immediate failings leading to the SPAD?

c) Is there any suggestion of blame being apportioned, and if so, has this got in the way of establishing and considering underlying systemic factors?

d) Is the term ‘disregard’ to be found anywhere in the investigation report?

e) Does the investigation report suggest any complacency and/or a ‘laissez-faire’ acceptance of the SPAD or SPADs in general?

f) Does the report demonstrate that the investigators were alert to the potential consequences or focussed solely on those that occurred on this occasion?

g) Does the investigation report demonstrate that the lessons learned as a consequence of previous and related SPAD investigations have been applied in responding to the SPAD in question? Where this is not the case, have the reasons why not been established?

h) Were there a catastrophic accident arising as a consequence of a further SPAD at the signal in question or involving the driver concerned, would external scrutiny show this investigation to have been proportionate and fit for purpose?
Appendix 1

The signal sighting investigation process

1. Establish initial facts
2. Decide Scope
3. Gather Evidence (basic data and other evidence)
4. Consider compliance and effectiveness issues
5. Scope OK? (Yes/No)
6. Consider actual and potential consequences
7. Evaluate remedial actions
8. Produce report
Appendix 2

Case studies

The following examples illustrate the application of these guidelines, particularly in respect of the scope and nature of the investigation that would be applied in practice. Reduction of future SPADs is obviously the objective, and it should be noted that some of the examples use a mix of two different strategies to achieve this:

a) identifying factors that are known to lead to increased rates of driver error (the aim being to reduce or remove these)

b) identifying features that enable a driver to recover from an error (the aim being to enhance these if possible).

Example 1: A running SPAD

Where a train has passed the previous cautionary aspects and then overrun the SPAD signal in one continuous movement (a so-called ‘running SPAD’), then the investigation should examine the whole aspect sequence. In the case of a SPAD at signal EX24 in the diagram, the investigation should, as a minimum, examine the signalling and other infrastructure back as far as the point at which signal EX28 first comes into view. This examination should include MRT and obscuration assessments for all signals.

On the basis of the limited information appearing on the above plan, there are two factors that should be probed in particular detail:

a) was the uneven signal spacing a possible factor? If so, how can this be corrected or alleviated?

b) did the driver expect signal EX24 to step-up under approach control conditions ‘because that’s what it always does’? Example 5 covers this particular problem in more detail.

Where MRT assessments indicate the existence of problem factors, then reasonably practicable ways of removing or alleviating these should be considered. Provision of extra reading time, as compensation for one or more problem factors, should always be regarded as a ‘second best’ solution. This is a general principle that should also be applied in all the other case study examples in this document.
Example 2: Start-away on a yellow aspect

Where a train has made a normal controlled stop at (or in sight of) the single-yellow aspect, and has subsequently accelerated from rest and overrun the red aspect ahead, then the investigation should not normally need to go back as far as the double-yellow aspect. Where a SPAD has occurred at signal EX30 in the diagram after a station stop at the platform, the investigation should, as a minimum, examine the signalling and other infrastructure back as far as the point at which EX32 first comes into view. In the situation shown, the following factors should receive special attention:

a) Did the driver observe the official stopping position at the platform, as dictated by any ‘car stop’ marks, CCTV monitors, etc?

b) Was there an adequate view of the signal from the official stopping position and (if this was different) the position at which the train stopped?

c) How far from the station did the train travel before the driver was able to read the red aspect, and therefore take corrective action (begin to recover from an incorrect response to the single-yellow)?

Depending on the circumstances, possible remedial actions include improving the driver's view of signal EX32 when stopped in the platform by:

i) changing the horizontal or vertical position of EX32

ii) moving EX32 further away from the platform

iii) extending the platform at the ‘running on’ end

iv) changing the positions of platform ‘car stop’ marks and CCTV equipment

v) introducing differential ‘car stop’ marks to keep all but the longest trains well back from EX32.

Where the approach view of EX30 is less than about one-third of the distance between EX30 and the platform, then ways should be sought to extend the approach view of EX30. The aim is to give the driver a chance to correct an error at an earlier point (reducing the distance through which the train accelerates and increasing the distance available for braking).

Note that the one-third rule mentioned in the paragraph above is based on the simplistic assumption that a train’s braking performance is twice its acceleration performance. Therefore a train accelerating from rest from the station will just be able to stop at the signal if the sighting point of the signal (and therefore the point at which braking starts) is one third of the distance back from the signal to the station.
Example 3: Start-away against a red aspect

Where a train has made a normal controlled stop at (or in sight of) the red aspect, and has then started away against the aspect, it is still necessary to investigate the previous cautionary signal. This is because it is important to establish how prominent (and therefore how memorable) the yellow aspect was to the driver. For a SPAD following a normal station stop at signal EX36 in the diagram, the investigation should, as a minimum, examine the signalling and other infrastructure back as far as the point at which EX38 first comes into view.

In the situation shown, when carrying out a standard SSC examination, the following factors should receive special attention:

a) Did the driver observe the official stopping position at the platform, as dictated by any ‘car stop’ marks, CCTV monitors, etc.

b) Was there an adequate view of the signal from the official stopping position and (if this was different) the position at which the train stopped?

c) What were the arrangements for train despatch at the platform? If a guard or station staff were involved, could they see the signal (or an effective indication) from the positions where they were supposed to be standing?

Depending on the circumstances, ways of improving the driver’s view of signal EX36 when stopped in the platform should be considered. Some possible measures were mentioned in Example 2. Again, depending on the circumstances, it is possible that the arrangements for train despatch should be changed. This might include moving any platform plungers and ‘off’ indicators to more suitable positions.
Example 4: Banner repeater and speed indicator

Within the boundary of the SSC investigation, all features of the infrastructure should be considered. In the case of a running SPAD at signal EX42 in this example, the banner repeating signal should be given a complete examination. The compliance of the banner signal and the related main aspect should be assessed against the requirements of GK/RT0037. A key factor in the above situation is the time for which EX44 main aspect was readable (on the presumption that the signal has limited approach view). At EX44 there should be no doubt in the driver’s mind about the single-yellow aspect. The banner is useful in that it alerts the driver to the presence of a signal ahead which is displaying a proceed aspect. However, sufficient time is still needed to read the exact aspect being displayed. Where the driver has only a fleeting view of the signal, then misreading a single-yellow for a double-yellow is a possibility.

Any sign which the driver is expected to read will inevitably divert attention away from the signals. In the case of speed indicators there is a further risk that the train will be controlled in response to those, rather than the signals. If the 70 mph permitted speed indicator shown in the example is giving advice of an increase in permitted speed, then the message conveyed is contrary to the action required when stopping at EX42 signal. Repositioning of signs to avoid the risk of conflicting stimuli should be considered.
Example 5: Parallel signals

The scope of the SSC investigation should normally include examination of signals reading in the same direction, on lines parallel to that being examined. A SPAD at signal EX226 on the Up Slow line in the example above, would normally require examination of the Up Slow line signals back as far as EX234, as well as the corresponding Up Fast line signals from EX228 to EX236. In the course of conducting a standard examination of all signals, the committee should be particularly alert to the presence of any factors that might increase the possibility of cross-reading errors between lines. Relevant factors include, but are not limited to:

a) signal beam alignment
b) obscurations to the view of signals
c) the distance at which each signal comes into view
d) the background against which each signal is read
e) the relative positions of the signals in the driver’s field of view.

It is only necessary to undertake MRT and obscuration assessments for signals on the route taken by the train (EX234, EX230 and EX226 in the diagram). Where cross-reading is a possibility, then independent evidence as to the exact state of each signal at the time of the incident should be sought. For signalling installations having a data recorder fitted (for example SSI) a data download and analysis should be obtained as a matter of routine.

Signals may only be excluded from the scope of the investigation if there is sufficient segregation (by distance or by physical obstruction) between the lines, such that mistaking one signal for another is impossible at any distance. For example if it is impossible to see signal EX228 from the Up Slow line, except in the final 50 m of the approach to EX226, at which point it is significantly to the left and of poor conspicuity, then EX228 could be excluded from the scope of the investigation.
Appendix 3

Guidance on SPAD causation – basic/underlying causes – human factors

3.1 Introduction

This appendix provides background information on human factors as the cause, or as a contributor to the cause, of a SPAD. This information is relevant for consideration in the investigation that follows a SPAD incident. It is structured in a way to support the inputting of basic cause data into the SPAD Data Collection Forms in GO/RT3252 for use in updating SMIS.

Since people design, manufacture, operate, maintain and manage complex systems, it is understandable that they are implicated in accidents. It is said that human error contributes to 80 - 90% of all major accidents. This statistic is often interpreted as errors caused by human inadequacies and that by considering the human factors the psychological origins of these unsafe behaviours and errors may be addressed.

However, the human factors approach is one that is based on the principle that behaviour is governed by the interplay between the individual, the task and the organisation. Human failures and errors can be reduced by ensuring that the system is matched to human capabilities and limitations.

Human factors refers to the environmental factors, organisational factors, job factors and human and individual characteristics, which influence behaviour at work (see HS(G)48 Reducing Error and Influencing Behaviour). This appendix has been developed both to reflect these factors and how SMIS records the information.

3.2 Personal factors

These are characteristics that an individual brings to a work situation (for example, personality, stress, medical fitness). They affect an individual’s performance because they limit the individual’s ability to perform safely (for example, due to lack of experience or an individual is distracted because they are preoccupied with a life event).

3.3 Job factors

These are factors associated with the tasks being performed and the environment in which they are being performed:

a) the procedures that detail how the job should be done

b) the competence of the individuals carrying out the task

c) the characteristics of the task itself (for example, undemanding or too complex given our memory limitations)

d) the physical environment in which the task is carried out, which can cause distraction or affect levels of comfort.
3.4 Equipment

These are factors associated with equipment, such as signalling displays, being used during maintenance and whilst driving cabs. These factors consider how the equipment is used and how it should be used, the state of the equipment and its design.

Humans can contribute to an accident in two ways. There are the errors and violations committed at the ‘sharp end’ of the system by the operators, controllers, drivers, signallers and so on. These are called active failures and they have a direct and immediate impact on the safety of the system.

However, it is now recognised that people working in complex systems make errors or violate procedures for reasons that generally go beyond the individual. These are latent conditions and include such issues as poor design, gaps in supervision, undetected manufacturing defects or maintenance failures, unworkable procedures, shortfalls in training and less than adequate tools and equipment. They arise from strategic and other top-level decisions made by regulators and senior managers, for example, and create the organisation’s safety culture.

While organisational factors are not included as a separate section within this appendix, information is given within the different sections about the sorts of organisational factors that can have an influence on individual behaviour. These include systems for supervision, the policy for training and assessment, manning strategies and the policy on working hours.

3.5 Fatigue

3.5.1 Introduction to fatigue

Fatigue refers to feelings of tiredness, aversion to effort and discomfort associated with prolonged activity. It affects levels of alertness, which affects attention and is also associated with an increased accident risk. Fatigue is not just something that occurs due to a lack of sleep; we show cyclical patterns (circadian rhythms) that enable us to perform better at some times of the day than others. For example, we experience significant reductions in alertness after lunch (post-lunch dip) and in the early hours of the morning. Fatigue can be caused by the amount and type of work being undertaken, the individual’s lifestyle and the shift or work patterns the individual is being asked to undertake.

3.5.2 Shift/work patterns as the cause of the fatigue

There are certain features associated with working shifts that contribute to the build up of fatigue and an increased risk of an accident, including successive night shifts (that is more than 2 or 3 unless it is permanent nights), early starts (that is before 07.30 hrs), long commuting times (that is over one hour), shifts that extend beyond 12 hours and inadequate breaks (that is no break for four hours). Shift patterns up to 12 days before the accident, not just on the day of the incident, are also relevant.

3.5.3 Lifestyle as the cause of fatigue

Lifestyle refers to those events or circumstances when an individual is not at work but which may be affecting their quality of sleep. These include personal concerns such as health, financial or relationship difficulties but also major life events such as the birth of a new baby. The quality of sleep the individual has been getting and why are also relevant for consideration.

3.5.4 Workload as the cause of fatigue

Prolonged mental and physical activity can cause fatigue and research has shown that there are time-on-task effects. For example, reaction times are known to increase the longer you have been carrying out a task, particularly when there has been no break. The cause of the workload may be identified by considering the factors within the workload section of this appendix.
3.6 Physical fitness

3.6.1 Introduction to physical fitness
Physical fitness is concerned with the effects of medication, drugs and alcohol or ill-health on an individual’s performance that may have been a contributory cause in an accident.

3.6.2 The effects of ill-health
Nobody feels at his or her best when ill and it is not surprising that ill-health is linked to performance impairment. Ill-health can be accompanied by anxiety and tiredness and some symptoms, such as a pain of headache, may divert attention away from the task at hand.

3.6.3 The side-effects of medication or treatment
Even commonly used medications such as anti-histamines for hay fever have side effects which can impair performance. Details about side effects should be available from the packaging or the occupational health specialists.

3.6.4 The effects of a physical disability
A physical disability may include poor eyesight, poor hearing or a temporary disability. There are standards that specify the eyesight and hearing requirements for certain roles. A temporary disability may be caused by an individual being involved in an accident and suffering a muscular strain or broken bones, for example. This may mean the individual is less able to move around and therefore at increased risk of slip, trip and fall-type accidents. In addition, whatever is causing the disability may be distracting and diverting attention away from the task at hand.

3.6.5 The effects of long-term ill-health
Individuals suffering a recognised illness are in effect suffering from chronic (long-term) ill-health. They are affected in the same way that an individual is affected by acute ill-health such as colds and flu. For much of the time the individual is aware of being ill though not troubled by specific symptoms, but this will be punctuated by episodes of acute illness.

3.6.6 The effects of drugs and alcohol
Alcohol generally tends to impair tracking, vigilance, memory, decision making and it slows reaction time. This is because alcohol is a depressant on our central nervous system. Drugs vary in their effects with opiates such as heroin and morphine, acting as a suppressant, contrasted to amphetamines which are stimulants. However, in the case of the latter, as the effects of the amphetamine wear off there is a compensatory let down period when the user feels depressed, irritable and fatigued. Cannabis has a similar effect to alcohol, but individuals also report disruption to their memory. Individuals under the influence of drugs and alcohol may exhibit changes in behaviour, becoming more aggressive, irritable, forgetful and depressed.

3.7 Training

3.7.1 Introduction to training
Training is concerned with the development of knowledge and skills. Individuals are trained so they know how to perform a job safely and efficiently. It includes on-the-job instruction, formal classroom-based training, induction and refresher training. Training and briefing can often be confused, particularly in relation to rule changes. Briefing simply involves the imparting of information whereas training is a more interactive and engaging process during which individuals have the opportunity to practice the skills and knowledge they are acquiring. When evaluating whether training was a contributory factor to an accident, the investigation can extend beyond, checking certification and when the last training took place. Training effectiveness is influenced by:

a) how well the training needs are identified (to ensure trainees are provided with the relevant skills and knowledge)
b) how well it is delivered (taking account of different learning styles and training media available).

3.7.2 Training considered unnecessary
If formal training and instruction has not been provided, there may have been other means from which an individual acquired the relevant knowledge and skills. Sometimes a formal programme of mentoring or on-the-job instruction is just as valid. However, if training should have been provided but was not, the reasons, for example, lack of resources or lack of training suppliers, may be relevant to the investigation.

Refresher training is a key component in maintaining skills, particularly of infrequent but crucial tasks. An individual is more likely to respond correctly in an emergency if they are highly trained in skills they will rarely use. Taking into account the frequency of training and skill fade improves the effectiveness of refresher training.

3.7.3 Adequacy of training resources
Lack of resources includes allowing time off for training, budget to fund the training, support to apply newly learnt skills in the workplace and equipment to conduct the training.

3.7.4 Appropriateness of training
Inappropriate training may occur because a training-needs analysis has not been carried out to identify the relevant skills and knowledge required to meet the performance criteria. There is therefore a risk that training includes irrelevant information and does not cover those things that are essential to undertake the task competently.

3.7.5 Quality of training
Substandard instruction/delivery may stem from the quality and competence of the trainer/instructor and their ability to convey the information in an effective manner. The most effective training programmes are those that take account of different learning styles by using a variety of training media (video, role play, talk and chalk, simulation) and are learner focussed (that is, they involve the individual).

3.7.6 Opportunity to practice skills
Inadequate training may result from insufficient opportunities to practice skills being taught and whether all the circumstances in which the knowledge and skills applied are covered, particularly the abnormal, degraded and emergency conditions.

3.8 Experience

3.8.1 Introduction to experience
Experience is also an essential component of being competent. As an individual gains more experience their behaviour changes so that it becomes skill based: unconscious, routine and highly practised. When faced with new circumstances or in the early stages of developing a skill, an individual is more conscious and therefore more error prone.

3.8.2 Familiarity with the task or situation
The level of experience in a particular task can be dependent on when they were last exposed to this type of activity or situation. There are a number of reasons why someone might be inexperienced: lack of or inappropriate training and assessment is one possibility. The factors in the training and assessment section of this appendix may assist in identifying whether this was the issue. Training and assessment is a particular issue if the activity being undertaken was an emergency, degraded or abnormal operation. Such situations do not usually occur but the consequences of such situations are potentially more serious. An employee may also be inexperienced in a particular activity because it does not normally form part of their job.
The reasons as to why they are having to perform this role may be one or more of the following: lack of resources, poor planning or abnormal, degraded or emergency situations caused by equipment failure.

3.8.3 Complacency with the task
Over-familiarity can lead to complacency and it can also cause people to stop noticing things that are part of that activity. This is sometimes known as habituation. Alternatively, an individual can become dependent on others performing certain activities. This can lead to error if the parties involved are not reaching a clear understanding about who is responsible for what. Over-familiarity can also increase boredom, which can lead to increased stress and the likelihood of distraction.

3.9 Assessment

3.9.1 Introduction to assessment
Assessment is concerned with measuring a person against a defined competence standard and is key to ensuring that an individual is competent following their training and that this competence is maintained over a period of time. Assessment should not be confused with monitoring which is more concerned with making judgements about performance and identifying instances where the required standard was not met. The key to consistent, effective and fair assessment is to have the appropriate standards to assess competence against, the appropriate tools to carry out the assessment and competent staff to undertake the assessment. This may be managed by a quality assurance / verification system.

3.9.2 Content of the competency assessment
It is important that the assessment contains the arrangements in place for assessing the skills and knowledge across the whole range of conditions and circumstances, including provision for assessing the application of the skills and knowledge in a practical, realistic situation. How the frequency of assessments has been established and whether this takes account of activities that are not likely to happen often may be a relevant factor to consider. This includes emergency and degraded operations where the consequences of not getting it right are usually severe. A frequent assessment can, in cases, ensure that employees do not experience skill fade for less practised activities.

3.9.3 Adequacy of resources for assessment
This adequacy includes the competency of those required to carry out the assessment and the tools they use to do so, including checklists and simulation exercises. The competency of the assessor incorporates more than just whether they have been awarded a national standard for assessment, but also their in-depth knowledge and understanding of the job to be assessed and the opportunities for assessment. The accessibility of the appropriate assessment tools is particularly important when establishing whether there has been a comprehensive assessment of employees’ performance in emergency, abnormal and degraded situations.

3.9.4 Appropriateness of standards for assessment
Appropriate standards used for assessing individuals incorporate the information to describe the critical activities that are required to be performed and the most critical areas of knowledge. Whether industry occupational standards or internal company standards have been used, and what processes exist to validate such standards, are factors which effect their appropriateness.
3.10 Briefing and information

3.10.1 Introduction to briefing and information
Briefing and information refers to the distribution of appropriate safety information to the relevant people. This includes, for example, site safety briefings, briefings to drivers about multi-SPAD signals and low adhesion sites and changes to rules or procedures. Failure of an employee to know something that is important to their safety is an information or briefing failure.

3.10.2 Adequacy of safety briefing system
Most organisations have systems in place to ensure all their safety-critical staff have a regular safety briefing at which they can be informed about changes in safety procedures and rules. Such briefings are often an opportunity to remind employees of the importance of safety in relation to their specific activities and for management to demonstrate its commitment to safety. Whether a regular safety briefing system exists, who carries out the briefing and the competence to do so, what type of material is briefed out and how frequently and the prioritisation of the information all affect the adequacy of the system. Quite often there is so much information that it is overwhelming and the safety messages lost. Other mechanisms are available for distributing safety information, such as notice boards, company publications, safety tours and near-miss reporting systems.

3.10.3 Adequacy of safety information advice process
As well as regular distribution of safety information, individuals can be advised quickly of changes to operations, changes in planned work and changes to safety systems, either because new, critical information has come to light, or because an emergency or abnormal situation has arisen. If an employee did miss an essential piece of information this was likely due to a failure in such communications.

3.10.4 Planning of information distribution
If a job or activity has not been planned properly, there is an increased likelihood that not all the eventualities have been considered or that all the parties concerned are not in possession of key pieces of information. Poorly planned jobs increase the likelihood of the activity being carried out under abnormal or emergency conditions that are more prone to errors because they are unfamiliar and quite often being performed in stressful and/or uncomfortable situations.

3.10.5 Adequacy of handover processes
Failures in communication and the passing of crucial information at crew or shift handovers are a common contributory factor to accidents. The parties in a handover tend to have different understandings of the current state of affairs and unless sufficient time and priority is given to the changeover, the chances of both parties reaching a clear understanding where all information has been clearly communicated are reduced.

3.11 Attention

3.11.1 Introduction to attention
There may be some situations where attention is not directed at the appropriate activity or where there is simply not enough information to be able to concentrate properly on that activity. If an individual is focusing on one specific thing, then the level of attention will be high. However, if an individual’s attention is spread across a broader range of factors, then this reduces the strength of the attention.
While a 'narrow beam' of attention allows the individual to focus on a specific activity or piece of information, it does reduce the ability to attend to several things at once. This could result in drivers, for example, being oblivious to important factors that would affect their decisions, such as a changing signal aspect.

The amount of attention available varies according to the level of physiological arousal, or general alertness. Attention is affected by extended periods of high mental workload leading to fatigue, but also low arousal, caused by the monotonous nature of the task. Both conditions decrease the amount of attention available for focusing on tasks.

3.11.2 Anticipating the situation

Anticipation is caused by an individual’s expectation of certain events on the basis of what normally happens.

In order to establish whether a SPAD, for example, has been caused by anticipation, it is relevant to consider how long the driver has been operating over that route, when he last drove over it and what the normal sequence of aspects would be. Drivers build up knowledge and experience of the route and the handling of the train; they store information about where signals are positioned and will drive according to where they are expected to be. These mental models reduce the mental workload and allow the driver to drive to their upper limits by being able to anticipate certain events or circumstances. However, they are difficult to override and lead to these expectation, anticipation or mindset errors.

Other types of error that arise from relying on what normally happens is the tendency to see information that will confirm what is already believed to be true and ignore information to the contrary (confirmation bias) and the tendency to stop noticing things around you (habituation). Confirmation bias may mean that drivers, for example, see what they expect to see, and fail to perceive what is actually there. This is also known as false hypothesis.

Habituation is a process by which we stop noticing things because of repeated presentation of the same information. Train drivers are repeatedly presented with the same information day in day out, which can lead to them becoming ‘over-used’ to the information around them. Their sensitivity decreases and therefore performance decreases. A good example of this is habituation with the AWS system. The purpose of the system is to provide an attention/alerting feature. However, the provision of auditory warnings for all signals is likely to actually lower the relative effectiveness of the warning system: the driver becomes habituated to the sound of the AWS and the repeated presentation of yellow signals, which results in a lack of awareness of the red signal.

3.11.3 Automatic response

There may be occasions when employees are not fully engaged in the task and relying on your mental models to perform. This can sometimes lead to the feeling of not being able to remember what has just happened. The task is learned so thoroughly that it does not require conscious responses and the task can be undertaken automatically.

3.11.4 Distraction caused by preoccupation

Preoccupation is another form of distraction and can be caused by issues specific to the individual such as problems at home, financial difficulties or work problems. However, an individual may not just be preoccupied with negative issues. Events that an individual is looking forward to, such as the birth of a child or an imminent holiday, can be just as distracting.
Sometimes changes in behaviour may indicate that an individual has significant concerns that are causing preoccupation. These include changes in appearance, changes in sociability (for example, previously lively and outgoing, now quiet and withdrawn), changes in expressed emotions (for example, increase in the number of petty arguments, changes in anger, irritability) and changes in performance (for example, absences from work or lateness). Individuals who have recently been involved in a traumatic event, such as an incident on the railway or a family bereavement, may also become preoccupied. There are huge variances between how well an individual will cope with trauma and in how this response might be exhibited: not everyone who experiences a traumatic event is traumatised and the perception of what is traumatic will depend on the individual. For some a traumatic event may result in lack of confidence, stress, anxiety, depression, aggression, apprehensiveness or problems concentrating. Some individuals also experience flash-backs to the incident, problems sleeping and distressing dreams.

3.11.5 Distraction caused by external factors
Distraction can be caused by external factors such as alarms, people on the track, passengers, colleagues, other work-related equipment, environmental stressors (that is heat, light and noise) and anything that is more attention-grabbing than the task being undertaken.

3.12 Motivation

3.12.1 Introduction to motivation
Motivation is the factor that relates to the internal state of an individual that drives and directs the person’s actions. How motivated an individual is towards safety and what drives that motivation is a factor for consideration. Motivation is also related to the level of supervision and management, workload, briefing/information and attention.

3.12.2 Consideration of the risks associated with the activity / circumstances
A possible influence on why workers do not behave safely could be that they do not perceive any risks with the situation they are in. This may be dependent on the employees’ knowledge of the hazards associated with their working environment/task and the possible consequences of an incident. The more knowledge someone has about the hazards and how dangerous they are, the more they are likely to behave safely.

Individuals gain knowledge about hazards and their potential risks from safety briefings, training and from the example set by supervisors and management motivation. It may also be that an individual has become complacent and complacency tends to reduce the quality of both performance and judgement. If individuals work regularly without incident, then their tolerance of the situation increases, fostering the belief that ‘it won’t happen to me’.

3.12.3 Negative incentives
Negative incentives include issues such as the behaviour of your colleagues (that is peer pressure, group norms), commercial and time pressures which take priority over safety, the desire to finish the shift on time and dissatisfaction with working and contractual conditions, including type and nature of work. These may cause employees to carry out inadequate handovers at the end of their shift, cut corners to get the job done, compromise their professionalism and behave indifferently. This can be exacerbated by improper supervision and management example, improper financial and contractual incentives and poor procedures. Lack of positive incentives tends to affect motivation by causing low morale.

3.12.4 Appropriateness of supervision / management
One of the strongest motivating factors for behaving safely is management example, for instance in the wearing of personal protective clothing or following a particular safe system of work.
The example set by senior and frontline managers is an indication as to how much importance is attached to safety and therefore how positively motivated individuals will be to behave safely. The processes in place for management to communicate their safety messages (as referred to in briefing/information section) and provide safety incentives affect the appropriateness of the supervision / management.

3.12.5 Motivation affecting morale
Low morale can be caused by poor dissemination of information from management, the reliability, quality and usability of frequently operated equipment, maintenance problems, fears for job security, lack of control, career progression concerns, alienation, and staff/management relations.

3.13 Procedures

3.13.1 Introduction to procedures
Procedures relate to safe systems and methods of work, including operating and maintenance procedures. They influence safe behaviour.

Written procedures are vital in maintaining consistency and ensuring that everyone has the same basic information. However, poor procedures can be a reason why people do not follow the recommended actions. It is possible that; the individual intended to follow the procedure correctly but implemented it incorrectly, did not follow the procedure but behaved in a safe manner (that is, the procedure was wrong) or deliberately ignored the procedure. Each scenario has a different root cause.

3.13.2 Adequacy and appropriateness of procedures
The reasons often quoted for staff not following procedures are that they are perceived to be inaccurate, impractical, too time consuming or that they do not describe the ‘best way’ of carrying out the work. They may even conflict with other requirements, especially given the other tasks and pressures on employees. If the procedure does not reflect what happens in reality, then it is unlikely to be complied with. How the procedure was developed, whether this process included end users and whether it is regularly reviewed to ensure it is up-to-date and take account of changing environments and equipment, may affect the appropriateness of procedures.

Sometimes the individual may have intended to follow the procedure correctly but left a step out, carried it out in the wrong sequence, delayed implementing it or simply misunderstood what was required. This may be due to both lack of training or because the procedure was poorly written and not easy to understand. In addition, fatigue and being physically unfit may impair the employee’s decision-making ability about how to follow the procedure or create reluctance in having to put effort into following it. Employees are more likely to comply with a process if they are being monitored and supervised.

Alternatively, the authorised procedure may have been deliberately ignored. This is when the individual is fully aware of what should be done, but for some reason, consciously decides not to follow the approved working practices. Wilfully disregarding safety procedures or violating them rarely occurs, and it is more often than not a case of mistaken priorities or simply that the procedure did not reflect the realities of the task.

3.13.3 Presentation of procedures
Inappropriate presentation of a procedure includes the way it is documented. It may be unclear to the user because there are too many steps to follow. It may not be accurate or complete. It may be difficult to read because of too many cross-references or there may be too much use of exceptions, for example. The level of detail of the procedure may also lead to a lack of understanding, either because there is too much information to process and remember or too little information to be able to carry out the activity safely.
3.13.4 Availability of procedures
Procedures may not be available, either because they have not been produced or because there has been a failure in their distribution. The systems in place to ensure distribution of safety information to employees, and whether these are adequate, may affect the availability of procedures. The questions in the briefing/information section may assist.

3.14 Communication

3.14.1 Introduction to communication
Communication refers to when information is transmitted from one source to another. Errors can occur when passing information or receiving it and at any of the key stages: commencing the communication, exchanging the information and confirming understanding. Some communication situations are known to be especially liable to communication problems, including: during maintenance (including site briefings), if the work continues over a shift change, during abnormal or emergency conditions, following an absence from work and between experienced and inexperienced staff.

3.14.2 Identification of parties
It is important for the parties involved to identify themselves (including location and job title).

3.14.3 Lead responsibility
Details of who takes lead responsibility are set out in Section A of the Rule Book. The party with the lead responsibility can prompt the other party if he/she has not identified him/herself appropriately, and also prompt that person to read the message back.

3.14.4 Complexity of message
Sometimes the amount and nature of the information that has to be conveyed may contribute to the communication error. Complex messages may need to be broken down into concise chunks of information. It may be relevant to consider whether the key points of the activity are covered (that is type of activity, time, area, contact details, authority numbers) and why the message is complex, for example, had there been a failure at the work planning stage?

3.14.5 Message repetition
Repeating back messages is one of the best ways to ensure both parties have reached a clear understanding and no assumptions have been made. Any safety-critical information, such as signal identifiers, head codes or isolation details, for example, can be repeated back.

3.14.6 Communications protocols
Problems with communications protocols include a failure to use the phonetic alphabet where it is appropriate to ensure a clear message is given (that is signal numbers, train head codes), a failure to use standard terms as set out in Section A of the Rule Book (that is, correction, over, out, negative), a failure to clarify and/or explain any ambiguous wording, terminology or jargon used, or to speak numbers singly.

3.14.7 Adequacy of equipment for communication
Inadequate communications equipment includes equipment that is unreliable or has failed.

3.15 Workload

3.15.1 Introduction to workload
Workload refers to both the amount of work and the nature of the tasks. There are a number of factors that will affect these. Activities can be both too physically or mentally demanding, or not demanding enough and this can be stressful and tiring, which affects employee motivation. Activities can be designed in accordance with ergonomic principles to take into account limitations in human
performance and in providing variety, autonomy (that is control and responsibility) and meaningfulness.

3.15.2 Mental capacity
We all have a mental capacity for handling information and making decisions and if an individual is mentally overloaded, performance will suffer becoming slower or less accurate. Sometimes a job may be demanding because the tasks are too similar and are easily confused, requiring greater attention from the employee.

While multi-skilling might be one way of including variety into an individual’s job, sometimes it has simply involved giving individuals more of the same. This may lead to increased boredom and stress.

3.15.3 Word under-load
Work under-load where a job is routine, repetitive and under-stimulating can also lead to errors with individuals being less alert and more prone to distraction. Under-load also induces boredom, which creates lack of motivation and a loss of skills.

3.15.4 Work over-load and planning
If the job is not planned properly this may lead to a lack of people to do the job properly creating extra demands on employees. This may also mean there is inadequate or improper supervision because the supervisors may have to carry out the tasks themselves, as well as supervise. Poor planning can also lead to inappropriate time pressure. If there are too many tasks to complete within a certain timescale, there may be additional pressures.

3.15.5 Work over-load and unplanned events
Certain situations may create an additional workload by their very nature. These include emergency, degraded or abnormal working conditions. These situations can often lead to, or be created by, a failure of equipment, which an operator is normally dependent upon. When operators are required to work with procedures or situations they are not familiar with the potential for error increases.

3.16 Supervision

3.16.1 Introduction to supervision
Supervision is key to ensuring an individual’s errors are detected either through direct monitoring and checking or through management activities such as competence assessment. Supervisors have an important role in correcting poor work practices, while encouraging good ones. Supervision activities are often seen as an organisational influence on an individual as they are key to facilitating good communication with employees, promoting an understanding of the hazards, providing feedback and finding a balance between the pressures of maintaining high levels of production and safe working practice.

3.16.2 Adequacy of supervisory skills and abilities
The skills and abilities needed by supervisors are often underestimated and therefore adequate support may not have been provided. Supervisory skills include training in line management skills and in identifying and managing poor working practices. Particular problems occur when supervisors are promoted from within a team: the team still sees them as a team player rather than a team leader and the individual has the technical skills but perhaps not the supervisory skills.

3.16.3 Lead set by supervisors
If supervisors do not correct poor working practices, employees will see this as implied approval of those practices. Vigilance, the monitoring of working practices and providing feedback to individuals about their performance may help to improve working practices.
3.16.4 Conflicting demands
Conflicting demands might be due to job demands, a lack of clear responsibilities or conflicting responsibilities. Pressure on supervisors to improve productivity, causing them to focus on meeting production targets, may lead to the detriment of safety standards.

3.17 Workplace

3.17.1 Introduction to workplace
Workload conditions can affect performance. In the rail industry, the workplace varies greatly from individual to individual. There are signal boxes and signalling centres, train cabs, control rooms and offices, but also the actual signalling system, over which the driver operates, and the track, which is effectively the workplace for maintenance staff. In particular the layout of the track and signalling has a significant influence on the driver’s behaviour and ability to respond to signals.

3.17.2 Contribution of environmental stressors
Environmental stressors include factors such as levels of lighting, noise, temperature, vibrations and they can lead to feelings of discomfort which impact on the individual’s performance.

   a) Lighting or more specifically over-lighting or glare, from VDUs for example, can cause distractions and visual fatigue as well as physical discomfort in the case of some types of glare.

   b) Noise makes performing tasks more demanding; perceived mental workload increases and tolerance reduces. It may impair performance when task demands are particularly high or when the individual is already being affected by factors such as fatigue or anxiety.

   c) Temperatures lower than 0ºC or higher than 32ºC can cause reductions in manual and mental performance. It is not a straightforward issue as there are variations in the impact of temperature depending on type and duration of the work. Continuous performance tasks involving sustained attention or vigilance are sensitive to temperatures above 30ºC. Increases in levels of humidity leads to considerable feelings of discomfort for the same temperature.

3.17.3 Adequacy of visibility
Inadequate visibility is a key issue with regard to SPADs. Visibility, for the purposes of this appendix, includes the factors that influence the process of detecting, interpreting and responding to a signal (or alarm or indicator).

The visibility and conspicuousness of a signal is likely to affect its detection and interpretation, but is affected by a number of other factors too.

These include whether or not the signal is obscured and by what (that is foliage, sunlight/glare, fog/snow, structures such as bridges and overhead line equipment), whether it appears in the driver’s line of sight for the required period of time and whether the signal is difficult to pick out. This may be because the signal is on a curve which may make it difficult for the driver to tell which line it is controlling or because it appears against a cluttered background or because there are a number of signals to pick it out from, such as when positioned on a gantry.

3.17.4 Workplace layout
This refers specifically to the positioning of equipment and therefore relates strongly to the design of equipment. The layout of a workplace can affect safe behaviour by influencing the order in which things are done. Work areas and operating positions can be laid out so they allow for free movement, safe access and egress, and unhindered visual and oral communication. In addition, the design of the controls and the layout can ensure that the operator is comfortable, and is compatible with the operator’s physical dimensions.
3.17.5 Appropriateness of warning / alarm systems
This relates to alarms such as AWS that warn of a signal, alarms in signal boxes and warnings that track maintenance staff might get from lookouts of automatic warning devices. Effective alarms are conspicuous and attention-grabbing, easy to understand, only presented when needed and distinctive. They also allow operators time to respond. Identification of the number of alarms there are during normal and emergency situations, what the rate of false alarms is and whether there is any prioritisation to the alarm system, may determine the effectiveness of the system. The response required of the operator when the alarm sounds, whether it is simple and well defined and whether the operator has been trained in it, may be relevant in determining the appropriateness of the system.

3.18 Equipment

3.18.1 Introduction to equipment
Equipment includes everything from the shovel used to dig ballast, the track and lineside infrastructure to the instruments and displays in signal boxes and train cabs. Equipment may be the cause of, or contribute to, an accident in a variety of ways, including how the equipment was purchased, how it was maintained and also how it was designed.

3.18.2 Contribution of supply process
This includes the non-supply of equipment and the supply of wrong or inappropriate equipment. This may be due to an inadequate purchasing process, which includes inadequate specifications to ensure the right type of equipment is provided, equipment not being supplied in time and lack of resources to purchase the right quality equipment. It also includes lack of clear procedures for replacing substandard equipment.

3.18.3 Appropriateness of equipment use
This concerns the equipment that is fit for use but is being misused or not used at all. This may be because the employees are not familiar with using it and/or have not been given the appropriate instruction in its use. Some pieces of equipment require specific certification to be able to use it. It may be the case that the training is adequate, and it is that the equipment has not been used for a while and the user’s experience of it is limited.

Some pieces of equipment have specific instructions or procedures covering their use. These may be inadequate and may be identified by considering the questions given earlier relating to procedures. Consideration of the level of supervision provided and whether that contributed to the misuse of the equipment, particularly where the equipment is being deliberately misused, may help determine whether the equipment was mis-used.

3.18.4 Condition of equipment
Equipment may be damaged or in a substandard condition because of poor housekeeping arrangements, due to vandalism, because it sustained damage during transportation, because it has been affected by the weather or simply because it has aged. Equipment may also be substandard because it is unreliable and regularly fails, perhaps because it is not being used as intended, not being maintained appropriately or has manufacturing defect.

3.18.5 Adequacy of maintenance of equipment
Maintenance is a significant contributor to the state of equipment and it adequacy depends on whether the maintenance specification (specifically frequency and nature of maintenance) was appropriate given the amount of use the equipment was receiving and the nature of that use and manufacturers guidelines.

Maintenance issues may also be due to inadequate or poor access, poor planning, or inappropriate time and performance pressures to the equipment for maintenance purposes. The actual maintenance process, particularly the ongoing inspection and monitoring regimes may be relevant. Inspections can detect wear and tear in equipment and changes in conditions that might affect the condition of the equipment. The adequacy of planned and critical parts/items
inspections and the resources allocated to the task, including their competency and workload may also be relevant when determining whether the equipment is maintained sufficiently.

3.18.6 Appropriateness of design
Equipment designed to fit the individual (that is by keeping possible human limitations and failings in mind) reduces the potential for operator error. Users are limited by the amount of information they can process and the effects of fatigue. There are some useful indications as to whether the equipment has been inappropriately designed – users may be:

a) unable to see important displays
b) unable to reach important controls
c) unable to work in a comfortable position
d) overloaded with too much information at one time
e) inattentive because there is too little to do.

Identifying whether an evaluation of the human-machine combination was conducted (including the design criteria used), whether it included input from the end users and whether it was adequately tested by the end user may assist in determining the appropriateness of the equipment’s design.

3.18.7 Consideration of ergonomic principles
The following are principles for good ergonomic design:

a) the most important equipment should be in the most advantageous locations
b) the most frequently used items should be in the most advantageous or accessible locations
c) items concerned with closely related functions or actions should be grouped together
d) items that are commonly used in sequence should be grouped together and laid out in a way which is compatible with that sequence
e) information on the use of the equipment should be presented clearly and without ambiguity.

Specifically, good ergonomic design dictates that all the critical functions are in the line of sight of the operator and therefore most likely to be noticed and acted upon, most frequently used controls are in key positions and the emergency stop button is positioned where it can be easily reached. Clear and consistent labelling of controls and displays to avoid unintentional use is another example of good ergonomic design.
Guidance on Category ‘A’ SPAD Investigations

References
Railway Group Standards and other Railway Group Documents

GA/RT6001  Railway Group Standards Change Procedures
GI/GN7606  Guidance Note: Prevention and Mitigation of Overruns – Risk Assessment
GK/RT0002  Glossary of Signalling Terms
GK/RT0032  Provision of Lineside Signals
GK/RT0037  Signal Positioning and Visibility
GO/GN3673  Guidance Note: Formal Inquiries, Formal Investigations and Local Investigations
GO/RT3062  Signalling General Instructions
GO/RT3252  Signals Passed at Danger (SPADs)
GO/RT3472  Incident Managing and Evidence Gathering
GO/RT3473  Formal Inquiries, Formal Investigations and Local Investigations
GO/RT8000  Rule Book

The Catalogue of Railway Group Standards and the Railway Group Standards CD-ROM give the current issue number and status of documents published by RSSB.

Other References
SPAD Investigation: A good practice guide –  National SPAD Focus Group and RSSB
Anti-SPAD Toolkit – Network Rail
HS(G)48 – Reducing Error and Influencing Behaviour