R&D Programme: Research Brief

Human factors associated with driver error and violation (T148)

**Background**
Protective devices such as the Train Protection and Warning System (TPWS), Automatic Warning System (AWS), Automatic Train Protection (ATP), Driver’s Reminder Appliance (DRA), Driver’s Safety Device (DSD) and Vigilance System (VS) are key elements in the drive to reduce SPADs. How drivers interact with these devices and their combined effects on driving performance was not previously well understood.

RSSB therefore commissioned QinetiQ to undertake research investigating the human factors issues associated with driver error and violation.

The effects of rest days on driver performance on returning to work has been implicated in the incidence of SPADs but has not been confirmed by substantive data analysis. Investigation of post-break error was therefore also included within the scope of research work.

**Aims**
The primary objectives of the study were to:

1. Understand drivers’ use of protective devices (PDs) and their positive and negative effects on performance.
2. Investigate the effects of availability of the devices.
3. Understand the factors involved in the phenomenon of increased SPADs on the first day back after rest days.

Previous work has considered drivers’ use of protective devices, but only on an individual system-by-system basis. This study, however, represents the first comprehensive attempt to consider together drivers’ use of all the key protective devices available on current rolling stock.

Adopting this holistic approach, the research findings address in turn each of the following questions:

1. How do devices influence driving performance?
2. How frequently do drivers switch between routes or trains fitted and not fitted with protective devices and how does switching between routes or trains with and without systems affect their performance?
3. How does device interface and implementation vary between train types or Train Operating Companies (TOCs), and how does this affect system operation?
4. What is driver understanding of device activation and the reason for activation?
5. What are the frequency, type and cause of driver errors and variations or violations in device operation?
6. What is the frequency and cause of faults (both train and track equipment) and warranted/unwarranted device activation?
7. What are drivers’ perceptions of devices: their value to safety, reliability, their trust in systems and ease of use?
8. How does the post-break phenomenon have an impact on performance and error?

**Research process**
The project investigated these issues extensively through a variety of research methods including:

- Predictive error analysis based upon SPAD data, hierarchical task analyses, Confidential Incident Reporting & Analysis System (CIRAS) reports and structured interviews with drivers
- Six hundred and fifty-one drivers questionnaire returns
- Five focus groups with five TOCs
• One focus group with system specialists
• Seventy-three in-cab video observations across five TOCs and 15 different routes.

Findings
The research methodology and results are discussed in detail in the following research reports. Copies of the reports can be downloaded from the RSSB R&D web page.

Driver error analysis report, July 2004
The error analysis highlights the potential for human failure that lies within both the setting-up and operation of the various protective devices that are the subject of this research.

Driver error data collection report, July 2004
This report presents the findings from a number of work elements: in-cab observation; retrospective analysis; focus groups and questionnaire survey.

Driver error final research report, July 2004
This document summarises the key findings from the previous reports and points to a number of potential human factors problems with the operation of the current set of protective devices, and suggests recommendations for improvements. The report also identifies lessons that can be learned to inform the design of the man machine interface on new protective devices and in-cab information systems, such as ERTMS.

The following bullet points list some of the key findings presented in the final report by device type and for the combined driving system. Please refer to the report for recommendation options that system designers and operators could consider to mitigate these particular routes to driver error and violation, and ultimately to improve driver performance.

Driver’s Safety Device (DSD) and Vigilance System (VS)
• Data from the survey and focus groups suggest that many drivers find the frequent alarms distract them from other driving tasks.
• Many drivers (over 50% of our sample) have to switch between trains driving with and without the VS system on a daily basis.
• The nature of foot pedal operation within cabs varies from train to train.

Automatic Warning System (AWS)
• Unconscious cancelling of warnings, possibly indicated by anticipatory and quick responding, is commonplace.
• Ergonomics of controls and displays could be improved, eg having to stand to view the brake light indicator, entailing loss of track view, should be addressed.
• It is not always clear to the driver why a brake application has occurred.
• Drivers sometimes forget the signal aspect following acknowledgement of a warning. Confusion caused by the lack of discrimination provided by the AWS yellow and black indicator (sunflower) is exacerbated by the extended use of AWS eg for temporary speed restrictions (TSRs).
• Drivers experience contradictions between AWS warnings and observed signal aspects, as a result of the proximity of TSRs and signals.

Train Protection & Warning System (TPWS)
• It is not always clear why a brake application has occurred (this is also implicated in the ‘reset and continue’ issue being addressed by research project T433).
• There is some evidence of a lack of understanding of TPWS workings by some drivers.
There is evidence of a lack of trust in the reliability of the system, which could lead to a greater inclination to over-ride the system, or perhaps circumvent procedures (ie reset and continue).

Drivers report that there is a tendency to spend more time thinking about speeds than signals; beliefs about the appropriate or otherwise of speed settings on TPWS sensors can undermine compliance with the system and associated procedures.

**Automatic Train Protection (ATP)**
- For some drivers, there is too much visual information to cope with, leading to increased workload and distractions.
- The majority of drivers have to switch between driving with and without ATP on a daily basis; any potentially harmful effects remain unknown, but changes in behaviour with other systems can result.
- The likelihood of making a mistake when inputting data appears to be quite high.
- Contradictions between line-side information and visual information from the ATP system appear to be prevalent engendering a lack of trust (over 50% of drivers experience problems at least occasionally).

**Driver's Reminder Appliance (DRA)**
- Departures from, or violations of, current procedures for DRA use still appear to be widespread (particularly use of the DRA on the move).
- Even the relatively small sample used for the observational research revealed evidence of failures to set when procedures state it is mandatory (despite the presence of video cameras in our study).

**Systems as a whole**
- There is evidence of drivers being confused by the different warnings provided by different systems.
- There is evidence of conflict between alarms, with one masking another.
- External noise levels eg from having windows open and when travelling through tunnels, distract drivers from systems and mask warning sounds.
- There is evidence of confusion over what has caused a brake application.
- Current systems engender a feeling of loss of control because of the inherent lack of transparency (ie they do not always let the driver know what is going on and why intervention has occurred or is about to occur). This increases the likelihood of violations, such as isolation of systems.

**Effect of rest days on SPADs**
The QinetiQ project team found that evidence for the effects of a rest day on performance was equivocal in that the data analysis neither proved nor disproved the notion that drivers may be more at risk of SPAD on the first day back at work following a rest day.

The influence of rest breaks on SPADs has also been considered in research project T255 investigating the May/summer peak in SPADs. The May/summer peak in SPAD project used different methodologies to that employed on the driver error project and, contradictory to the results presented herein, provided support that rest breaks do impact on SPADs.

As a result of the different research findings on post-break error RSSB is itself performing further analysis of the data collected to assess the impact of rest breaks on SPAD risk. Although this additional analysis work is ongoing the early results indicate that rest breaks do increase SPAD risk on the first day back at work. This is particularly related to rest breaks which last only one day, when compared to longer rest break periods.
**Next steps**

RSSB is using the findings of this work to inform a number of human factors projects, including:

- Human factors good practice guide to managing alarms and alerts
- Development and evaluation of TPWS improvements to combat reset and continue risk
- Human factors issues surrounding automation in the rail industry
- Human factors associated with CCTV monitoring
- ERTMS design and operations

Equipment designers and railway operators are encouraged to consider how else the findings might be utilised to improve current systems, and how the lessons learned might be used to inform more appropriate design of future systems and associated operational rules and standards.

The RSSB R&D department would welcome your feedback on the usefulness of the knowledge generated by this research project, and is open to suggestions on how it might be better disseminated and applied to good effect to ensure that the UK railway operates in a safer and more cost-efficient manner.

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