THE DEVELOPMENT OF BEST PRACTICES FOR LAYOUT SPAD RISK ASSESSMENT

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SYNOPSIS

The railway industry has long been aware of the risks from trains passing signals at danger and the problem has been the focus of much attention for several years. This paper outlines the methods available to assess these risks and describes an approach to structured expert judgement developed for Railtrack by WS Atkins. The incorporation of SPAD risk assessment into the design process is discussed, in particular, how the ALARP principle can be employed. The key issues that require further analysis are identified and suggestions are made for their resolution.

1 INTRODUCTION

When a signal protecting a junction is passed at danger, it can lead to a collision or derailment and therefore to injuries and fatalities. The main purpose of the work described in this paper has been to establish a preliminary understanding of the current industry best practices for risk assessment. Firstly the paper discusses the background to SPAD risk assessment, including the methods available for risk assessment. Next, an approach is proposed to Structured Expert Judgement and its inclusion in the design process. Finally, an approach to demonstrating the ALARP principle is described and issues that would allow the risk assessment to be further improved are identified.

1.1 Background

The Group Standard relating to overrun protection at signals is GK/RT0078 [1]. The standard requires the use of risk assessment in the design of a junction layout to evaluate the risks due to SPADs. This reflects the basic regulatory requirements to conduct a suitable and sufficient risk assessment and to ensure that risks are reduced so far as is reasonably practicable. The standard requires a suitable and sufficient risk assessment to be undertaken using one or more methods, as appropriate to the circumstances:

- The Layout Risk Method (LRM);

- The Platform Starting Signal Risk Model (PSSRM) described in Railway Group Standard GK/RC0578 [2];
- Any other system that is acceptable to Railtrack.

The Railway Group Guidance Note GK/GN0678 [3] outlines the limitations of LRM and PSSRM, and provides a basic description of Structured Expert Judgement (SEJ).

LRM is a computer based tool which is ideal for modelling risk variables at junctions such as the layout geometry, overlaps, interlocking and train frequencies, train types and train speeds. "Softer" variables such as signal sighting, mitigation effectiveness, human factors, gradients etc are beyond the scope of LRM and best dealt with in the SEJ.

2 STRUCTURED EXPERT JUDGEMENT

Structured Expert Judgement (SEJ) is the name given to a straightforward, generic risk assessment methodology that can be applied to all types of risk, including SPAD risk at junction layouts. The Guidance Note GK/GN0678 does not provide detailed guidance as to how SEJ should be employed, or how other tools and techniques should be integrated into the judgement. A Workshop Based Risk Assessment (WBRA) method for SEJ has been developed by various personnel from WS Atkins Rail Ltd and Railtrack [4]. The method has been employed several times, each time being upgraded and revised. The method has not been formally adopted by Railtrack and is at a preliminary stage. The whole issue of layout risk assessment is currently being comprehensively reviewed within Railtrack as part of its ongoing work to ensure a safe railway [5].

The power of the WBRA is that it facilitates a comprehensive design safety review of a location through a series of searching questions and the selection of mitigation measures from a checklist. The workshop method is a compromise between necessary detail and what is reasonably obtainable in a workshop. It has been designed to obtain the information necessary to produce an overall risk ranking for each signal without overloading the participants.

2.1 The SPAD Risk Assessment Form

The WBRA requires that a SPAD risk assessment form be completed which comprises the following fields:

- Information regarding the overrun protection, compliance and overlap distance.
- Signal is a platform starter?
- Percentage of trains that do not stop?
- Criteria for enhanced overrun protection.
- Estimated SPAD probability per demand.
- How often a train will approach or be held at the signal when it is showing a red aspect?

- ❑ SPAD history?
- ❑ Causal factors for disregard SPAD - discriminatory factors?
- ❑ Causal factors for disregard SPAD - perception factors?
- ❑ Causal factors for disregard SPAD - ‘visibility’ physical and ergonomic?
- ❑ Causal factors for driver misjudgement SPAD?
- ❑ Other factors relevant to location?
- ❑ Causes of the SPADs, i.e. is there a pattern?
- ❑ Conflict scenarios, the speeds and conflict probabilities?
- ❑ Signal demand rate?
- ❑ Distance of the fouling point past the signal?
- ❑ Conflict opportunity?
- ❑ Collision probability estimate?
- ❑ Checklist of mitigations that may be effective in reducing SPAD probability and consequence at a particular signal.
- ❑ The probability and consequences of derailment or level crossing conflict following a SPAD?

From the data gathered in the WBRA, and available SPAD data, a quantified estimate of the frequency of a collision at a particular signal can be made. A risk ranking for each signal assessed in the layout is derived using the risk model shown in a simplified form in Figure 1.

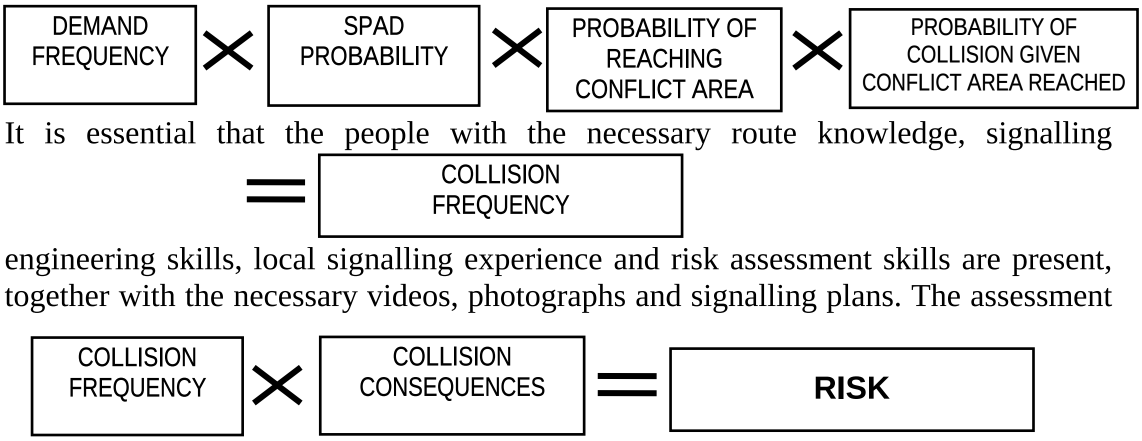

Figure 1. SPAD Risk Assessment Calculation

It is essential that the people with the necessary route knowledge, signalling engineering skills, local signalling experience and risk assessment skills are present, together with the necessary videos, photographs and signalling plans. The assessment of the consequences of a collision is based upon an FEA collision modelling method that is also used in the LRM.

The outputs from the WBRA are:

- ❑ Risk Ranking for each signal, based upon Collision frequency and Collision Consequence.
- ❑ A Series of potential SPAD probability mitigation measures.
- ❑ A series of potential SPAD consequence mitigation measures.

It is necessary to make reference to cost when considering mitigation. The form has a field for entering cost data. The WBRA process enables a comprehensive, structured, consistent and auditable approach to layout risk assessment which the project team can buy into and which can be taken forward for project approval.

3 SPAD RISK ASSESSMENT WITHIN THE DESIGN PROCESS

The incorporation of risk assessment into the signalling design process is essential. It is important that a safety plan is prepared at the outset of the project which outlines how risk will be identified, quantified and mitigated. A description of the safety management system that will be adopted to ensure that the safety plan is carried out is a necessity. Guidance upon these issues is given in Engineering Safety Management, Version 3, colloquially known as the Yellow Book [6]. A risk assessment may only enable a snapshot to be taken of the design in its state of completion at that time; it is therefore imperative that the configuration management of the design is robust. A robust system will enable the design team to establish definitively, what was risk assessed.

Experience indicates that the inclusion of the SPAD factors in the WBRA will results in early consideration of signal sighting, which can pre-empt problems for the signal sighting committee.

3.1 LRM and SEJ

SEJ is required on all resignalling projects. LRM should be seen as a complementary tool to SEJ, used concurrently to analyse *complex* areas, to provide comparative risk levels at each signal. By reviewing the LRM and SEJ results side by side, any inconsistencies can be revealed. A process model for the SEJ activities, as used by WS Atkins, is shown in Figure 2. In this figure, LRM is shown in parallel and series with the SEJ workshop. For complex layouts it is usually clear that an LRM is required. If LRM can be done so as to feed into the SEJ, this will enable the workshop to target risk hotspots effectively.

The SEJ can only consider the ALARP principle in qualitative terms, as the LRM results are not absolute risks and therefore the application of traditional cost benefit analysis is not appropriate. A reasonable approach is to compare a new layout and new time table (NLNT), assuming that a new timetable is planned, with the existing layout and the existing timetable (ELET). If more trains are timetabled, risk will generally increase accordingly, unless the layout has been changed radically to limit conflicts e.g. a grade separation.

Mitigation at a NLNT should seek to ensure, as a minimum, that no additional risk has been imported onto the network. This is achieved by considering mitigations at each signal and assessing how much the mitigations will lower the risk. The revised risks after mitigation for the NLNT should be compared with the ELET. The NLNT risk after mitigation should be at least as low as those for the ELET.

The SEJ should be able to state that no reasonably practicable measures have been identified that have not been adopted. In order to decide whether mitigation is reasonably practicable, the SEJ must weigh the likely risk as evidenced by the analysis and discussion within the SEJ and the results from the LRM if available, against the additional cost resulting from the mitigation.

Generally TPWS should been seen as additional safeguard over and above those risk control measures that are adopted as a result of the risk assessment process.

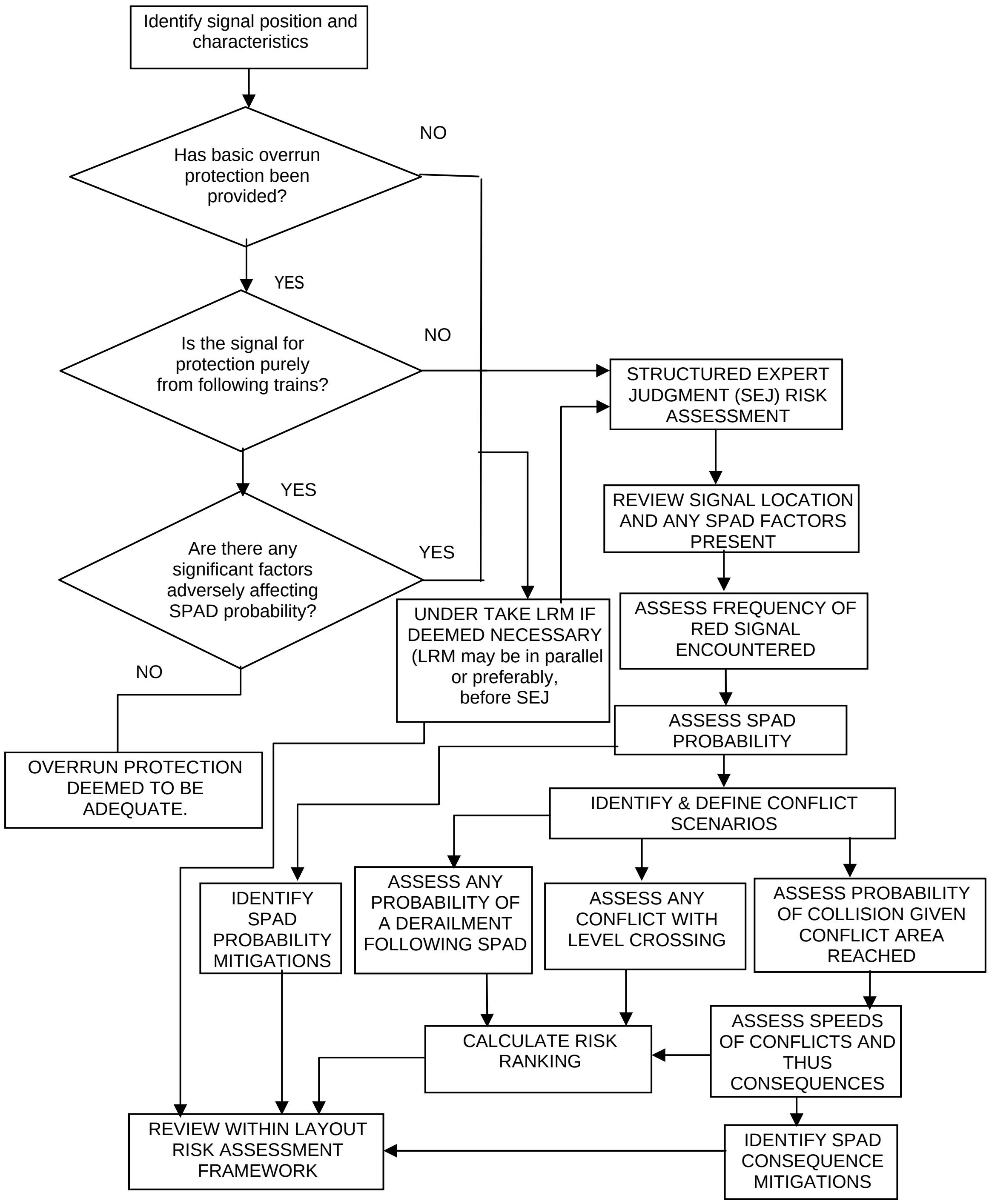

Figure 2. Structure Expert Judgement Risk Process

4 FUTURE DEVELOPMENTS AND ISSUES

If the SEJ and a simple risk model were proposed as an alternative to LRM in low complexity areas, such as simple double junction, more work would be necessary to validate the model's output. The workshop participants take a view on collision probability that is significantly more prone to variance than the LRM model. A cut-down LRM model that is easier to apply concurrently may be the answer.

The generic figure of 1 $\times 10^{-4}$ SPADs/demand has been used for the SEJ and LRM. It would useful to develop a greater understanding of SPAD probabilities and demand rates, especially regarding platform starter signals, junction signals and plain line signals. A Human Factor approach has been used previously to assess SPAD probability, employing the HEART technique. It may be informative to ascertain whether this technique or similar could be simplified and employed to determine SPAD probability. It is clear that disregard type SPADs will have a higher likelihood of reaching the conflict point than misjudgement type SPADs. It would be useful to derive conflict probabilities for the different types of SPAD. This would also be beneficial when considering mitigation, as the different types of SPAD will be amenable to different mitigation.

The fire risk associated with diesel powered trains and the structural integrity of modern aluminium bodied stock in collisions is an issue that is currently being given attention in the industry. Any revised collision consequences will require feeding into risk assessment tools.

5 CONCLUSIONS

The main purpose of this paper has been to establish and understand the current industry best practices for layout risk assessment, and to seek to integrate them into the layout design process in the most effective manner. The current group standards, guidance notes and acceptable risk assessment methods, including the scope of the current approaches, have been discussed. A workshop based structured risk assessment process has been proposed, with guidance given regarding its integration with existing approaches and the layout design process. An approach to demonstrating ALARP has been described and areas requiring further work for SPAD risk assessment have been identified.

The Author would like to thank Railtrack PLC and WS Atkins Rail Ltd for giving permission for this paper to be published. The views expressed in this paper belong solely to the Author and do not necessarily represent those of any other party.

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