

1. Résumé

On Monday 15 February 2010 at 08:28:19, the trains E3678 et E1707 operated by SNCB/NMBS, had an almost head-on collision between Hal station and the unmanned stopping point in Buizingen. The omnibus train E3678, coming from Leuven, was travelling to Braine-le-Comte on track A of line 96 in accordance with the planned timetable. The train E1707 Quiévrain-Liège was travelling from Hal to Brussels Midi on track B of line 96 and was running 10 minutes late when it reached Hal.

At around 08:26, the train 3678 completed its stop at the unmanned stopping point in Buizingen on platform 1.

Following a stop of around 30 seconds, having been informed that the unloading - loading operation was complete via the "lamp door" in the driver's cabin, the driver pulled away with full acceleration. It is almost certain that at this moment, the main signal H-E.1, 335 metres ahead of the Buizingen platforms was red. The driver had received and cleared the warning by passing the warning signal C-D.1 on double yellow, 590 metres before the platforms.

The investigation revealed no action, even momentarily, by the signaller in the Brussels Midi control centre responsible for the zone, that could have caused the H-E.1. signal to show a clear aspect. On the contrary, at 08:26, the signaller mapped out an alternative route for the train 1707 which deviated towards the 96N line by crossing the path of train 3678. As is logical within the system, this manoeuvre automatically locked the signal H-E.1. in the danger position. The investigation has not revealed any physical causes of an inappropriate lighting of the green signal. We can therefore assume that a reflection based on the hypothesis that the signal H-E.1. remained red during the stopping and subsequent pulling away and acceleration of the train, is sufficient to take the necessary and pertinent safety lessons from this accident.

The train 3678 passed the signal H-E.1. at approximately 60km/h, and continued its acceleration. The driver then noticed that the train 1707 was crossing its path. It sounded its horn several times and put on the emergency brake. The two trains collided almost head-on. The driver of the train E1557 stopped at the scene and called for help. In the first instance, the Infrabel emergency plan was put into action. Traffic Control called the emergency services at 08:32. The public service emergency plan was quickly activated, followed by the local intervention plan at 09:15. There were to be 19 fatalities, 35 serious injuries, and 44 light injuries with around 92 cuts and bruises. Massive damage was left on the track, the catenaries, rolling stock, passenger belongings.

The scenario of the accident is based on the overrunning of a signal at danger. The accident has revealed a failure of the fundamental safety principles of the railway system in which drivers must respect signals at danger. We have conducted an analysis of the possible reasons for this overrunning. The H-E.1. signal was theoretically visible. The analysis has not revealed any physical or physiological reasons that could explain the poor perception of the colour of the signal by the driver of train 3678. It has also not identified a particular reason for distraction, abnormal fatigue, time pressures or a state of stress. The study of the driver's timetable of service over the 45 days preceding the accident does not show an accumulated sleep deprivation and therefore did not increase the driver's level of fatigue. The only significant element likely to affect the driver's concentration level is the loss of sleep brought about by an early morning (03:30) to start his shift on the morning of the accident.

Concerning the psychological, and in particular cognitive aspect of the activity of the driver of train 3678, the operational context that he experienced provided some possible explanations for the overrunning of a signal at danger:

- the stop at the unmanned stopping point facilitates short term memory loss of the double yellow warning signal seen before the stop at the unmanned stopping point, even more so as no external memory aide was provided,
- the driving routines "on yellow" acquired from the high frequency of encountering signals in "double yellow" position with clearing of the track before the signal at danger causes a loss or weakening of the mental association "double yellow-red",
- the different means of communication for drivers for TO information (Terminated Operations) favours confusion,
- supplying TO information before the track is clear and independently of the line-clear signal encourages the misplaced activation of the departure routine.

In a general context with very routine activities (omnibus), with a level of alertness undeniably slightly reduced by a shorter night's sleep, a concentration level certainly momentarily rather low but without major distraction, these elements together suggest that the driver reacted to the lamp door with an automatic reflex and subsequently created an incorrect image of the situation in which the signal was symbolically clear and could only be seen as "green".

These elements do not indicate a clear mechanism at fault on which we could create an effective corrective action. From this point of view, the leads suggested by the analysis of the fault are in particular:

- the removal of the interruption of the double yellow-red sequence by unmanned stopping points,
- standardisation of the means of communication of TO information,
- the line track signal must be sent before any TO information,
- taking into account of the risk of fatigue in the organisation of drivers' timetables.

However, an essential observation remains that the scenario of overrunning a signal is a common one, and a lot of work has been done over the years. Therefore the accident confirms above all the existence of "background noise" in the overrunning of signals at danger for complex reasons, linked to the limits of human reliability, and which the system cannot really control. The level of observance of signals at danger is already at a level (around 10-5) which demonstrates an excellent human reliability and is difficult to improve upon in this context. The growing number year upon year of overrun signals at danger in Belgium, is due to an increase in passenger transport (number of trains in circulation) and of its density relative to the network capacity, the growth of which produces an even greater increase in interference and therefore the number of signals at danger encountered by drivers. While room for improvement in human reliability does exist, it is no longer able to make up for and compensate for this growing risk.

The only solution for rendering the Belgian railway system sufficiently safe is to install automatic protection by automatic speed and braking control, in the same way as other comparable European countries and such as is in process in Belgium since 2009 with the TBL1+ system.

An additional solution would be to equip the system, in addition to the automatic functions, with a real capacity to recover the overrunning of signals at danger. This is practically non-existent today: nothing indicates the overrunning of a signal at danger to the driver or signaller, the signaller has no means of action which is sufficiently fast, etc.

More generally, the railway safety system would be improved by a real concern for the recovery of situations of loss of control, and for passive safety.

The main elements - the powerlessness to "sufficiently" reduce human error, and its results, the inevitable necessity of a technological support - has been known about the Belgian railway system for nearly a decade. Consequently what has happened that the Belgian railway safety system, taken in its widest sense, has been unable to transform this awareness into effective action?

One element is cultural heritage. The Belgian railway system has historically been marked by a reactive culture, reacting to accidents case by case, rather normatively, focussing on obeying orders, and therefore logically centred on the failures of the first line operators seen as the "explanation" for safety problems. It has therefore quite logically "closed down" its work on eradicating, cause after cause, the overrunning of signals at danger.

The rate of change adopted has reflected very little enthusiasm for the rallying together of management and regulatory authority to the SMS cause. The concept did not initially reveal the benefits that it would represent in comparison with everything that was already being done for safety. The recognition by the railway system of the need to reinforce safety by a supervision plan and for automatic braking has not been sufficient to choose an effective corrective strategy and to implement it rapidly.

The evaluation of the safety problem posed by the overrunning of signals at danger has remained fairly qualitative, biased by a cultural perception of the responsibility of the driver, therefore of a solvable problem (training, reprimand, sanctions). This has created a situation of political underestimation and of the time-scale for resolution, of an absence of calling into question, and of an overconfidence by the managers in railway safety, in an institutional context otherwise marked by a certain instability in decisions and in the follow-up to investments in the long term.

We have also picked up a certain weakness in the National Safety Authority, unique in its position to propose and impose a systematically integrated vision external to the interests of business, and a considerable delegation of safety management responsibility to the infrastructure manager, Infrabel. This weakness is the direct result of the fact that the setting up of this authority, and more generally the implementation of the regulatory framework for railway safety management has suffered systematic delays in the time limits of regulatory obligations.

The application of the European Directive has resulted in a formalising of the approach to risk management. Progress has been made but the suitability and managing of methods for risk management and the systematic and organisational analysis of accidents remain to be improved.

The two companies Infrabel and SNCB/NMBS have presented an accelerated plan for fitting the TBL1+ system for infrastructure (end 2015) and for rolling stock (end 2013). This plan constitutes an urgent catch-up acceptable for the expressed requirement. Nevertheless the driver assistance system TBL1+ is not a full supervision system. Its accelerated installation on the Belgian network can only constitute a provisional solution and linked with installation of the ETCS system as foreseen by the two companies.

6 Recommendations

Generally speaking, the recommendations of the investigation body must be addressed to the Safety Authority (SSICF) and compiled as "goal-oriented". The recommendations do not constitute a prioritisation. It comes down to the SSICF in consultation with the infrastructure manager and the railway undertakings to transform them into "solution-oriented" recommendations.

An effective management of the risks is only possible if they put in place a process centred on three basic dimensions:

- technical component: tools and equipment
- human component: skills, training, staff motivation
- organisational component: procedures and methods allowing definition of the relationship between the different tasks.

Overrunning of signals at danger		
no.	Observations and conclusions of analysis	Recommendations
1		<p>R1.1 The IB recommends that Infrabel and SNCB/NMBS provide a detailed action plan to respond to the IB's various recommendations to the SSICF within a maximum of 3 months including the time estimated for realisation.</p> <p>R1.2 The IB recommends that the SSICF verifies the need to distribute recommendations to other railway undertakings.</p>
2	<p>The accident has revealed a failure in a fundamental safety principle of the railway system which requires that drivers respect signals at danger. The operational context provides elements that could explain the overrunning and the leads are suggested through an analysis of the failure in the report:</p> <ul style="list-style-type: none"> • the removal of the interruption of the double yellow - red sequence by unmanned stopping points; • standardise the means of communication for the TO signal; • the imposition of a wait for the line-clear signal before any TO information; • taking into account the fatigue risk in driver timetable planning. 	<p>R2.1 The investigation body recommends that SNCB/NMBS and Infrabel take concrete steps to prevent collisions resulting from the overrunning of signals at danger and to reduce the consequences of collisions between trains;</p> <p>R2.2 The investigation body recommends that the SNCB/NMBS and Infrabel take concrete measures to reduce the number of signals overrun at danger and the short and long-term consequences in a systematic way;</p>

3	<p>Following the accident in Buizingen, the two companies Infrabel and SNCB/NMBS have presented an accelerated plan for fitting the TBL1+ system for infrastructure (end 2015) and for rolling stock (end 2013).</p> <p>This plan constitutes an urgent catch-up acceptable for the expressed requirement. Nevertheless the driver assistance system TBL1+ is not a full supervision system. Its accelerated installation on the Belgian network can only constitute a provisional solution and linked with installation of the ETCS system.</p> <p>The ambitious timetable for the equipping of the ETCS system suggested by Infrabel and by SNCB/NMBS envisaging complete equipping (ground + on board) of the Belgian network before 2025 involves an acceptable medium and long-term response.</p>	<p>R3 The investigation body recommends the SSICF, in coordination with the service or services concerned within FPS Mobility and Transport, provide a follow-up to the deployment of the ETCS with an overview of the development of safety, with the intention to check that the rate of deployment is being respected, and at the same time to check that the transition, and in particular the deactivation of existing systems, is not being done to the detriment of safety.</p>
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SAFETY MANAGEMENT SYSTEM		
no.	Observations and conclusions of analysis	Recommendations
4	<p>The investigation has shown that the suitability and managing of the methods for risk management and systematic and organisational analysis of incidents and accidents remains incomplete for Infrabel as well as SNCB/NMBS and does not allow these organisations to sufficiently question their beliefs and their current safety model. By reacting to events separately and by looking at the cause of each overrunning, the reasoning encourages an understanding centred on the actions and the "errors" on the front line. What is more, the training programmes for investigators does not involve training in technical investigation or the systematic analysis of incidents and accidents. The attempt at an analysis of the historical development of automatic protection provisions for trains in Belgium has revealed that decisions are not sufficiently documented and supported by an explicit evaluation of risks.</p> <p>With any decision involving management, it is advisable to take into account the direct and/or indirect effects on safety. It is necessary to be aware of the transparency of decision-making processes.</p>	<p>R4 The investigation body recommends that Infrabel and SNCB/NMBS submit to the SSICF a review of their manuals for Safety Management Systems to positively develop and take the appropriate measures to compensate for the insufficiencies identified in the investigation report.</p>

The emergency services		
no.	Observations and conclusions of analysis	Recommendations
5	<p>The safety perimeter was installed at around 10:30 even though the accident took place around 08:30. Several people were able to access the installations before it was cordoned off. Infrabel was able to work on the crocodile and in the signal housing. It should be reminded that taking measures, or carrying out repairs is prohibited without prior authorisation from the judicial authority and/or the investigation body.</p>	<p>R5 The investigation body recommends that Infrabel and SNCB/NMBS remind its personnel to respect the instructions for access to the site of an accident, to remind personnel that taking measures, or carrying out repairs is forbidden without prior authorisation from the judicial authority and/or the investigation body, that access should be strictly limited to the emergency services and to the investigators.</p>
6	<p>The configuration of the terrain, the wall along the tracks, the distance to the station and the train 1557 stopped next to the accident created serious problems for access by the emergency services in transporting the injured to the ambulances. Emergency workers had to move long distances on foot. SNCB/NMBS took the initiative to propose buses to transport passengers. This action is commendable but a list of the names of the persons on board the trains was not available before transporting them to other stations.</p>	<p>R6 The investigation body recommends that the infrastructure manager and SNCB/NMBS adjust their emergency plans for the evacuation of the injured, passengers etc. according to the lessons learned from this accident.</p>

Others		
no.	Observations and conclusions of analysis	Recommendations
7	The investigation body of FPS Mobility and Transport was belatedly informed of the accident. The information arrived at the IB more than an hour after the accident.	R7 The law of 19 December 2006 forces the infrastructure manager to immediately inform the investigation body. The IB recommends that Infrabel reviews its priorities for informing parties to allow everyone to carry out their duties.
8	The H-E.1 signal was not emitting its normal brightness at the time of the accident. Even though the visibility of the H-E.1 signal was not the principal cause of this accident, the lack of luminosity could have had an impact on the perception of the signal by the driver in other weather conditions.	R8 Infrabel is recommended to propose an amendment to its safety management manual to the SSICF to ensure respect of the periodic signal maintenance and of its clear-cut traceability.
9	Systematic guarantees via the safety points, that all routes authorised and travelled by a train cannot be crossed or subject to a face-to-face situation in the case of an overrunning of a signal by any other movement, are impossible requirements to satisfy in current operational situations without severely restricting operations or without massively adapting the infrastructure.	R9 The IB recommends that Infrabel, in the conception of new installations or for major readjustments of existing installations, limits, in consultation with operators, the risk that an authorised and travelled route may be crossed or result in a face-to-face situation in the case of the overrunning of a signal by any other movement.