Investigation Body for Railway Accidents and Incidents

Summary
Safety Investigation Report
Collision between a passenger train and the rear of a freight train
Hermalle-sous-Huy - 5 June 2016

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This report has been prepared exclusively for the purpose of preventing accidents occurring during the exploitation of the railways. The legal assessment of the circumstances and the causes is not the subject of the present investigation according to article 119 of the law of 30 August 2013 concerning the Railway Code.
This report is therefore not intended to establish liability or elucidate questions of civil liability.

SUMMARY

Following storms that occurred on 5 June 2016 around 7 p.m., a lightning strike caused various disturbances to the signals on line 125 at Hermalle-sous-Huy: three track circuits were interrupted. As a result, the signals protecting access to the concerned sections turned red: the three signals involved (B222, K.10 and KX.10) were thus closed.
Indeed, during this type of track circuit interruption, the intrinsically safe nature of the system has the effect that the associated electromechanical relay is no longer powered. This situation corresponds to a safety mode: an interruption causes a “restrictive” reaction and not a “permissive” reaction, the track is classified as occupied, and the signal protecting the track section turns red.

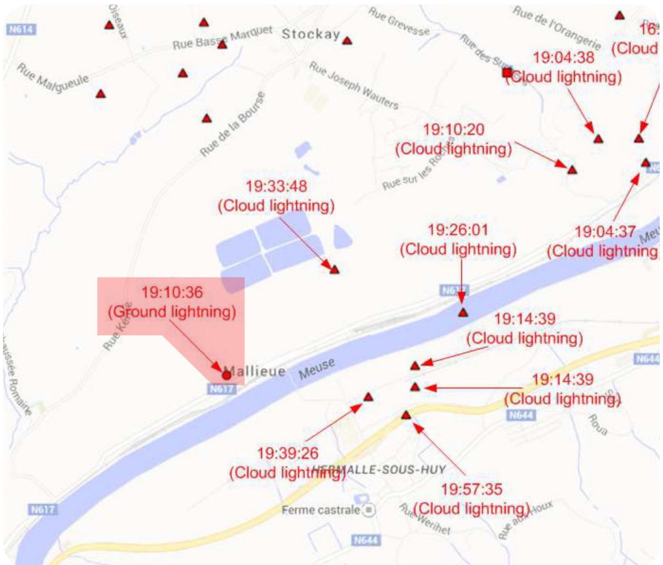

Figure: location of the lightning strikes registered in the vicinity of the accident site on 5 June 2016 between 7 p.m. and 8 p.m. (source: Elia).

The signal station operators noticed these interruptions and contacted technicians to remedy these interruptions. The technicians started their work at around 8:20 p.m.

In the meantime, and in order to allow railway traffic in such situations, procedures are in place. The driver must make a stop at the foot of the closed signal in all cases:

- in the case of an automatic signal, such as the signal B222, the train driver must then complete document M510 and can then pass the closed signal while running on sight to the foot of the next major stop signal;
- in the event of an operated signal, such as signals K.10 and KX.10, the driver must then contact the signalling station by telephone in order to receive clearance authorisation from the signal station operator.

The technicians decided to start their work on track A: the replacement of overvoltage fuses allowing a return to normal operation of the signalling on this track.
The technicians made contact with Flémalle signalling station (Block 7) at around 8:50 p.m.: after checking, track A of line 125 could be travelled on without any restriction or clearance authorisation.

The replacement of burned fuses in the K.10 signal box on track B allowed the interruption of the corresponding track circuit to be eliminated shortly before 10 p.m.

The last track circuit in advance of signal B222 was still out on track B with signal B222 consequently being closed.

At around 10:52 p.m., freight train E48535 arrived at the unmanned stopping point of Amay : signal D.11 showed a "Double Yellow" aspect. The driver started braking and acknowledged the restricted signal on the on-board equipment: the restrictive information of the signal was transmitted by the crocodile associated with the D.11 signal to the Memor equipment of the locomotive. The Double Yellow aspect indicated to the driver that the following signal (signal B222) was to be considered closed.
He continued to slow down his train and stopped a little in rear of the next signal, the B222, which is red. The driver completed his on-board document, took a picture of signal B222 and restarted his train, running on sight. He crosses the B222 signal and travels at a speed of about 12 km/h towards signal K.10.

At around 11:01 p.m., the E3820 passenger train arrives at the unmanned stopping point of Amay: the signal D.11 displays a "Double Yellow" aspect, indicating to the driver that the following signal (the signal B222) is to be considered closed.
The driver is late to acknowledge the restricted signal, that is to say after having passed the signal but within the 4 seconds time frame allowed by regulation.
The restrictive information of the signal was transmitted by the beacon TBL1+ associated with signal D.11 (double yellow) to the equipment TBL1++ of the railcar AM96.
The driver did not start braking: he continued his journey at a speed of about 112 km/h.
About 50 meters after signal D. 11 (double yellow), the train passed over a TBL1+ "OUT_P44" beacon: its function is to emit information that signals leaving a TBL1+ zone and that activates the "Memor-Crocodile" function on board the rolling stock.

The train E3820 arrived at signal B222 at a speed of 112 km/h. As provided in the operation of the signals, and in accordance with the closed aspect of signal B222, the crocodile associated with the signal did not emit an electrical current: the E3820 train passed the closed B222 signal without the driver being warned by the equipment aboard the train. The train continued to move.

By the time the E3820 driver probably saw the tail signal of the freight train, he began an emergency braking while the train was travelling at about 118 km/h. The E3820 train travelled a distance of approximately 178 meters before colliding with the rear of train E48535 at a speed of approximately 88 km/h.

The catch-up collision was due to having passed a signal that showed a closed aspect after the lack of braking by the passenger train driver.

A technical survey was conducted with the help of external expertise to confirm the condition of the signals encountered by the driver. A fault tree was established in order to verify the circumstances in which the signal could have had a different aspect than red on the basis of the wiring plans provided by the infrastructure manager, but also on the basis of various studies and analyses carried out regarding the operation, the impact of the malfunctions, the impact of the actions performed by the cabin crew and the impact of the actions of the two technicians on the signalling.
The elements in our possession, interviews and studies carried out, confirm the scenario of the passing through a closed signal (B222).

A study of human factors with the help of external expertise has also been conducted: it focuses on the relationships between individuals and the systems with which they interact, focusing on improving effectiveness, creativity, productivity and job satisfaction with a view to minimising errors. The work environment must be designed and organised in such a way as to reduce the likelihood of errors occurring and the impact of those errors when they actually occur. It is not possible to eliminate human error but it is necessary to act to mitigate and limit the risks. It should be noted that the study of human factors is not as directly related to people as its name might suggest. Rather, it is about understanding human limitations and designing the working environment and materials used, taking into account the variability of the professionals and their activities.
During this study, the characteristics of the driver's vigilance, level of alertness and possible distractions were derived indirectly through interpretations of the actions taken by the driver during the journey.

The driver involved covered a shift over the weekend. He was replacing a sick driver. The driver's schedule was analysed using an "RFI" tool (Risk Fatigue Index). According to this calculation, the level of fatigue of the driver was not high. However, this Risk Fatigue Index calculation is based on the scope of the driver's service: it gives no indication on the time and the quality of the actual sleep of the driver, nor on his level of stress.
The actions of the driver on the automatic standby system ("dead man's pedal") show that the driver did not suffer prolonged discomfort or sleepiness during his service on the day of the accident (3 journeys) but this gives no indication of possible micro sleeps.

The driver's cab of an AM96 railcar offers good visibility of the signals. The visibility distance of the warning signal (double yellow D11) gives the driver time to apply the expected professional actions. The signal B222 (red) is correctly visible and its salience is good despite the urban luminous environment.
The driver did not start braking when approaching signal B222 which showed a closed aspect.

The study of train data records ("black boxes") for the journeys of the day of the accident revealed:

- various late acknowledgements of restrictive signals, i.e. within 4 seconds after the train passing by at the foot of the signal;
- automatic braking intervention by the TBL1+ system on other signals.

From this, we conclude that it is likely that the driver's level of alertness was not optimal.

The ability of humans to be distracted allows them to notice abnormal events. This ability allows him to recognise and respond to situations quickly and adapt to the new situation and new information.
However, this same distracting ability also predisposes him to errors. Indeed, in the case of distraction, there is a risk of not being attentive to the most important aspects of a task or situation.
Distractions can be numerous and diverse: external to the individual (work on the track, ...) or coming from the individual (mobile phone, multimedia tablet, drink, newspaper, music, ...)
No call via the mobile phone or GSM-R device was made on the moments of the belated acknowledgements or TBL1+ interventions. The private mobile phone of the driver could not be analysed by the Investigation Body.

Activity with a mobile phone is difficult to measure: indeed, activities may be due to automatic programs (update, ...), the driver can also use the mobile phone in a disconnected way to view photos, to watch videos downloaded beforehand, to listen to music,…
No other potential source of distraction was noted.
The question regarding the use of mobile phones was however raised during the investigation by the external experts. Drivers are aware of the ban on the use of private mobile phones in the driver's cab but recognise that sometimes the rule is not strictly followed.
Prevention through making the driving staff responsible therefore plays a leading role.
During the last consultation meetings, the national safety authority raised awareness among railway companies about the risks of using mobile phones.

The Investigation Body recommends that the railway company continue its investigations and checks to avoid distractions during driving.

The brain can also play tricks by poorly assessing the situation and thus contributing to the occurrence of errors. A poor assessment of the situation is, whatever the good intentions may be, one of the main reasons why decisions and actions may be erroneous and lead to errors, regardless of the level of experience, intelligence, motivation or alertness.
The monotonous nature of the journey and the habits and expectations of the driver are risk factors to the driver's attention to signals: these factors determine the mental pattern of the driver and influence his interpretation of the signals he encounters. According to the testimonials gathered by the experts from drivers on the line concerned, signal B222, a major automatic stop signal, generally shows a green aspect at this late hour.

During the operational sequence, the driver of the passenger train arrived at signal D.11 showing a "Double Yellow" aspect which indicates to the driver that the following signal (signal B222) is to be considered closed. The driver is late to acknowledge the restrictive signal, that is to say after having passed the signal but within the 4 seconds time frame allowed. Beyond 4 seconds, an emergency brake would have been engaged.
Passing through a restrictive signal is shown in the driver's cab by the yellow memorisation indicator light turning on.
The memorisation function of the yellow lamp in the driver's cab is not sufficient to allow the driver to realise that he is travelling towards a closed signal (B222 showing a red aspect).
The driver unduly passes signal B222 equipped with the Memor system.

The accident shows, as in the case of the Wetteren accident, that it is possible for a driver to "automatically" acknowledge a signal without this triggering any particular action.

The goal of the Memor system is to obtain, through the presence of a device for driver assistance and surveillance, risk reduction linked to the possible relaxation in vigilance of the driver. With the Memor system, no alert is expected to warn the driver of his passing the signal and allow him to make an emergency brake. It is the absence of the sound signal that is supposed to "alert" the driver of passing through.
Memor is not designed to trigger an emergency brake in case of passing the signal, unlike an ATP/ATC system[1].

The investigation also focused on the management systems implemented by the two companies. Although compliance with the signals is a rule that is stressed intensively during training and during the monitoring of drivers, the reaction patterns of a driver faced with a restrictive signal may undergo deviations from the rule and from good practice: some drivers adopt a more reactive approach and regularly acknowledge belatedly.
In interviews with drivers, experts from the external company mentioned that the driving habits of some drivers who recently entered into service are different to those of drivers who drove on other systems (Memor, Gong-Whistle) : they would tend to rely more on reminders of certain aspects of signals by the TBL1+ system on board trains. This is a deviation from the requirements: every driver has to observe lateral signalling and respect the rules defined by the company and included in the HLT.

1 ATP = Automatic Train Protection - ATC = Automatic Train Control. Examples of such systems: TBL1+, KVB, ATB, TBL2, ETCS,…

The TBL1+ system is a driver assistance system, not an automatic train control system.
The TBL1+ system does not equip all the signals: schematic signalling plans[2] mention this information but drivers cannot and should not know, according to the NMBS/SNCB, which signals are equipped with TBL1+ and which are not.
Indeed, the train driving rules do not change according to TBL1+ equipment or Memor signals.
Controls via tape recordings analysis are carried out by the railway company. However, it is not possible to check all daily journeys.

The Investigation Body recommends that the railway company continue raising awareness and accountability of train drivers regarding the risks posed by the non-compliance with driving rules.

After the Buizingen accident in 2010, the two companies, Infrabel and NMBS/SNCB filed an accelerated equipment plan for the TBL1+ system at the infrastructure level and in rolling stock.
Infrabel communicates on the state of protection of its network by the TBL1+ system in terms of, inter alia, "efficiency coverage". This communication may have led to confusion: the 99.9% efficiency coverage does not correspond to 99.9% reduction in risk of reaching the danger point provided by the installation of the TBL1+ system, nor to the equipment of 99.9% of all Infrabel network signals with TBL1+.

2 PSS are available to railway companies by the infrastructure manager.

Why was the B222 signal not equipped?

Infrabel works in two phases to make the network safe:
- the first consists in a rapid deployment (4-5 years) of TBL1+ in 75% of the signals, and
- the second phase consists in the equipment of the network with ETCS.

During the first phase, the TBL1+ system was not installed on all of the network signals: the objective of the manager is to reduce by 75% the danger point being reached when signals are overrun. To decide to equip or not equip a signal with TBL1+ equipment, Infrabel conducted a risk analysis.

In summary, the B222 signal was not equipped for the following reasons:
- the level of risk estimated by the method used was relatively low and the category to which the signal belongs did not have to be equipped with the TBL1+ system as a priority;
- the signal was not involved in achieving the objective set by the infrastructure manager to reduce by 75% the danger point being reached when signals are overrun;
- the delay in the schedule of modernisation of the line section in PLP[3];
- the Infrabel decision to install the TBL1+ on the section "any relay" without waiting for the installation of the PLP but via a minimum deployment;
- the B222 signal is an automatic signal that required new wiring to allow the installation of TBL1+. It will disappear under the new PLP configuration of the section "Ampsin-Haute-Flône".

<u>The second phase</u>
The Masterplan prepared by Infrabel and NMBS/SNCB is an ambitious plan to make the Belgian rail network safe using ATP (TBL1+) and ATC (such as ETCS 1, 2 and 1 Limited Supervision) systems.
Many signals should be equipped by 2020: analysis of changes in the past of ATP/ATC (TBL, TBL 1, TBL2,) systems implementation projects on the Belgian rail network show that these projects undergo revisions because they are considered too ambitious. The TBL1+ schedule has been respected, the monitoring of the ETCS deployment schedule is one of the recommendations of the Investigation Body as part of the Wetteren accident investigation.

Risk analysis by Infrabel established that the risk of reaching a danger point if a closed signal is passed decreases as follows:
- 75% in the case of TBL1+ equipment;
- 85 à 90% in the case of ETCS 1 Limited Supervision equipment;
- 95% in the case of ETCS 1 or ETCS 2 equipment.

Certain signals are not to be equipped:
- the independent simplified stop signals that can be passed in major movement are not taken into account;
- lines for which the reference speed is less than or equal to 70 km/h equipped with crossings, protected by simplified stop signals are not taken into account.

ETCS is being installed following a deployment plan from 2012 to 2022.
We must remain aware that zero risk does not exist. ETCS's goal is to reduce the risk of reaching a danger point if a closed signal is passed.

3 *PLP: schematically electronic and programmed control signalling.*


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