Federal Authority for
Railway Accident Investigation

Translation of an excerpt of the investigation report

"Train collision Altheim (Hesse) halt – Dieburg station on 19/05/2022"

Status as of 11/12/2023, version 1.0.

Note:

In accordance with Article 3 of Implementing Regulation (EU) 2020/572, points 1, 5 and 6 of Annex I of an investigation report shall be written in a second official European language. This translation should be available no later than three months after the delivery of the report.

The following English translation is a corresponding excerpt of the investigation report. The German language version is authoritative.

Excerpt translation:

1 Summary

The first section contains a brief description of the event, as well as information on the consequences, primary causes and safety recommendations provided in the individual case.

1.1 Brief description of the event

On 19/05/2022 at 02:52 am, the train number (TN) of the DGS 46192, which was between Babenhausen and Dieburg, was automatically overwritten with the TN of the subsequent DGS 42174 following a route cancellation. As a result, the DGS 46192 travelled onward towards Darmstadt, initially without a TN and then subsequently with the wrong TN of the DGS 42174. The DGS 42174 undetected remained on the route and came to a stop between the Altheim (Hesse) halt and Dieburg station. The Dieburg dispatcher ultimately reset the block section, which was still occupied by DGS 42174 without this having been detected. As a result, the subsequent GAG 60101 travelled on the block section at the signal position and collided with the stationary DGS 42174 at around 04:04 am.

1.2 Consequences

As a result of the collision, the train driver of the GAG 60101 was fatally injured, and the train driver of the DGS 42174 suffered minor injuries. The traction unit (TU) and the first carriages of the colliding GAG 60101 and the last carriage of the DGS 42174 were significantly damaged. There was also a high level of material damage to the freight on the two trains and to the infrastructure.

1.3 Causes

The collision was due to a chain of events that originated in Babenhausen.

Time Issue	Factor	Causal factor	Contributing factor	Systemic factor
02:52 am Untimely advancing of the train number and overwriting of TN 46192 with TN 42174	F1	X		X
02:53 am Automatic deletion of TN 42174 from block field 36 after manual new entry of the TN in the station field	F2		X	X
02:53 am Original TN 46192 no longer entered in block field 36	F3	X		
02:56 am Blank number in TN field 34 deleted by Babenhausen dispatcher	F4		X	X
03:11 am Dieburg dispatcher assumes there is a fault	F5	X		X
03:26 am Driving on sight procedure incorrectly implemented (including entry signal 30F set)	F6	X		X
03:31 am Timeout message in block section 34 not observed	F7		X	X
03:32/03:35 am Location query DGS 42174	F8		X	X
03:34 am Operation of axle counter reset	F9	X		
03:06/03:39 am No query from driver 46192 about reason for signal stop	F10		X	

Table 1: Summary of influencing factors

1.4 Safety recommendations

The following safety recommendations are issued in accordance with section 6 of the Eisenbahn-Unfalluntersuchungsverordnung (EUV, German railway accident investigation regulation) and Article 26(2) of Directive (EU) 2016/798. It is recommended that

- the working system for processing and transmitting train messages is examined and modified so that its information always complies with the requirements as per Reg. (EU) 2018/762, Annex 2, point 4.4.3, in particular when transitioning between automated and manual processes.
- the processes for planning, running and approving the functions of TN systems should be examined and improved as per Reg. (EU) 2018/762 Annex II point 5.2.1, including the associated change and risk management, in order to ensure that the physical asset is integrated safely into the working systems.
- in order to ensure the protective function of the work procedure “the same train has entered a section and left it again” as per Reg. (EU) 2018/762 Annex II point 3.1.1.1, the risks in the event of errors by the people involved must be determined and the work procedure must be improved.
- according to Reg. (EU) 2018/762 Annex II point 3.1.1.1, the risks in the event of discrepancies between the location of a train assumed by the dispatcher and the location reported by the train driver must be determined and suitable work procedures must be developed for safe continuation of operation.
- the technical conditions for the effectiveness of the operator control action of an axle counter reset should be further developed in order to further minimise or exclude the risks of successful, untimely operator control actions. Until these measures are implemented technically, and in order to minimise potential damage, it is recommended that compensatory procedure-based solutions are implemented.

5 Conclusions

The following section contains a summary of the identified causal, contributing and systemic factors. In addition, two further subsections are provided containing information about measures already taken, and additional comments.

5.1 Summary and conclusion

The collision was due to a chain of events that originated in Babenhausen. The starting point was the automatic advancing and overwriting of a TN without train travel due to the planning of TN reporting

system 800 in Babenhausen. Several causal, contributing and systemic factors resulted in the chain of events being continued by the people involved, which ultimately resulted in the collision.

5.1.1 Classification of influencing factors

The table below contains the summary of the influencing factors relevant for the chain of events. These are assigned to causal, contributing and systemic factors according to Regulation (EU) 2020/572 Article 2. The numbers in brackets for the factors are used to aid assignment to the explanations in the chapters below.

Time Issue	Partial aspect, causal factor	Partial aspect, contributing factor	Partial aspect, systemic factor
02:52 am (F1) Untimely advancing of the train number and overwriting of TN 46192 with TN 42174	Untimely advancing of the TN without a train having moved, with overwriting/deletion of a normal TN		Newly implemented functionality does not correspond to the original performance of the TN system
02:53 am (F2) Automatic deletion of TN 42174 from block field 36 after manual new entry of the TN in the station field		Information deleted without the knowledge and, if necessary, cooperation of the dispatchers involved	Technical planning of the printer output for the deletion is absent
02:53 am (F3) Original TN 46192 no longer entered in block field 36	Failure of Babenhausen dispatcher, meaning that a train was moving on the route without a TN		
02:56 am (F4) Blank number in the TN field 34 deleted by Babenhausen dispatcher		Rules in guideline 408.0591 not observed	Planning TN system Babenhausen: technical access to TN field 34 was possible

03:11 am (F5) Dieburg dispatcher assumes there is a fault	No clarification about train journeys that have been made		Incomplete work specifications in guideline 408.0591 in relation to missing information in the TN system with a simultaneous occupied display
03:26 am (F6) Driving on sight procedure incorrectly implemented (including entry signal 30F set)	Rule in guideline 408.0248 not observed		Error in application of rules results directly in the failure of their protective objectives
03:31 am (F7) Timeout message in block section 34 not observed		Rule in guideline 408.0641 not observed	Ignoring of technically generated warnings due to planning errors in the infrastructure
03:32/03:35 am (F8) Location query DGS 42174		Location details from driver 42174 not taken into consideration by Dieburg dispatcher	Procedure for discrepancies in location information not regulated
03:34 am (F9) Operation of axle counting reset for block section 34	Last action that made the collision possible		
03:06/03:39 am (F10) No query from driver 46192 about reason for signal stop		Rules in guideline 408.2455 not observed	

Table 6: Summary of influencing factors

The diagram below provides another visual representation of the key steps in the chain of events in time order, separated according to the infrastructure manager (right) and railway undertaking (left). The causal factors mentioned above are indicated by red dots, while orange dots are used for the contributing factors.

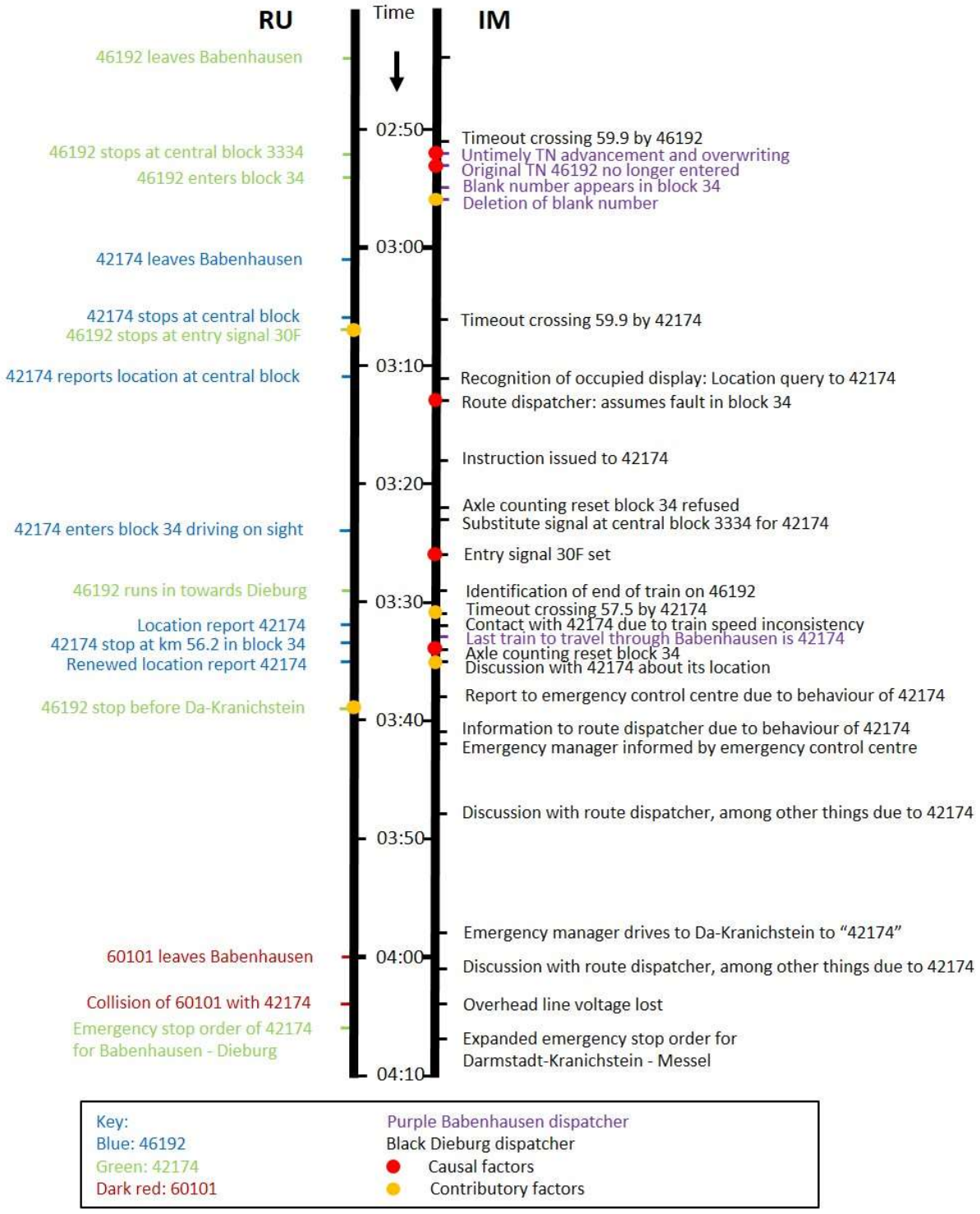

Figure 25: Timing of the chain of events

5.1.2 TN systems

As part of the adjustment measures for TN reporting system 800 in Babenhausen, individual technical and operational peculiarities emerged on the Dieburg computer-based interlocking, which caused the start and contributed to the further progression of the chain of events.

Causal factor

For F1: When cancelling an only preset outward train route, the Babenhausen TN system removed an automated train message without there having been an actual train movement with signal proceed aspect and halt aspect. At the same time, with this untimely deregistration, the TN system overwrote a TN saved in block section 36 of a train that had previously left properly and been deregistered automatically. Contrary to Regulation (EU) 2018/762 Annex II point 4.4.3 c), the safety-related information generated/altered in these situations was not correct. It did not match the actual operations. An automated deregistration must only take place as the result of a train journey that has actually happened. The TN system must therefore behave according to the permitted processes for telephonic train reporting procedures, according to which telephonic deregistration only takes place if there has been an actual train journey. A saved TN for an actual train journey should not be able to be overwritten due to automated, untimely deregistration. Data loss of this kind must be avoided.

Contributing factor

For F2: The automated deletion of the TN that was in block section 36, triggered by the manual new entry, resulted in a change to the data for operations on the route without other people involved knowing or being aware of this. Before a manual or automated deletion of a TN on the route, all people involved should be informed accordingly or agree based on a defined work procedure, analogously to the processes for telephonic train message procedures.

Systemic factors

For F1: The data processing in the TN system, which was newly set up during the adjustment and as a result was not correct or consistent, seems to have been neither identified in the infrastructure manager's planning and implementation process nor assessed in terms of acceptability and sufficient control via appropriate work instructions. The infrastructure manager's processes for planning, implementation and introduction of altered behaviour of TN systems as physical assets must identify and assess risks in accordance with Regulation (EU) 2018/762 Annex II point 5.2.1 in conjunction with point 3.1.2. If, as a result of this, additional measures are required, they must also be incorporated into the risk management and corresponding work instructions must be introduced for the operators.

For F2: After the TN had been entered manually again in a TN field of Babenhausen station following the explained incorrect deregistration, the TN system did not simultaneously log the automated deletion of the deregistration saved in block section 36. Although the monitor output of the TN system showed the situation that the dispatcher wanted, the printer log did not reflect this situation. Contrary to Regulation (EU) 2018/762 Annex II point 4.4.3 d), the safety-related information was therefore no longer consistent. In contrast, handwritten logs of telephonic train messages remain unchanged in a scenario such as this, or agreed changes are cancelled by the people involved in accordance with specifications. The deletion of a TN that has been deregistered must remain traceable.

For F4: According to the planning of the TN system, the Babenhausen dispatcher had access to TN field 34, which contains important data within the knowledge and decision-making authority of the Dieburg dispatcher about trains travelling towards him. Contrary to Regulation (EU) 2018/762 Annex II point 4.4.3 f), this meant that it was possible for safety-related information to be deleted without the responsible Dieburg dispatcher being aware of this. In order to prevent "manipulation" of data for which another person involved is responsible, the access authorisation of the Babenhausen dispatcher must be withdrawn.

5.1.3 Babenhausen dispatcher

During the cancellation of the outward train route for the DGS 42174, the Babenhausen dispatcher noticed the technically required advancement of TN 42174 into the still-occupied block section 36 and manually re-entered TN 42174 in his station track 301. According to the functionality of the TN reporting system 800, TN 42174 in TN field 36 was automatically deleted again.

Causal factor

For F3: The Babenhausen dispatcher failed to re-enter the previously overwritten TN of DGS 46192 into TN field 36. Although sufficient information was available, he did not notice that DGS 46192, which had previously been released, was still in block section 36. On the operating console in Babenhausen signal box, block section 36 had an occupied display (illuminated red). It could be seen from the TN monitor that DGS 46192 had not yet moved into the next block section 34, therefore it still had to be in section 36. In addition, the TN printer documented the overwriting with the note "46192 overwritten with 42174". Obviously, at this time, the Babenhausen dispatcher was no longer aware of the DGS 46192 and he therefore failed to re-enter TN 46192, which had unintentionally been overwritten automatically, in TN field 36. Consequently, a train without a TN was travelling on the route.

Contributing factor

For F4: Due to the failure mentioned above, it was possible for the DGS 46192 to change from block section 36 to block section 34 without being noticed by the two dispatchers, and it generated a blank number there. The Babenhausen dispatcher noticed the blank number and possibly attributed this to the unintentional automatic TN advancing that had previously taken place. Although block section 34 was no longer part of his area of responsibility, he had access to this TN field and was able to delete the blank number. The associated signal-related occupied report for block section 34 was not displayed to him because it was outside of his adjusting range. Irrespective of the fact that he was not responsible, according to guideline 408.0591 section 3, agreement with the responsible Dieburg dispatcher and querying of the location of the train journeys would have been mandatory before the deletion. Operational reliability in the event of faults must be improved and awareness must be raised of the need for and the application of rules.

5.1.4 Dieburg dispatcher

As was shown by the train radio conversations, at the time of the "disappearance" of the TN of the DGS 46192 caused by Babenhausen, the Dieburg dispatcher was dealing with operations at another

point in his adjusting area. It is possible that he did not directly observe the prohibited deletion of the blank number by the Babenhausen dispatcher, or the previous overwriting of the TN of the DGS 46192. This was not unlikely due to the size of the workstation and the tasks for a computer-based interlocking dispatcher.

Causal factors

For F5: From the perspective of the Dieburg dispatcher, there was no reason to question the (incomplete) information in the TN system and to look for a missing train. He interpreted the occupied display in block section 34 without a saved TN as an axle counting fault.

For F6: Accordingly, the Dieburg dispatcher handled the supposed fault in block section 34 according to the rules in guideline 408.0248 “most recently moved train undetectable”. However, the dispatcher did not implement the specifications from the guidelines. He failed to have the DGS 42174, which had been given an instruction, stop at entry signal 30F and to determine the location and TN again. Instead, he prematurely set entry signal 30F to travel, as a result of which the protective target of the specifications from the guidelines was significantly undermined. The rule is intended to ensure that only one and the same train can go through this section in full and that there is no confusion with another train that is driving ahead undetected. However, the open position meant that the DGS 46192, which was waiting undetected at the entry signal, entered and travelled through the station instead of the expected DGS 42174, and the Dieburg dispatcher then carried out a clearance check for DGS 42174 with a mistaken assessment of the end of the train of the DGS 46192. According to Regulation (EU) 2018/762 Annex II point 4.3, within an organisation it must be ensured that employees entrusted with tasks that affect safety are aware of the relevance, importance and the consequences of their activities. In accordance with point 6.1.2 of the aforementioned Regulation, the performance of safety-related tasks must be monitored and there must be intervention if these tasks are not being performed properly. The infrastructure manager’s evidence of training and further education/monitoring did not clearly show whether the Dieburg dispatcher was appropriately aware of the protective objectives of the regulation.

For F9: Although the observation of the end of the train by the Dieburg dispatcher was carried out according to the rules, due to the aforementioned error this was for the wrong train. The operation of the axle counting reset based on this resulted in an operating status that was actually safe (occupied display) turning into a potentially unsafe status (block section free), which simultaneously had a very high potential level of damage. The aim must be to reduce the possible level of damage if there is a certain risk of established work procedures being carried out incorrectly.

An appropriate, temporary procedure-based approach to reduce the possible level of damage is to implement the principle, which has been considered increasingly in recent years, that “in the event of a fault the first train drives on sight” even if travel has indeed been approved with the main signal, but auxiliary actions in the signal box would be required in advance for this purpose. This does not reduce the probability of the prohibited situation of two trains being in the same section, but driving on sight would considerably reduce the level of potential damage.

A technical approach would be to use technical further developments already available in the railway sector for the axle counting reset, such as the “preparatory axle counting reset” already used by other infrastructure managers. Further possible technical solutions have already been developed by the industry and are being advanced using studies. For example, a research project by the German Centre

for Rail Traffic Research [Deutsches Zentrum für Schienenverkehrsforschung, DZSF] at the Federal Railway Authority [Eisenbahn-Bundesamt)] entitled “Supporting measures when carrying out auxiliary operating actions[1]” promises interesting approaches.

Contributing factors

For F8: When identifying the end of the train, the Dieburg dispatcher did indeed notice that the travel time and speed of the observed train were not consistent and under no circumstances could they have been the result of driving on sight according to the rules. In order to resolve this discrepancy, he correctly attempted to contact the driver of the DGS 42174. He was repeatedly given correct and clear location details by the driver. Although, according to the valid procedural regulations, these location reports provide a fall-back level for elements that are faulty or not working properly, the Dieburg dispatcher did not give the necessary credence to the location details from driver 42174. He continued to trust the displays of his reporting equipment (TN system), which was not secure in terms of the technical signals. Evidently, the Dieburg dispatcher did not succeed in reflecting the situation and correcting it himself if necessary. He even continuously attempted to persuade driver 42174 of a different location, which according to analysis of the recorded train radio conversations he repeatedly, and towards the end even emphatically, answered with incomprehension.

For F7: A timeout message generated by DGS 46192 at 03:31 am in block section 34 was not processed by the Dieburg dispatcher according to the regulations, possibly out of habit. The timeout message in the section illuminated red at this time (during or after the observation of the end of the train) was a clear indication of actual train travel and not the result of a fault. Even though the operational measures in the event of a timeout message from remotely monitored crossings primarily aim to avoid crossing accidents, as a side effect dealing with the message in accordance with the rules may have resulted in reflection on own actions in the specific situation and may possibly have resulted in the Dieburg dispatcher noticing the DGS 46192. Operational reliability in the event of faults must be improved and awareness must be raised of the need for and the application of rules.

Systemic factors

For F5: Judging from the train radio conversations, the Dieburg dispatcher assumed that there was an axle counting fault left by a train that had previously travelled in block section 34. The regulations in guideline 408.0591 section 3 contain no instructions on what to do if no TN is displayed in a TN field of a section that is displayed as occupied. They do not even refer to the work instructions for an identified occupied display (here guideline 408.0248) for a track section. The regulations in guideline 408.0591 should be supplemented for the scenario “no TN in the TN field” with simultaneous occupied display.

For F6: The operationally important procedure for protecting against confusing an incoming train with a train that is still advancing undetected in the same section depends on the correct actions of a single person. The process should be designed suitably so that the dispatcher is forced to wait for the involvement and result message from another person involved, e.g. the driver, to protect against his own incorrect actions.

For F7: Evidently, the dispatchers in Dieburg generally did not have the necessary awareness of the need to apply the rules in the event of a timeout. The risks of unwanted operating statuses with

[1] DZSF - projects - German title: Unterstützungsmaßnahmen bei der Durchführung von betrieblichen Hilfshandlungen (bund.de) dated 09/08/2023

resulting frequent technical warnings were obviously not highlighted sufficiently during the infrastructure planning, and the consequences of this were not considered. According to Regulation (EU) 2018/762 Annex II point 5.2.1, the organisation must manage safety risks associated with physical assets and fulfil the requirements related to human factors. Where trains may be stopped, the occurrence of timeout messages must already be considered when planning the infrastructure.

For F8: In the event of contradictory location information from the driver on the one hand and technical systems, such as the TN system, on the other hand, there are two equal sources available to the dispatcher. As the decision-maker, he is free to judge and select which information he gives credence to. An additional decision maker using reliable information should therefore be incorporated in order to ensure clarification of the correct information. Until there is a decision from this decision maker, continuing operations does not seem advisable.

5.1.5 Driver 46192

The DGS 46192 was stationary for around 21 minutes at entry signal 30F of Dieburg station and also for around 25 minutes until the incident at Darmstadt-Kranichstein entry signal, without reporting to the dispatcher within five minutes in each case.

Contributing factor

For F10: If driver 46192 had asked the Dieburg dispatcher about the reason for the stoppage during these periods as per the regulation specifications, his TN would have come to the attention of the Dieburg dispatcher again. It must be noted that this regulation is largely optional. During the period in consideration, it was also not fully implemented by other drivers of other trains not involved in the incident because before embarking on the route they had already been informed about expected operational difficulties. It was not possible to determine whether driver 46192 had also been given this information.

5.1.6 Observations about TN systems

The telephonic train messages procedure is used by the dispatcher for safety-related information about train journeys and for the scheduling of these journeys. The technical safety system is largely used to protect the succession of trains. The information about which train journey with which characteristics is coming up to a station or stop and how it must be handled there according to the schedule specifications must be seen as safety-related, even if there is an effective signalling block system. In the event of a fault at the latest, the telephonic train message procedure then also has the sole task of ensuring that the succession of trains move with the right spacing. The transition from normal to malfunction mode is therefore critical in relation to the mandatory correctness and consistency of the data that the people involved continue to use. Technical systems incorporated into a safety-related work system must therefore be created so that, on the transition to malfunction mode, they directly provide reliable information about operations. If necessary, supplementary work processes must be used to compare the correctness and consistency of the data available with the current operating status. In addition, the supporting technical systems should not be a source of error themselves. The awareness of the infrastructure manager is therefore very important for the

relationships between appropriate planning, performance and monitoring of operations and inherent procedures.

TN systems are not secure reporting systems from a technical signalling perspective, but, in the case of computer-based interlocking in particular, they are integrated into secure technical signalling displays and displayed on the operating monitors. The Dieburg dispatcher did not seem to be fully aware of the discrepancy between the two display types. He believed that the incorrect TN display and advancement of TN 42174 was more important than the clear and correct location information from driver 42174. It therefore seems to be necessary to raise awareness among operating personnel of the limited significance of TN systems, and also to critically scrutinise the organisation of the human-machine interface.

In spite of the unresolved contradiction between his technical notification displays and the location information from driver 42174, the Dieburg dispatcher produced a block reset for section 34. The information available from the non-secure display of his TN system was the basis for the dispatcher carrying out the axle counting reset, i.e. for an intervention in the secure signal technology that had serious consequences. Interventions in the secure signal technology must not be made solely on the basis of findings made based on displays on notification equipment that is not secure from a technical signalling perspective.

5.1.7 Conclusion

Operationally implausible functions of the TN reporting system 800 in Babenhausen in conjunction with operating errors by the Babenhausen dispatcher resulted in a train without a TN saved in the TN system travelling on the route between Babenhausen and Dieburg. The data saved in the TN system did not reflect the actual operations and encouraged the Dieburg dispatcher to make incorrect decisions based on this information. In spite of other indications of a train journey, the Dieburg dispatcher incorrectly assessed the technical occupied report for block section 34 as an axle counting fault. Further errors in the application of the rules in conjunction with solely relying on the correctness of the TN system display, which is not secure in terms of signal technology, resulted in a serious misinterpretation of the actual operational situation by the Dieburg dispatcher. As a result of this, he reset block section 34, which ultimately resulted in the trains colliding.

The entire working system for processing and transmitting train messages is directly relevant for safety. It must be ensured that this system always provides sufficient safety, even when switching from normal mode to malfunction mode. This relates, in particular, to the routines for adding or correcting information that was previously processed, transmitted or archived automatically, and which then, in particular when faults occur or are assumed to have occurred, is a new factor to be incorporated into subsequent decisions on further actions by operating personnel.

5.2 Measures taken since the event

Following the event, DB Netz AG issued service order 2022-46 to the Babenhausen and Dieburg signal boxes. This governed the operational procedure for releasing a route in the direction of Dieburg.

DB Netz AG is examining whether there can be further development of the software for the TN reporting system 800 in Babenhausen. Using an earlier software version is not possible.

DB Netz AG has taken measures relating to the increasing occurrence of timeout messages. The dispatcher received training and targeted monitoring relating to this issue. At the same time, DB Netz AG is examining further measures to eliminate the cause of the frequent messages, e.g. altered signal locations for the block signals.

5.3 Additional observations

None

6 Safety recommendations

The following safety recommendations are made in accordance with section 6 of the EUV [German railway accident investigation regulation] and Article 26(2) of Directive (EU) 2016/798:

No.	Addressee and safety recommendation	Relates to company
01/2023	Safety authority: It is recommended that the working system for processing and transmitting train messages is examined and modified so that its information always complies with the requirements as per Reg. (EU) 2018/762, Annex 2, point 4.4.3, in particular when transitioning between automated and manual processes.	IM
02/2023	Safety authority: It is recommended that the processes for planning, running and approving the functions of TN systems should be examined and improved as per Reg. (EU) 2018/762 Annex II point 5.2.1, including the associated change and risk management, in order to ensure that the physical asset is integrated safely into the working systems.	IM
03/2023	Safety authority: It is recommended that, in order to ensure the protective function of the work procedure “the same train has entered a section and left it again” as per Reg. (EU) 2018/762 Annex II point 3.1.1.1, the risks in the event of errors by the people involved must be determined and the work procedure must be improved.	IM

04/2023	Safety authority: It is recommended that, according to Reg. (EU) 2018/762 Annex II point 3.1.1.1, the risks in the event of discrepancies between the location of a train assumed by the dispatcher and the location reported by the train driver must be determined and suitable work procedures must be developed for safe continuation of operation.	IM
05/2023	Safety authority: It is recommended that the technical conditions for the effectiveness of the operator control action of an axle counter reset should be further developed in order to further minimise or exclude the risks of successful, untimely operator control actions. Until these measures are implemented technically, and in order to minimise potential damage, it is recommended that compensatory procedure-based solutions are implemented.	IM