STATE COMMISSION ON RAILWAY ACCIDENT INVESTIGATION
Ministry of the Interior and Administration

REPORT No. PKBWK 02/2024

on the investigation of a railway accident
that occurred on 7 February 2023 at 02:00 hrs
at the Wrocław Brochów station,
km 1.701 of track no. 1N of railway line no. 349 Św. Katarzyna – Wrocław Kuźniki

the area of the rail infrastructure manager PKP PLK S.A. Railway Line Plant in Wrocław

WARSAW, 23 January 2024

https://www.gov.pl/web/mswia/panstwowa-komisja-badania-wypadkow-kolejowych

Pursuant to Article 28f(3) of the Act of 28 March 2003 on rail transport, the Commission's investigation determines neither guilt nor liability.

This Report has been prepared under the provisions of *Commission Implementing Regulation (EU) 2020/572 of 24 April 2020 on the reporting structure to be used for railway accidents and incidents investigation reports*
(OJ L 132 of 27 April 2020)

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I. SUMMARY

Type of occurrence:	Accident.
A description of the occurrence:	During entry of freight train no 654027 operated by rail carrier T&C Sp. z o.o. on the Kłodzko Główne – Olsztyn Główny route onto track no. 1N at the Wrocław Brochów WBA station, railway line no. 349, the last freight wagon (the 45th wagon in the train set), type Eamnos no. 33 51 5839 055-9, derailed at turnout no. 501.
Date of the occurrence:	7 February 2023, 02:00 hrs.
Place of the occurrence:	Railway line no. 349 Św. Katarzyna – Wrocław Kuźniki, turnout no. 501, track no. 1N, km 1.701, geographical location: 51°04'34N, 17°10'71E.
Consequences of the occurrence:	The occurrence resulted in the following damage: a derailed wagon, damaged turnouts no. 501, 502, 503 and 506 of tracks no. 1N and 3N, damaged turnout segments. Furthermore, the train was broken apart between the 34th and 35th wagons, and the 42nd and 43rd wagons in the train set.
Causal factor: *(means any action, omission, event or condition, or a combination thereof that if corrected, eliminated, or avoided would have prevented the occurrence, in all likelihood)*	Breakage of the first axle of the first bogie of Eamnos wagon no. 33 51 5839 055-9.
Contributing factors: *(means any action, omission, event or condition that affects an occurrence by increasing its likelihood, accelerating the effect in time or increasing the severity of the consequences, but the elimination of which would not have prevented the occurrence)*	1) Inappropriate machining of the radius of transition of the wheel seat into the centre section of the axle, leading to the occurrence of a large gradient of tensional and compressive stress. 2) Formation of microcracks in the place subjected to machining. 3) Decreased strength along the axle cross section up to the critical moment at the place of the fatigue crack. 4) Introduction to service of a wheelset as a reusable set from the second-hand market without documented history of prior use.
Systemic factors *means any causal or contributing factor of an organisational, managerial, societal or regulatory nature that is likely to affect similar and related occurrences in the future, including, in particular the regulatory framework conditions, the design and application of the safety management system, skills of the staff, procedures and maintenance*	No obligation regarding traceability of wheelsets for freight wagon axles.

Recommendations and	1. Entities in charge of maintenance (ECMs) of freight wagons shall

their addressees:	strengthen supervision of the process of repairs of wheelsets during replacement of wheels and P4 and P5 maintenance. 2. Entities in charge of maintenance (ECMs) of freight wagons shall check their Maintenance Management Systems (MMSs) for factors contributing to the occurrence, and shall consider inclusion of the following elements in those systems: a) detailed requirements regarding contractors that perform P4 and P5 maintenance activities, b) inclusion in the freight wagon Maintenance Management System (MMS) of competence requirements and detailed tasks for workers authorised to perform commissioning, in particular as regards in-process commissioning. 3. As part of its Maintenance Management System, TORPOL S.A. shall take actions relating to: a) increasing the supervision of compliance with the Maintenance Management System procedures, b) ensuring detailed supervision of rail vehicle maintenance service providers, in particular as regards tests of running gear. 4. MEGA–MET Sp. z o.o. Sp.k. in Łazy shall take actions to strengthen the supervision of its P4 and P5 maintenance activities, including enhanced quality control of repair activities provided, in particular ones that are outsourced. 5. The President of the Rail Transport Office shall finalise the actions commenced in 2020 to introduce **the *obligation regarding traceability of wheelsets for freight wagon axles*** in accordance with the ***Implementation guide for the European Wheelset Traceability (EWT) for freight wagon axles*** made in Brussels on 26 July 2010 by the *Joint Sector Group for ERA Task Force on wagon/axle maintenance* and agreed with the National Safety Authority. 6. Entities in charge of maintenance (ECMs) of freight wagons shall immediately implement the obligation to carry out detailed documented[1)] non-destructive tests of wheelset axles prior to their re-introduction to service. 7. The President of the Rail Transport Office shall consider appointing a team of experts to obtain opinions and knowledge to define the scope of additional tests of wheelset axles in service in freight wagons for longer than 40 years.

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1) *The scope of a detailed non-destructive test of freight wagon wheelset axles, as used in the Report, includes inter alia disassembly of wheelsets from under a freight wagon, disassembly of bearings and exposure of the centre section of the axle, external examination. The test must be carried out with the ultrasonic testing (UT) and magnetic particle testing (MT) methods following removal of the protection coating from the side surface of axle journals and from the centre section of the axles.*

Photograph 1 - A view of the derailed wagon (source: materials provided by the railway commission)

Photograph 2 - A view of one part of the broken axle (source: materials provided by the railway commission)

Photograph 3 - A view of the other part of the broken axle (source: materials provided by the railway commission)

Photograph 4 **- A general view of the occurrence site (source: materials provided by the railway commission)**

Photograph 5 - A view of the broken axle (material provided by the railway commission)

Photograph 6 - A view of the broken axle (material provided by the railway commission)

II. THE INVESTIGATION AND ITS CONTEXT

1. The decision to establish an investigation

The Chairman of the State Commission on Rail Accident Investigation (hereinafter referred to as "PKBWK" or "the Commission") Tadeusz Ryś issued decision no. PKBWK.590.4.2023 on 22 February 2023 to establish an investigation to clarify the causes and circumstances of a railway accident that occurred on 7 February 2023 at 02:00 hrs at the Wrocław Brochów station, track no. 1N, km 1.701 of railway line no. 349 Św. Katarzyna – Wrocław-Kuźniki. Taking into consideration the provisions of Article 28e(4) of the Act on rail transport (Journal of Laws of 2021, item 1984, as amended), hereinafter referred to as "the Rail Transport Act", the occurrence was reported on 27 February 2023 to the European Union Railway Agency and was registered in the EURA's database under number PL-10379.

2. The motivation to the decision to establish an investigation

Based on an analysis of the circumstances of the occurrence, considering that it was an accident which forms a series of accidents concerning the system as a whole, in accordance with Article 28e(3)(2) of the Rail Transport Act, the Chairman of PKBWK decided to establish an investigation to be conducted by the Commission's Investigation Team.

3. The scope and limits of the investigation including a justification thereof, as well as an explanation of any delay that are considered a risk or other impact to the conduct of the investigation or its conclusions

There were no limits during the investigation that would have a negative impact on its course.
The investigation into the causes of the occurrence was conducted under Article 28h(1) of the Rail Transport Act and, in accordance with the provisions of Article 28f(3) does not determine guilt or liability.

4. An aggregated description of the technical capabilities and the functions in the team of investigators.

The Chairman of the Commission appointed a team from among the standing members of the Commissionto carry out the investigation.

5. A description of the communication and consultation process established with persons or entities involved in the occurrence during the investigation and in relation to the information provided

In accordance with Article 28h(2)(5) of the Rail Transport Act, the Chairman of PKBWK obliged the designated members of the railway commission to cooperate with the Investigation Team on a permanent basis under a written request no. PKBWK.590.4.1.2023 of 22 February 2023 addressed to their employers. Furthermore, in letter no. PKBWK.590.4.2.2023 on 2 March 2023, he obliged the chairman of the railway commission to hand over the accumulated documentation to the Investigation Team.
On 9 March 2023 2023, the documentation accumulated by the railway commission was officially handed over in the registered office of the Railway Line Plant of PKP Polskie Linie Kolejowe S.A. in Wrocław.

As part of the investigation, in accordance with Article 28H(2)(5) of the Rail Transport Act, under letter no. PKBWK.590.4.4.2023 of 14 March 2023, the Chairman of the Commission obliged the rail carrier T&C Sp. z o.o. to commission a notified body to carry out an expert examination of the broken axle.

6. A description of the level of cooperation offered by the entities involved

During the investigation, the level of cooperation with the representatives of the entities involved in the circumstances of the occurrence was standard and did not raise any reservations of the Investigation Team.

7. A description of the investigation methods and techniques as well as analysis methods applied to establish the facts and findings referred to in the report

Throughout the process aimed at clarifying the causes and circumstances of the occurrence, the Investigation Team relied on their own knowledge, experience and established findings.
The team used their own documentation as well as documentation gathered by the railway commission.
Within the framework of the investigation, the Investigation Team applied *inter alia* the following methods:

- an inspection of the occurrence site after the accident,
- on-site verifications at the occurrence site,
- an interview with the train driver,
- an analysis of the findings of the expert examination carried out by the Railway Research Institute,
- an analysis of the contents of the train event data recorder,
- analyses of the Safety Management System (SMS) operated by the infrastructure manager and the carrier,
- analyses of the rail vehicle's maintenance system documentation (MSD),
- analyses of the Safety/Maintenance Management System (SMS/MMS) in place at the entity in charge of maintenance,
- inspections at the registered offices of the entity in charge of maintenance of wagons, the supplier of the wheelset, and the entity that carried out P4 maintenance of the coal wagons.

Below is a list of selected legal acts, rules and internal instructions used during the investigation:

European Union rules:

1) Regulation (EU) No. 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (OJ L 119, 04.05.2016, p. 1, as amended), and the related Act of 10 May 2018 on the protection of personal data (Journal of Laws, item 1000).
2) Commission Implementing Regulation (EU) 2020/572 of 24 April 2020 on the reporting structure to be followed for railway accident and incident investigation reports (OJ L 132, 27.04.2020).
3) Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety (OJ L 138, 26.05.2016, p. 102, as amended).

National rules:

1) Act of 28 March 2003 on rail transport (consolidated text: Journal of Laws of 2023, item 602, as amended.),
2) Regulation of the Minister of Infrastructure of 11 January 2021 on personnel employed on positions related directly to the conduct and safety of rail traffic and to driving of specific types of rail vehicles (Journal of Laws of 2021, item 101, as amended),
3) Regulation of the Minister of Infrastructure of 18 July 2005 on general conditions for rail traffic operation and signalling (consolidated text: Journal of Laws of 2015, item 360, as amended).

Internal instructions of infrastructure manager PKP PLK S.A.

1) Ie-1 (E-1) Instruction on signalling operations,
2) Ir-1 Instruction on operating rail traffic,
3) Ir-8 Instruction on the handling of serious accidents, accidents and incidents in rail transport.

Internal instructions of rail carrier T&C Sp. z o.o.

1) 11 - Instruction for a traction vehicle driver,
2) 2 - Instruction on the rules of technical maintenance of freight wagons.

Internal rules of the entity in charge of maintenance (ECM) of freight vehicles – TORPOL S.A.

TORPOL S.A. is the owner and at the same time an entity in charge of maintenance (ECM) of freight wagons that carries out P1, P2 and P3 maintenance activities by own means in accordance with procedure P-09 Maintenance of Rail Vehicles, Integrated Safety/Maintenance Management System.

P-4 and P-5 maintenance is outsourced by the company.

8. A description of the difficulties and specific challenges encountered during the investigation

Members of the Investigation Team did not encounter any difficulties or problems that could have impact on the course, timeliness or conclusions of the investigation.

9. Any interaction with the judicial authorities.

The case under investigation did not require any interaction with the judicial authorities.

10. Other information relevant in the context of the investigation

Not applicable.

III. A DESCRIPTION OF THE OCCURRENCE

1. The occurrence and background information

1.1. The description of the occurrence type

The occurrence in question involved derailing of the last loaded wagon Eamnos no. 33 51 5839 055-9 in the train set of freight train no. 654027 operated by carrier T&C Sp. z o.o. due to the breaking of the first axle of the first bogie of the said wagon.

1.2. The date, exact time and location of the occurrence

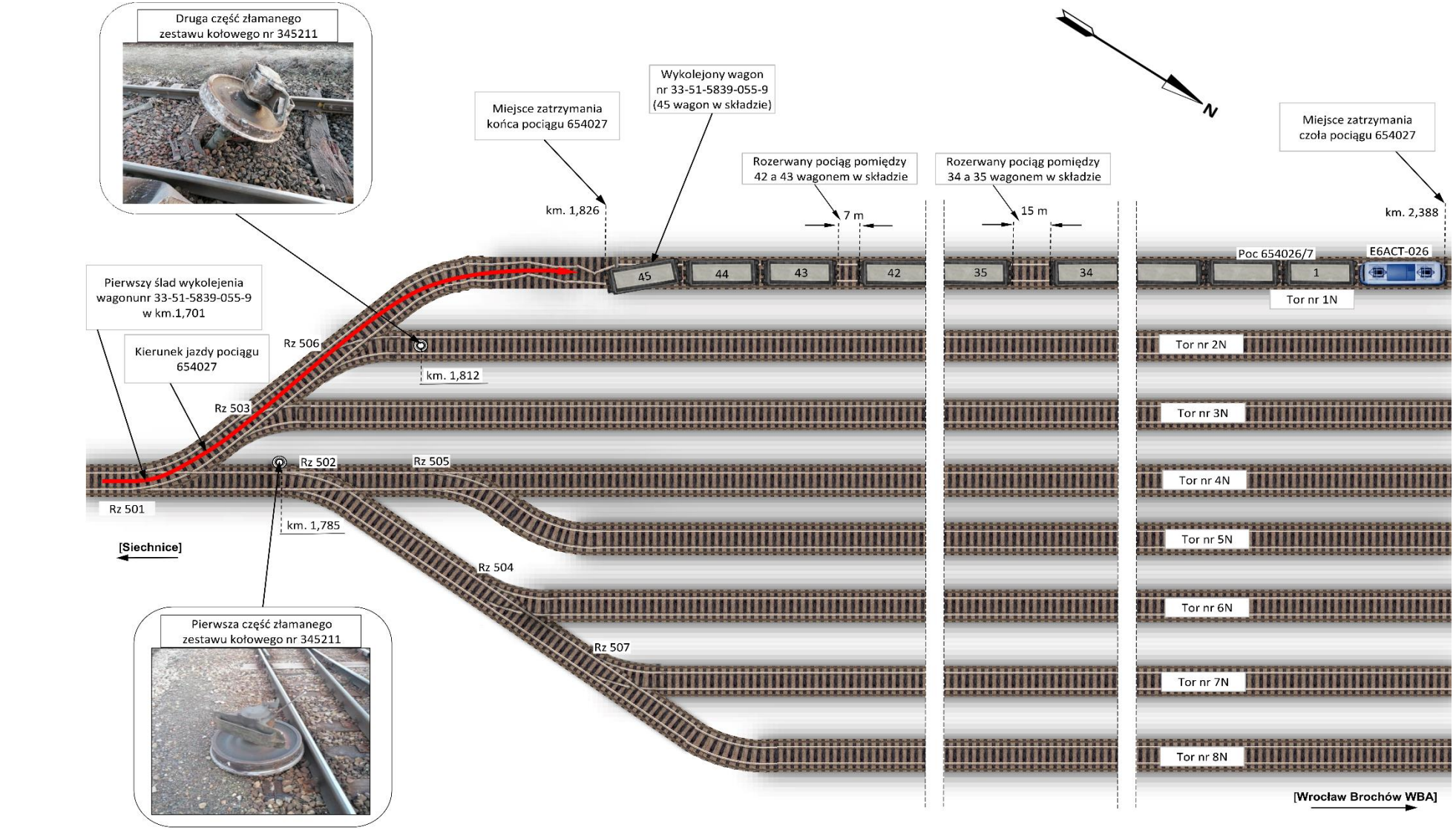
The occurrence took place on 7 February 2023 at 02:00 hrs at the Wrocław Brochów station, turnout no. 501 of railway line no. 349 Św. Katarzyna – Wrocław Kuźniki, track no. 1N, km 1.701, geographical location: 51°04’34.8”N, 17°10’71.0”E.

1.3. The description of the occurrence site, including weather and geographical conditions at the moment of the occurrence and if any works were carried out at or in the vicinity of the site.

Railway line no. 349 Św. Katarzyna – Wrocław Kuźniki, turnout no. 501, track no. 1N, laid in a curve.
Good weather conditions, no precipitations, temperature -9ºC, good visibility.
At the time of the occurrence in question there were no works on rail infrastructure in progress near or at the place of the occurrence.

STATE COMMISSION ON RAILWAY ACCIDENT INVESTIGATION
al. Jana Chrystiana Szucha 2/4, 00-582 Warszawa, e-mail: pkbwk@mswia.gov.pl

Figure 1 - A drawing of the accident (author: PKBWK)



1.4. Deaths, injuries and material damage

a) passengers, employees or contractors, level crossing users, trespassers, other persons at a platform, other persons not at a platform

No person was injured in the occurrence.

b) cargo, luggage and other property

The cargo carried in the train was not damaged.

c) rolling stock, infrastructure and the environment

Damage to wagon no. 33 51 5839 055-9

bogie no. 42-8897 – deformed bogie frame

– first wheelset no. 345211 – broken axle

– the second wheelset – damaged due to the derailing

bogie no. 42-8896 – deformed bogie frame

– the third and fourth wheelsets - damaged due to the derailing.

Visual examination of the damaged wheelsets of wagon no. 33 51 5839 055-9 confirmed damage to the wheels and axle boxes qualifying them for scrapping.

There was also damage to elements of the brake system, draw devices and wagon body.

As a result of the derailing, the train set was broken apart between the 34th and 35th wagon, and between the 42nd and 43rd wagon, counting from the train head.

Damage to the rail infrastructure included damage to turnouts no. 501, 502, 503 and 506 on tracks no. 1N and 3N, and turnout segments with turnout bearers, sleepers and other elements of track infrastructure such as elements of turnout heating.

1.5. The description of other consequences, including the impact of the occurrence in the regular operations of the actors involved

The occurrence resulted in disruption of freight train traffic on tracks no. 1N and 3N at the Wrocław Brochów station from 02:00 hrs on 7 February 2023 to 21 February 2023.

Furthermore, there were freight trains were delayed by a total of 631 minutes.

1.6. The identification of the persons, their functions, and entities involved, including possible interfaces to contractors and/or other relevant parties

The Investigation Team identified the following persons involved in the occurrence:

– the driver of train no. 654027.

1.7. The description and identifiers of train(s) and their composition including the rolling stock involved and their registration numbers

Rail carrier T&C Sp. z o.o.

Freight train no. 654027 was formed of E6ACTad-026 locomotive no. EVN PL 91 51 3160 452-1 operated by rail carrier T&C Sp. z o.o. and 45 loaded coal wagons of the Eamnos type.

The locomotive has release to service and notice of return to operation no. 6/DL/KR/01/2023/ issued on 13 January 2023 in Gliwice – the vehicle's mileage 297,750 km. The year of manufacture 2019, serial number 026, manufactured by NEWAG S.A. Nowy Sącz.

Eamnos freight wagon, EVN 33 51 5839 055-9, had "Notice of return of a freight wagon to operation no. 25/E/2020" of 19 November 2020, valid until 19 November 2024 or for the mileage of 300,000 km. The wagon's mileage, as recorded by the owner as of the end of January 2023, was 142,296 km.

Train no. 654027 was released to service following the required detailed brake test on 6 February 2023.

Train no. 654027 data:

– length	– 540.00 m
– total mass	– 3,490 tonnes
– required braked mass percentage	– 57 %
– required braked mass	– 1,989 tonnes
– actual braked mass	– 2,102 tonnes
– actual braked mass percentage	– 60%

1.8. A description of the relevant parts of the infrastructure and signalling system – track type, switch, interlocking, signal, train protection systems

Track superstructure:

– rail type	– 60E1
– sleepers	– hard wood
– turnout bearers	– hard wood
– attachment type	– alloy bolts
– ballast type	– gravel
– turnout no. 501	– regular right, R300, 1:9, 60E1, year of installation 1991
– turnouts no. 501,502,503 and 506	– on hard wooden bearers, gravel ballast

1.9. Other information relevant for the purpose of the description of the occurrence and background information

Carrier T&C Sp. z o.o. performed carriage at the order of the owner of the wagons and was not responsible for their maintenance. The technical condition of the wagons assigned to carry out carriage did not raise any reservations.

2. The factual description of the events

2.1. The proximate chain of events leading up to the occurrence, including actions taken by persons involved, the functioning of rolling stock and technical installations, the functioning of the operating system

On 7 February 2023 at 01:57 hrs, freight train no. 654027 operated by carrier T&C Sp. z o.o. on the Kłodzko Główne - Olsztyn Główny route, consisting of an E6ACTad locomotive (serial number 026) and 45 standard-gauge coal wagons , was received from track no. 1 of the Siechnice - Wrocław Brochów WBA route. Train no. 654027 was received in the Wrocław Brochów station from the Siechnice station in the WBA post area. Once the route for track 1N of the Wrocław Brochów station (WBA control area) was prepared, a signal was given clearing the train to enter. During the entry of the train, at the speed of 26.5 km/h, 9 metres past the start of turnout no. 501 at km 1.701, the first axle no. 345211 in the first bogie of the last wagon no. 33 51 5839 055-9 broke, as a result of which the last wagon was derailed to the left side in the driving direction of the train. The wagon travelled 124.8 m in the derailed condition passing through turnouts no. 501, 503 and 506, and stopped on track no. 1N at km 1.826 of line no. 349. All wheelsets of the wagon were derailed. A broken part of the wheelset, moving in the driving direction of the train, additionally damaged turnout no. 502 and track no. 3N. One part of the broken wheelset stopped to the left of turnout no. 502, before the interface between the frog and connecting rails, on the right side looking in the driving direction of the train at km 1.785. The other part of the broken wheelset stopped (embedded in the ballast) on track no. 2N at km 1.812 to the right of the train set looking in the driving direction of the train. The head of the the locomotive stopped 562 metres from the end of the train at km 2.388 of track no. 1N. The train set was broken apart in two places, between wagons 42 and 43, and between wagons 34 and 35, counting from the head of the train.

2.2. The chain of events from the occurrence until the end of the actions of the rescue services, including measures taken to protect and safeguard the site of the occurrence, the efforts of the rescue and emergency services

The occurrence was reported by the driver of train no. 654027 by radio to the signaller at the Wrocław Brochów station. At 02:05 hrs, the signaller notified the line and plant dispatchers as well as immediate superiors. Plain tracks no. 1N and 2N had to be closed due to the derailment. Outcomes of the occurrence required conducting an operation involving railway emergency services. The emergency operation commenced at 04:25 hrs on 7 February 2023.

A Special Technical Rescue Train UNIROLLER from Wrocław Nadodrze, requested at 02:40 hrs, on site at 04:25 hrs. A rescue train from Wrocław Nadodrze departed at 09:58 hrs and arrived on site at 12:27.

A maintenance train requested at 04:50 hrs, on site at 05:40 hrs. At 09:45 hrs, power was turned off in the overhead contact line at the Wrocław Brochów station for the "N" – WBAN track group for the purpose of the recovery operation.

The rescue operation and repair of the track infrastructure ended on 10 February 2023.

By instruction of a member of PKBWK, the damaged wheelsets of the first bogie of wagon no. 33 51 5839 055-9 were secured by the railway commission until handover to a notified body for tests.

IV. ANALYSIS OF THE OCCURRENCE

1. Roles and responsibilities

1.1. Railway undertaking(s) or infrastructure manager(s)

Infrastructure Manager – PKP PLK S.A. Railway Line Plant in Wrocław

The primary task of the rail infrastructure manager is maintenance and operation of rail infrastructure as regards:
a) provision of rail infrastructure and related services, and collection of charges thereon,
b) safe operation of railway traffic.

Rail carrier T&C Sp. z o.o.

The rail vehicle designated to carry out a transport task by the rail carrier had a rail vehicle type operation approval certificate and a valid technical railworthiness certificate. The designated train crew that operated the train held all ratings and qualifications requirement by law. The train was driven on the basis of a timetable.
The responsibilities of rail carriers concerning safe operation of rail vehicles are laid down in the infrastructure manager's instructions *Ir-1 – Instruction on operating rail traffic*, *Instruction Ie-1(E-1) – Instruction on signalling operations*, and the internal instruction of the rail carrier *11 – Instruction for a traction vehicle driver*. Based on an analysis of the material gathered in the case, the Investigation Team did not find any irregularities in the conduct of the train crew during operation of the train or after the occurrence.

1.2. The entities in charge of maintenance, the maintenance workshops, or any other maintenance suppliers

Based on the documentation gathered, The Investigation Team identified the following entities connected with the occurrence:
- TORPOL S.A.,
- P.W. "Inter-KomTrans" Sylwester Komisarek,
- RAIL-CARS Sp. z o.o.,
- Przedsiębiorstwo Wielobranżowe EL-TOR2 Antoni Perkowski and Przedsiębiorstwo Usługowo-Handlowe EL-TOR Elżbieta Perkowska,
- MEGA-MET POLAND Sp. z o.o. Sp.k. in Łazy,
- "Tabor" Dębica Sp. z o.o.

TORPOL S.A. is the owner of the freight wagons included in the set of train no. 654027, and the entity in charge of their maintenance (ECM). As regards P1, P2 and P3 maintenance (in accordance with the Maintenance System Documentation, MSD), the company carries out its tasks by own means, while other maintenance levels (P4, P5) included in the MSD are outsourced to external entities. The maintenance levels indicated in the DSU were carried out in accordance with the cycles defined in the documentation. Maintenance of freight wagons carried out by TORPOL S.A. did not have any impact on the occurrence concerned.

The Investigation Team analysed the acquisition and operation of the wheelset in question.

On 6 December 2017, TORPOL S.A. signed agreement no. TP5b/1002/2017 with P.W. "Inter-KomTrans" Sylwester Komisarek for the purchase of 35 Eamnos series freight wagons. The wagons were delivered to TORPOL S.A. against a delivery-acceptance report on 1 February 2018. The group of wagons purchased

by TORPOL S.A. included wagon no. 33 51 5839 055-9. After 18 months of operation of the purchased wagons, due to wear involving nearing the limit dimensions of the wheelset tread, TORPOL signalled the need to purchase 16 wheelsets from RAIL-CARS Sp. z o.o. The purchase took place on 18 October 2019. In September 2019, RAIL-CARS Sp. z o.o. purchased the wheelsets, as reusable ones, from Przedsiębiorstwo Wielobranżowe EL-TOR2 Antoni Perkowski and from Przesiębiorstwo Usługowo-Handlowe EL-TOR Elżbieta Perkowska.

Prior to the sale of the 16 wheelsets by RAIL-CARS Sp. z o.o., in accordance with contract requirements, the complete wheelsets, including the wheelset with axle no. 345211 , were inspected by P.W. "Inter-KomTrans" Sylwester Komisarek, which issued acceptance certificate 3.1 No. 30/10/2019 as per PN-EN 10204:2006 of 18 October 2019.
The wheelset in question was installed in wagon no. 33 51 5839055-9 on 12 November 2019. With its P4 maintenance date reached, wagon no. 33 51 5839 055-9 was sent to MEGA-MET POLAND Sp. z o.o. Sp.k. in Łazy. Six wagons were sent for P4 maintenance. During P4 maintenance of wagon no. 33 51 5839055-9 in November 2020, the wheelsets were swapped and set no. 345211 was installed in wagon no. 33 51 5839 073-2. After completion of the works related to P4 maintenance, the wagons returned to service. After less than a year of service, on 29 September 2021, the wheelsets were reprofiled at "Tabor" Dębica Sp z o.o., and swapped again, with set no. 345211 being installed in wagon no. 33 51 5839 055-9 (the derailed wagon). From 29 September 2021 up until the accident, the set was in service in the said wagon.

As established by the Investigation Team, EL-TOR and EL-TOR2 had purchased the wheelsets as reusable sets without recording their serial numbers. The wheelsets did not have any operating documentation. According to information provided by the owner of EL-TOR2, the wheelsets were bought as reusable sets from the second-hand market in European Union Member States, including France, Belgium, Netherlands, Bulgaria and Romania. The Investigation Team was unable to established which company, EL-TOR or EL-TOR2, imported specific wheelsets and from what country, because the trade (sales and purchases) had been conducted without specifying wheelset numbers. The related invoices show only quantities of wheelsets.
Due to the absence of documents relating to the production, operation and maintenance of reusable wheelsets imported to Poland, the Investigation Team was unable to establish the course of their maintenance and operation before they were imported to the Polish market. The absence of the obligation to hold and submit such documentation on the occasion of sales provides for putting wheelsets of unknown origin (e.g. involved in railway occurrences) on the market. The Investigation Team recommends completing the work related to the implementation of the European Wheelset Traceability (EWT) for freight wagon axles to prvide for identifying the course of maintenance and operation of wheelsets.

By instruction of the Commission, the carrier commissioned a notified body to conduct an expert examination of the broken axle. The carrier commissioned the examination to the Railway Research Institute in Warsaw.
The Railway Research Institute examined the broken axle to determine the cause of the breaking - job as part of the project titled *"Determination of the cause of breaking of a wheelset axle in a freight wagon at the Wrocław Brochów station" Project no. 003305/22 of 29 September 2023.*
The following transpires from the examination:

1. *The chemical composition of the axle, sample no. B41/23, corresponds to the A3 (P45) grade and falls within the scope of the requirements concerning the content of elements laid down in the standards UIC 811-1 OR and PN-87/H-84027/02.*
2. *Ultrasonic testing of the axle, carried out from the head surfaces of the axle journals confirmed good ultrasound penetrability above 0.9H and did not reveal any internal discontinuities of the material.*
3. *Testing of strength properties of samples taken from the wheel seat showed conformity of the strength parameters with the requirements of UIC 811-1 OR and PN-87/H-84027/02; furthermore, the shock resistance of the axle also meets the requirements of the aforementioned standards.*
4. *Calculations of tensions in the axle under load, carried out with MES computer simulation of the axle, showed that the sum of tensions oscillates within the elastic range and does not exceed the yield*

strength of the axle material. At the same time, the calculations showed a high gradient of tensile and compressive tensions within the radius between the wheel seat and the centre section of the axle ranging from (-118.5 MPa) to (+ 152.1 MPa). The said tensions contributed to the formation of microcracks on the wheel seat - axle centre section surface.

5. *Metallographic tests of the surface of axle breakage in the area of the crack revealed existence of corrosion; furthermore, the tests revealed clear traces of a tool bit after rough machining of the radius of transition of the wheel seat to the axle centre section. The wagon driving dynamics coupled with the existing tensions became the source of a fatigue crack in the axle. The direction of propagation of fatigue lines visible on the axle breakage also confirms the starting point of the axle crack.*
6. *Based on the ultrasonic testing carried out during P4 repair in 2020, which did not show any surface defects of the tested axle of wheelset no. 345211, it was determined that the crack in the axle had been developing until the moment of derailment, i.e. for a period of around 2 years. Over that period, the wheel rim had been significantly worn from the thickness of 60.0 mm to 42.2 mm, which indicates that the wagon had been operated with high intensity. Based on information obtained from TORPOL S.A., during the 23 months of operation, the wheelset no. 345211 of the wagon with EVN 33 515839 055-9 travelled 128,476 km.*

In summary, it was established that the crack in the axle started probably during the period of intensive operation after the repair carried in 2020, with the roughly machined and corroded surface of the transition of the wheel seat to the axle centre section becoming the place of the crack that propagated during subsequent operation of the wagon. The propagation of the fatigue crack caused the strength of the axle cross-section to deteriorate up to the critical moment where the sudden crack visible in the axle breakage occurred.

The Investigation Team established that following P4 maintenance activities the wheelset in question was subjected to two reprofile machinings of the wheel treads. Furthermore, it was established on the basis of the evidence material gathered that the wheelset axle crack formed between the maintenance level prescribed in the MSD. It has been the third case of a wheelset braking in a freight wagon in four years. Two of the broken axles were older than 40 years, while the year of manufacture of the third axle could not be identified (the occurrence described in Point 5).
It is therefore advisable in the opinion of the Investigation Team to introduce obligatory annual flaw detection testing for freight wagon wheelset axles older than 40 years.

1.3. Manufacturers of rolling stock or other suppliers of rail products

Based on the investigation material gathered, the Investigation Team established that wheelset no. 345211 had been delivered to TORPOL S.A. by RAIL-CARS Sp. z o.o., and that the inspection was carried out and the 3.1 acceptance certificate was issued by P.W. "Inter-KomTrans" Sylwester Komisarek. P4 maintenance was carried out by MEGA-MET POLAND Sp. z o.o. Sp.k. in Łazy. The aforementioned entities were inspected by the Investigation Team.

1.4. National safety authorities or the European Union Agency for Railways

The President of the Rail Transport Office (Polish: *Urząd Transportu Kolejowego*, UTK) supervises the safety of rail traffic. Based on the evidence gathered, the Investigation Team did not establish any relation between the national safety authority and the occurrence under investigation.

1.5. Notified bodies, designated bodies or risk assessment bodies

Based on the evidence gathered, the Investigation Team did not identify any relation between the accident and notified bodies or risk assessment bodies.

1.6. Certification bodies of entities in charge of maintenance mentioned under Point 1.2.

Based on the investigation material gathered, the Investigation Team did not establish any relation between the certification body of the rail carrier or entity in charge of maintenance and the occurrence under investigation.

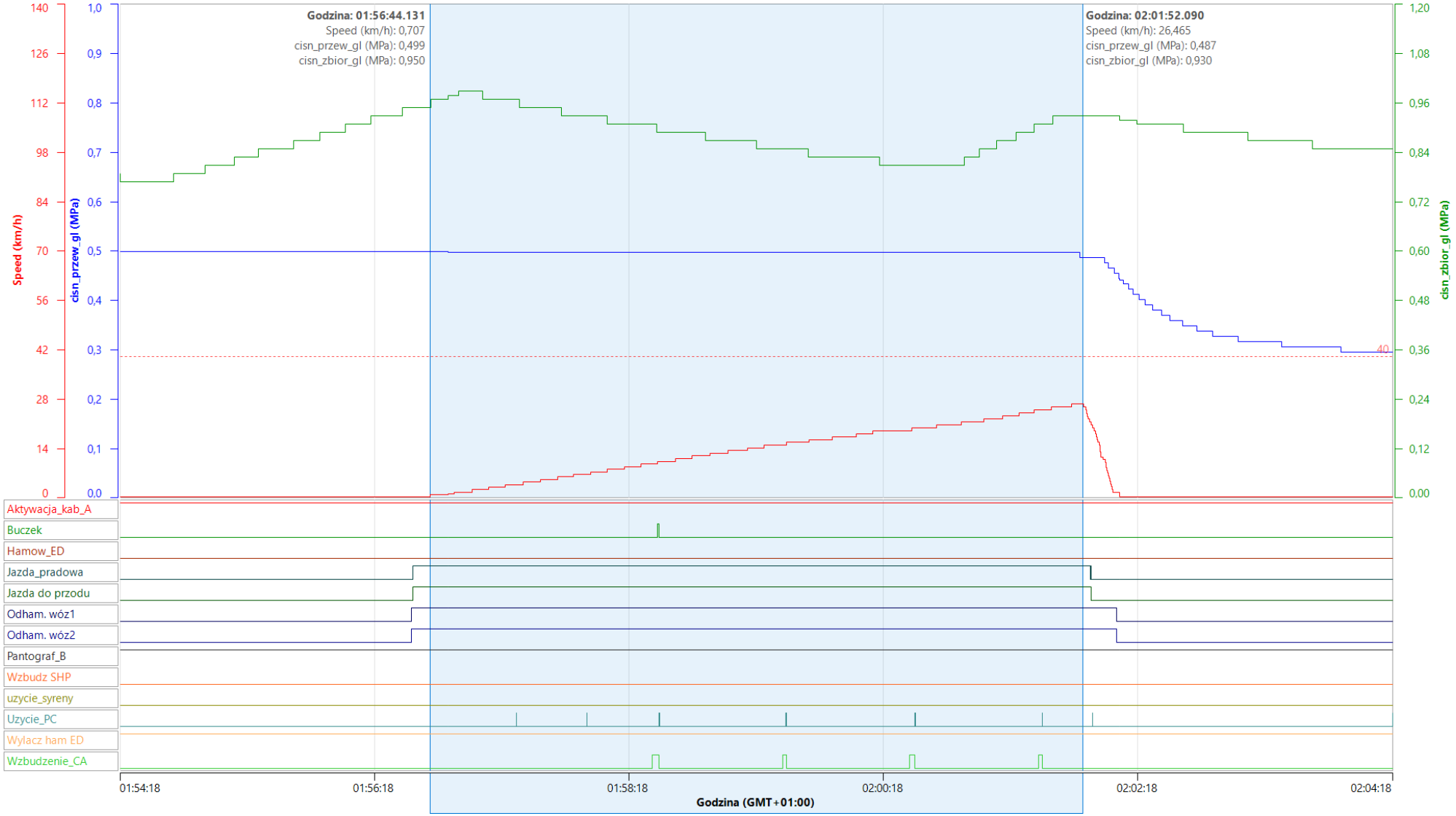
1.7. Any other person or entity relevant to the occurrence, documented or not in one of the relevant safety management systems or referred to in a register or relevant legal framework

Not applicable.

2. Rolling stock and technical installations

Rail vehicles:
Powered rail vehicle of the E6ACTad-026 series is equipped by the manufacturer with the electronic event data recording system TELOC 1500 as well as systems for recording video images of the foreground of the vehicle and voices in the cabin.
The Investigation Team analysed selected event data parameters of train no. 654027 recorded by the electronic data recorded to examine the train's driving characteristics until the moment of the occurrence. The driving parameters of the rail vehicle on the railway line section from the entrance semaphore to the Wrocław Brochów station (until the moment it stopped) are shown in the chart below.

Figure 2 - A chart showing the driving parameters of the E6ACTad-026 locomotive in the function of time (developed by PKBWK)



Analysed were the driving parameters of train no. 654027 recorded on 7 February 2023 between 01:56:44 hrs and 02:02:09 hrs;

- 01:56:44 hrs - start of the train from the entrance semaphore to the Wrocław Brochów station; an increase in the speed to 26.46 km/h and a sudden decrease in the speed accompanied by activation of emergency braking
- 02:02:09 hrs - the train stops after covering 1,241 metres from the start time.

The footage from the foreground recording system installed in the vehicle in question confirmed the above findings from the event data recorder.

3. Human factors

Not applicable.

4. Feedback and control mechanisms, including risk and safety management as well as monitoring processes

The relevant regulatory framework conditions:

4.1. The processes, the methods, the content and the results of risk assessment and monitoring activities, performed by any of the involved actors: railway undertakings, infrastructure managers, entities in charge of maintenance, maintenance workshops, other maintenance providers, manufacturers and any other actors, and the independent assessment reports referred in Article 6 of Implementing Regulation (EU) No 402/2013

TORPOL S.A., the entity in charge of maintenance of the wagons, carried out a detailed analysis of the risk related to breaking of a freight wagon wheelset axle.
The company took actions which were implemented in response to the hazard identified. The requirements concerning wheelset revision laid down in the Maintenance System Documentation for freight wagons were expanded; inspections were carried out at wheelset revision service providers; and, most importantly, wheelsets operated in other freight wagons owned by the Company were subjected to detailed checks.

4.2. The safety management system of the involved railway undertaking(s) and infrastructure manager(s) including the basic elements stated in Article 9(3) of Directive (EU) 2016/798 and any EU legal implementing acts

Railway infrastructure manager infrastructure PKP Polskie Linie Kolejowe S.A.

The Safety Management System (SMS) at PKP Polskie Linie Kolejowe S.A. was put in place under Resolution no. 30/2011 of 24 January 2011 regarding the adoption of the order introducing the Safety Management System at PKP Polskie Linie Kolejowe S.A. A summary of selected SMS elements in place at PKP PLK S.A. is shown in the table below.

Table 1 - A summary of selected SMS elements in place at PKP PLK S.A. related to the occurrence

Item	Symbol/ Procedure no.	Document / procedure name
Main process		
1.	SMS-PG-01	Provision of rail infrastructure and operation of rail traffic
Procedures for supporting processes		

2.	SMS-PW-01	Maintenance of a railway line in technical and organisational serviceability
	SMS/MMS-PR-02	Technical and operational risk assessment
3.	SMS/MMS-PW-03	Procedure for railway occurrences
4.	SMS-PW-04	Conduct of railway accident recovery operations
5.		Hazard record

Rail carrier T&C Sp. z o.o.

Safety Management System (SMS) in pace at T&C Sp. z o.o.. was implemented on 28 May 2021. A summary of selected SMS elements in place at T&C Sp. z o.o.

Table 2 - A summary of selected SMS elements in place at T&C Sp. z o.o. related to the occurrence

Item	Document no.	Document / procedure name
1.	P/04	Performance of the carriage process
SUBSYSTEMS OF T HE SAFETY MANAGEMENT SYSTEM		
2.	P/06 P/10 P/12	Identification and assessment of occupational hazard Preparation for and response to failures, accidents and other hazards Management of personnel competences: 1. linked directly to the operation and safety of rail traffic and the driver of rail vehicles
3.		Risk and hazard record
4.		Safety improvement programme for the year 2023

Based on an analysis of the SMS documentation of the railway carrier T&C Sp. z o. o., having considered the circumstances, course and effects of the occurrence, the Investigation Team does not raise any reservations concerning the functioning of the SMS as regards the conduct of the process of carriage, management of worker competences, knowledge of the SMS by the workers, procedures in case of a railway traffic hazard, availability of up-to-date versions of respective procedures. The company keeps a record of risks and identified hazards.

4.3. The management system of the entity/entities in charge of maintenance and maintenance workshops including the functions stated in the Article 14(3) and Annex III of Directive (EU) 2016/798 and any subsequent implementing acts

TORPOL S.A. is the owner of the wagons and the entity in charge of their maintenance, and also a carrier. The company has implemented a Safety and Maintenance Management System SMS/MMS.

Table 3 - A summary of selected SMS /MMS elements in place at TORPOL S.A. related to the occurrence

Item	Document no.	Document / procedure name
SUBSYSTEMS OF T HE SAFETY MANAGEMENT SYSTEM		
1.	P-09	Maintenance of rail vehicles
2.	P-10	Hazard identification, technical risk analysis and assessment
3.		Risk and hazard record
4.		Safety improvement programme for the year 2023

4.4. The results of supervision performed by the national safety authorities in accordance with Article 17 of Directive (EU) 2016/798

In 2020-2022, the President of UTK carried out tree inspections at the registered office of TORPOL S.A., the owner of the wagon and the entity in charge of maintenance (ECM).
The inspection carried out in 2020 was documented in report no. OT7.503.7.2020.3.WMa of 23 December 2020.
The inspection carried out in 2021 was documented in report no. OT5.501.35.2021.40.BN of 12 February 2022.
The inspection carried out in 2022 was documented in report no. OT7.503.8.2022.6.WMa of 18 November 2022.

Irregularities found during those inspections concerned mainly documentation of wagon maintenance and measusrement cards. TORPOL S.A. responded to the identified irregularities by presenting actions aimed at rectifying the irregularities in the future.

4.5. The authorisations, certificates and assessment reports granted by the Agency, the National Safety Authorities or other conformity assessment bodies

Railway infrastructure manager: PKP Polskie Linie Kolejowe S.A. holds:
Safety authorisation:
- number EU PL2120210000,
- date of issue 26 February 2021,
- date of expiry 1 March 2026,
- type of infrastructure; standard-gauge (99.2%), broad-gauge (0.8%).

Size of the infrastructure under management:
- total length of railway lines 18,566 km,
- total length of tracks 36,042 km,
- 39,389 turnouts,
- 13,695 level crossings,
  of which on operated railway lines 11,938.

TORPOL S.A.
Certificate of conformity for an entity in charge of maintenance:
- certificate number PL/31/0022/0091,
- issue date 9 June 2022,
- expiry date 14 June 2025,
- vehicle category – freight wagons, locomotives, on-track machines.

4.6. Other systemic factors

None found.

5. Previous occurrences of a similar character

As part of the investigation, the Investigation Team analysed accidents that took place in similar circumstances in 2019 - 2022.
A brief description of the events and their consequences.

1. On 17 March 2019, during travel of freight train no. TMS 654035 operated by carrier Przedsiębiorstwo Obrotu Surowcami Wtórnymi DEPOL w Bydgoszczy on the Jerzmanice Zdrój - Bydgoszcz Główna route, led by locomotive BR232-154-5 on track no. 1 of the Taczanów - Pleszew route, a loaded wagon (crushed rock) no. 84 51 5945 940-1 was derailed. The derailed wagon was the 20th wagon behind the locomotive - two twin-axle bogies derailed (with the axle in the first one broken). The site of the derailment was at km 107.985 of railway line no. 272, where the wheelset slipped from the rail head to the right side of the driving direction, leading to destruction of the track structure and derailment of all axles of the wagon at turnout no. 1. There was damage to the wagon and track structure on a distance of around 6,000 m. The train stopped at

the Pleszew station after the derailed wagon had been blocked in turnout no. 1 and the train set had been broken apart at km 113.740 of railway line no. 272 Kluczbork – Poznań Główny.
The derailment was caused by breaking of the first wheelset axle (manufactured in 1975) of the first bogie of freight wagon no. 84 51 5945 940-1 due to the irregular structure of the axle material in the place of braking.
Furthermore, the Investigation Team found a systemic cause involving inappropriate supervision of maintenance of the freight wagon by "Inter- KomTrans" Sylwester Komisarek, the entity in charge of maintenance (ECM).

2. On 8 August 2019, during travel of freight train no. TME 464045 operated by carrier PKP CARGO S.A. on the Ornontowice Budryk - Opole Elektrownia route, made up of an ET22-1064 series lead locomotive and 40 coal wagons loaded with coal dust, at around 23:00 hrs the signaller at the "Kms" point in Kamień Śląski noticed that something was glowing in one of the train's wagons. He immediately reported it to the signaller at the Tarnów Opolski station. After receiving the report, the signaller at the Tarnowie Opolski station observed the train and noticed sparks in the fourth or fifth wagon. He reported that fact by train radiotelephone to the driver of the train and instructed him to stop the train at the entry semaphore of the Tarnów Opolski station. The train driver stopped the train at 23:04 hrs. After stopping the train, the driver got out of the locomotive to check the wagons. He checked the adherence of brake blocks to the wheelset tread in the fifth, sixth and seventh wagons from the train head. At 23:10 hrs, he notified the signaller that he had checked the fourth, fifth, sixth and seventh wagon and had not found anything of concern or smelled the characteristic odour that would indicate overheating of running gear elements in the checked wagons. Having found no defects, the driver decided to continue driving and, with the consent of the signaller, started the train. He continued driving at the speed of around 60 km/h. At 23:18 hrs, after covering a distance of around 3.8 km, he noticed swinging of the overhead line, a jolt of the locomotive, and he initiated emergency braking. When he looked out the window, he noticed overturning wagons. He immediately reported to the signaller at the Tarnów Opolski station that the wagons derailed at km 87.973 of railway line no. 132 Bytom – Wrocław Główny, and requested the signaller to close tracks no. 1 and 2, as the wagons lied on those tracks. The accident was caused by derailment of loaded wagon no. 31 51 5496 893-9 (the fifth wagon in the train set) as a result of fatigue breaking of the axle journal.
An inspection of the axle breakage revealed a fatigue character of the crack, with the focus on the element's surface. It could be read from specific features of the breakage that around 40% of the cross-section surface had a fatigue character. The other part of the breakage was the final crack of the material with visible strands characteristic of ductile steel. In the opinion of both the Railway Research Institute and the Investigation Team, the direct cause of the crack in the axle of wheelset no. 5249978 was poor technical condition of of the axle journal, which in consequence led to its breaking. Furthermore, the Investigation Team demonstrated other indirect causes of the occurrence, such as:
    1. The exceeded roughness value of the wheelset axle journal surfaces following machining, i.e. the roughness of the average value of 2.8 µm (the area ground within the crater) to 8.7 µm (in the undercut area), which exceeds the permitted limit.
    2. The inappropriately conducted repair of the wheelset axle, involving giving an inappropriate shape (inconsistent with the WT-2 documentation) to the transition of the axle journal to the wheel seat.
    3. A negligent acceptance procedure following the repair of wheelset no. 5249978 and release to operation with a technical flaw.

    The inappropriate repair was characterised by inconsistency with the *Part 3a WT-2 Technical Conditions – Wheelsets in terms of dimensions, machining tolerance and roughness*. Furthermore, it was established that the broken axle was inconsistent with the execution documentation as an inappropriate shape was given to the transition of the axle journal to the place where the crack occurred and the axle journal shape error, i.e. cylindricity, was not observed, which in consequence, through the excessive interference, led to another fatigue crack. According to the execution documentation, decreasing the dimension of any axle cross-section shall entail remachining of all diameters. That undercut caused adverse concentration of tensions and, as in effect, initiation of the fatigue crack.

V. CONCLUSIONS

1. A summary of the analysis and conclusions with regard to the causes of the occurrence

The Investigation Team established that as a result of breaking of the first axle of wheelset no. 345211 in the first bogie of wagon no. 33 51 5839 055-9 during entry of train no. 654027 to the Wrocław Brochów station, 9 metres from the beginning of turnout no. 501, there occurred derailment to the left side of the driving direction of the aforementioned wagon.
The wheelset with axle no. 345211 had been imported to the country as a reusable one.
The company that imported the wheelset was unable to determine the country of origin of that wheelset, for the related invoices show the quantity of reusable wheelsets. A track record of reusable wheelsets is not required.
Prior to release to operation, the wheelset was inspected and the required documentation was created at P.W. "Inter-KomTrans" Sylwester Komisarek. After 18 months of operation of the wheelset in wagon no. 33 51 5839 055-9 by TORPOL S.A., the wagon was sent for P4 maintenance to MEGA-MET POLAND Sp. z o.o. Sp.k. in Łazy. During that maintenance, flaw detection testing was carried out on the wheelset with axle no. 345211 in November 2020. After further 10 months of operation, it became necessary to reprofile wheel treads of the wheelsets in wagon no. 33 51 5839 055-9, and the wagon was sent to TABOR Dębica Sp. z o.o. Reprofiling was carried out on 29 September 2021 and the wagon was released to operation. Until the accident day, the wagon with the wheelset with axle number 345211 had been operated by TORPOL S.A.
Based on the analysis carried out by the Investigation Team and the conclusions arising from the expert examination carried out by the Railway Research Institute, the Investigation Team established that the factors contributing to the occurrence included:

1) inappropriate machining of the radius of transition of the wheel seat into the centre section of the axle, leading to the occurrence of a large gradient of tensional and compressive stress,
2) formation of microcracks in the place subjected to machining,
3) decreased strength along the axle cross section up to the critical moment at the place of the fatigue crack,
4) release to service of a wheelset as a reusable set from the second-hand market without documented history of prior use.

Implementation of the European Wheelset Traceability (EWT) would provide for obtaining information on wheelset operation history, including also participation in railway occurrences, if any.
The crack in the wheelset formed between the maintenance levels prescribed in the MSD. It has been the third case of a wheelset braking in a freight wagon in four years. Two of the broken axles were older than 40 years, while the year of manufacture of the third axle could not be identified. It is advisable in the opinion of the Investigation Team to introduce obligatory annual flaw detection testing for freight wagon wheelset axles older than 40 years.

2. Measures taken since the occurrence

TORPOL S.A., an entity in charge of maintenance of wagons, took actions involving detailed non-destructive testing of all wheelsets in its wagons in order to prevent similar occurrences in the wagons in the future.

On 9 February 2023, a Safety Team appointed under Internal Order no. 8 no. 53/VI/2022 of the President of the Management Board of TORPOL S.A. of 15 June 2022 discussed the initial causes of the accident and defined the procedure regarding the railway occurrence on 7 February 2023 at the Wrocław Brochów station, train no. 654027 travelling from Kłodzko Główne to Olsztyn Główny (carrier T&C) - derailment of the last coal wagon no. 33 51 5839 055-9 in the train set due to breaking of a wheelset axle.

The Safety Team identified the already existing hazard in Hazard Record ZSZ SMS/MMS TORPOL "A2 *Cracks / breaking / other damage to wheelset and bogie elements (including axles, suspension, dampers)"*, and updated the risk assessment with the FMEA method - the value of the "W" parameter was increased to 6 / the value of the "Z" parameter was increased to 3.

In connection with reaching the TOLERATED value of the "R" parameter, preventive measures were developed and implemented to eliminate or mitigate the risks:

1) detailed ultrasonic testing (UT) and magnetic particle testing (MT) of all 136 wheelsets in 34 coal wagons was carried out at a rolling stock repair facility,
2) requirements were extended as regards obligatory detailed ultrasonic testing (UT) and magnetic particle testing (MT) as part of revision repairs and overhauls of wagons in the Maintenance System Documentation (MSD) of freight wagons,
3) The Management Board of TORPOL S.A. decided to carry out audits at all entities that conduct wheelset revisions for TORPOL S.A. The findings of the audits will be used for updating the list of qualified suppliers.

VI. SAFETY RECOMMENDATIONS

Recommendations arising from the investigation:

1. Entities in charge of maintenance (ECMs) of freight wagons shall strengthen supervision of the process of repairs of wheelsets during replacement of wheels and P4 and P5 maintenance.
2. Entities in charge of maintenance (ECMs) of freight wagons shall check their Maintenance Management Systems (MMSs) for factors contributing to the occurrence, and shall consider inclusion of the following elements in those systems:
   a) detailed requirements regarding contractors that perform P4 and P5 maintenance activities,
   b) inclusion in the freight wagon Maintenance Management System (MMS) of competence requirements and detailed tasks for workers authorised to perform commissioning, in particular as regards in-process commissioning.
3. As part of its Maintenance Management System, TORPOL S.A. shall take actions relating to:
   a) increasing the supervision of compliance with the Maintenance Management System procedures,
   b) ensuring detailed supervision of rail vehicle maintenance service providers, in particular as regards tests of running gear.
4. MEGA–MET Sp. z o.o. Sp.k. in Łazy shall take actions to strengthen the supervision of its P4 and P5 maintenance activities, including enhanced quality control of repair activities provided, in particular ones that are outsourced.
5. The President of the Rail Transport Office shall finalise the actions commenced in 2020 to introduce **the *obligation regarding traceability of wheelsets for freight wagon axles*** in accordance with the ***Implementation guide for the European Wheelset Traceability (EWT) for freight wagon axles*** made in Brussels on 26 July 2010 by the *Joint Sector Group for ERA Task Force on wagon/axle maintenance* and agreed with the National Safety Authority.
6. Entities in charge of maintenance (ECMs) of freight wagons shall immediately implement the obligation to carry out detailed documented[1)] non-destructive tests of wheelset axles prior to their re-introduction to service.
7. The President of the Rail Transport Office shall consider appointing a team of experts to obtain opinions and knowledge to define the scope of additional tests of wheelset axles in service in freight wagons for longer than 40 years.

CHAIRMAN
OF THE STATE COMMISSION ON RAIL ACCIDENT INVESTIGATION

……
Tadeusz Ryś

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1) The scope of a detailed non-destructive test of freight wagon wheelset axles, as used in the Report, includes inter alia disassembly of wheelsets from under a freight wagon, disassembly of bearings and exposure of the centre section of the axle, external examination. The test must be carried out with the ultrasonic testing (UT) and magnetic particle testing (MT) methods following removal of the protection coating from the side surface of axle journals and from the centre section of the axles.

List of acronyms used in Report **No. PKBWK 02/2024**

Item	Symbol (acronym)	Explanation
1	*2*	*3*
1.	EUAR	European Union Agency for Railways
2.	MSWiA	Ministry of the Interior and Administration (Polish: *Ministerstwo Spraw Wewnętrznych i Administracji*)
3.	UTK	Office of Rail Transport (Polish: *Urząd Transportu Kolejowego*)
4.	PKBWK	State Commission on Railway Accident Investigation (Polish: *Państwowa Komisja Badania Wypadków Kolejowych*)
5.	IZ	PKP PLK S.A. – Railway Line Plant (Polish: *Zakład Linii Kolejowych*)