



**DIREZIONE GENERALE
PER LE INVESTIGAZIONI FERROVIARIE**
Italian Railway Investigation Body
Director General Marco Pittaluga

***Accident occurred
in Viareggio, June 29th 2009***

Presentation in Roma –11-13 April 2012

Massimo Costa – HoU International Relationship of the Italian National
Investigation Body



DIREZIONE GENERALE PER LE
INVESTIGAZIONI FERROVIARIE

Italian Railway Investigation Body

The Commission nominated by Italian NIB

Commission nominated by the Italian NIB :

Ing.Franco Branciamore (president)

Ing.Roberto Lucani

Ing.Lorenzo Loreto



1. Accident description

1.1. Accident dynamics

- June 29, 2009, hours 23.48: freight train 50325 derailment. Train from Trecate to Gricignano, composed of 14 tank wagons containing LPG
- cause: rupture of the journal of the second axle of the anterior bogie of the first tank car attached to the locomotive
- after 370 meters from the point of derailment, overturning of the first five rail tank
- broken axle hurled at a distance of 30 meters
- the other axle, bent, remains on the embankment about 15 meters from the stopping point of the wagon
- first tank car overturned, streaking along 100 meters, hits an element of infrastructure: rupture of the coat and leakage of LPG
- LPG fire and fire setted in the surrounding area: 32 dead and many injured
- along the path traversed by the first wagon overturned, several infrastructure elements deform:





1. Accident description

1.2. The wagon

- Traveled a whole of 236.118 km, 228.768 km in Italy
- January 09, 2005, enters in Italy (Tarvisio) and never leaves the country area
- used for the relation Trecate - Gricignano (24 trips/year)
- tank sent in the CIMA Riparazioni of Bozzolo repairing garage on January 21, 2009:
 - checks and inspections
 - triennial tests provided by international regulations for tanks
 - replacement of two axles of the same bogie whose wheels were not geometrically suitable for running (the owner of the wagons proceeded to send the revised wheelset to CIMA that has been mounted them on the wagon. The revision of the wheelset and the subsequent tests, before of the sending to CIMA, were made in Germany by Jugenthal):



- LKM supplier's brand
- date of casting February 1974
- October 27, 1974 axle manufacturing
- UIC 811 technical specification reference
- March 02, 2009 the revised bogie is made available to FS Logistics that on March 04, 2009 provides to put it in circulation
- after revision ended on March 2, 2009 and to the date of the accident the wagon has traveled 22.525 km.



1. Accident description

1.3. The tank

- tank for liquid gas under pressure, sealed, with sunscreen, designed for a pressure of 25 bar and filling from the bottom
- year of construction: 2004
- Producer: Chemet SA
- approval: EBA - Eisenbahn - Bundesamt (Federal Office for Railways - Germany)
- test (and design) pressure: 2.5 MPa (25 bar)
- plating thickness 12 mm, funds thickness 13.5 mm
- capacity 109,800 liters
- initial control: December 2004 (with a hydraulic control test, pressure 25 bar)
- interim control: February 19, 2009 (tightness test)
- tests and inspections performed on the tank: February 19, 2009 type of verification: external inspection, leak test at 6.5 bar, loading/unloading test
- next revision date: December 15, 2012
- tank containing "Hydrocarbon gas mixture, liquefied, UN number 1965 - Hazard Identification Number 23"





2. Activities of the investigators

2.1. First activities

Preliminary activities

- with suitable equipment, check of the status of installation of the infrastructure, that was in perfect geometric conditions
- identification of the point of overlap
- defining of the cause of derailment: exclusively due to the broken axle
- On December 18, 2009 the investigators completed an initial report followed by an update in February 2011



Intermediate activities

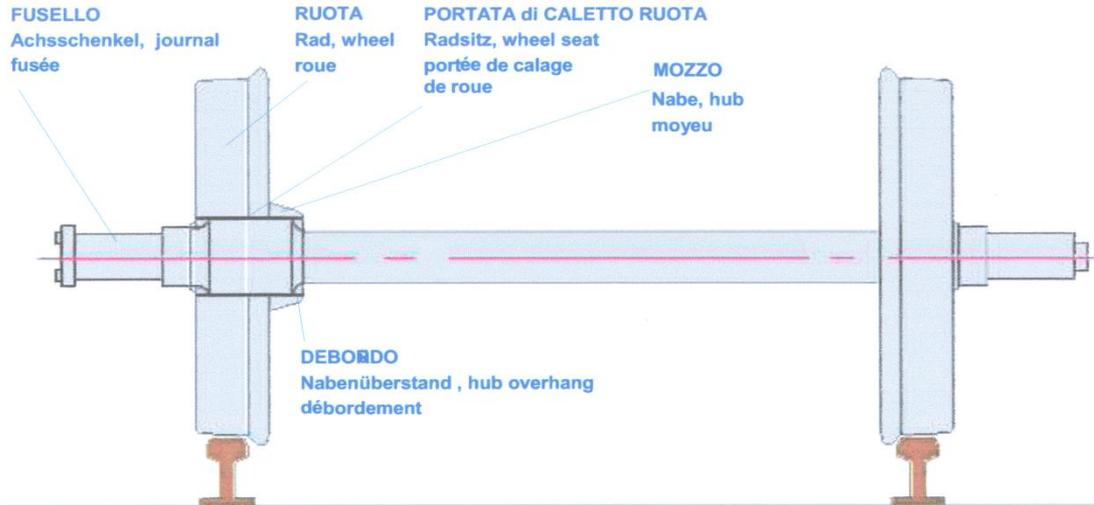
The Italian NIB has operated in continuous connection with the judicial authorities:

- On February 10, 2011 the magistrate in charge of preliminary investigations (italian GIP) has enabled the investigators in charge to attend the all stages relating to non-destructive and destructive tests to be carried out on important components for railway safety on the tank car and on both axles of the bogie
- On March 07, 2011 (first preliminary hearing) the magistrate, taking into account all the questions received, formulated to his technical consultants the following questions:



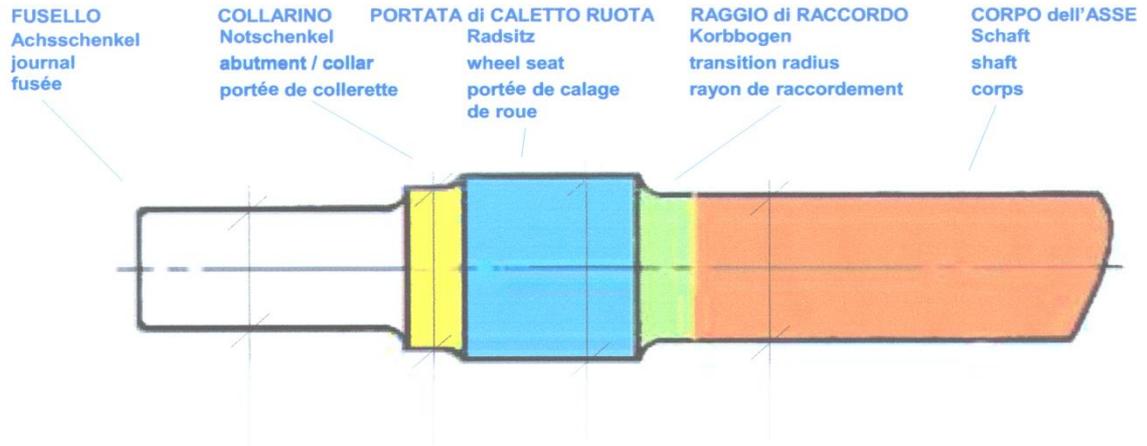
2. Activities of the investigators

2.2. Questions of the magistrate



Sala Montata

Radsatz
Wheelset
Essieu monté



Assile
Radsatzwelle
Axle
Essieu-axe



2. Activities of the investigators

2.2. Questions of the magistrate

Question A.1

Concerning the fractured axle and the other axle of the same bogie: “to ensure -through the analysis of the surface layers of the axles - if they have undergone the same treatment as maintenance, in particular regarding the application of the layer of protective coating“

Question B.2

Concerning the fractured axle and its wheelset: “to characterize by the chemical and metallographic point of view the material”

Question B.3

Concerning the fractured axle and its wheelset: “to identify the mechanical properties of the material, possibly through removal of samples oriented in the sense appropriate, tested for:

- *traction*
- *hardness*
- *resilience (in the axial and transverse direction)*
- *fatigue*
- *speed of crack propagation in the direction perpendicular to the axle”*

Question B.4

Concerning the fractured axle and its wheelset: “to define shape and size of the oxidized band present in the axle centerline - by taking a metallographic sample of the oxidized zone and of the surrounding area - to measure, with the most appropriate tools and procedures, the thickness of the oxidized layer also estimating the time taken to reach this thickness”



2. Activities of the investigators

2.2. Questions of the magistrate

Question B.5

Concerning the fractured axle and its wheelset: “to ensure - through the removal of the bearings and ultrasonic inspection - whether there is the presence of other cracks as well as that which led to the axle failure - particular attention must be paid in the area of the axle journal and the wheel seat”

Question B.6

Concerning the fractured axle and its wheelset: “after completely removing the axle from other parts of the wheelset (wheels and bearings) to define: through non-destructive tests (visual, magnetoscopic and penetrant liquids) of the surface of the component, before and after the removal of the protection layer - if other defects are present”

Question B.7

Concerning the fractured axle and its wheelset: “to ensure - with the eventual estimated installation interference - if the wheel has been mounted correctly”

Question B.8

Concerning the fractured axle and its wheelset: “to define, through the removal of layers (paint, rust, dirt, etc.) the dimensions of the whole axle (with particular attention to the presence of the junction radii and their value) if the axle can be attributed by the morphology and geometry to the family of axles used by the Austrian Railways, known as type “75.2””



2. Activities of the investigators

2.2. Questions of the magistrate

Question B.9

Concerning the fractured axle and its wheelset: “to define, through the separation of the two fracture surfaces by cutting, the fractographic/microfractographic and metallographic analysis - what is the position of the start point(s) of the fracture and to reconstruct the history of propagation of the defect”

Question B.10

Concerning the fractured axle and its wheelset: “to verify the suitability of the instrumentation and of the procedures used during the last ultra-sound test carried out on the axle (at Jugenthal)”

Question B.11

Concerning the fractured axle and its wheelset: “to make a control of perfect roundness of the wheels”

Question C.12

Concerning the pressure tank containing the LPG: “to verify compliance with international rules (RID) in force at the date of registration”



2. Activities of the investigators

2.2. Questions of the magistrate

Question C.13

Concerning the pressure tank containing the LPG: “to characterize the material from the mechanical, metallographic and chemical point of view, and verify if it meets the requirements of acceptability imposed by international rules (RID)”

Question C.14

Concerning the pressure tank containing the LPG: “to detect, describe and analyze all the facts useful to evaluate the possibility of cutting the tank caused by the peg No 24 or by the wing rail of the switch 13b”

- In the same meeting, the consultants of the magistrate in charge of preliminary investigations established that the tests would take place from May 16, 2011 at the laboratories of Lucchini RS*
- The investigated material, subject to seizure, sealed in boxes by the Railway Police and protected from weather actions (especially the broken axle) arrived at the laboratory Lucchini RS in Lovere on May 10, 2011*



2. Activities of the investigators

2.3. Activities in collaboration with the judicial authority

ACTIVITIES on May 16, 2011

The railway police has removed the seals and opened the container putting at the disposal of the technicians the components of the wagon.

The experts' activities began and continued with the following steps :

- Visual checks by the method EVIC V.2.11 (ERA)
- Dimensional check of the broken axle and preparation for further analysis
- "Tear test" of the oxide layer present on the axle
- Samples of protective paint were sent to two separate laboratories for verification

ACTIVITIES on May 17, 2011

- Removing of the (fracture side) and extraction - from the bearing- of the part of the broke axle remained in the bush
- Removing hot of the three rings (bearing) and cleaning of the axle piece
- Stripping axle fractured
- Examination by ultrasound of the fractured axle to search for additional cracks
- Disassembly of the wheel placed in the opposite side of the fracture





2. Activities of the investigators

2.3. Activities in collaboration with the judicial authority

ACTIVITIES on May 18, 2001

- Disassembly of the wheel placed in the side of the fracture
- Cut of the piece of the axle near the fracture and transport in the laboratory for the fractographic analysis and identification of the samples for mechanical testing
- Ultrasounds examination with different angles (37 °, 40°, 45°, 50°, 52°, 54°)
- Magnetic particle examination of the fractured axle

ACTIVITIES on May 19, 2001

- Roughness detection of the fractured axle
- Penetrant liquids analysis of the broken spindle (stump)
- Penetrant liquids analysis of the broken axle
- Removal of a cross section from the axle in the central area corroded by the oxide
- The intact wheelset is also examined .
- Ultrasounds analysis of the bearings after disassembling (axial examination)
- Visual inspection of the bearing removed from the spindle broken and controls

ACTIVITIES on May 20, 2011

- Sampling of the layer of paint from the broken axle
- Samples cutting for metallurgical analysis (beginning of operations)
- First analysis (by SEM –scanning electron microscope) of the area from which the crack was originated in order to verify the type of “crater” (erosion, oxidation, other...)



2. Activities of the investigators

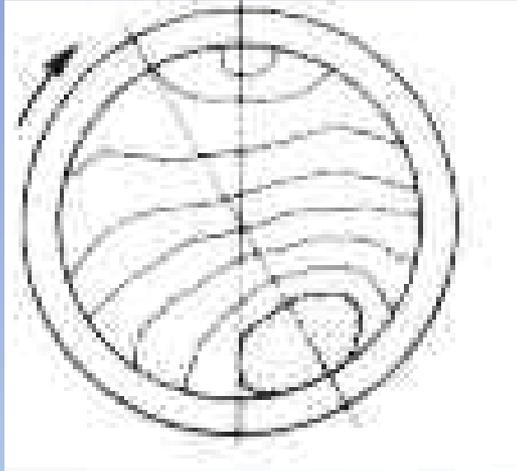
2.3. Activities in collaboration with the judicial authority

ACTIVITIES on June 6, 2011

- Assessment of the status of the tank, of the picket and the part of rail removed from the accident site and put in a protected area subject to seizure

ACTIVITIES on June 8, 2011

- Sampling of the tank for subsequent chemical metallographic and mechanical tests. The sampling was carried out from the area opposite to the gash in order to avoid any residual stress or plastic deformation that could affect the portion of the tank in the vicinity of the gash



From ASM Handbook Vol. 11



3. Conclusions

3.1. Observations

Some tests (rotating bending stress to the fractured pieces taken from the axis and tests on paint) were completed at the end of August 2011

It is possible only to express some considerations

- The initiation of the fracture is originated from oxidation and thus are excluded other phenomena such as mechanical actions
- The propagation of the crack started from a single point with a diameter of 3/5 mm



3. Conclusions

The essential theme of the accident of Viareggio concerns not only the identification of the cause of the failure of a structural component of the wagon so important for rail safety, but also and especially the identification of the reasons for which the progression of fracture was not found and detected before the complete rupture.

If it will be determined - through the investigation - that rules and procedures in place are not able to bring out in good time the presence of a crack it will be necessary that the international community or national bodies responsible for issuing the regulations governing this sector should have as their main priority the updating and the refinement of the framework of the rules on safety checks.





4. Recommendations

Official recommendations of the Directorate General for Rail investigations (Italian National Investigative Body – Italian NIB) subsequent to the survey conducted by the Ministerial Commission investigation of the accident of Viareggio 06/29/2009

In consequence of the contents of the technical report of the Ministerial Commission (**published on April 2, 2012**) which constitutes the outcome of its investigation, in order to prevent railway accidents it is considered essential to propose primarily legislative recommendations as well as recommendations about the technical-operational aspects. These recommendations are listed below and are expressly brought to the attention of DG MOVE (European Commission) as foreseen in the article 28 of the European Directive 2004/49/CE:



Recommendations from No. 1 to No. 10 are addressed to:

- the European Railway Agency in its position of a board for the trend orientation of the NSAs
- the OTIF
- the Italian National Agency for Railway Safety - ANSF
- the Ministry of Infrastructures and Transports (*Department for Transports, shipping, informative and statistics systems*)

The recommendation No. 11 is addressed to:

- the Italian National Agency for Railway Safety - ANSF
- the Ministry of Infrastructures and Transports (*Department for Infrastructures*)
- the Italian Infrastructure Managers



4. Recommendations

Recommendation no. 1)

To establish supranational laws for the maintenance and monitoring activities aimed at the safe transport of railway wagons carrying dangerous goods, individuating "mandatory" operational procedures to apply to maintenance activities on rolling stock and components as well as for reassembly activities performed within the European Union and also in the territories of non-EU member states belonging to COTIF and having the scope and validity to ensure their effects on all wagons circulating in the European Union territories.

Those "mandatory" procedures must be a complement to the best practices already adopted for maintenance in the rail sector, avoiding redundancies and duplications .

•For this purpose it is recommended that:

- the European Railway Agency in its position of a board for the trend orientation of the NSAs

- the OTIF

- the Italian National Agency for Railway Safety - ANSF

- The Ministry of Infrastructures and Transports (Department for Transports, shipping, informative and statistics systems)

strive in order that will be started and completed the implementation of a regulatory framework for maintenance, described in their essential aspects in the subsequent recommendations from No. 2 to No. 10.



4. Recommendations

Recommendation No. 2)

To constitute, within the organization with the maximum international partnership, a single register (European and/or international Data-Base) of rolling stock carrying dangerous goods, circulating on the railway networks of the territories referred to Recommendation No. 1. This register shall include computer data suitable for the identification of the rolling stocks carrying dangerous goods, in terms of: technical and homologation data, date of construction and/or reassembly, maintenance history of their major components for safety, mileage of wagons and of their components



4. Recommendations

Recommendation No. 3)

To establish a general rule of application of sanctions against the subjects involved in various processes that have behaved in a different manner from those provided by the rules and regulations that could be defined in consequence of the Recommendations from n. 2 to n. 10

These sanctions have to be imposed by the national organizations responsible for safety with regard to the territory under their jurisdiction, without prejudice to the right of each Member State to adopt measures restricting the circulation.



4. Recommendations

Recommendation no. 4)

To introduce in the rules the prediction of maintenance interventions for safety purposes that have to be carried out with "temporal" frequency and with "fixed distances". These methodologies have to be used in combination and in correlation. This need arises from the increased use of the wagons and important components for the rail safety resulting from the modification of the legal arrangement and organizational architecture of the sector in Europe.

That forecast must also include the principle of intensification of the frequency of the checks in function of the progress of the age of wagons carrying dangerous goods.



4. Recommendations

Recommendation No 5

To establish an obligation requirement of certification of the authorized personal that performs maintenance aimed at the safety of transport, on rolling stocks transporting dangerous goods circulating within the European Union. The certification must be set under the control of the member states and it must exclude any hypothesis of self-certification.



4. Recommendations

Recommendation no. 6)

To establish a rule that defines a limited service life of important components for rail safety. In order to prevent train accidents is necessary to introduce a maximum time limit for the use of components related to safety (axles, wheels, bushings, suspension, etc.), taking into account the concept of cyclic fatigue, to which certain mechanical components are subjected to during their operational life.



4. Recommendations

Recommendation No 7)

To introduce a requirement for full traceability of all axels and components that a specific working group has to study to highlight as "fundamental" for safety and for the dynamic stability of the wagons, with particular regard to components subjected to cyclic efforts. At the time of the activity of maintenance and/or reassembly, the subject responsible must:

- uniquely identify the components of the rolling stock on which maintenance is performed by punching an identification code (if not already punched). This code must be affixed already by the manufacturers at the time of production according to procedures to be defined.
- Insert in the Data-Base described in Recommendation No. 2, the evidence of transactions on the component, which must be identified as described in the previous paragraph, all its structural and geometrical data collected, the maintenance work performed, the execution date and the date scheduled for further maintenance. This Database will be accessible - for inspection - by entities that are responsible for controls and - for the operation – by all the certified and notified responsible for the maintenance.

All test results of a sensitive nature (Non Destructive Testing, ultrasound tests, Magnetoscopic checks, work sheets, etc.) performed on the components which are important for safety of rail transport will be placed in the same Database in hidden or clear format but not manipulatable, in order to verify at a later time the state of the component or the evolution of any defects or anomalies detected during the entire life of the component itself.



4. Recommendations

Recommendation No. 8)

To establish a requirement for the destruction of components important for safe transport, for which it isn't possible to reconstruct the history of maintenance and operational through a continuous tracking. If the history of the component is not completely clear, it is necessary to require its destruction, giving the proof this to the safety organizations.

This condition must be realized since the first useful opportunity in correspondence to a normal maintenance carried out according to the maintenance plan expected. the first phase of application of the rule needs a short period of transition to the new protocol for the components already in circulation. Beyond this period they must be destroyed anyway.



4. Recommendations

Recommendation no. 9)

To define, on the basis of legal requirements to be introduced in consequence of the previous recommendations, a procedure for conducting inspections on those responsible for the maintenance of wagons carrying dangerous goods or their components. These inspections must be made by Railway Undertakings (RU) as a part of its Safety Management System (SMS) to ensure safe operation of its part of the system.

The supervisory role of NSAs on RUs remains unchanged. Therefore, Railway Undertakings must include in their Safety Management System adequate check procedures on the staff responsible for maintenance of the rolling stock that RUs haul.



4. Recommendations

Recommendation no. 10)

To impose the use of Detectors of Derailment Devices (DDD) for all wagons carrying dangerous goods, starting from the older ones.

The application of such devices must make possible to activate automatic actions of brakes, needing an evolution of the detection techniques as much as possible free from false alarms.

These devices should also be installed necessarily on the wagons carrying normal freights when they are in composition with those carrying dangerous goods.

To provide for the production of new wagons, the obligation to adopt such devices taking into account possible technological developments towards more advanced solutions, also in terms of selectivity and modulation of the braking reactions.



4. Recommendations

Recommendation no. 11

To set up by the Italian Infrastructure Managers an analytical study on the current distribution on the territory of the Italian railway network of thermal bushings revelators, taking into account the topological layout of the railway network, including railway interconnections and the multiple paths that can be runned by trains.

The study is intended to highlight the paths longer than 60 km that are not yet covered by the revelators and that have to be equipped immediately by automatic systems, in order to overcome the current procedure that admits a possible visual detection.



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Thank you

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