Worldwide FI Summary

January 2012

This is a collation of some of the world’s railway formal inquiry reports. It includes a brief incident synopsis, along with the main causes and recommendations from each investigation. Readers may find some of the actions and recommendations useful to their own operations.

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Key issues in this edition:

- Drug misuse (train crew)
- Mobile telephones in cabs
- Level crossing user behaviour
- Sighting at level crossings
- Train component manufacture and maintenance
- Emergency procedures (train crew)
- Driver error (permissive working)
At around 14:10 (local time) on 3 March 2010, a Canadian Pacific (CP) freight train approaching KC Junction on the ‘north’ line collided with the side of a freight that was crossing from the ‘north’ line to the ‘south’ one.

The impact caused three locomotives and 26 wagons to derail.

The crew of the incident train was transported hospital for observation. The driver was later air-lifted to a Calgary hospital in serious condition.

No traces of drugs or alcohol were found on the conductor. However, the driver was very concerned that traces of marijuana may be found in his urine. From the time of the accident until he was admitted to hospital, he consumed approximately 10 litres of water in an effort the flush any traces of the drug from his system. This caused hyponetremia (water intoxication) and at approximately 19:50 the locomotive engineer lost consciousness and was immediately air-lifted to Calgary Foothills Hospital for further care and observation.

At approximately 01:30 the following day, the driver was tested for drugs. The results for the urine cannabinoid screen were ‘Below cut off’ at 50 ng/ml, but these results were unconfirmed.

In addition, both crew – between them – conducted numerous mobile telephone communications (voice and text) in the 3-hour period before to the accident. While engaged in these communications, the crew operated the train and performed various safety-critical tasks (eg negotiating public crossings, passing slide detectors, complying with temporary and permanent slow orders, analyzing hot box detector broadcasts, identifying and responding to wayside signals). The last communication prior to the accident was completed about 1 minute before receiving the first radio transmission from the signal maintainer re a hot axle box detector (HABD) activation.

The Transportation Safety Board of Canada (TSBC) identified the following causes and contributory factors:

- The collision occurred when the incident train was driven past the stop signal at KC Junction and into the side of the train that was crossing over from the north main line to the south main.

- While processing conflicting information from the signal maintainer and from the active HABD, the crew’s attention was momentarily diverted from the primary task of stopping the train.

- The crew’s situational awareness was likely focussed on resolving the HABD issue and not on the impending requirement to stop the train.

- The crew did not positively identify and announce the ‘stop’ indication at the signal over the radio, thereby missing an opportunity to update their situational awareness and bring their train to a safe stand.

The TBSC also listed the following:

- Without a requirement to conduct timely post-accident testing for drug and alcohol use (when warranted), there is an increased risk of inconclusive test results.
When work begins on a railway accident site before a hazard assessment has been made and the results communicated to all concerned, employees and the public may be subject to unnecessary risks.

When a switch heater propane tank is installed immediately adjacent to the track, there is an increased risk that the tank will be struck by rolling stock during a derailment; this could lead to tank rupture, explosion and fire.

In the absence of enhanced protection against signal recognition errors, such as that provided by cab signalling systems or Positive Train Control (PTC), Centralized Traffic Control (CTC) and its current defences do not always adequately ensure that the requirements of signals are followed.

Despite the existence of rules and protocols regarding the use of personal electronic devices, not all railway employees working in safety sensitive and safety critical positions understand and accept the risks associated with such distractions; this increases the risk from unsafe train operations.

Safety actions undertaken

On 1 July 2010, in response to 10 recent collisions involving movements exceeding limits of operating authority, CP developed and delivered a Crew Resource Management (CRM) programme, including training materials to all train crew members. Revisions were communicated via summary bulletins. The initial CRM focus was on reducing in-cab distraction, enhancing communication and focusing on critical tasks. The following revisions were included in the manual:

- Employees are prohibited from using personal electronic devices. These must be switched off, with any ear pieces removed, and stored out of sight in a location not on their person. (NB, this is not applicable to medical devices such as hearing aids, etc.)  Exception: Employees may use personal cellular telephones:
  - During a recognized break or meal period; or
  - For minimal voice communications when the movement/track unit/work activities are stopped, the employee is not foul of any track and a job briefing with all involved employees confirms such use will not interfere with any safety related duty.

- The person initiating a radio communication and the responding party must establish positive identification. The initial call must start with the railway company initials of the person being called. When the initial call is to a movement, the conductor must respond when conditions permit.

- Crew members within physical hearing range must communicate to each other, in a clear and audible manner, the indication (by name) of each fixed signal they are required to identify. Each signal affecting their movement must be called out by the conductor and acknowledged by the person responsible for controlling the locomotive as soon as it is positively identified. However, crew members must watch for and promptly communicate and act on any change of indication that may occur.

- In CTC (or at any other signal to a signal in CTC), except as otherwise indicated in special instructions, when passing more than two controlled locations the conductor must complete the applicable portions of the CTC Signal Record form immediately after the leading end of the movement has passed each signal subject to the Rules.

- Management monitoring (proficiency testing) and peer-to-peer reinforcement of correct behaviour has been established as CP's approach to deal with compliance of personal electronic devices.
CP is targeting January 2012 for the implementation of Oral Fluid Testing, in addition to the current Breath Alcohol Concentration and Urine Drug testing for Reasonable Cause and Post Incident/Accident Testing.

Declared to ERA 9 January

**Hungary: Level crossing collision between Kiskunlacháza and Délegyháza, 20 October 2011**

At 11:05 (local time) on 20 October 2010, a freight train collided with a lorry laden with sand at a level crossing between Kiskunlacháza and Délegyháza.

The train driver was killed instantaneously; the lorry driver was seriously injured.

The locomotive and first two wagons derailed, the loco falling from the embankment. Around 300 metres of track was also damaged.

The resulting investigation noted that the immediate cause of the accident was the lorry driver's behaviour. However, it also commented on the adequacy of the sighting at the crossing and made two recommendations in this area.

**Recommendations**

- The infrastructure manager should examine the crossing, including the visibility of the warning lights, with special emphasis on heavy lorries, taking any actions deemed necessary.

- The infrastructure manager should examine the crossing with particular attention to the reduced visibility triangles, taking any actions deemed necessary.

Published 30 January

**UK: Passenger train derailment near East Langton, 20 February 2010**

For the full report, click here: [LINK](#)

At around 15:49 on 20 February 2010, a seven-car Meridian derailed by one axle (fourth vehicle), while travelling at 94 mph; it subsequently ran for approximately 2 miles before coming to a stand. The train remained upright throughout and did not foul the adjacent line. There were no injuries among the 190 passengers and 5 crew, but there was damage to the track and the train, including loss of diesel fuel.

RAIB found the immediate cause of the derailment to be the overheating and subsequent fracture of the powered trailing axle of the leading bogie of the fourth vehicle.

It found the causal factors to be as follows:

- The spinning of the axle within the inner ring of the (gear end) GE bearing, due to rotational stiffening of the bearing (‘causal’);

- The insufficiency of the interference fit of the GE bearing inner ring onto the axle at manufacture, due to the effect of the adjacent gear wheel fit on the hollow axle (‘probably causal’);

- The possibility that the bearing seat on the axle had been manufactured undersize (‘possibly causal’);
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• The progressive loss of the GE bearing interference fit in service, due to bearing bore growth and fretting wear (‘probably causal’); and

• The nature and rapidity of the failure precluded prior detection by the gearbox maintenance regime at the time (‘possibly causal’).

Factors which exacerbated the consequence of the derailment re the delayed stopping of the train (and therefore increased the risk to passengers and damage to the track and train) were:

• The initial delay before the driver began to reduce the train speed, after receiving the red bogie fault lamp alarm; and

• The driver’s decision to stop the train beyond the approaching cutting.

According to RAIB, the underlying factors related to the failure of the final drive gearbox were:

• The effect of the interference fit of the gear wheel on that of the GE output bearing was not identified during design; and

• There were no known previous incidents to alert industry to the potential for axle failures of this type. This meant that the need for mitigating output bearing failures was not perceived.

The following underlying factor was also noted:

• The refresher training on alarm handling provided to drivers and on-board train crew, following the incident at Desborough in June 2006, did not adequately cover handling safety critical alarms and out-of-course situations.

Actions reported as already taken or in progress

National Incident Reports
East Midlands Trains (EMT) initially issued a National Incident Report (NIR) on 21 February 2010 to alert the industry to the final drive failure and derailment at East Langton. Three further updates followed, the last on 28 June 2010, to update the industry on the measures that were being taken at that time.

Engineering precautions
Following the accident, EMT and Bombardier put in place the following measures to minimise the risk of recurrence while investigations proceeded:

• Inspections of all Meridian final drives to check that they were correctly filled with oil, in case the failure had been caused by a lack of oil.

• Torque checks on all Meridian output bearing housing bolts in case the failure had been caused by these bolts working loose (some loose and missing bolts were found on the failed final drive).

• Temperature monitoring of all Meridian, Voyager and Super Voyager gearboxes, using infra red thermometers, once trains had stopped at various allocated termini. (For the Meridian fleet these were London St Pancras, Sheffield and Derby Etches Park depot, where monitoring was continued until 15 September 2010.)

• A reduction in the ultrasonic axle testing intervals for the Meridian, Voyager and Super Voyager fleets from 300,000 miles to 100,000 miles until 18 May 2010, which is when the original interval was restored. This was in case the failure had been caused by metal fatigue of the axle.
Introduction of a minimum diameter of 200.030 mm for the output bearing seat on the axle, with the adjacent gear fitted. Axles found to be below this size were scrapped.

RAIB Urgent Safety Advice
On 14 July 2010, RAIB issued an urgent safety advice (USA) to the industry, including those who do not receive NIRs. The purpose of the USA was to raise awareness among other operators about the accident and the emerging focus of the technical investigation. It was subsequently sent to the European Rail Agency (ERA). The USA advised that, on the basis of emerging evidence, relevant considerations for designers, operators and maintainers should include:

- Allowing for shrinkage of bearing seats due to other nearby interference fits (eg gear wheels, and other bearings) in the design process;

- Checking that the level of interference between bearings and their shafts or housings is within the specified tolerances at new build; and

- Checking bearing seats when gearboxes are overhauled, to ensure that they remain within tolerance, and assessing the extent of any growth on the bearing inner rings that are removed.

Gearbox design review work
Bombardier is conducting a review of the Meridian final drive gearbox, and is undertaking tests and analyses to identify any relevant differences from the performance of Voyager final drive gearboxes. Work is also under way to redesign the axle to compensate for the loss of interference on the GE bearing due to the fit of the adjacent gear wheel.

Review of passenger evacuation
After the accident, EMT undertook a review of its emergency response arrangements and, in particular, the causes of the delay in providing a rescue train to the site and evacuation of passengers from the incident train. Learning points were identified and EMT has reported to the RAIB that, as a result of the review, it has put in place the following measures:

- Improved the command and control arrangements for emergency situations;

- Improved communication facilities, so that a greater volume of telephone calls can be handled in emergency situations;

- Increased frequency of exercises to practise control of emergency situations and further training of controllers;

- Trained more drivers on diversionary routes to increase operational flexibility when main routes are blocked; and

- Improved systems for communication with passengers at stations.

Actions reported that address factors which otherwise would have resulted in a RAIB recommendation

Installation of output bearing over-temperature detection
During June 2010, Bombardier designed and began installation of the following two devices on each GE and non-gear end (NGE) final drive output bearing on the Meridian and Voyager fleets:
A fusible plug connected to the existing hot axle box detection system (HABD), in order to detect and alert the driver in the event of an overheated final drive output bearing. The fusible plug is set to trigger at 145°C and activate the red bogie fault lamp and audible alarm in the cab.

A ‘ribbon bolt’ which activates at 125°C and indicates (by means of a tell-tale) to drivers or maintenance staff inspecting an affected bogie from the track side or in the depot, that the final drive output bearing has an overheating problem and requires immediate attention. The ribbon bolt enables the person inspecting the train to differentiate between a hot final drive output bearing and a hot axle box bearing.

The installations on the operational fleet were completed by 15 September 2010. Operational constraints on the laboratory test rig at Voith precluded a full test of the fusible plug in January 2011; therefore Bombardier is additionally undertaking thermal modelling to check that the plug will provide adequate warning under all anticipated bearing failure scenarios. These actions, which are being monitored by the Office of Rail Regulation (ORR), address the need for on-board mitigation devices, and therefore the RAIB has decided not to issue a further specific recommendation in this area.

Design selection of bearing fits
Voith has stated that, as a result of a bearing interference fit issue on another gearbox design, it has revised the design process for bearing fits on final drive gearboxes. Bearing fits are now specified by the bearing supplier. This change was effected after the design of the Voyager/Meridian gearbox, but prior to the East Langton accident. Therefore RAIB has decided not to issue a recommendation for Voith to review its design procedures for output bearing interference fits.

Train crew briefing
EMT carried out a review of the operating instructions provided to drivers in relation to actions following receipt of a yellow level 3 alarm and red bogie fault lamp, including discussion with other train operators. The original instruction in the operating manual, to stop the train at the first suitable location, was recognised as not prohibiting the driver from proceeding to the suitable location at high speed. Consequently, EMT clarified the instruction to read as follows:

In the event of a bogie fault light illuminating, an audible level 3 alarm will activate. On receiving this warning, the driver must bring the train to a stand immediately. If the location at which the train would come to a stand is not considered to be safe and suitable (as defined within the Rule Book), then the driver must reduce speed to no more than 10 mph in order to bring the train to a halt at the first safe and suitable location that does meet this criteria.

This revised instruction was posted for the attention of drivers on 21 May 2010, together with operating procedures concerned with the newly fitted ‘ribbon bolts’ and fusible plugs. EMT report that its driver managers have used safety training updates to discuss the learning points arising from the accident at East Langton. Formal (signed for) re-briefing and knowledge testing of the actions to take following receipt of a red fault lamp, etc was completed on 4 October 2010.

In the light of these actions, RAIB has decided not to issue a further recommendation to re-brief train crew. However, a recommendation is made relating to practising how to handle out-of-course incidents including the handling of on-board alarms (see below).

Recommendations
- Bombardier Transportation, in conjunction with Voith, should undertake a design review of the final drive gearboxes and axles used on the Meridian and Voyager fleets (Class 220, 221 and 222) and, where appropriate, implement design and maintenance improvements, including verification of the over-temperature detection, to reduce the risk from loss of output bearing interference fits on the axles.
ROSCOs and other Contracting Entities (purchasers of rolling stock), and Entities in Charge of Maintenance (those responsible for overhaul of rolling stock) should review and, where appropriate, improve the design, manufacture and overhaul procedures used for final drive gearboxes in their current and future fleets (in particular those featuring hollow axles) by checking that they adequately address the following factors:

- Reduction in the size of output bearing seats due to shrinkage arising from other nearby interference fits and/or wear during service;
- Bearing bore growth during the service life of the bearing (eg obtained by measuring a sample of bearings);
- Bearing seats being made undersize; and
- Detection of overheating output bearings.¹

Bombardier Transportation should review the final drive oil sampling regime on the Meridian and similar fleets (including consideration of sampling frequency and consistency, action levels, oil colour and use of cumulative trending) and, where necessary, make changes to maximise effectiveness in detecting impending failures.

EMT should provide practical, rolling stock specific, initial and refresher training, that includes the simulation of on-board emergency and out-of-course situations. This should enable drivers and train crew to maintain their understanding of, and familiarity with, correct alarm handling in various scenarios.

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Australia: Freight train collision at Yass Junction, NSW, 9 December 2010

For the full report, click here: [LINK]

At about 01:53 (local time) on 9 December 2010, a northbound laden grain train, travelling from Barellan to Maldon, collided at low speed with the rear of a northbound train of similar consist on the Down Main line at Yass Junction. The intention had been for both trains to wait, one behind the other, while a third northbound freight passed them on the adjacent Up Main line.

The second train had been ‘called on’ past a stop signal, meaning that its driver should proceed at caution and expect another train to be standing in the section ahead. Its driver applied the brake as soon as this train was sighted, but a collision nevertheless ensued. The impact occurred at approximately 15 km/h.

The Australian Transport Safety Bureau (ATSB) found that the signalling system worked correctly as designed and that the driver of the incident train applied the emergency brake immediately upon sighting the ‘end of train marker’ on the rear of the stricken rake.

The investigation highlighted that the definition of restricted speed applying in these sorts of cases requires considerable judgement on the part of train drivers.

The ATSB identified three contributory factors as follows:

¹ In conjunction with the publication of the East Langton report, RAIB has written to the ERA to request its assistance with the dissemination of the issues therein to national safety authorities and national investigation bodies in other EU member states.
The driver of the incident train was operating the train at a speed too fast for the prevailing conditions and the status of the ‘calling on’ signal.

At the time of the collision, it was dark with moderate rain. The sighting distance was limited by the curvature of the track, embankments, and the effective illumination of the train’s headlight.

The driver had expected to be told by the network controller if a train was stopped ahead, so he could anticipate the location of the rear of the train and drive accordingly.

Recommendations

- None issued.