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.

Co-ordinated by Greg Morse, RSSB

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- Wagon inspection, maintenance and suitability
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Canada: Runaway, derailment and explosion of oil train at Lac-Mégantic, 6 July 2013

For the full report, click here.

At around 20:50 (local time) on 5 July 2013, a Montreal, Maine & Atlantic Railway (MMA) freight arrived at Nantes, Quebec, carrying 7.7 million litres of petroleum crude oil in 72 Class 111 tank wagons.

In keeping with MMA practice, after arriving in Nantes, the driver stabled the train on a descending grade on the main line. (A replacement driver was due to continue the trip east in the morning.)

The driver applied hand brakes on all five locomotives and two other wagons, and shut down all but the lead locomotive. The local rules require that hand brakes alone be capable of holding a train, and that this must be verified by a test. That night, however, the locomotive air brakes were left on during the test, meaning the train was being held by a combination of hand brakes and air brakes. This gave the false impression that the hand brakes alone would hold the train.

The driver then contacted the rail traffic controller in Farnham, Quebec, to advise that the train was secure. He then contacted the rail traffic controller in Bangor, Maine, who controls movements for the crews east of Lac-Mégantic. During this conversation, the driver indicated that the lead locomotive had experienced mechanical difficulties throughout the trip, and that excessive smoke was coming from its exhaust. Because the smoke was expected to settle, it was agreed that the train would be left as it was and that the situation would be dealt with the next morning.

 Shortly after the driver left, the Nantes Fire Department responded to an emergency call reporting a fire on the train. After shutting off the locomotive’s fuel supply, the firefighters moved the electrical breakers inside the cab to the off position, in keeping with railway instructions. They then met with an MMA employee – a track foreman who had been dispatched to the scene, but who did not have a locomotive operations background.

Once the fire had been extinguished, the firefighters and the track foreman discussed the train’s condition with the rail traffic controller in Farnham, and departed soon after. With all the locomotives shut down, the air compressor no longer supplied air to the air brake system. As air leaked away, the main air reservoirs were slowly depleted, gradually reducing the effectiveness of the locomotive air brakes. Just before 01:00 on 6 July, the air pressure had dropped to a point at which the combination of locomotive air brakes and hand brakes could no longer hold the train, and it began to roll downhill toward Lac-Mégantic, just over seven miles away.

As it moved down the grade, the train picked up speed, reaching 65 mph. It derailed near the centre of the town at about 01:15.

Almost all the 63 derailed tank wagons were damaged, and many had large breaches. About six million litres of petroleum crude oil was quickly released. The fire began almost immediately, and the ensuing blaze and explosions left 47 people dead. Another 2000 people were forced from their homes, and much of the town centre was destroyed.

The Transportation Safety Board of Canada (TBSC) considered many issues in its investigation, as follows:

Locomotive fire

In October 2012, eight months before the accident, the lead locomotive was sent to MMA’s repair shop following an engine failure. Given the significant time and cost of a standard repair, and the pressure to
return the locomotive to service, the engine was repaired with an epoxy-like material that lacked the required strength and durability. This material failed in service, leading to engine surges and excessive black and white smoke. Eventually, oil began to accumulate in the body of the turbocharger, where it overheated and caught fire on the night of the accident.

Braking force

The Canadian Rail Operating Rules required that unattended equipment be left with a ‘sufficient’ number of hand brakes applied to prevent movement, and that the effectiveness of the hand brakes be tested. MMA’s rules called for a minimum of nine hand brakes for a 72-wagon train. These rules also required that a train’s air brake system not be depended upon to prevent an undesired movement.

Even more crucial is the requirement to test the effectiveness of the hand brakes. That night, the engineer carried out the hand brake effectiveness test with the locomotive air brakes still applied. As a result, the test did not identify that an insufficient amount of hand brake force had been applied to secure the train.

The TSB concluded that, without the extra force provided by the air brakes, a minimum of 17 and possibly as many as 26 hand brakes would have been needed to secure the train, depending on the amount of force with which they had been applied.

Air brakes

Trains have two types of air brakes: automatic brakes and independent brakes.

Automatic air brakes are used to slow or stop the entire train, and are controlled by means of a brake pipe connected to each car and locomotive. Decreases in pressure within this pipe cause air to flow into each car’s control valve, which injects stored air into the brake cylinder, applying the brake shoes to the wheels.

By contrast, independent air brakes are available only on locomotives. They are activated by the direct injection of air into their brake cylinders, which then apply the brake shoes to the wheels.

Both independent brakes and automatic brakes are supplied with air from a compressor on each locomotive. When a locomotive is shut off, the compressor no longer supplies the system with air.

When air leaks from the various components, the pressure in the brake cylinders gradually drops, and the amount of force being applied to the locomotive wheels by the independent brakes is reduced. Eventually, if the system is not recharged with air, the brakes will become ineffective and provide no braking force.

When the air brake control valves sense a drop in pressure in the brake pipe, they are designed to activate the brakes on each car. In this accident, however, the rate of leakage was slow and steady – approximately 1 pound per square inch per minute – thus the automatic brakes did not apply.

Hand brakes

In addition to air brake systems, all locomotives and wagons are equipped with at least one hand brake.

The effectiveness of hand brakes depends on several factors, including their age, their maintained condition, their application in conjunction with air brakes, and the force exerted by the person applying the hand brake, which can vary widely.

Class 111 tank wagons: damage and construction

All 72 tanks wagons were Class 111 vehicles, manufactured between 1980 and 2012. Although they met requirements in effect at the time, they were built to an older standard, and they lacked enhancements such as a jacket, a full head shield, and thermal protection.
Almost every wagon that derailed was breached, some in multiple areas, including shells, heads, top and bottom fittings, and pressure relief devices. The exact location and extent of the damage varied depending on the orientation and speed of the wagons during the derailment.

When the tank cars were breached, the petroleum crude oil was released, fuelling the fire. The damage to the tank wagons could have been reduced by enhanced safety features. This is why the TSB called for tougher standards for tank cars carrying flammable liquids.

Safety culture at MMA

An organization with a strong safety culture is generally proactive when it comes to addressing safety issues. MMA was generally reactive. There were also significant gaps between its operating instructions and how work was done day to day. This and other signs in MMA's operations were indicative of a weak safety culture – one that contributed to the continuation of unsafe conditions and unsafe practices, and significantly compromised the company's ability to manage risk.

When the investigation looked carefully at MMA's operations, it found that employee training, testing, and supervision were not sufficient, particularly when it came to the operation of hand brakes and the securement of trains. Although MMA had some safety processes in place and had developed a safety management system in 2002, the company did not begin to implement this safety management system until 2010; by 2013, it was still not functioning effectively.

Transport Canada

For several years, Transport Canada's regional office in Quebec had identified MMA as a company with an elevated level of risk that required more frequent inspections. Although MMA normally took corrective action once problems were identified, it was not uncommon for the same problems to reappear during subsequent inspections. These problems included issues with train securement, training, and track conditions. Transport Canada's regional office in Quebec, however, did not always follow up to ensure that these recurring problems were effectively analyzed and that the underlying conditions were fixed.

In addition, although MMA had developed a safety management system in 2002, Transport Canada's regional office in Quebec did not audit it until 2010 – even though this is Transport Canada's responsibility, and despite clear indications (via inspections) that the company's safety management system was not effective. Transport Canada Headquarters in Ottawa, meanwhile, did not effectively monitor the Region's activities. As a result, it was not aware of any weaknesses in oversight of regional railways in Quebec, and did not intervene.

Single-person crews

The TSB looked very carefully at single-person train operations, and at whether having just one crew member played a role in the accident. After looking at the circumstances that night, the investigation was not able to conclude that having another crew member would have prevented it.

However, there are some clear lessons for the system. If railways in Canada intend to implement single-person train operations, then they need to examine all the risks and make sure measures are in place to mitigate those risks. Transport Canada, for its part, should consider a process to approve and monitor the railways' plans so as to assure safety.

Dangerous goods: Inadequate testing, monitoring, and transport

The petroleum crude oil in the tank wagons was more volatile than described on the shipping documents. If petroleum crude oil is not tested systematically and frequently, there is a risk from it being improperly classified. The movement of these improperly classified goods increases the risk to people, property, and the environment. That is why the TSB issued a safety advisory letter calling for changes.
Action taken

In the weeks and months after the accident, the TSB communicated critical safety information on the securement of unattended trains, the classification of petroleum crude oil, rail conditions at Lac-Mégantic, and the employee training programs of short line railways.

MMA, meanwhile, eliminated single-person train operations, stopped moving unit trains of petroleum crude oil, and increased operating-rules testing and enforcement.

For its part, Transport Canada introduced numerous initiatives, including an emergency directive prohibiting trains transporting dangerous goods from operating with single-person crews. Sections of the Canadian Rail Operating Rules were also rewritten, and new tank car standards have been proposed.

Considerable action was also undertaken in the United States (US). The National Transportation Safety Board issued recommendations aimed at route planning for hazardous materials trains, petroleum products response plans for worst-case spills, and the classification of hazardous materials. The US Department of Transportation also issued an emergency order strengthening train securement rules, and a notice of proposed rulemaking targeting, among other items, improved tank wagon standards.

Recommendations

In January 2014, the TSB made three recommendations to address systemic safety issues that posed a significant risk. Three months later, it assessed the action that had been taken by government and industry. In August 2014, it made two further recommendations:

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Status</th>
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<tr>
<td>R14-05 (August 2014)</td>
<td>NEW</td>
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<td>Transport Canada must take a more hands-on role when it comes to railways' safety management systems—making sure not just that they exist, but that they are working and that they are effective.</td>
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<tr>
<td>R14-04 (August 2014)</td>
<td>NEW</td>
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<td>Canadian railways must put in place additional physical defences to prevent runaways.</td>
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<tr>
<td>R14-03 (January 2014)</td>
<td>Fully Satisfactory (June 2014)</td>
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<td>Emergency response assistance plans must be created when large volumes of liquid hydrocarbons, like oil, are shipped.</td>
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<tr>
<td>R14-02 (January 2014)</td>
<td>Satisfactory Intent Note 1 (June 2014)</td>
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<tr>
<td>Railway companies should conduct strategic route-planning and enhance train operations for all trains carrying dangerous goods.</td>
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<tr>
<td>R14-01 (January 2014)</td>
<td>Satisfactory in Part Note 2 (July 2014)</td>
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<td>Enhanced protection standards must be put in place for Class 111 tank cars.</td>
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**Note 1:** Railways must make progress on the development and implementation of new rules to improve their operating practices for the safe transportation of dangerous goods.

**Note 2:** Although progress has been made, more work is required. All older Class 111 tank cars must not transport flammable liquids, and a more robust tank car standard with enhanced protection must be set for North America.

Findings

The TSB identified 18 distinct causes and contributing factors, many of them influencing one another:
The report also contains **16 findings as to risk**. Although these did not lead directly to the accident, they are related to unsafe acts, unsafe conditions, or safety issues with the potential to degrade rail safety. Some of the risks that need to be addressed are:

- The continuing risk from leaving trains unattended;
- The risk from implementing single-person train operations;
- The risk from not systematically testing petroleum crude oil;
- The risk from not planning and analyzing routes on which dangerous goods are carried;
- The risk from not having emergency response assistance plans in place; and
- The risk from Transport Canada not ensuring that safety management systems work effectively.

**Conclusion**

The TSBC note that the Lac-Mégantic accident ‘was not caused by one single person, action or organization. Many factors played a role, and addressing the safety issues will take a concerted effort from regulators, railways, shippers, tank wagon manufacturers, and refiners in Canada and the United States’.

Although its investigation is complete, the TSBC says it will continue to monitor the five recommendations, and to report publicly on any progress – or lack of progress – until all of the safety deficiencies have been corrected.  

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For the full report, click here.

On Wednesday 28 August 2013, a wheelchair user and her carer were waiting at Southend Central station for the arrival of a train when the wheelchair started to roll towards the edge of the platform, and then fell to the track. Although the passenger and her wheelchair were recovered to the platform before the train arrived, the passenger was seriously injured in the fall.

On Wednesday 18 September 2013, a mother and her two young children entered Whyteleafe station, near Caterham in Surrey. As the mother was purchasing a ticket from the ticket machine on the platform, the pushchair with baby strapped in started to roll away. The mother was unaware of this until it was too late to stop the pushchair rolling off the edge of the platform and on to the track. The baby suffered minor injuries in the fall.

The RAIB investigation into the accidents found that the platforms at both Southend Central and Whyteleafe stations sloped towards the railway. At the time of their construction there was no specific requirement for platforms to slope away from the railway.

The RAIB’s investigation also found that the individuals in charge of the wheelchair and pushchair had not applied the brakes and had not noticed that the platform sloped towards the track. There was nothing to alert users of either station to the presence of the slope.

The railway industry had generally recorded previous incidents of a similar nature as due solely to errors by the individuals concerned. As a consequence, the industry had not recognised the part that sloping platforms had played in the incidents.

RAIB has identified the following learning point for the railway industry:

- All Station Facility Operators are reminded of the importance of providing a means for their staff to call the signaller in case of emergency. Measures for consideration include the provision of mobile phones with a quick dial facility, or alternatively, posting a current and legible list of emergency numbers at prominent positions throughout the station.

**Recommendations**

- Network Rail and Station Facility Operators should implement processes for managing the risk of wheelchairs and pushchairs rolling onto the track. These should include:
  - The inclusion of platform slopes as a factor to be considered when assessing the risk to passengers on platforms;
  - Guidance to risk assessors on factors likely to exacerbate any risk of roll away (such as the presence of ticket machines, help points and shops/kiosks where people are more likely to release their hold on pushchairs and wheelchairs);
  - Consideration of measures to manage the risk (taking account of the work arising from the implementation of Recommendation 3 in the short term and Recommendation 2 in the longer term);
  - Specific consideration of the impact on platform slopes of any works that are to take place at the station and methods of ensuring that those works will, as a minimum, not worsen the slope (and reduce or eliminate it if reasonably practicable to do so); and
  - The sharing of information concerning any residual risk at the conclusion of works.

- Network Rail in consultation with the Association of Train Operating Companies (ATOC), RSSB and the Department for Transport, should (as part of the national strategy for managing the platform train interface risk) arrange for work to be undertaken to determine when a slope towards
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the railway could become a significant hazard, and ways of mitigating the risk. The scope of the exercise should consider:

- All slopes on platforms including those that have been installed intentionally (for example to accommodate changes in level along the platform length);
- At what point a slope towards the railway makes it more likely than not that a wheelchair or pushchair without brakes applied could roll away, taking account of modern designs of such equipment; and
- Other factors such as how individuals perceive a slope hazard, the most appropriate way to highlight the hazard, appropriate methods to influence public behaviour, and other ways of mitigating the risk.

Once the work is complete the industry should publish appropriate guidance, including consideration of standardisation in the contents of signage, announcements, and so on.

- As an interim measure, pending the outcome of the research identified in Recommendation 2, ATOC should, in consultation with passenger groups including those representing the interest of disabled passengers, review the findings of this report and seek to understand the ways in which the risk of wheelchairs and pushchairs rolling onto the track can be more effectively managed by operators. This review should include consideration of:
  - Locations where passengers may need to remove both their hands from a pushchair or wheelchair because of the nature of another task to be performed (eg at a ticket machine or shop/kiosk);
  - Reference to any existing good practice in this area; and
  - Measures that could most effectively influence the behaviour of passengers using wheelchairs and pushchairs on station platforms.

The output of the review should be consolidated into suitable guidance for train operators.

- Network Rail, in consultation with Station Facility Operators and RSSB, should implement a process to improve the investigation and recording of roll-off incidents and the way in which data is shared. Particular attention should be paid to the following areas:
  - Improvements in capturing and recording incidents involving roll-off type events, including the identification of the key factors that caused the roll-off such as the presence of a slope towards the railway on the platform;
  - A review of previous roll-off incidents and accidents (covering at least the last five years) to identify those that may have been solely attributed to ‘user error’ or ‘trespass’, including establishing whether there may have been other causal factors such as a slope at the location concerned; and
  - A review of how intelligence on roll-off incidents should be shared within and between SFOs and Network Rail as an input to decisions on the nature and content of improvement works at stations (Recommendation 1 also refers).

Published 18 August

Australia: Freight train derailment near Ouyen, Victoria, 10 August 2013

For the full report, click here.

At about 08:34 (local time) on 10 August 2013, a freight train derailed at a failed mechanical rail joint between Tempy and Bronzewing in Victoria. Nine wagons located mid-consist derailed and separated from the rest with three wagons ending up on their side. The two locomotives, the leading 21 wagons
and the last 10 wagons remained on the track. Approximately 300 metres of track were destroyed. There were no reported injuries to the train crew.

The Australian Transport Safety Bureau (ATSB) found that the mechanical rail joint failed due to the development of fatigue cracks in both fishplates resulting in their subsequent overload fracture. The fatigue cracks had originated in the top surface of each fishplate and it is possible that differential sleeper support may have contributed to higher than normal cyclic tensile stress in the fishplates. Lower than required fishbolt torque was also identified and it is possible that movement within the joint may also have contributed to the development of the fatigue cracks, and the subsequent joint failure.

The fatigue cracks had developed over a period of time and the overload fractures had occurred beforehand. Movement of the separated rail ends during the passage of the train resulted in a lateral discontinuity in the running rail at the joint and the train’s derailment.

The ATSB found that the degraded and deteriorating condition of the rail joint was not detected by V/Line’s track inspection. In the 27 months before the derailment, visual inspections of this section of track had been conducted solely from rail vehicles and track walking inspections had not been conducted at intervals specified by maintenance procedures.

Action taken

V/Line has updated its maintenance system to generate automated work orders for track walking inspections. In order to improve the detection of track defects, maintenance staff have been provided with specific inspection criteria for track infrastructure including joints and fastenings in their work orders.

Safety message

The implementation of effective inspection and maintenance regimes for the early detection and management of track defects is critical to the safety of rail operations.

Published 21 August

**UK: Fatal accident at Barratt’s Lane No.2 footpath crossing, Attenborough, Nottingham, 26 October 2013**

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

At 14:48 on Saturday 26 October 2013, a pedestrian was struck and fatally injured by a train on Barratt’s Lane No.2 footpath crossing, at Attenborough near Nottingham.

The train was travelling from Nottingham towards Birmingham. At the same time, a London to Nottingham train was slowly approaching the crossing from the other direction. It is likely that the pedestrian had concentrated her attention on the London train and did not notice the train approaching from the Nottingham direction.

Both trains were fitted with forward-facing CCTV equipment and the recording from the London to Nottingham train showed that the pedestrian approached the crossing and waited at the gate for 17 seconds before opening it; she started to cross the line 9 seconds later (the train was stopped at a red signal for part of this time). It is most likely that, having seen the London train stopped at the signal, she waited until she had determined that the train was not moving before deciding to cross the line. The sighting distances in both directions were adequate.

Network Rail had assessed the risk at the crossing, in accordance with its standard procedures, and, because the risk rating was relatively high, discussed the options for reducing this risk at a meeting with the highway authority. The chosen option was to divert the footpath and close the crossing. This had not been implemented at the time of the accident as the route of the proposed diversion was obstructed by an equipment room. The room contained signalling equipment that did not become redundant until
completion of the Nottingham station resignalling project at the end of August 2013. The equipment room was demolished and the footpath diverted after the accident.

RAIB has identified the following key learning point16 for the railway industry:

- For double track lines, kissing gates arranged with the hinge on the right-hand side encourage footpath users to face towards the oncoming traffic on the nearest line as they exit from the gate. This is particularly relevant where the gate is close to the track. RSSB is shortly to provide advice on how the arrangement of gates and barriers at a crossing influences the behaviour of pedestrians (project T984), and will include this in a future update of the level crossing risk management toolkit.

Recommendations

- None issued.

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