LESSONS LEARNED FROM TSB RAIL INVESTIGATIONS:

THE EVOLUTION OF THE TSB WATCHLIST

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SUMMARY

The Transportation Safety Board of Canada (TSB) is an independent agency that investigates marine, pipeline, rail and air transportation accidents and communicates the results to Canadians. Using the results of hundreds of investigations and countless hours of accident analysis, the first TSB Watchlist was developed in 2010 and was intended to serve as a blueprint for change in the transportation sector. Watchlist issues are regularly monitored and the Watchlist is revised every 2 years. Issues that have been addressed are removed from the list while other emerging issues are added to the revised list.

Following the release of the Watchlist, the TSB assumed more of an advocacy role to engage the regulator and industry stakeholders. To date the Watchlist has played a useful role in advancing safety as evidenced by the issues that have been addressed and subsequently removed from Watchlist 2010. However, as new issues emerged, they were added to Watchlist 2012 and the cycle continues.

INTRODUCTION

Individual accidents/incidents are investigated for cause and contributing factors while structured analysis of the results reveals trending and re-occurring issues that also have the potential to impact rail safety. With this in mind, this paper outlines *Lessons Learned from TSB Rail Investigations* over the years that have resulted in *The Evolution of the TSB Watchlist* to date This includes the:

- Role of the TSB, its mandate and how work is performed;
- Communication of Risks and communication tools;
- Initial Top 10 Significant Safety Issues List (1995) that reflected recurring safety issues;
- *Watchlist 2010,* criteria used for its development/review and the rail safety issues identified;
- Development of Watchlist 2012 including a review of 2 recent TSB investigations that identified emerging issues

ROLE OF THE TSB

The TSB is an independent multi-modal agency that consists of up to five Board members, including a chairperson, and about 220 employees nationwide which includes 21 Rail Investigation Branch staff.

The TSB mandate is advance transportation safety in the marine, pipeline, rail and air modes of transportation by:

- Conducting independent investigations
- Identifying safety deficiencies
- Identifying causes and contributing factors
- Making Recommendations
- Reporting publicly

It is not the function of the TSB to assign fault or determine civil or criminal liability.

How we do our work

In Canada, the TSB is the keeper of all rail accident data. There are about 1300 rail occurrences per year reported to the TSB. When reported, each occurrence is assessed using the TSB Occurrence Classification policy in order to determine an immediate course of action. If no immediate action is necessary, occurrences are assigned to the Investigator responsible for the area in which accident/incident occurred and the investigator follows up to obtain missing mandatory data and close out the file. If immediate action is required, an Investigator-in-Charge (IIC) is assigned and a team is deployed to the accident site. There are approximately 25 to 30 deployments per year that result in about 15-25 formal TSB rail investigations.

For each reportable occurrence, mandatory data and accident cause codes are recorded in the TSB Rail Occurrence Data System (RODS). The data is used extensively for statistical analysis in order to identify trends or provide analysis in support of ongoing investigations. Each year the data is also compiled into an annual report which is formally submitted to the Parliament of Canada for review.

COMMUNICATION OF RISKS

The TSB communicates identified risks in the system to those persons or organizations best able to effect change to convince them to take remedial action. The TSB has the following communication tools:

- Rail safety information letters (RSI)
- Rail safety advisory letters (RSA)
- TSB investigation reports
- Safety concerns
- Board recommendations
- Watchlist

Safety information and advisory letters

RSIs generally deal with local conditions that pose low systemic risk while RSAs generally deal with safety deficiencies of a systemic nature and suggest a remedial action to reduce the risk.

Both can be issued as part of a Class 5 investigation follow-up or a formal Class 2/3 investigation. They are directly approved by the Rail Branch Director of Investigations (DOI) and can be issued quickly as evidenced by the 2 RSAs issued in relation to the Lac-Megantic, Quebec accident (R13D0054) less than 2 weeks into the investigation.

TSB investigation reports

The key TSB product is the Board's investigation report. This is the culmination of extensive investigation which includes interviews, data analysis, wreckage examination, and a thorough review of all relevant information associated with an accident. The report goes through extensive vetting, including the review by designated reviewers. It also receives review and approval by the Board at the initial draft and final stages. Once the investigations are complete, the TSB publicly releases the reports on its website and through traditional and social media.

Safety concerns and Board recommendations

Safety concerns and recommendations require TSB Board approval and are usually contained in final investigation reports.

Safety concerns identify an unsafe condition for which there is insufficient evidence to validate it as a systemic deficiency, but the risk still warrants highlighting. A safety concern provides a marker to the industry and the regulator for that particular issue and the Board may re-visit the issue if it recurs.

During or at the conclusion of an investigation, if a systemic deficiency poses a high risk to the system, the Board can issue recommendations to a regulator or other stakeholder. Federal ministers must respond to TSB recommendations within 90 days. The responses are assessed by the Board to determine the extent to which the issue is being or has been addressed.

Watchlist

Using the results of hundreds of investigations and countless hours of accident analysis, the first TSB Watchlist was developed in 2010 and was intended to serve as a blueprint for change in the transportation sector. Watchlist issues are regularly monitored and the Watchlist is revised every 2 years. Issues that have been addressed are removed from the list while emerging issues are added to an updated list.

TOP 10 SIGNIFICANT SAFETY ISSUES LIST (1995)

From TSB's inception in 1990 up to and including 1995, the Rail Branch produced 346 reports (average 58/year). The volume of work gave the TSB a good understanding of the primary causes of rail accidents at that time and it became clear that there were a number of causes or safety issues that continually re-occurred. This resulted in a change in philosophy. The TSB became more selective about the types of accidents it investigated but the investigations became more detailed. In 1995, the TSB developed a Top 10 Significant Safety Issues List that reflected recurring safety issues (see Table 1).

Issue	More Recent TSB Investigations
Frequency of Runaway Cars Equipment	R13D0054 Lac-Megantic, R12E0004 – Hanlon, R09T0057 – Nanticoke
Inadequate Car Inspections	R09W0016 – Dugald Stub Sills, R04W0148 – Estevan
Detection of Internal Tracks Defects	R13W0145 – Sutherland RSA, R08C0164 - Burdett
Regulatory Overview of Operations	R13D0054 – Lac-Megantic, R12T0038 – Burlington, R09T0092-Brighton
Shipping Dangerous Goods	R13D0054 Lac-Megantic, R10T0020 MacMillan Yard , R09W0016 - Dugald
Onboard Safety of Passengers /Employees	R12T0038 Burlington, R10Q0011 – St. Charles
Adequacy of Crew/Work Rest Scheduling	R07E0129 – Peers, R03W0169 - Carlstadt
Subgrade Embankment Instability	R13W0124 – Togo, R10D0077 – St Lazarre
Lack of Voice Recorder Capabilities	R12T0038 – Burlington, R10Q0011 – St Charles, R99T0017 – Trenton Junction
Frequency of Crossing Collisions	R11T0175 – Glencoe R08T0158 – Kingston, R07D0111 - Pincourt

Table 1. TOP 10 SIGNIFICANT SAFETY ISSUES LIST (1995)

Many of the same issues continue to be relevant today as evidenced by the number of more recent TSB investigations that identified some of the same causal or risk elements that were highlighted on the TSB Top 10 Significant Issues List Rail - 1995.

ORIGIN OF TSB WATCHLIST 2010 – RAIL

The Significant Issues List served to identify common issues up to the mid-late 2000's. However, there was no structured analysis used to develop the list and no communication with the Regulator or Industry to advocate for improvements.

A more concentrated effort was necessary, and the concept of the TSB Watchlist was developed in 2010.

The Watchlist is based on analysis of TSB investigation reports, safety concerns and Board recommendations. It identifies rail safety issues that re-occur and pose significant risk to the system.

Watchlist criteria

The following criteria are used to identify and add Watchlist issues:

- Issue validated by TSB statistical analysis, investigation reports, findings, safety advisories/info letters, safety concerns and/or recommendations.
- Insufficient or inadequate safety action has been taken.
- Issue considered as High Risk (probability & severity).

The following criteria are used to remove Watchlist issues:

- Significant Safety Action has been taken.
- TSB Recommendations assessed as "Fully Satisfactory"
- Residual risk considered Low.

WATCHLIST 2010 ISSUES

The first Watchlist included the following 4 rail safety issues:

- In-train forces/longer, heavier trains
- Safety management systems (multi-modal)
- Data recorders (multi-modal)
- Passenger trains colliding with vehicles

In-Train forces/longer, heavier trains

Inappropriate handling and marshalling can compromise the safe operation of longer, heavier trains. Freight trains cross the country every day. The length of each train, as well as the manner in which its cars are marshalled, or put together, affects the forces involved during train handling. Lighter cars, for example, slow down and speed up more quickly than heavier ones, generating disruptive push/pull forces that can derail the train. This effect is more pronounced in longer trains, particularly when empty cars are located at the front.

Since 2000, the TSB has investigated at least 12 derailments[1] where these in-train forces have been a causal or contributing factor, and the problem is growing. Not only are trains involved in main-track derailments heavier than ever, they are longer, too—over 25 per cent from just 15 years ago.[2] Some of today's longer, heavier trains stretch over three kilometres in length and contain 150 cars or more. These trains are seeing expanded use across Canada, including into the country's busiest traffic corridors. The consequences of any derailment, therefore, can become magnified, and it is important that those who identify and monitor the risks be able to mitigate them.

Following the 2007 derailment of a freight train near Cobourg, Ontario, the TSB once again drew attention to train configuration and braking, expressing concern that effective measures have not been taken to reduce the continued risks of derailment.[3]

The TSB has issued four other safety communications since 2001[4] 6 all dealing with the safe operation of longer, heavier trains. Despite these efforts, some railways have not taken sufficient steps required to safely manage these in-train forces. To solve the problem, railways need to take further steps to ensure the appropriate handling and marshalling of longer heavier trains and risk assessments should be performed whenever operating practices change.

Safety management systems

Implemented properly, safety management systems (SMS) allow transportation companies to identify

hazards, manage risks, develop and follow effective safety processes. However, Transport Canada (TC) does not always provide effective oversight of transportation companies transitioning to SMS, while some companies are not even required to have one.

Although SMS has been in place in the rail industry since 2001, recent investigations have shown that the

railways are not always taking effective action to identify and mitigate risk through their SMS. The TSB has also found that regulatory audits are not always effective and do not consistently produce the expected benefits.

In the rail industry, 6 separate Board investigations have examined the issue of SMS.[5] The Board has also issued 4 safety communications[6] dealing with this issue, as well as a formal recommendation calling for the identification and mitigation of risks to safety as required by a railway's SMS.[7] Significant deficiencies, however, remain across a wide range of operations. To solve the problem, TC must proactively monitor SMS practices to ensure they are effectively applied.

1 TSB Investigation Reports R00Q0023, R01M0061, R01T0006, R02C0050, R02W0060, R05C0082, R7T0110 and R07D0009 and TSB Occurrence Summaries R01T0026, R05T0070, R05D0039 and R05T0051

2 Between 1995 and 1999, average mass of trains involved in main-track derailments was 5130 tonnes, average length was 4097 feet, and average number of cars per train was 66. Between 2005 and 2009, average mass increased to 7163 tonnes.

3 Rail Safety Information letter (RSI) 14/07, RSA 08/07, RSA 09/07, Safety Concerns (i) and (ii) R07T0110.

4 Recommendation R04-01, Safety Concern R02C0050, RSI 08-02, RSA 02-06.

5 TSB Investigation Reports R03V0083, R05V0141, R06V0136, R06V0183, R07V0213 and R08M0015.

6 Rail Safety Advisories (RSA) 02/07, 12/07, 14/07 and 04/08.

7 TSB Investigation Report R06V0136

Data recorders

Data critical to understanding how and why transportation accidents happen are frequently lost, damaged or not required to be collected. Following any accident, investigators have a long list of questions, starting with "what happened," and "why." A prime source for information is the locomotive event recorder (LER). It contains valuable information related to engine and equipment settings that can help pinpoint what happened. However, LERs can be lost or damaged in accidents and some important parameters are not required to be recorded.

Lost locomotive data in the rail industry has impeded investigation efforts in 6 fatal railway accidents in the last 18 years.[8] Although new crashworthy recorders are slowly being phased in as older locomotives reach the end of their service life, given the 20-30 year lifespan of locomotives, complete replacement of all LERs may be decades away.

Without a secure, retrievable information record, the search for hard evidence becomes more difficult. This can translate into longer investigations and can cause delays that place public safety at risk. With objective data, however, it is easier to pinpoint deficiencies which, when corrected, will make the system safer.

The TSB has also emphasized the survivability of recorded data on trains, and made multiple calls for improved crashworthiness standards to better preserve data.[9] To solve the problem, the industry needs to expand adoption of recently improved recorder standards to prevent the loss of data following accidents.

Passenger trains colliding with vehicles

The risk of passenger trains colliding with vehicles remains too high in busy rail corridors. Every day, cars and trucks regularly cross Canada's 15000 railway crossings. Negotiating the crossing is usually successful but 380 times in the last 15 years—on average, once every 2 weeks—something has gone wrong and 106 Canadians have died when their vehicle was struck by a passenger train.

Warning signs, at both public and private crossings, are the first line of defence, helping to reduce the risk by making drivers aware of approaching trains and approximately 1/3 of public crossings also feature automatic warning devices (AWD) such as flashing lights, a bell, and crossing gates. Yet even when crossings are equipped with AWD protection, collisions between vehicles and passenger trains continue to occur.

In 1993, prior to authorizing an increase in train speed from 95 mph to 100 mph along the Québec-Windsor corridor, Transport Canada conducted safety assessments to identify crossings that required upgrading. These assessments are nearly 20 years old. They no longer reflect the present risks, nor do they consider emerging ones. Given that a 3rd track is being constructed along portions of the busy corridor between Montréal and Toronto, the need for action is even more pressing.

Following the investigation of a 2008 collision between a passenger train and an immobilized tractor-trailer, the TSB called for clearer warning signs at steep crossings, noting that the design and placement of these signs has been inconsistent.[10] This recommendation was the 6th that the TSB has made since 1999 about the dangers of vehicles crossing railways in busy corridors.[11]

As Canada's population has grown, so has rail traffic in communities along busy rail corridors. Improving the design and placement of signage is just the beginning. New information from safety assessments is needed to reduce the risks of collisions at rail crossings. To solve the problem, Transport Canada and the railways need to conduct safety assessments to identify high-risk crossings along busy passenger train routes and make the necessary safety improvements.

WATCHLIST 2010 REVISION

Following the rollout of Watchlist 2010, the TSB actively engaged the regulator and industry stakeholders and a broad discussion surrounding the issues ensued. All parties were asked to think "outside the box" in terms of what could be done to mitigate issues. Two years later, after numerous discussions and updates from the regulator and industry, the Watchlist 2010 issues were reassessed against the Watchlist criteria.

This resulted in the 3 issues being removed and 1 issue being retained from Watchlist 2010.

8 TSB Investigation Reports R92T0183, R96C0172, R97V0063, R99H0010, R03V0083 and R06V0136.

9 TSB Investigation Reports R96C0172, R97V0063 and R99H0010, Recommendation R02-04.

10 TSB Investigation Report R08T0158.

11 Five additional recommendations can be found in TSB Investigation Reports R99T0298 and R07D0111.

Issue removed - operation of longer, heavier trains

Since 2004, CP had developed, implemented and operated using a proprietary Train Area Marshalling system (TrAM). Since that time there were very few CP derailments caused by in-train forces. TrAM is computer-supported and includes instructions regarding marshalling and trailing tonnage limits for specific types of car equipment. TrAM also considers the placement of remote locomotives within the train and the placement of cars equipped with “end of car cushioning devices” (EOCCD). Other operating factors considered include the curvature and grade of the track. This system is applied to all mainline operations and is continually modified and improved upon. CP is noted in the industry for TrAM and its ability to manage in-train forces.

In 2010, CN initiated marshalling rules in Canada in an effort to minimize in-train forces. CN also uses the Witronix system which automatically generates train handling alerts and sends them to management whenever a train handling rule is potentially violated.

The railway industry has made significant progress in the use and development of new technologies and strategies for operating longer, heavier trains with distributed power. Consequently, from 2010 - 2012, the number of derailments caused by in-train forces appears to have decreased. Therefore, this issue was removed from the Watchlist.

Issue removed - rail safety management systems

Both the Regulator and industry have improved SMS guidelines and processes to help identify hazards, manage risks, and develop effective safety procedures.

The Regulator continues to monitor railway SMS programs through audits and inspections to ensure that they are effectively implemented by the railway.

The related TSB recommendation was rated as *Fully Satisfactory*.

With these safety actions in place, the residual risk was re-classified as low and this issue was removed from the TSB Watchlist.

Issue removed - data recorders

The revised Transport Canada approved Locomotive Inspection and Safety Rules now include improved parameter and survivability requirements for new LERs.

Both CN and CP are working towards having about 65% of their locomotive fleet equipped with new LERs while VIA works towards having all its locomotives equipped with new LERs.

LER survivability has also improved with the use of Distributed Power (locomotives distributed throughout the train) and in some cases, wireless transmission of LER information at regular intervals.

The related TSB recommendation was also rated as *Fully Satisfactory*.

With significant progress made on this issue, it was removed from the Watchlist.

Issue retained - passenger trains colliding with vehicles

On the Quebec-Windsor corridor, there are 1022 crossings (excluding grade separations). Of these, there are 632 public crossings and 390 private / farm crossings. Approximately 85% of the public crossings are protected by flashing lights, bells and gates but only 3% of the private / farm crossings are protected by an active warning device. Within the past 2 years, over 80 crossings have been closed on this corridor.

There continues to be progress in conducting crossing safety assessments along the Quebec – Windsor corridor. Progress is also being made towards the development of special signage at crossings for emergency contact numbers and low ground clearance advance warning signs.

Since 2010, there have been 10 crossing accident on the Quebec-Windsor corridor (i.e., an average of 5 per year). Over the past 10 years (2001 to 2010), the average number of crossing accidents on this corridor has been 5.6 per year.

The revised Railway-Roadway Grade Crossing Regulations (draft) will provide for better standards on high-speed corridors and prevent new crossings from being built where train speeds exceed 128 km/h. However, delays approving the new regulations (25 yrs) continue to be problematic and the corridor accident rate remains similar (5/yr since 2010 vs 5.6/10 yr. avg.)..

While progress has been made, accidents continue to occur at a similar frequency and implementation of the new Grade Crossing Regulations remains problematic. Until the new grade crossing regulations are in place, this issue shall remain on the Watchlist.

WATCHLIST 2012 – NEW CHALLENGES EMERGE

Since 2010, new challenges emerged. Two more recent accidents investigated by the TSB (R10Q0011 - Saint- Charles-de-Bellechasse, Quebec and R12T0038 – Burlington, Ontario) have highlighted 2 significant emerging issues, *Following Signal Indications* and *On-Board Video & Voice Recorders*.

Case study of TSB investigation R10Q0011 - Saint-Charles-de-Bellechasse

On 25 February 2010, VIA passenger train No. 15 was travelling west from Halifax, NS to Montréal QC, through a severe winter storm. Upon approaching Saint-Charles-de-Bellechasse QC, the train encountered an advance signal displaying a clear-to-stop indication (Picture 1) which meant to proceed at track speed and be prepared to stop at next signal. The next signal encountered was for the Saint-Charles-de-Bellechasse siding which displayed a restricting signal that should have indicated to the crew that the train was restricted to 15 mph. At about 0435, the train entered the siding at about 64 mph and derailed 2 locomotives and 6 passenger cars (Picture 2). Two locomotive engineers and 5 passengers were injured.

Extensive testing of the signaling system was carried out and it was determined that the signals did not malfunction; they operated exactly as intended. The investigation determined that the crew likely misperceived the signals displayed.

Picture 1. Advance signal displayed.


Picture 2. Locomotive derailed.

R10Q0011 – findings as to cause and contributing factors

- The derailment occurred when the train entered the siding travelling at about 4 times the authorized speed.
- The crew's mental model combined with the poor weather likely led to the misperception that the advance signal was clear, rather than clear–to–stop.
- Due to reduced visibility caused by snow, the home signal was not recognized and acted upon until the crew was within 500 feet of the main–track switch.
- The crew's planning and reaction to more complex issues was likely degraded due to fatigue.

R10Q0011 – findings as to risk

- Existing defences, such as 2–man crews and the Centralized Traffic Control (CTC) system, do not ensure that signal indications will always be followed. In the absence of additional defences, the risk of serious train collisions or derailments remains.

- The absence of voice recordings made it impossible to confirm the nature of crew communications. Where investigators are not able to understand all of the human factors involved, the Canadian railway industry is deprived of valuable information that can improve safety.

Case study of TSB investigation R12T0038 – Burlington

On 26 February 2012, VIA passenger train No. 92 was travelling east from Niagara Falls to Toronto, Ontario, on track 2 of the Canadian National Oakville Subdivision. Beyond a stop at Aldershot Station, the track switches were lined to route the train from track 2 to track 3. The last signal displayed required the train to proceed through the crossover at 15 mph. However, at about 1525, the train entered the crossover at about

67 mph, causing the locomotive and all 5 coaches to derail (Picture 3). The 3 operating crew members in the locomotive cab were killed; 44 passengers and the VIA service manager were injured. About 4300 litres of diesel fuel spilled from the locomotive fuel tank.

Extensive testing of the signaling system was carried out and it was determined that the signals did not malfunction; they operated exactly as intended. The investigation determined that the crew likely misperceived the signals displayed.

Picture 3. VIA passenger train derailment.

R12T0038 – findings as to cause and contributing factors

- The stop at Aldershot Station interrupted the continuous progression of signals which may have contributed to the train crew forgetting the previous Clear to slow (Y/Y) indication.
- The frequent use of track 2 may have influenced the misperception of signal 334T2 as being more permissive.
- The crew likely became focused on resolving a track occupancy conflict with a signals crew working ahead on track 2 rather than identifying signal 334T2 and slowing the train.
- The crew may have become focused on the more salient Flashing Yellow (FY)/Flashing Green (FG) aspects and misinterpreted signal 334T2 as Advance Clear to Limited, which would permit them to travel at track speed, rather than Slow to Limited (Red/FY/FG) which should have restricted speed to 15 mph.

R12T0038 – findings as to risk

- Without additional physical fail safe defences to reduce the consequences of inevitable human errors in signalled territory, the risk of collisions and derailments persists.
- The lack of locomotive in-cab voice and video recorders and forward facing video recorders deprives accident investigators of valuable sources of information that can enhance safety.

As a result of this investigation, the Board recommended that:

> The Department of Transport require major Canadian passenger and freight railways implement physical fail-safe train controls, beginning with Canada's high-speed rail corridors.
>
> (Recommendation R13-01)

and

> The Department of Transport require that all controlling locomotives in main line operation be equipped with in-cab video cameras.
>
> (Recommendation R13-02)

WATCHLIST 2012

The case studies of TSB investigations R10Q0011 and R12T0038 highlighted 2 emerging issues. Subsequently, *Following Signal Indications* and *On-Board Video & Voice Recorders* have been included in the updated Watchlist 2012.

Following signal indications

Since 2002, there has been an average of 11 occurrences per year where a train crew either misidentified, misinterpreted, did not recognize or respond to a wayside signal displayed. As evidenced by a number of TSB investigations,[12] this type of occurrence can result in a train collision or derailment that imposes significant risk to both the public and the environment.

Since 1911, the railway industry in Canada has relied on centralized traffic control (CTC), a system of visual signals, to control traffic on a significant portion of its network. The CTC system provides train crews with a series of signal indications requiring actions relative to the signal displayed. The signal indications convey information such as operating speed and the operating limits within which the train is permitted to travel. Train crews must be familiar with the signal indications and must control their trains accordingly.

If signal indications are not followed, the CTC system cannot ensure that trains on the same line are separated appropriately. CTC does not provide any warning that a train may be passing beyond a restricted location, nor does it provide automatic means to slow or stop a train before it passes a stop signal or other points of restriction.

To augment CTC safety measures, railways have adopted various operating rules and instructions to help prevent accidents. However, these primarily administrative defences have proven to be ineffective when a train crew misperceives a signal indication or does not apply, or misapplies, an operating rule. The TSB has previously made a recommendation on this important issue. It recommended that:

> The Department of Transport and the railway industry implement additional backup safety defences to help ensure that signal indications are consistently recognized and followed.
>
> (Recommendation R00-04)

In response to recommendation R00-04, the industry implemented more rules and procedures but there was still no physical fail-safe train control system in place and these types of accidents continued to occur. Consequently, following the derailment of a VIA passenger train near Burlington Ontario in 2013 (R12T0038), the Board issued recommendation R13-01.

To solve the problem, physical fail-safe train control systems should be implemented to ensure that signal indications of operating speed or operating limits are consistently recognized and followed.

On-board video and voice recorders

Objective data is invaluable to investigators in helping them understand the sequence of events leading up to an accident and for identifying operational issues and human factors, including crew performance. Video and voice recordings would allow the Transportation Safety Board of Canada (TSB) investigators to confirm the nature of crew communications and the dynamics of crew actions and interactions. Moreover, such information would allow accident investigators to eliminate extraneous factors that did not play a role in the accident. Technology abounds in the area of recorded information and, indeed, the aviation industry has had voice recordings for at least three decades, and some sectors of the marine industry are considering adding video recordings to supplement their voice recordings.

A number of rail accident investigations in North America have led to findings, recommendations and other safety communications where human factors were identified as an underlying condition or an unsafe act. Many of these investigations would have benefitted from a recording of crew communications immediately prior to the accident. While some Canadian railway companies have already installed forward-facing video recorders on their locomotives, progress toward broader use of voice and video recorders in locomotive cabs has not been made. Subsequently, following the derailment of a VIA passenger train near Burlington Ontario in 2013 (R12T0038), the Board issued recommendation R13-02.

To solve the problem, the rail industry should ensure that communications in locomotive cabs are recorded.

[12] TSB investigations R12T0038, R10Q0011, R10V0038, R09V0230, R09W0118, R07E0129, R99T0017 and R98V0148.

CONCLUSIONS

- Structured analysis of TSB investigations and data identified rail issues that recurred and posed significant risk to the system. This led to the development of Watchlist 2010.
- With the emergence of Watchlist in 2010, the TSB assumed an advocacy role and more actively engaged the regulator and industry on Watchlist issues.
- In 2012, after numerous discussions and updates, Watchlist 2010 was reassessed and it was determined that there was significant progress on 3 of the 4 issues. Subsequently, the issues of *In-Train Forces/Longer, Heavier Trains, Safety Management Systems* and *Data Recorders* were removed from the Watchlist.
- The Watchlist evolved as the issues of *Following Signal Indications* and *On-Board Video & Voice Recorders* emerged and were added to Watchlist 2012.
- To date the Watchlist has proven to be a useful communication tool that has encouraged effective dialogue and change within the industry to improve safety.