THE STATE OF RAIL SAFETY IN CANADA

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1. Introduction

This paper describes work carried out for the *Railway Safety Act* Review Panel as part of its research program.[1] The purposes were:

- To examine and assess the state of rail safety in Canada as determined mainly from the Transportation Safety Board statistics on rail accidents and incidents;
- To consider the reliability and appropriateness of the statistics being used by regulators and provided to the public; and
- To make recommendations on how the information available can be improved for purposes of future assessments.

The study also included some comparison of rail safety in Canada and the United States, and considered the different accident/incident reporting criteria being used in the U.S., Australia and New Zealand.

The paper proceeds as follows: Section 2 describes the data sources and identifies important problems concerning the data; Section 3 outlines what may be concluded about the state of rail safety from the available data; Section 4 deals with international comparisons, comparing in particular Canada and the U.S.; Section 5 focuses on the critical issue of normalizing the data on accidents and incidents; Section 6 highlights the recommendations.

[1] The list of studies commissioned by the Panel may be found at http://www.tc.gc.ca/tcss/RSA_Review-Examen_LSF/research.htm.

2. Data Sources and Data Issues

This study is based largely on an examination of the railway accident and incident statistics published by the Transportation Safety Board (TSB),[2] supplemented by other information as needed.

Any rail accident or incident meeting the criteria stated in the TSB's regulations renders the occurrence reportable. Railway operators are required to report substantial information about such occurrences. For railways, the TSB categorizes accidents or incidents according to type of occurrence (e.g. derailments, collisions), location (e.g. main track, non-main track), third party involvement (crossings and trespassers) and other factors. Measures of safety typically cited using this data are the numbers of accidents and incidents, and the numbers of serious injuries and fatalities. Accidents and incidents specifically involving dangerous goods are also reported by the TSB.

The accident and incident reports made to the TSB are the principal source of safety-related occurrence data in Canada.[3] For purposes of this study, a major drawback of the data is that they pertain only to railways under federal regulation. This reflects the TSB's mandate but means that the data do not give the whole picture. In addition, the TSB data do not take into account changes that have occurred in the size of the rail network under federal jurisdiction. This includes the large reduction in the network in the 1990s, enabled by the *Canada Transportation Act*, and the increase in the network occurring with CN's takeover of BCR in 2004.

Another drawback is that the data does not account for the changes implemented in 1992 by the TSB in its reporting regulations. As a

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[2] See Transportation Safety Board, *Statistical Summary Railway Occurrences 2005* (Minister of Public Works and Government Services Canada, 2006) at http://www.tsb.gc.ca/en/stats/rail/2005/statssummaryrail05.pdf, as well as the earlier issues of this annual report and the Preliminary Statistics for 2006. The latest version of the annual report, *Statistical Summary Railway Occurrences 2006*, has not yet been posted.

[3] Dangerous goods are an exception in that the primary source of information on occurrences involving dangerous goods is the Dangerous Goods Directorate of Transport Canada.

result of these changes, which took a few years to become fully effective, it is difficult to make meaningful comparisons of the number of railway occurrences before and after the mid-1990s.

Discussions were held with a number of key stakeholders. These included the TSB, CN and CPR, Transport Canada's Rail Safety Directorate, Dangerous Goods Directorate and Surface and Marine Statistics and Forecasts division, and VIA Rail Canada. Important matters came up in these discussions. In particular, there are new TSB reporting regulations under consideration. These are currently with the Department of Justice for approval before being published in the Canada Gazette. Approval by Justice is likely a few months away but the regulations could become effective in 2008. In any event, these regulations will significantly affect reporting and therefore the comparability of future data with that currently available.

Another development is that some of the data has recently undergone revisions. These relate to the reported numbers of derailments, and were implemented with publication of the data for June 2007.[4] Derailment numbers have been revised back to 2002, making comparison with prior years more difficult. According to the TSB, the revisions are the result of clarifications to the industry concerning the reporting requirements. We understand that the TSB does not plan to reflect these revisions in its forthcoming annual *Statistical Summary Railway Occurrences 2006*, but they will presumably be included in the annual report for 2007.

It has also come to light that one of the principal measures being used by the TSB is of questionable validity, yet neither the TSB nor Transport Canada seem to have been aware of this. This data is the series on "Main Track Train Miles." This is provided to the TSB by Transport Canada and used by the TSB to normalize the statistics reported in its annual summary on total main track accidents, main track derailments and crossing accidents. Transport Canada, in turn,

[4] See Transportation Safety Board of Canada, Rail Occurrence Statistics for June 2007 at http://www.tsb.gc.ca/en/stats/rail/2007_jun/R06_2007_e.pdf.

has been taking the main track train miles data as published by the TSB and using it in its own Annual Report.[5]

The problem with the Main Track Train Miles data is that these are not actual numbers reported by the railways to Transport Canada but are estimates created within Transport Canada and provided to the TSB. No one, it seems, can explain with certainty how these estimates are developed, nor what they actually represent: how is "main track" defined, and are the data applicable only to federally regulated railways or to all railways?

3. The State of Rail Safety in Canada

Railway safety has been examined in terms of the following indicators: the total numbers of accidents; the numbers of accidents by type (i.e. main track, non-main track, crossing/trespassing accidents and others); accidents per train mile (see Section 5 below); the severity of accidents in terms of human casualties and numbers of cars derailed; the distribution of accidents by cause (i.e. environment, track, equipment and human actions); accidents involving passenger trains; and accidents involving dangerous goods.

In assessing the results, it is important to recognize that railways (like other modes) are inherently risky and, according to most experts, cannot be judged relative to a benchmark of zero occurrences. However, measuring true safety, which is the product of both the occurrences and their consequences, is complex and beyond the scope of this study.[6]

Bearing this in mind, and the data issues noted above, certain observations may be made about railway safety trends in Canada, at least since the mid-1990s. Space here precludes the inclusion of

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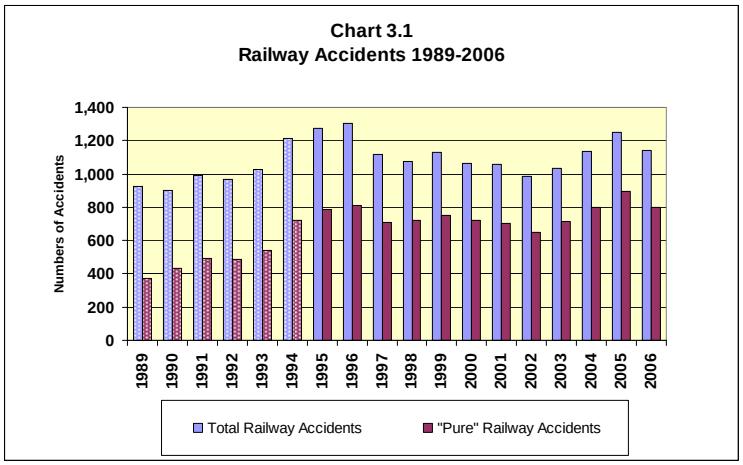
[5] See, for example, Transport Canada, *Transportation in Canada 2006 Annual Report* (Minister of Public Works and Government Services, 2006), p. 24 and 25.

[6] In discussions, some government regulators stated that, in their view, it is the numbers of occurrences that matters and not some complex product of numbers of occurrences and their consequences. They pointed out that many accidents had minor consequences only by luck. Thus, from the perspective of prevention, it is the absolute numbers of accidents that is indicative of safety problems and that matters.

charts for most of the indicators. Chart 3.1, however, shows two overall measures: total railway accidents; and "pure" railway accidents (i.e. total railway accidents excluding crossing and trespasser accidents and therefore not involving third parties).



Source: Transportation Safety Board

Total Accidents and Their Distribution by Type

- The system does not appear more risky today than a decade ago based on the total numbers of accidents as shown in Chart 3.1.
- Accidents are of different types with varying causes and consequences. About 1/2 are non-main track collisions and derailments that are generally minor. Somewhat more than 1/4 occur at crossings or involve trespassers. About 1/6 of rail accidents are main track collisions and derailments.

Crossing and Trespasser Accidents

- Crossing and trespasser accidents remain the cause of almost all fatalities and serious injuries, with vehicle occupants and trespassers suffering the vast majority of injuries and deaths.
- Due to the role of third parties (individuals who are not employees or passengers and who have usually played a causal

role in the accidents), it has been difficult to achieve reductions in crossing and trespasser accidents. Also, interpreting the data is difficult because of factors that have affected reporting (e.g. the transfer of many low density lines to provincial shortlines).

Employee Casualties

- Casualty rates for employees in railway accidents have been low but should obviously be improved.

Passenger Train Accidents

- Because of their small role, passenger trains account for only about 6% of trains involved in accidents. Passenger trains, however, account for a disproportionate number of crossing and trespasser accidents. More than 70% of passenger train accidents are crossing/trespasser accidents.

Accidents Involving Dangerous Goods

- Two agencies track accidents involving dangerous goods, the Transport Canada Dangerous Goods Directorate (TDG), which is the regulator and primary source of this type of information, and the TSB. TDG and TSB have very different criteria for defining reportable occurrences involving dangerous goods.
- Rail transport of dangerous goods has grown strongly, by almost 60% since 1997.[7] Data limitations prevent determining if this growth reflects similar growth in dangerous goods traffic overall, or a modal shift in favour of rail.
- TDG reportable accidents have varied considerably over the past decade. They show no uptrend, and have fallen in the past few years. The amount of dangerous goods released in any year has also varied widely, but shows little correlation with the number of accidents. As tracked by the TSB, occurrences involving dangerous goods have tended to decline over the past decade.

[7] CN and CPR combined, millions of revenue ton-miles or thousands of freight cars moved.

"Pure" Railway Accidents

- As noted, these are accidents not involving third parties. The overall trend in these accidents has been similar to that of total accidents as may be seen in Chart 3.1. This includes sharp increases in the period 2002-2005 and a decrease in 2006, both driven by non-main track and main track derailments.
- Measured in terms of cars derailed per accident, there has been no increase in the severity of accidents over the past decade, including the 2002-2005 period when accidents were rising.
- Focusing on the period 2002-2005, the increases in "pure" railway accidents, including the non-main track and main track derailments, are only partly ascribable to growth in railway activity. A substantial portion were not, suggesting a deterioration in safety in this period.
- The bulk of increases in derailments in 2002-2005 were associated with track conditions. The particular track-related factors indicated suggest the causes were likely associated with maintenance and inspection practices and capital replacement.

4. International Comparisons

Mention has made of two ways of assessing rail safety: in terms of the absolute numbers of safety-related occurrences; and in terms of a more sophisticated measure that would combine occurrences with measures of their consequences or severity. A third possible way is through international comparisons. Such comparisons, however, are extremely difficult and have generally proven to be impractical.[8]

Canadian Versus U.S. Rail Safety Records

The closest possible "apples to apples" comparison between rail safety in Canada and that of other countries is one that compares CN

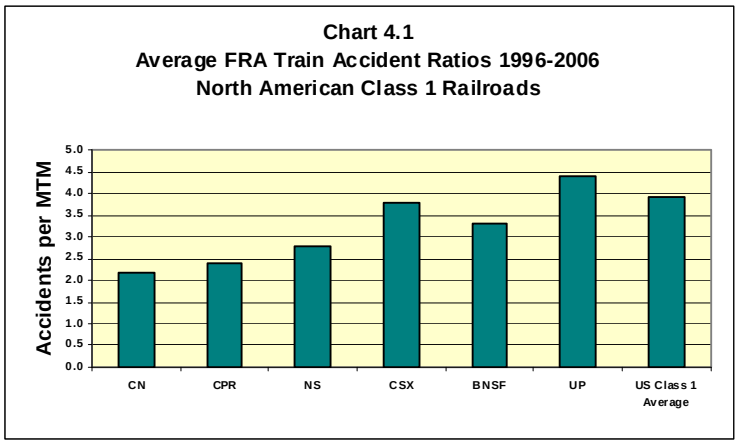
[8] Rob Burrows, *Benchmarking Railway Safety Data in Australia and Internationally*, written for the International Railway Safety Conference 2006 (Dublin, Ireland) and available at http://www.intlrailsafety.com/Dublin/23_Oct_2006_%20Papers/02_Rob_Burrrows.pdf discusses the issues and difficulties with international benchmarking.

and CPR with their U.S. Class I rail counterparts, using the U.S. Federal Railroad Administration (FRA) definition of reportable train accidents, and with the data normalized on the basis of train-miles. However, as explained below, even this is far from ideal.

The results are summarized in Chart 4.1. Based on the FRA definitions, the chart indicates that CN's and CPR's performance compares favourably to that of the large U.S. carriers. As can be seen, the CN and CPR accident rates per million train miles averaged 2.2 and 2.4, respectively, over the period 1996-2006. These figures are lower than the averages of each of the four largest Class I U.S. railways, which range between 2.4 and 4.4, and are lower than the U.S. Class I average of 3.9 per million train miles.

In Chart 4.1, the U.S. data are official FRA statistics. The CN and CPR data are statistics that CN and CPR are not obligated to provide, but calculate on their own using the FRA criteria and make public. They do this because they need to benchmark themselves against their main rail competitors, the major U.S. railways, and they can only do this using FRA measures since that is how the U.S. railways report. It is important to recognize that CN's and CPR's results in Chart 4.1 relate to their entire North American operations, while the U.S. Class 1 average includes only the U.S. operations of CN and CPR along with the other U.S. railways.[9]

[9] The U.S. railways generally considered comparable to CN and CPR are the four largest of the U.S. Class Is: Burlington Northern Santa Fe (BNSF), CSX Transportation (CSX), Norfolk Southern (NS) and Union Pacific (UP). Under U.S. federal regulations, railways are classified as Class I, II or III depending on the size of their annual operating revenue. Applying the regulatory definition, the Association of American Railroads (AAR) calculates that U.S. Class I railroads are those having 2005 operating revenue in excess of (U.S.) $319.3 million. The AAR further notes that CN and CPR are large enough that they would be U.S. Class I railroads if they were U.S. companies, and that both CN and CPR own railroads in the U.S. that, by themselves, qualify as Class Is. Currently, there are seven U.S. Class I railroads: BNSF, CSX, Grand Trunk Corporation (owned by CN), Kansas City Southern (KCS), NS, Soo Line Railroad (owned by CPR) and UP. See Association of American Railroads, *Class I Railroad Statistics* (June 5, 2007) at http://www.aar.org/PubCommon/Documents/AboutTheIndustry/Statistics.pdf.



Source: CN, CPR, FRA Office of Safety Analysis

The criteria for determining reportable accidents and incidents are very different in Canada and the U.S. In particular, the word "accident" has a very different meaning in the two countries. Thus, what are counted as "accidents" by each country are not the same and cannot be compared. In Canada, the definition of accident is far more encompassing. For this discussion, the most important difference is that the U.S. definition includes a monetary threshold of severity, limiting reportable accidents to those causing property damage above a set limit ($8,200 for 2007). In Canada, there is no such provision.

The Canadian railways have long been critical of the TSB definitions (as well as the TSB data and their presentation). Among other things, the railways have argued that the current definition of reportable accidents contains ambiguities, for example in phrases such as "affects its safe operation" and "poses a threat to the safety of any person, property of the environment."[10] They have argued that the TSB weighs occurrences (such as main track derailments) equally, irrespective of their severity. In connection with this, the railways often point to the FRA criteria where there is a monetary threshold.

[10] See Department of Justice, *Transportation Safety Board Regulations (SOR/92-446)* at http://laws.justice.gc.ca/en/C-23.4/SOR-92-446/index.html.

The railways, however, have not recognized the difficulties of a monetary threshold, namely that damages from two accidents of roughly equal severity can vary widely depending on the age of the equipment and depreciation method used. This is an issue that has been studied in the U.S., but was found difficult to resolve.[11]

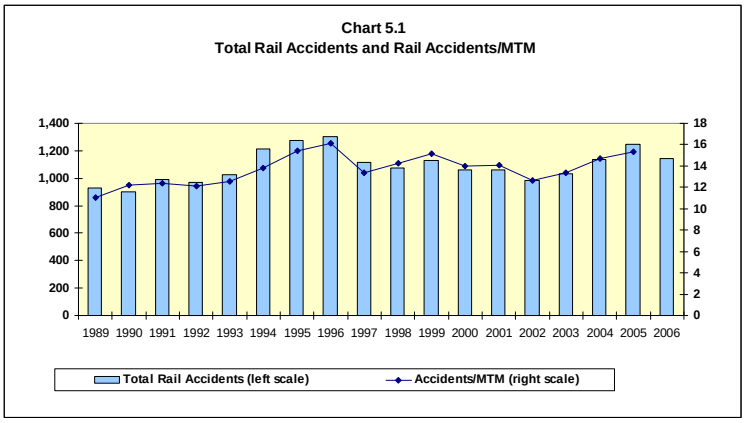
Referring again to Chart 4.1, another matter has not been well appreciated. This is the potential, because of the FRA threshold, for changes in the Canada-U.S. dollar exchange rate to affect the results. For example, the Canadian dollar's rapid rise to (near) parity will have the effect of worsening the perception of Canadian railway safety relative to that of the U.S. This is because the threshold, when converted to Canadian dollars, will now be lower than before, thus capturing a larger number of accidents on CN's and CPR's Canadian operations. Similarly, a fall in the dollar back to levels that prevailed for most of the past decade would have the opposite effect.

5. Measures Used for Normalization

In Canada and elsewhere, train-miles is the most common measure used as a denominator to adjust the numbers of rail occurrences. The purpose is to divide or "normalize" occurrences by the amount of rail activity, thus enabling more reliable comparisons over time or across railways of varying size. Train-miles is not the only measure of railway activity suitable for this purpose, and whether it is the best measure is an issue that has been carefully examined in this study.

For Canada, the results of normalizing rail accidents by train-miles are striking. As shown in Chart 5.1, normalization by train-miles provides no additional knowledge concerning the behaviour of accidents over time. Whether looking at the numbers of accidents or at accidents per million train-miles (MTM), the picture is identical. Normalizing accidents by train-miles does not help to better understand the trends in aggregate rail accidents in Canada.

[11] Railroad Safety Advisory Committee, *Minutes of Meeting February 13, 2002*, pp. 14-15 at http://rsac.fra.dot.gov/Meetings/MinuteDoc/RSAC18.pdf.



Source: Transportation Safety Board and Transport Canada

The explanation lies in the behaviour of the train-miles data.[12] While train-miles have shown a tendency to vary over time, the series shows no significant upward or downward trend and the amount of variation is small.[13] Hence, the procedure of normalizing accidents by train-miles is practically the same as dividing the number of accidents by a constant and has no discernable affect on the trend observed. If the intention is to take account of the growth in rail activity, train miles is clearly inadequate, at least according to Canadian data.

Train-miles also has disadvantages for cross-sectional comparisons. Other things equal, a railway operating with longer trains, and therefore fewer train-miles, will appear to be less safe than others when compared on the basis of accidents per train-mile. Similarly, if the industry is moving towards the use of longer trains, this will tend to slow the growth in train-miles and make the system appear less

[12] The train-mile data used in this study has been provided by Transport Canada and is information that is reported by the railways on an annual basis. The data measures total train-miles, relates specifically to federal railways only, and includes freight, passenger and work trains.

[13] Since 1989, industry train-miles have ranged between a low of approximately 74.1 million in 1990 and a high of 87.5 million in 1994, with a mean over the period 1989-2005 of 79.3 million and a standard deviation of 3.8 million (4.8% of the mean value).

safe than otherwise. This means that, besides adequately representing the growth in activity, the best normalization measure is one that filters out factors that unintentionally detract from normalization.

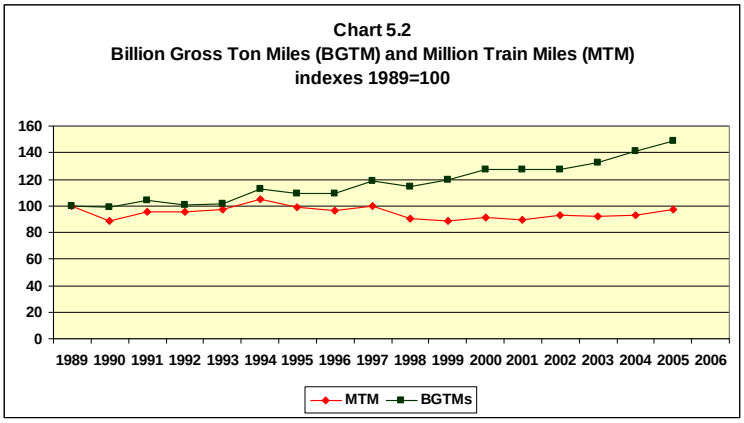
Other measures of activity that can be used to normalize accidents are gross ton-miles (GTMs) and car-miles. These also have their pros and cons. For example, GTMs puts much more emphasis on weight than car-miles. Thus, a railway whose traffic mix is less weighted towards heavy commodities, or that carries a high percentage of empty traffic, will tend to produce fewer GTMs and appear less safe based on accidents per GTM. Similarly, a trend towards a growing mix of lighter traffic will tend to slow the growth in GTMs and make the system appear less safe over time than otherwise. Significantly, there has not been much change in the overall balance of light and heavy traffic in Canada over the past decade.[14]

Between GTMs and car-miles, GTMs appear to be a better choice. This is certainly a more familiar statistic than car-miles, which is an important consideration. Furthermore, weight does play a role in safety and should not be left out. Weight is a driver of the wear and tear of infrastructure and of equipment, and weight also makes the train harder to stop. That said, when it comes to derailments, some types are more prone with light or empty cars while others are more prone to loaded or heavy cars. On the other hand, a loaded car derailed will likely do more damage than an empty car, though this is not always the case. Finally, when it comes to reflecting the growth in rail traffic in Canada, GTMs and car miles are similar.

To summarize, there is no perfect measure but having considered train-miles, car-miles and GTMs, we conclude that GTMs is the best

[14]For example, measured by originated carloads, intermodal traffic has increased from approximately 16% of total rail traffic in 1996 to 19% in 2005. The other categories that have grown in importance over this period are minerals, forest products, fuels and chemicals and paper products. Categories that have declined in importance are agriculture, coal, metals, manufactured and miscellaneous products. The Railway Association of Canada, *Railway Trends 2006*, p.18 at http://www.railcan.ca/documents/publications/1349/2006_10_24_RAC_Trends_en.pdf

choice for Canada. Figure 5.2 shows the trend in GTMs and compares it to that of train-miles.[15]



Source: Transport Canada

One question remains: should all accidents, regardless of type, be normalized the same way? Despite the problems with train-miles, they probably remain the best measure for normalizing crossing and trespasser accidents. Any measure used should be representative of the activity that creates the risk. In the case of crossing accidents, this is better captured by train miles than GTMs. Hence, we would argue for using train-miles in the case of crossing accidents. In the case of trespasser accidents, these should also be normalized by train-miles, or possibly by length of track operated.

As regards passenger train accidents, we would also argue in favour of train-miles. The great majority of accidents involving passenger trains are crossing and trespasser accidents. In addition, unlike freight, the weight of passengers carried is of little consequence, and train consists are also generally fixed. This means there should be little difference in the behaviour of train-miles, GTMs and car-miles.

[15]The GTM series does not include passenger. Gross ton-miles is not normally a measure that is used as an indicator of passenger rail activity. However, when it is required, it is usually estimated by assuming a standard weight per passenger car.

6. Improving Future Rail Safety Reporting

An important aim of the study has been to consider how the statistical information made available on railway safety might be improved for purposes of future assessments. We make three recommendations.

- **Establish a (non-permanent) Railway Occurrence Reporting Task Force.**

This group would address the many outstanding and emerging issues with the data, its use and dissemination. Members would come from the TSB, the industry, independent experts and Transport Canada. This would not be just a study group but a group established to ensure that issues are addressed and solutions are implemented.

Discussions with the TSB, various Transport Canada groups, and the railways have indicated long standing concerns with reporting to the TSB (e.g. issues of compliance, interpretation of the regulations), the reliability of the data, its use and manipulation by the TSB (e.g. normalization of accidents, categorization of accidents) and how the results are reported (manner of presentation and explanation provided). Among the more urgent matters are problems that are about to arise over the comparability between data that will be generated under the new reporting regulations and the existing data. The Task Force should also immediately resolve the problems noted with the "Main Track Train Miles" data being used by the TSB to normalize accidents. There is a need for better coordination among agencies, such as in reporting on accidents involving dangerous goods. There are also large amounts of untapped data that could be drawn upon, residing for example with TDG as well as the railways. Among other matters that could be addressed are the development of additional or better measures of safety or risk, improvement in the procedures for normalizing occurrences, and the preparation of a guidance document.

- **Change the practices for normalizing occurrences.**

This is necessary to improve comparability in the published statistics and is a matter that should be on the agenda of the Task Force.

Based on our work, we recommend adopting GTMs as the principal measure for normalizing total rail accidents, total rail accidents excluding crossing and trespasser accidents and other key categories including derailments and collisions. We would retain train-miles as a supplementary measure since this is the international standard and will undoubtedly remain so. We also consider train-miles to be the most appropriate measure for normalizing crossing accidents as well as trespasser accidents (although the latter might also be normalized by length of track operated). Train miles should also be the basis for normalizing accidents involving passenger trains. With respect to passenger trains, we note there is also a problem due to lack of historical data on commuter rail activity.

- **Remove ambiguities in the current criteria for determining reportable accidents, especially with respect to derailments.**

We recommend redefining reportable railway accidents to include all derailments. This would address the apparent ambiguities in the current criteria that define reportable accidents, and that should be clarified or better guidance provided