

Title of Paper: A 'new' approach to measuring rail safety performance

Alan Ross

Country: Australia

**Address: A & K Ross Associates Pty Ltd
100, Kings Road
Kangaroo Ground
VIC 3097**

E-mail info@akra.com.au

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Abstract

A 'new' approach to measuring rail safety performance:

Measurement of safety performance should not only be of negative results such as breaches of safe work procedures, broken rails, SPADs, but also a measure of the positive aspects of an effective Safety Management System. An effective SMS will prevent or significantly mitigate the negative events, so it is more important to measure its effectiveness than downstream control measures.

*A two-stage process to measure the effectiveness of the SMS is proposed. **Stage 1** is a 10-point assessment tool to be used as an initial measure of the **likely** success of the SMS. Are the basics in place?*

***Stage 2** provides a spectrum of lead and lag indicators/measures that attempt to capture all potential risk vulnerabilities, wherever possible in a way that anticipates the unforeseen and possibly unidentified hazards, sometimes called latent hazards, often systemic in nature as well as providing accurate indicators on the known and documented risks.*

Introduction

In order to understand something you must first measure it. Anon

At the Perth IRSC two years ago, I presented a Paper that outlined a high level approach to the measurement of an effective Safety Management System (SMS). It focussed on a 10-point Assessment Tool to determine if the management of an organization, at the highest levels, is set up in such a way that it will provide effective safety governance. Without this senior management and/or Board input, it is unlikely that the SMS will be optimally effective in managing the safety risk profile of the organisation. For those of you who were there, the Paper I am presenting here in Dublin is essentially Part 2 of the Perth Paper.

One of the things I notice in my travels around the World of risk management is that most of the measures that are used to gauge the effectiveness of safety management systems are what I would call 'lag' indicators. For example, if we look at the Annual Safety Performance Report produced by Rail Safety & Standards Board (RSSB)¹ for the UK rail network, whilst this is clearly an excellent report, it focuses almost entirely on what I would call lag indicators. There is nothing wrong with recording such lag indicators, but at best they will only tell you how well you managed the consequences of undesirable events. What we need are genuine 'lead' indicators – portents of the future that we ignore at our peril.

As Rose (1994) put it at a seminar on positive performance indicators: "*If we are in the business of promoting OSH, why do we use failures as the measure of our success?*" (Quoted in Blewett, 1994). For OSH read 'rail safety'.

Back to the RSSB Report - even in the so-called '*Precursor Indicator Model*' in Section 6.5 of that report the precursors are all typically one step removed from and accident, examples such as infrastructure failures, level crossing misuse, irregular working etc. These are not true lead indicators and once you are at this stage, you are often at the point where control has already been lost and the consequence is in the lap of the Gods.

I would argue that the enlightened organization would **not** want to reach such a point and find out that something was not as it should be, after the event. Of course, we do not live in a perfect

world and crystal balls are hard to find. The question is, what things **can** we measure that will give us advanced notice that there is likely to be a circumstance or circumstances that will create the conditions for undesirable events?

Aspects of measurement

The only devils are those running around in our own heads

Mahatma Gandhi

I shall begin with a few words about the whole business of measurement, with the well-known adage in mind that there are '*lies, damn lies and statistics*'. However you measure something it must stand up to a few basic requirements, such obvious things as the reliability and validity of the data. Reliability has to do with the *quality* of measurement – the consistency and repeatability of the measures. However you do measure something, the result is likely to have a component of error. Validity of data and the way it is interpreted has to be matched against what is seen in reality – does the data reflect the reality²?

The lead indicator

Accidents are rarely accidental

He heard it, but he heeded not – his eyes were in his heart, and that was far away.

Byron, *Childe Harold, cxli*

The focus of this paper is clearly on lead indicators, and I shall be concentrating mainly on that theme.

The lead indicator is in the realm of the future – something that provides a level of **prediction** that, without appropriate action, there **will** be an undesirable event, an outcome to our activities that we do not want. The simple analogy of a barometer comes to mind – if the pressure is dropping rapidly you can expect high winds and stormy weather, and plan accordingly – it gives you time to do that. Another analogy concerns the traditional yardstick of a commercial organisation's success, profit and loss statements – clearly lag indicators. Such results at best will tell you that the company has just gone over a cliff. The obvious appeal of lead indicators is that they should tell you of the approaching cliff in time to do something about it.

We are talking about information here. Dr David Morgan, the CEO of Westpac Bank in Australia said 'what you find in most organizations is that what gets measured gets done'. Sounds good to me. So what do we measure and how do we measure it?

The BHP Billiton Sustainability Report for 2005³ stated 'If lagging indicators are used as the only index of safety achievement (or failure), they can do more harm than good, as people are not empowered to take control of safety and develop an effective organizational safety climate. It is important that we use a mix of lead and lag indicators to measure overall safety effectiveness and performance.'

'..... the only thing we have to fear is fear itself'

Franklin Delano Roosevelt

Here is a sample list of what BHP Billiton consider to be their lead indicators:

- Field visits conducted (by senior managers)
- Observations/ Audits/ Inspections: conducted versus planned
- Face time in field versus planned (again – senior managers)
- Number of safety contacts (staff spoken to during field visits etc)

- Safety communications conducted (by managers & supervisors)
- (Level of) Implementation of Site Safety Action Plan
- (Level of) Implementation of Fatal Risk Control Protocols*
- (Level of) Implementation of action plans resulting from HSEC audit findings
- Percentage of Incidents investigated
- Number of positive rewards and recognition given
- Number of near misses reported (more is better)
- Number of repeat incidents
- Percentage of Job Safety Analyses (JSA) completed for critical activities
- Percentage of safe behaviours observed (versus unsafe behaviours)
- Percentage of actions implemented from observations
- Percentage of Significant Incidents reviewed and closed out from circulation lists
- Percentage of hazards rectified
- Ratio of near misses to accidents reported

* This consisted of a review of past fatalities and significant incidents that identified a series of key fatal risks that required the development of sound practices. These *Fatal Risk Control Protocols* developed by workgroups from across the company establish **minimum** performance expectations for managing the risks. 10 different areas are addressed in the protocols.

Of course, I would argue that not all of the indicators chosen by BHP are actually lead indicators, but many of them are.

Interestingly, the pyramid below provides an indicative breakdown of lead and lag indicators being promoted at various levels of the organisation. The use of a greater proportion of leading indicators at individual and department levels reinforces personal involvement and improves the perceptions individuals and work teams have about their control and management of risk. These are also the people with the most to lose at a personal level, if something nasty happens. With lag indicators the reverse tends to be the case, I think this is because, being at an evolving stage of their development, they still have a reasonable number of accidents, and senior management want to know about those because they cost money.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

BHP Billiton is clearly a very large global organization, operating mainly in the resource/mining sector, but it also has a range of rail operations, where they also apply this approach. I note that the conference theme is *Managing Safety – Keeping pace with change* and changes such as are being made by companies like BHP Billiton are done not only from an altruistic angle, they have learned from hard experience that this will improve their 'bottom line' dramatically. BHP has not always been so progressive and has had to undergo a significant cultural change to get this far.

Interestingly I developed my suggested list of indicators before learning of the BHP Billiton approach. The Table at the back of the Paper contains the list and is based on some actual work I did for RailCorp in New South Wales, Australia. RailCorp has also undergone a major and very thorough review of how it manages safety, following the Waterfall accident in 2003. They have introduced the concept of 'safety governance', starting with the Board of Directors and working down. The range of 20 Safety Indicators is designed to bridge from the past, which was predominantly/exclusively lag indication to a future where lead indication dominates (because that **will** result in a dramatic decrease in the undesirable events that go to make up most of the lag indications). Many of the indicators I have are the same as or similar to BHP Billiton.

An aside here shows that the main **lag** indicator of the chemical company DuPont is now 'off the job accidents' (things that staff do to themselves during their time off – ballroom dancing, sport, DIY etc!). This is because there are so few work incidents and almost all lost time is due to sports and other recreational injuries. Obviously, if such an accident incapacitates a member of staff that still represents a loss to the company.

Man is a battlefield, a dark cellar in which a well-bred spinster is locked in combat with a sex-crazed monkey, their struggle being refereed by a nervous bank clerk
Civilised man – Bannister, D.

I do not intend to go through the list of indicators in Table 1 one by one but I will talk about a couple by way of example.

Item 4: Hazard Reporting effectiveness – seeking to tap into the workforce knowledge in such a way that precursor hazards like weak, non-existent or ineffective controls are identified. Number of such reports lodged is the measure.

In the traditional triangle 'hazards' sit at the bottom below 'near misses'. In this sense a hazard is just something 'waiting to happen'. It could be something obvious such as a faulty step or something less obvious such as a flawed procedure, where this may be known to front line staff but not to others further back, essentially the James Reason cheese approach. Staff would need to have some training in what kind of things to look for and there would need to be a user-friendly reporting system that did not put people off submitting reports.

Item 8: Senior Management Safety Tours – conducted according to an annual programme of at least one per month and involving individually the CEO and all Executive members. I recommend the use of the excellent RSSB Guideline for the conduct of Safety Tours⁴.

Senior Management Safety Tours are a very powerful tool in overall Safety Governance, showing clearly the personal commitment of those managers and giving them a valuable insight into the 'real world'.

Not quite a 'safety tour' but I was gratified to read recently of the new CEO of Pacific National (Australia's premier general rail freight operator) joining one of his freight trains from Adelaide to Kalgoorlie – a 2100km journey. What better way to understand the issues that confront the people at the 'pointy' end. Amongst other matters, he discovered that there are over 100 temporary speed restrictions (TSRs) on the Melbourne – Perth corridor, costing PN approximately \$110,000 in extra fuel each week!

There is no substitute for this, and the senior manager who does not **make** time to see what is happening at the front line will inevitably fail.

Conclusions

'..... for they know not what they do'

St Luke 23:24

I think most organisations recognise the message that I am delivering here and, increasingly, use lead indicators in their mix of Key Performance Indicators of safety performance. The challenge is to have the right mix such that there will not be too many surprises when things go wrong. Many effective lead indicators require an organisational culture change to allow their introduction so that such change should be over a period of time with parallel emphasis on both the safety performance indicators and the culture required by them.

Though the Life Force supplies us with its own purpose, it has no other brains to work with than those it has painfully and imperfectly evolved in our heads

George Bernard Shaw – *The Irrational Knot*

References

1. RSSB Annual Safety Performance Report, 2005
2. <http://www.socialresearchmethods.net/kb/reliable.htm>
3. <http://hsecreport.bhpbilliton.com/2005/repository/safety/ourApproach/leadIndicators.asp>
4. <http://www.rgsonline.co.uk/docushare/dsweb/ApplySearch>

Appendix 1: The five rules of causation

You will notice that in Table 1, the second lead indicator relates to the effectiveness of the implementation of a 'Just Culture' as an important measure. RailCorp had chosen to pursue the introduction of a 'Just Culture' and needed some means of determining the success of this. This included recognition of the so-called 'five rules of causation'* (in incidents) – providing a 'just' assessment of incident causes. The five rules of causation are designed to improve the process by creating minimum standards for an investigation and where the results should be documented. The rules are created in response to the very real biases we can all bring to an incident investigation process.

"For the want of a nail, the shoe was lost; for the want of a shoe the horse was lost; and for the want of a horse the rider was lost, being overtaken and slain by the enemy, all for the want of care about a horseshoe nail."

(Benjamin Franklin - *Poor Richard's Almanack* 1758)

- **Rule 1 - Causal Statements must clearly show the "cause and effect" relationship.**

This is the simplest of the rules. When describing why an event has occurred, you should show the link between the root cause and the bad outcome, and each link should be clear. Focus on showing the link from your root cause to the undesirable patient outcome you are investigating. Even a statement like **"driver was fatigued"** is deficient without your description of **how and why this led to a slip or mistake**. The bottom line: the reader needs to understand the logic in linking your causes to the outcome.

- **Rule 2 - Negative descriptors (e.g., poorly, inadequate) are not used in causal statement**

As humans, we try to make each job we have as easy as possible. Unfortunately, this human tendency works its way into the documentation process. We may shorten our findings by saying **"maintenance manual was poorly written"** when we really have a much more detailed explanation in our mind. **To force clear cause and effect descriptions (and avoid inflammatory statements), we recommend against the use of any negative descriptor that is merely the placeholder for a more accurate, clear description.** Words like "carelessness" and "complacency" are bad choices because they are broad, negative judgments that do little to describe the actual conditions or behaviors that led to the mishap.

- **Rule 3 - Each human error must have a preceding cause.**

Most of our mishaps involve at least one human error. Unfortunately, the discovery that a human has erred does little to aid the prevention process. You must investigate to determine WHY the human error occurred. It can be a system-induced error (e.g., step not included in procedure) or an at-risk behavior (doing task by memory, instead of a checklist). **For every human error in your causal chain, you must have a corresponding cause.** It is the cause of the error, not the error itself, which leads us to productive prevention strategies.

- **Rule 4 - Each procedural deviation must have a preceding cause.**

Procedural violations are like errors in that they are not directly manageable. Instead, it is the cause of the procedural violation that we can manage. If a worker is violating a procedure because it is the local norm, we will have to address the incentives that created the norm. If a worker is missing steps in a procedure because he is not aware of the formal checklist, work on education.

- **Rule 5 - Failure to act is only causal when there was a pre-existing duty to act.**

We can all find ways in which our investigated mishap would not have occurred - but this is not the purpose of causal investigation. Instead, we need to find out why this mishap occurred in our system as it is designed today. The duty to perform may arise from standards and guidelines for practice.

*Adapted from David Marx.

Table 1: Safety Lead/Lag Indicators

Measure	Lead/Lag Status	Required Reporting Process (Detailed in the 'Knowledge Management ' part of SMS)
1. A measure of the Board's Safety Governance capability.	Lead.	Assessment based on independent application of the 10-point Assessment Tool and reported to the Chairman of the Board (see Perth IRSC Paper for details)
2. A measure of the effectiveness of implementation of a 'Just Culture', including the 5 Rules of Causation – see Appendix 1	Lead. Note – this is not a 'no blame' culture	A simple matrix of the 5 Rules of Causation is applied to all incident investigation reports and they are scored accordingly. Reported to the highest level as an important precursor to the required change in culture.
3. Effectiveness of (Independent) Design Checks of any new safety critical equipment or process, incorporating the concepts of a project Standard such as EN50126 or the 'Yellow Book' (UK)	Lead. A measure of the earliest stage of a proposed activity. If the check picks up negatives this may be a good thing but also indicate some underlying process problems	For all new/modified safety critical equipment and/or processes and procedures, reported through the Change Management part of the SMS to defined levels depending on the nature of the change. Checked via Audit
4. Hazard Reporting effectiveness – seeking to tap into the workforce knowledge in such a way that precursor hazards like weak, non-existent or ineffective controls are identified. Number of such reports lodged is a measure.	Lead. The precursors picked up may lie two or three 'levels' behind the undesired outcome (Reason) – staff training required – a reasonable number of such reports, properly formatted, would be expected in a successful system	Reported via the Incident/Accident reporting part of the SMS and the number of such reports flagged to the Board – low numbers, at least initially, unsatisfactory
5. Number of Safety Critical Control Measures identified, against an agreed definition – to be found in the Risk Management Framework.	Lead. Knowing what the safety critical controls are is an important lead indicator – as they are then given a higher profile and scrutiny	If a Safety Critical Control Measure fails, it presents an immediate threat to the organization. Any such failure to be reported through to the Board via the Incident/Accident reporting part of the SMS
6. Performance Standards for the identified Safety Critical Control Measures and indications that performance is within agreed parameters. Details of the Performance Standard(s) are given in the Risk Management Framework.	Lead. This measure shows the reliability of the identified Safety Critical Controls when they are required to work to mitigate or prevent an undesired event	In the event of an incident occurring that relies on Safety Critical Controls to mitigate or prevent the consequences, and this works, it should be recorded. Equally all Safety Critical Controls should be subject to periodic (actual) test and the results recorded/reported.
7. Board, CEO & Executive – personal safety related initiatives put in place – as part of demonstration of commitment – at least one per year per person would be reasonable.	Lead. Individually all members of the Board, CEO & Executive are in a position to develop ideas and drive them into the organisation –See Personal Safety Action Plans as required by the Safety Governance Framework	Number established and results reported to the Board

Measure	Lead/Lag Status	Required Reporting Process (Detailed in the 'Knowledge Management ' part of SMS)
<p>8. Senior Management Safety Tours – conducted according to an annual programme of at least one per month and involving individually CEO and Executive members. Use RSSB Guideline for the conduct of Safety Tours.</p>	<p>Lead. Senior Management Safety Tours are a powerful tool in overall Safety Governance, showing clearly the personal commitment of those managers and giving them a valuable insight into the 'real world'.</p>	<p>Number of Safety Tours and locations plus any critical follow up reported to the Board</p>
<p>9. Workplace assessment - by using something like the 'Stop Take Five' approach developed by Dupont and used by Pilbara Rail, where every employee is encouraged to conduct a certain number per month. 80%+ per month & number of actions resulting</p>	<p>Lead. This measure encourages all members of staff to perform simple evaluations of workplace peer activity, in a non threatening way, and pick up hazards before they can lead to the undesired outcome</p>	<p>Sufficient to monitor this at Department level with clear instructions from above of what is expected as a minimum.</p>
<p>10. Level of compliance of reporting to the Board – whatever the eventual defined reporting requirements are, they should be part of the assurance/audit programme to determine compliance.</p>	<p>Lead/Lag. Accurate and timely knowledge of what is going on is essential to the Board's exercise of it Safety Governance responsibilities</p>	<p>The Board should see the results of the audits</p>
<p>11. Degree of alignment of the Assurance/Audit programme with identified top 10/20 risks – the Risk Management Framework will identify what the top 10/20 risks are and from that the emphasis of the audit programme follows.</p>	<p>Lead/Lag. Eventually a totally lead indicator and, of course, the top 10/20 list changes over time, as will the emphasis of the audit programme follow suit</p>	<p>Depends on how the audit programme is structured, as the top 10/20 risks will vary from one part of the organisation to another. From that the overall corporate top 10/20 will emerge</p>
<p>12. A measure of the effectiveness of the Assurance/Audit programme – a combination of completion on time, NCRs* raised, close out of actions, follow up on effectiveness of actions + results of independent audit on the audit process</p>	<p>Lead/Lag.</p>	

* NCR – Non Conformance Report

Measure	Lead/Lag Status	Required Reporting Process (To be detailed in Knowledge Management Framework)
<p>13. Near Miss Reporting effectiveness – the 'safety triangle' suggests there should be several hundred near misses for each major incident – the expected figure would be based on history of defined major incidents x a multiplier.</p>	<p>Lead/Lag. This measure indicates the success of near miss reporting, one of the final lead/lag boundary measures. If the ratio is low it means that near misses are going unreported</p>	
<p>14. A measure of the effectiveness of change management validation – how completely are changes validated as per the appropriate procedure</p>	<p>Lead/Lag. Effective Change Management is crucial to overall safety governance</p>	
<p>15. Effectiveness of actions resulting from audits, investigations, inspections – not just the 'close out' but a subsequent assessment of the effectiveness of the action – based on a tool developed for the purpose.</p>	<p>Lead/Lag. Actions may be closed out but fail to deal with the issue for some reason</p>	
<p>16. Line management personal involvement in incident investigation – in the area for which they are accountable - from nothing to detailed – involvement to be required for investigations above a certain defined level.</p>	<p>Lead/Lag. If the line manager has some appropriate personal involvement in an investigation they are more likely to understand and follow up on that investigation.</p>	
<p>17. A measure of the effectiveness of interface management – assumes all interfaces have been identified – measure to be based on the requirements of AS4292.6</p>	<p>Lag. Interfaces are often the source of problems and accident precursors.</p>	
<p>18. Breaches of Safety Governance – as defined in the Safety Governance Policy, both reported and unreported (possibly picked up in audits) – any number above zero</p>	<p>Lag. The importance of effective Safety Governance means that this is a key indicator, either in a latent or actual sense – more serious if only picked up via audit</p>	
<p>19. Breaches of safe working requirements, Rules, SMS etc – both reported and unreported (possibly picked up in audits) – any number above zero</p>	<p>Lag. A critical indicator that could either be a lead or lag measure depending on the circumstances – more serious if only picked up via audit</p>	
<p>20. Effectiveness of causal analysis – in incident investigation against a Standard that should be defined in the Assurance & Investigation Manual. Based on an assessment tool to be used by the line manager.</p>	<p>Lag. A critical measure in picking up the underlying reasons behind an incident and not just the immediate causes or resorting to the 'human error' approach</p>	