Runaways Risk Workshop

- Ironmen / Trolleys
- RRVs / Trailers
- Engineering Train / OTM

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Executive Summary

Three separate workshops were carried out to identify and prioritise failure modes associated with unsafe acts relating to runaways. The three workshops were designed to use the same methodology but each focusing on different vehicle types:

- Workshop 1 – Ironmen and trolleys
- Workshop 2 – Rail Road Vehicles (RRVs) and coupled trailers
- Workshop 3 – Engineering Trains and On-Track Machines (OTM)

The full risk exercises were completed in response to Action A5 following a 'Deep Dive' review into Irregular Working. The BowTieXP risk software was used to document all failure modes, effects, controls and relative ratings during each workshop.

The top 5 failure modes in relation to greatest risk are presented below (where more than 5 are presented, one or more were scored equally):

- Ironmen and trolleys

14. Planning does not account for risks and limitations
20. Operating outside equipment safe limits - no. of people
3. Deliberate violation of braking system
21. Operating outside equipment safe limits - environmental factors
1. Operating outside equipment safe limits - gradient
10. Use of unspecified components
22. Operating outside equipment safe limits - intentional overspeeding

- Rail Road Vehicles (RRVs) and coupled trailers

6. Operator puts machine in free wheel condition
11. Operator does not apply handbrake
3. Operating outside safe limits - environmental factors
8. Braking system not maintained in accordance with maintenance plan
9. Operating outside equipment safe limits - intentional overspeeding
10. Operating outside equipment safe limits - load
14. Vehicle owner does not seek approval of engineering change
15. Braking system deliberately overriden
16. Failure to report defective equipment
18. Fitters do not hold suitable competence

- Engineering Trains and On-Track Machines (OTM)

4. Contaminated railhead (not cleared up)
7. Safe recovery procedure not applied following machine breakdown
11. Movement performed by non-competent person
14. Uncontrolled modifications to vehicle
16. Deliberate override of safety system
1. Parking brake not applied when required
3. Driving technique not adapting to local conditions
6. Regular brake tests not applied in adverse conditions
15. Incorrect marshalling of vehicles within a possession

The following common themes emerged as a result of the three workshops:

- Behaviour and safe culture requires strengthening and is critical to potential improvements
- Opportunities for improvement include strengthening of product acceptance
- Not many truly automated detective controls exist and should a failure mode occur, they are difficult to correct once it happens
- There is much less control of ironmen and trolleys with the resultant risks being scored very high – some failure modes as identified through this workshop, have very little overall control
- There are many machines out there in use today with unknown risks due to pre dating product acceptance and grandfather rights

Background & Methodology

Three separate workshops were carried out to identify failure modes associated with unsafe acts relating to runaways. The three workshops were designed to use the same methodology but each focusing on different vehicle types:

- Workshop 1 – Ironmen and trolleys
- Workshop 2 – Rail Road Vehicles (RRVs) and coupled trailers
- Workshop 3 – Engineering Trains and On-Track Machines (OTM)

The full risk exercises were completed in response to Action A5 following a 'Deep Dive' review into Irregular Working. The BowTieXP risk software was used to document all failure modes, effects, controls and relative ratings during each workshop.

The essence of the workshop was to identify the following:

- Failure modes (and likelihood of occurrence 1-5)
- Effects (and their severity leading to a possible Runaway 1-5)
- Existing preventive controls (and their effectiveness 1-5)
- Existing detective controls (and their effectiveness 1-5)

*"**Irregular Working Deep Dive Action A5***

Network Rail should undertake a Failure Modes & Effects Analysis Bowtie Risk Assessment to review the causes of Unsafe Acts, giving particular consideration to the use of in identifying the nature, severity, rate of occurrence and detectability of such events. Consideration should be given to using a Risk Priority Number methodology to assist in prioritising improvements to risk controls."*

**amended from FMEA to a bowtie due to retrospective nature of work. It has been identified that an FMEA approach is not the best fit for this exercise*

Refer to Appendix A first for the full background and methodology.

Analysis & Main Findings

Workshop 1 – Ironmen / Trolleys

An understanding was first required on the actors involved, whose unsafe act could result in a runaway ironman or trolley. These were identified as:

- Operator
- Fitter / maintainer
- Supplier
- Planner
- Supervisor

Analysis of Failure Modes

Failure modes were identified alongside their effect in the context of a runaway and preventive and detective controls were also identified. Failure modes are presented in descending order of risk score, using the Risk Priority Number methodology presented within Appendix C.

Various significant weaknesses were found through analysis of potential failure modes, level of control and effects in relation to runaways of ironmen and trolleys.

14. Planning does not account for risks and limitations (Risk Score: 15/15)

This was the one failure mode that resulted in the maximum possible risk score with the main actor involved being the planner.
A likelihood score of 5 was assigned due to its recurring nature and lack of control.
There are no identified preventive or detective controls for this failure mode and was identified as a serious weakness that requires addressing.
An effect of 'Unable to regulate speed' was chosen due to its effect on the operators and a lack of information regarding the presence of safety risks and limitations regarding the tasks involved.

20. Operating outside equipment safe limits - no. of people (Risk Score: 14.5/15)

This failure mode was noted as a recurring issue, using anecdotal evidence from the group, and was a contributory factor to the runway ironman incident in Wales, 2014. A behavioural issue was cited, noting a general willingness to proceed with the job even when the number of people required to man the machine is below the minimum.
Two preventive controls were identified. 'Safe System of Work' was given a score of 4 due to the planner not aware of the operational constraints. 'Training' was given a score of 4 due to the lack of a follow up assessment, mentorship and monitoring and its nature of being undertaken in optimal conditions.
One detective control was identified. 'Colleague Intervention / site supervision' was given a score of 5 citing the need for a much more positive safety culture.
An effect of 'Unable to regulate speed' was chosen due to its direct influence on a runaway event.

3. Deliberate violation of braking system (Risk Score: 14/15)

This failure was noted as a recurring issue, using anecdotal evidence from the group as operators involved would override the parking brake's default position using various objects. Root causes were identified as mainly ergonomic design issues relating to the fact that operators are expected to transport ironmen across long distances while keeping the parking brake depressed.
No preventive control was identified.
Two detective controls were identified. 'Anti-Tamper Paint' was given a score of 5 due to various issues including the need for human intervention, which is the other detective control, also scored as 5.
An effect of 'Reduced or elimination of braking capacity' was chosen and given a severity score of 4.

21. Operating outside equipment safe limits - environmental factors (Risk Score: 14/15)

The likelihood of the failure mode and the control score were both given a score of 5 due to the lack of documented and defined environmental safe limits. These were missing throughout manufacturers and Network Rail issued documentation. For the purposes of this exercise, environmental factors include the weather and contamination of the railhead. It was also noted that no detective controls exist.
An effect of 'Reduced or elimination of braking capacity' was chosen and given a severity score of 4.

1. Operating outside equipment safe limits - gradient (Risk Score: 13.5/15)

This failure mode was noted as an issue that occurs or can occur frequently and was given a likelihood score of 4. This was was a contributory factor to the runway ironman incident in Wales, 2014.
Two preventive controls were identified. 'Training' was given a score of 4 due to the lack of a follow up assessment, mentorship and monitoring and its nature of being undertaken in optimal conditions. It was also noted that the quality of training given is largely inconsistent across those performing the training material.
No detective controls were identified.
An effect of 'Unable to regulate speed' was chosen due to its direct influence on a runaway event.

10. Use of unspecified components (Risk Score: 13.5/15)

This failure mode related to the suppliers of ironmen and trolleys and relates to suppliers using components that have not been authorised for use within ironmen and trolleys. The group concluded that a likelihood score of 4 should be given.
Two preventive controls were identified. Suppliers are required to be ISO9001 accredited, so the first control was identified as 'Supplier Quality Management System' but this was scored as a 4 due to inconsistencies and evidence found that this is not as robust as intended. Similarly 'Supplier Assurance' was scored as a 5 due to a lack of robustness in the Supplier Assurance process and not doing enough of it in order for it to be effective.
No detective controls were identified, though a future control was identified through the imminent 'RISQS Approval' process.
An effect of 'Reduced or elimination of braking capacity' was chosen and given a severity score of 4.

22. Operating outside equipment safe limits - intentional overspeeding (Risk Score: 13.5/15)

This failure mode was identified as a cultural behavioural issue and was therefore given a high likelihood rating. It was cited that from a human factors point of view, people have a more complacent perception to risk when pushing downhill.
Two preventive controls were identified. 'Training' was given a score of 4 due to the lack of a follow up assessment, mentorship and monitoring and its nature of being undertaken in optimal conditions. 'Safe operating limits provided by manufacturer and Network Rail' are given though these are largely conflicting and therefore is given a control rating of 4.
'Colleague intervention and site supervision' was identified as a detective control though this is largely manual and is not effective due to widespread behavioural issues.
An effect of 'Unable to regulate speed' was chosen due to its direct influence on a runaway event.

11. Repairs carried out with worn or defective components (Risk Score: 13/15)

This failure mode related to the replacement of components by either a supplier or at a local level and it was recognise that this is common practice.
It was recognised that no preventive or detective controls are in place to prevent this from occurring.
This would result in a potential reduction or elimination of braking capacity which has been assigned an effect score of 4.

2. Operating outside equipment safe limits – load (Risk Score: 12.5/15)

This failure mode related more to trolleys rather than ironmen being overloaded, and this was reflected within the likelihood score of 3.
Two preventive controls were identified. 'Training' was given a score of 4 due to the lack of a follow up assessment, mentorship and monitoring and its nature of being undertaken in optimal conditions. A second control was identified through 'Safe working loads marked on ironman / trolley' though this was scored as a 4 as it heavily relies on human intervention and compliance.
An effect of 'Unable to regulate speed' was chosen due to its direct influence on a runaway event.

5. Braking design does not meet end user requirements (Risk Score: 12.5/15)

This failure mode was identified as a critical issue and relates to the non-provision of a service brake. The likelihood score of 5 is reflected in the fact that all ironmen and trolleys suffer from this problem.
A preventive control was identified through the 'Product Approval' process though this pre-dates the introduction of the equipment and will only apply to new equipment.
No detective controls were identified, though the future 'Product Specification' control will be brought in to further control this failure mode. There is no control that addresses the issue of existing equipment.
An effect of increased deterioration of braking components was assigned due to the parking brake being used as a service brake. A score of 3 was given for the effect.

17. Deliberate violation of operating instructions (Risk Score: 12.5/15)

This failure mode is concerned with the operator of the ironman or trolley and includes illegal riding on trolleys and other horseplay.

It was cited that there is an apparent lack of consequence to those who are in violation, as long as a safety event does not occur. It was felt that in terms of likelihood, it is fairly high so a score of 4 was given.
A preventive control was identified through 'Training' and was rated as a score of 2 in this case.
'Colleague intervention and site supervision' was identified as a detective control though this is largely manual and is not effective due to widespread behavioural issues.
An effect of 'Unable to regulate speed' was chosen due to its direct influence on a runaway event.

7. Ironman / trolley not stored or transported in a suitable and safe manner (Risk Score: 12/15)
This failure mode was mainly concerned with unsafe practices relating to the storage of ironmen through transport and damaging key components, though its likelihood was scored as a 3.
A preventive control was identified through 'Operating Instructions' though it was felt this does not address the risk and was therefore scored as a 5.
No detective controls were identified.
An effect of 'Increased deterioration of braking components' was chosen and was given a score of 3.

9. Ironman / trolley not adequately maintained (Risk Score: 12/15)

This failure mode was concerned with the role of the maintainer and was given a high likelihood score of 4.
Three preventive controls were identified, though two were rated as a 5. These were 'Local maintenance' and 'Supplier Assurance'. It was cited that local maintenance is performed sporadically though this is instructed to be done by the maintainer. It was noted that there is a cost saving and efficiency opportunity here as local staff could be taught how to perform basic repairs, removing the need to send equipment back to the maintainer. Associated with this, 'Supplier Assurance' was scored as a 5 due to a lack of robustness in the Supplier Assurance process and not doing enough of it in order for it to be effective. The control 'Maintenance Plans' was scored as a 3 (adequate) as it was felt they are fit for purpose but again the weakness lies within the supplier assurance and that there is no detective control in place for poorly maintained ironmen and trolleys.
This would result in a potential reduction or elimination of braking capacity which has been assigned an effect score of 4.

16. Inability to communicate on site (Risk Score: 12/15)

The operation of ironmen relies on two people operating them at any one time and has been scored a 3 in terms of likelihood of causing a runaway due to other failure modes needing to occur in addition, such as a steep gradient and inclement weather conditions.
However, no preventive and detective controls were identified.
The effect is 'Unmanaged speed control' and was scored as a 4.

18. Inadequate site supervision (Risk Score: 12/15)

This failure mode was concerned with unsafe acts relating to supervisors on site and likelihood was scored as a 4 due to widespread concerns around safety culture.
A preventive control was identified through 'Planning and delivery of task' to facilitate the availability of resources on site, though this was scored as a 4 as resource requirements can change at very short notice, relying on the supervisor to make a critical safety decision. This was cited as a contributory factor to the runway ironman incident in Wales, 2014.
A detective control was identified through monitoring and assurance but was scored as a 4 due to its reliance on human intervention and it was stated that this should happen more often.
The effect is 'Unmanaged speed control' and was scored as a 4.

19. Imbalanced utilisation of available ironmen / trolley (Risk Score: 12/15)

This failure mode related to a common practice that equipment is chosen for use according to convenience so certain equipment is used much more frequently than others. Likelihood was scored as a 4.
However, no preventive and detective controls were identified.
An effect of 'Increased deterioration of braking components' was chosen and given a score of 3.

4. Adverse distributed load (Risk Score: 11.5/15)

This failure mode related to imbalanced loading causing a potential runaway and a likelihood score of 4 was given.
Two preventive controls were identified. 'Training' was given a score of 4 due to the lack of a follow up assessment, mentorship and monitoring and its nature of being undertaken in optimal conditions. The second control consisted of an instruction on the equipment itself around the requirement for uniformly distributed loads. However it was scored as a 4 due to the reliance on human intervention to notice and take action following acknowledgment of the sign.
'Colleague intervention and site supervision' was identified as a detective control though this is largely manual and is not effective due to widespread behavioural issues.
The resultant effect of this failure mode is 'Reduced rail wheel frictional interface' and was given the severity score of 3.

8. Adequate pre-use checks not carried out (Risk Score: 11.5/15)

It was felt that this failure mode regularly occurs and the only control identified was the 'Pre-Use Check Process' itself with no detective control. The Pre-Use Check Process was scored as a 4, noting that it is very inconsistently applied and does not provide assurance of how often and to what extent it is applied.
The identified effect of this failure mode is "Unable to identify effectiveness of braking system" and therefore scored a 2.

13. Supplier issues products with unauthorised modifications (Risk Score: 11.5/15)

This failure mode was concerned with suppliers who issue various minor changes to products without going through an approval process, due to each individual change being minor. However, many minor changes may equal a major change at some stage. This was regarded as a recurring likelihood.
Three preventive controls were identified. Suppliers are required to be ISO9001 accredited, so the first control was identified as 'Supplier Quality Management System' but this was scored as a 4 due to inconsistencies and evidence found that this is not as robust as intended. Similarly 'Supplier Assurance' was scored as a 5 due to a lack of robustness in the Supplier Assurance process and not doing enough of it in order for it to be effective. A further control was identified through the 'Product Approval' process though as minor changes are not generally required to go through this process, it cannot be considered a robust control in this context.
No detective controls were identified, though a future control was identified through the imminent 'RISQS Approval' process.
The identified effect of this failure mode is "Unable to identify effectiveness of braking system" and therefore scored a 2.

6. Inadequate assembly on site (Risk Score: 10.5/15)

This failure mode relates to the effectiveness of the assembly of ironmen on site but it was acknowledged that it is highly unlikely that a runaway could occur as a result and would more likely be involved in a derailment.
'Training' was identified as the only preventive control and was given a score of 4 due to the lack of a follow up assessment, mentorship and monitoring and its nature of being undertaken in optimal conditions. It was however deemed unnecessary to add any extra control in due to its low likelihood.
No detective controls were identified.
However, should the failure mode occur, the potential severity is high as the braking system could be greatly reduced or eliminated.

12. Use of unauthorised equipment (Risk Score: 9.5/15)

This failure mode was concerned with the operational use of relevant equipment that has not been accepted for use on Network Rail infrastructure. This received a fairly low likelihood score of 3 and 'Product Approval' was identified as the only preventive control though this pre-dates the introduction of the equipment and will only apply to new equipment.
No detective controls were identified.
The identified effect of this failure mode is "Unable to identify effectiveness of braking system" and therefore scored a 2.

15. Operators do not hold suitable competence (Risk Score: 9.5/15)

This failure mode was concerned with incompetent operators using the ironmen and trolleys and it was cited that the likelihood of this is very low. This is associated with the one preventive control identified as 'Sentinel card (NR) / Authority to work (contractor)' was identified as a very good control, earning the control rating of 2.
No detective controls were identified but it was deemed unnecessary.
An effect of 'Unable to regulate speed' was chosen due to its direct influence on a runaway event.

23. Combined use of ironmen types (Risk Score: 8.5/15)

This failure mode was concerned with multiple ironmen types being used in conjunction with one another but it was accepted that the likelihood of this occurring was very low and scored a 2.
It was acknowledged that training given for this purpose was very good and was rated as a 2.
No detective control was identified.
The resultant effect is 'Reduced braking capacity' which was scored as a 3.

Refer to Appendix B for the full register of failure modes, effects and identified controls and Appendix C for the full RPN table

Likelihood and Effects Analysis

Likelihood: Likelihood was consistently scored in terms of their collective risk rather on an individual basis.
Effects: As evident during the detailed analysis, many failure modes have the same overall effect and were scored in the context of a runaway and in relation to each other. A score of 5 was given where the effect should occur, a runaway is inevitable. Please see below for a list of all identified effects, ranging from high to low severity:

- Unable to regulate speed (by either engineering or human means): 5
- Reduced or no effectiveness of braking system: 5
- Reduction or elimination of braking capacity: 4
- Increased deterioration and damage of braking components: 4
- Unmanaged speed control: 4
- Reduced rail wheel frictional interface: 3
- Increased deterioration of braking components: 3
- Reduced braking capacity: 3
- Unable to identify effectiveness of braking system: 2

Findings & Themes to Consider

Several key themes emerged as a result of undertaking this risk workshop, in addition to the analysis of each failure mode in isolation documented above. These are discussed in each sub-section below.

Recurring Controls

Several recurring controls appeared throughout the workshop, and should be noted for their apparent criticality:

- Training for use of ironman / trolley (occurs 9 times)
- Colleague intervention / site supervision (occurs 6 times)
- Supplier Assurance (occurs 3 times)
- Safe operating limits provided by manufacturer and Network Rail (occurs 3 times)
- Product Approval (occurs 3 times)

It should be noted that these controls have generally been assessed as ineffective in the context of each identified failure mode.

Failure Modes with No Preventive Controls (or highest control rated as 5)

- 3. Deliberate violation of braking system
- 7. Ironman / trolley not stored or transported in a suitable and safe manner
- 11. Repairs carried out with worn or defective components
- 14. Planning does not account for risks and limitations
- 16. Inability to communicate on site
- 19. Imbalanced utilisation of available ironmen / trolley
- 21. Operating outside equipment safe limits – environmental factors

Failure Modes with no Detective Controls (or highest control rated as 5)

It must be noted only one failure mode had a detective control rated better than a 5. This was ‘Monitoring / assurance’ in the context of the failure mode ‘18. Inadequate site supervision’.

Most failure modes have no detective control and all rely on human intervention. There is a distinct lack of engineered detection mechanisms.

Behaviour and Safe Culture

The overall subject of behaviour and culture was cited as critical. As most of the preventive and directive controls rely on human intervention, a safe culture becomes increasingly important. However, through various anecdotes and examples given during the workshop, it remains that this is still a key issue to tackle and concerns all actors involved in runaways.

Workshop 2 – Rail Road Vehicles (RRVs) and coupled trailers

An understanding was first required on the actors involved, whose unsafe act could result in a runaway RRV. These were identified as:

- Operator /driver
- Fitter
- Supplier
- Vehicle Acceptance Body

Analysis of Failure Modes

Failure modes were identified alongside their effect in the context of a runaway and preventive and detective controls were also identified. Failure modes are presented in descending order of risk score, using the Risk Priority Number methodology presented within Appendix C.

Various significant weaknesses were found through analysis of potential failure modes, level of control and effects in relation to runaways of engineering trains and on-track machines.

6. Operator puts machine in free wheel condition (Risk Score: 10.5/15)

This failure mode scored the highest in relation to RRVs with the main actor involved being the operator.
However, a low likelihood score of 2 was assigned due to an accepted low occurrence rate.
Preventive and detective controls exist though these are recognised as weak due to a huge reliance on human intervention, training and a strong safety culture. It was also noted that manufacturers' instructions explicitly states the risk though there is a need for enforcement. Training was assessed as inconsistently applied and does not address the identified risk.
An effect of 'Uncontrolled movement' was chosen due to the danger with regards to a runaway that putting a machine in free wheel condition can cause. An example of such an event is to navigate around cattle grids.

11. Operator does not apply handbrake (Risk Score: 10/15)

This failure mode was concerned with non-application of the handbrake by an operator before leaving a vehicle and a moderate likelihood score of 3 was given.
Preventive controls are heavily reliant on human application and no detective controls were identified.
An effect of 'Potential for uncontrolled movement' was chosen due to the requirement for other conditions and failure modes to occur before this could cause a runaway including a gradient and surface condition. There would be little threat of a runaway if this was to occur on a flat stable ground.

3. Operating outside safe limits – environmental factors (Risk Score: 9.5/15)

The likelihood of failure for this failure mode was assessed as 4 mainly due to performance related pressures. Preventive controls were generally assessed as good with frequent briefings and a good assessment of training, though a slight weakness was noted due to differing qualities of assigned trainers. This failure is also well addressed through Network Rail control documentation and

manufacturers' instructions. For the purposes of this exercise, environmental factors include the weather and contamination of the railhead. However, it was also noted that no detective controls exist.
A reduced severity effect was given in this exercise, when compared to the Ironmen / Trolley exercise due to no reliance on the human as a direct means of stopping the vehicle. An effect of 'Reduced braking capacity' was chosen and given a severity score of 1 as it was noted that the severity of this failure mode would generally not cause a runaway though it was recognised that the vehicle's ability to stop in time is greatly reduced.

8. Braking system not maintained in accordance with maintenance plan (Risk Score: 9.5/15)

This failure was mainly concerned with the maintainer through the supplier and the likelihood was given a moderate score of 3 due to inconsistencies of application throughout the supplier base.
Four preventive controls were identified including the training and competence of the fitter and the approved maintenance plan though the strength of this is dependent on consistent application by the Vehicle Acceptance Body and the quality of application by the supplier. 'Supplier Quality Assurance' was assessed as a very good control though it was recognised that there are several inconsistencies within the suppliers' quality management systems.
No detective controls were identified.
An effect of 'Reduced or elimination of braking capacity' was chosen with a severity score of 3.

9. Operating outside equipment safe limits - intentional overspeeding (Risk Score: 9.5/15)

This failure pertained to the operator and the likelihood score of 4 has suggested that this is an expected occurrence. A vast range of preventive and detective controls exist though they are largely ineffective. Emergency speed restriction boards are in place, though are largely ineffective and overspeeding is covered within the handbook. 'Speedometers' were recognised as heavily reliant on human behaviour and only exist for a small number of vehicles. In terms of detective controls, they tend to fail as they are reliant on human intervention and follow up investigation, which is rarely enforced.
However, due to firmer links with derailment rather than runaway, a low score of 2 was given when scoring the effect.

10. Operating outside equipment safe limits - load (Risk Score: 9.5/15)

Overloading of the vehicle included both the payload and the trailing load and the likelihood score of 4 has suggested that this is an expected occurrence. Preventive controls were largely adequate and included the provision of codes of practice and training as well as engineering acceptance certificate. Only one detective control exists in the form of the 'Data Logger' and it was deemed inadequate due to a lack of follow up activity and investigation.
However, due to firmer links with derailment rather than runaway, a low score of 2 was given when scoring the effect.

14. Vehicle owner does not seek approval of engineering change (Risk Score: 9.5/15)

This failure mode pertained to the owner of the vehicle and the unsafe act of not gaining approval following an engineering change. The likelihood score of 4 has suggested that this is an expected occurrence. All preventive controls require compliance with processes including the owner's own engineering change processes, the RIS 1530 and the infrastructure plant manual. It was noted that the owner's engineering change processes are not well applied at the lowest level and several culture issues exist. The RIS 1530 is a good control but only applicable to new machines while the

‘infrastructure plant manual’ is in need of greater integration with the business. Despite these weaknesses, it was felt that all of these preventive controls are adequate.
A detective control exists in the form of on-site monitoring and was deemed inadequate due to a very low sample size of 0.1%. Therefore, the need for greater assurance around this is evident.
An effect score of 2 was given due to its fairly remote effect regarding an RRV runaway.

15. Braking system deliberately overridden (Risk Score: 9.5/15)

This failure mode pertained to any actor with a motive of deliberately overriding the braking system for a quick gain, including for better ease of use. This includes the operators, machine controllers and fitter and the preventive controls are largely reliant on the competency of these people. However, the training itself is not focused on controlling this risk so therefore may be a good opportunity to do so.
Detective controls focused on colleague intervention and pre-use checks though these were identified as weak controls.
A high effect score of 4 was given due to the potential of no braking capacity.

16. Failure to report defective equipment (Risk Score: 9.5/15)

This failure mode pertained to any actor who is required to report defects in equipment and a moderate likelihood score of 3 was assigned.
Several preventive controls were identified which relied on competency and local plant management arrangements which were largely adequate.
Two detective controls exist including ‘pre-delivery inspection’ and ‘on-site monitoring’ though they were both inadequate due to commercial pressures locally and infrequent monitoring.

18. Fitters do not hold suitable competence (Risk Score: 9.5/15)

This unsafe act centred on the role of the fitter and the likelihood that a fitter works on a machine without holding the correct competence. It was noted that this was not well controlled due to the specific needs of the competency system itself and the variations across the machines. Reliance is put upon the quality of all users’ competence management system which all needs to be in compliance with Sentinel.
Three detective controls apply but are all deemed inadequate. ‘Authority to work’ cards are inconsistently applied while sample sizes are too small regarding ‘on-site monitoring’ and ‘RISQS’.
It was identified that this failure mode could result in reduced or eliminated braking capacity which scored a 3.

4. Driver physically incapacitated (Risk Score: 9/15)

This unsafe act related to the driver of the vehicle or the main controller and was noted as a very remote occurrence.
Control was also generally good due to firm drugs and alcohol rules and well applied medical standards.
However, even as a low likelihood event, control should remain strong as a severity rating of 5 was given due to potentially disastrous results. If there was an opportunity for improvement, then colleague intervention could be improved by spotting those people who could potentially be at risk.

12. Operator fails to follow on / off tracking procedure (Risk Score: 9/15)

This failure mode pertained to the operator of the vehicle and a moderate score of 3 was given due to a perceived occurrence.
Preventive controls were largely adequate, including on/off tracking interlocks. However, it has been known that these have been removed, either without permission or following approval by the Head of Plant. There is also a reliance on operator training and compliance with the plant manual.
Two detective controls were identified though they are of low adequacy. Colleague intervention was scored as largely unacceptable due to poor safety culture and information from the data logger is not investigated enough.
Should this unsafe act occur, there is potential for uncontrolled movement but only scored a 3 due to various other conditions required occurring at the same time.

19. Braking system damaged in transit (Risk Score: 9/15)

This failure mode pertained to those transporting the vehicle and related to poor handling. It was noted that a likelihood of 2 was assigned due to a low possibility of this occurring in the first place.
Only one preventive control exists in the form of the 'driver certificate' and was deemed inadequate due to extra requirements needed in the form of familiarisation and experience of the driver for each vehicle and the process being constrained by the equipment provided.
'On-site monitoring' and 'pre-use checks' have been designed as detective controls but have been deemed inadequate due to low frequency.
It was identified that this failure mode could result in 'reduced or eliminated braking capacity' which scored a 3.

13. Vehicle Acceptance Body does not apply the RIS (1530) (Risk Score: 8.5/15)

This unsafe act pertained to the vehicle acceptance body and this high level unsafe act revolves around their duty to apply the railway group standard. It was acknowledged by the group that the likelihood is possible and subsequently scored a 3 as application was deemed inconsistent.
Two preventive controls exist in the form of a signatory process which has two weaknesses in the form of no formal competence to examine the vehicle and commercial pressures to get the work done swiftly. Even with these weaknesses, it was felt that this control is adequate and scored a 3. However, the second control, 'RSSB Quality Assurance', was deemed an unacceptable control. 'On-site monitoring' was identified as the only detective control but was deemed inadequate.
An effect score of 2 was given due to its fairly remote effect regarding an RRV runaway.

20. Repairs carried out with worn or defective components (Risk Score: 8.5/15)

This unsafe act pertained to any actor who repairs vehicles and knowingly uses worn or defective parts, often due to commercial pressures to cut corners. It was noted that the likelihood is possible and scored a 3.
Commercial pressures was cited as a weakness of the first control 'Manufacturers' Recommendations / Maintenance Plan' and scored a 4 (inadequate) accordingly. Users' own repair policies were deemed adequate for controlling this risk, as a formal agreement is required for the use of approved parts, as was the competence of the fitter. 'On-site monitoring' was identified as the only detective control but was deemed inadequate.
An effect score of 2 was given due to its fairly remote effect regarding an RRV runaway.

7. Braking system not installed correctly (Risk Score: 8/15)

This failure mode pertained to the brake fitter and was assessed as an unlikely occurrence so scored a 2. The competence of the fitter was identified as a key control and was assessed as adequate, as was 'RISQS Approval'. 'Supplier Quality Assurance' was also identified as a robust preventive control and scored a 2.
'Pre-Use Check' was identified as the only detective control but was identified as inadequate.
It was identified that this failure mode could result in 'reduced or eliminated braking capacity' which scored a 3.

2. Trailer service brake line not connected (Risk Score: 7.5/15)

This failure mode pertained to the operator or machine controller's duty to connect the brake line to the trailer and was deemed a possible occurrence so scored a 3.
Three preventive controls were identified and were all deemed at least adequate and relied on operator and machine controller training which was assessed as good. Reliance was also on 'manufacturers' instructions' (which was specifically identified as a strong control) and the operator and machine controller's compliance with the 'infrastructure plant manual'.
However, no detective control was identified for this unsafe act.
The effect of this unsafe act in the context of a runaway was assessed as very low as this would only cause 'reduced braking capacity'.

17. Operators do not hold suitable competence (Risk Score: 7.5/15)

This unsafe act revolved around people operating machinery without holding the necessary competence. This was assessed as an unlikely scenario so scored a 2. However, it was emphasised by the group that due to slight differences between machines and their attachments, operators can be competent without having a full understanding and familiarity of that machine.
The first preventive control was identified in the form of Sentinel cards & authority to work though this control does not provide specific detailed information of the competency on site for use of RRVs. This control was backed up with the users own competence management system which is required to comply with the Sentinel scheme. Both controls were assessed as adequate.
'On-site monitoring' was identified as the only detective control but was deemed inadequate.
An effect score of 2 was given due to the fact that the failure could result in being 'unable to regulate speed' though it would unlikely result in a runaway.

21. Diverse trailer types used in consist (Risk Score: 7.5/15)

This unsafe act related to the fact that all trailers are physically compatible but use different braking systems. The likelihood was assessed as possible so scored a 3.
One preventive control was identified in the form of 'OTP planning and briefing processes' and although it scored as a 3, it was highlighted that there is instances of poor application of these processes due to over complication of the process itself which contains too much unnecessary information.
'On-site monitoring' was identified as the only detective control but was deemed inadequate.
The effect of this unsafe act in the context of a runaway was assessed as very low as this would only cause 'reduced braking capacity'.

1. Machine supplied with no direct wheel braking (Risk Score: 6.5/15)

This unsafe act pertained to the supplier of vehicles and was assessed with a very low remote likelihood.
This was reflected within the preventive controls which were largely good and included 'pre-delivery inspections', 'compliance with legislation' and the plant manual and training for operators and machine controllers which all control the failure mode at an either good or adequate level. However, an inadequate control was identified through 'Product Acceptance'. It was noted that Product Acceptance is not applied retrospectively and the majority of RRVs have not gone through the process.
The 'pre-use check' process was identified as the only detective control and was deemed adequate for this failure mode.
It was identified that this failure mode could result in reduced or eliminated braking capacity which scored a 3.

5. Operating outside safe limits - gradient (Risk Score: 6.5/15)

This failure mode pertained to the operator and assessed as a remote likelihood of occurrence due to the limited areas of unsafe gradient available on the network for RRVs.
Preventive controls rely on training for operators and machine controllers, the use of 'Engineering Acceptance Certificate' and the 'OTP Planning and Briefing' process which all scored either a 2 or 3. However, no detective control currently exists for this failure mode but it was noted that a future control will exist soon in the form of 'OTP Assurance'.
An effect score of 2 was given due to the fact that the failure could result in being 'unable to regulate speed' though it would unlikely result in a runaway.

Refer to Appendix B for the full register of failure modes, effects and identified controls and Appendix C for the full RPN table

Likelihood and Effects Analysis

Likelihood: Likelihood was consistently scored in terms of their collective risk rather than on an individual basis.
Effects: As evident during the detailed analysis, many failure modes have the same overall effect and were scored in the context of a runaway and in relation to each other. A score of 5 was given where the effect should occur, a runaway is inevitable. Please see below for a list of all identified effects, ranging from high to low severity:

- Uncontrolled movement: 5
- Significant reduction of braking capacity: 4
- Reduced or elimination of braking capacity: 3
- Potential for uncontrolled movement: 3
- Unable to regulate speed: 2
- Unable to identify effectiveness of braking system: 2
- Reduced braking capacity: 1

Findings & Themes to Consider

Several key themes emerged as a result of undertaking this risk workshop, in addition to the analysis of each failure mode in isolation documented above. These are discussed in each sub-section below.

Recurring Controls

Several recurring controls appeared throughout the workshop, and should be noted for their apparent criticality:

- Training for operators and machine controllers (occurs 11 times)
- On-site monitoring (occurs 8 times)
- Compliance with Infrastructure Plant Manual (occurs 7 times)
- Colleague intervention / site supervision (occurs 5 times)
- Training and competence of fitter (occurs 5 times)
- Pre-Use Check Process (occurs 4 times)
- Manufacturers' Instructions (occurs 4 times)

It should be noted that these controls have generally been assessed as ineffective in the context of each identified failure mode.

Failure Modes with No Preventive Controls (or highest control rated as 5)

- None

Preventive controls are noted as generally good across this risk assessment.

Failure Modes with no Detective Controls (or highest control rated as 5)

- 2. Trailer service brake line not connected
- 3. Operating outside safe limits – environmental factors
- 5. Operating outside safe limits – gradient
- 8. Braking system not maintained in accordance with maintenance plan
- 11. Operator does not apply handbrake

Despite most failure modes having a detective control, it must be stressed that most current detective controls rely on human intervention and a safe culture.

However, in comparison with the risk assessment on ironmen and trolleys, there are more automated controls in the form of data loggers and a possible opportunity has emerged to make more use of these controls by conducting deeper data analysis of its findings.

Behaviour and Safe Culture

The overall subject of behaviour and culture was appeared on numerous times throughout the risk assessment, as many detective controls rely on human intervention or a competent supervisor.

Unknown Risks

A theme emerged during the risk assessment where unknown risk exists due to several reasons, including:

- Vehicles that can bypass product acceptance scrutiny due to exemptions
- Vehicles that were introduced before product acceptance procedures existed
- Several minor changes to vehicles attributing a major change resulting in the major change not assessed
- Commercial pressures on behalf of the suppliers and approvers

It is recommended that these areas are explored to gain a more comfortable position on safety risk.

Workshop 3 – Engineering Trains and On-Track Machines (OTM)

An understanding was first required on the actors involved, whose unsafe act could result in a runaway engineering train or on-track machine. These were identified as:

- Driver / operator
- General track workers
- Maintainer
- Vehicle designer
- Vehicle owner
- Marshall
- Vandal / saboteur

Analysis of Failure Modes

Failure modes were identified alongside their effect in the context of a runaway and preventive and detective controls were also identified. Failure modes are presented in descending order of risk score, using the Risk Priority Number methodology presented within Appendix C.

In contrast with the other workshop, there was less cause of concern though the themes of safe culture and competence were evident throughout. The lack of detective controls also highlights a weakened ability to react to failure modes when they occur although they may be well prevented.

4. Contaminated Railhead (not cleared up) (Risk Score: 11/15)

This failure mode pertained to anyone working in the vicinity of the area not clearing up after contaminating the railhead. A likelihood score of 3 was given which suggests this occurs on a semi-regular basis.
Preventive and detective controls exist for this failure mode and all were assessed as adequate. Preventive controls included the use of the 'operators' manual' and the use of provided spill kits. A detective control exists in the form of real time reporting of such incidents to NSC but this is a human driven detective control. Overall, no great concerns emerged around the control of this failure mode.
A strong safety culture is required here that focuses on a disciplined approach to site housekeeping as the potential effect of this is an inability to retard the vehicle and therefore has the potential to result in a runaway event. The severity of this scored the maximum of 5 as a result.

7. Safe recovery procedure not applied following machine breakdown (Risk Score: 11/15)

This failure mode pertained to the operator and included both recovery from an unbraked situation and the towing of an unsafe load. A likelihood score of 3 was given which suggests this occurs on a semi-regular basis.
Two preventive controls exists for this failure mode in the form of driver / operator competence and the use of the vehicle handbook. Driver / operator competence was deemed adequate but it was noted that this was not regularly exercised. The use of the Vehicle Handbook was scored as inadequate due to non-consideration of the operational environment including gradients amongst other constraints and safe towing practice.
No detective controls exist for this failure mode.

The severity of this failure is very high as should it occur, will result in a vehicle being left in an unbraked condition. Only the requirement for a gradient prevented it receiving the highest possible score and ended with a score of 4.

11. Movement performed by non-competent person (Risk Score: 11/15)

The failure mode was concerned with a person not authorised to be competent to be operating an engineering train or OTM and received a score of 3 as it was noted that this does occur mainly within sidings and depots.
Only one control exists in the form of driver / operator competence which is reliant on a strong safety culture of the drivers and operators on shift to prevent such an occurrence.
No detective controls exist for this failure mode.
A high severity rating of 4 was given due to the fact that a non-competent person will not be able to control the vehicle.

14. Uncontrolled modifications to vehicle (Risk Score: 11/15)

This failure mode pertained to vehicle suppliers with a focus on incremental small changes to vehicles when combined, result in a major change. It was noted that the size or significance of the changes involved are based on interpretation whether or not it goes through change control and as a result, was deemed that this happens on a fairly regular basis.
Two preventive controls exist and we both assessed as adequate; 'Engineering Change Participant Competence' and 'Engineering Change Process'. Engineering Change Participant Competence has the caveat that there is no external standard for competence set which could potentially bolster this control. Engineering Change Process is often bypassed.
No detective controls exist for this failure mode.
The severity of this failure is very high as should it occur, will result in a 'vehicle being left in an unbraked condition'. Only the requirement for a gradient prevented it receiving the highest possible score and ended with a score of 4.

16. Deliberate override of safety system (Risk Score: 10/15)

This failure mode related to an unsafe act of the operator and was concerned with the taking of shortcuts at the expense of safety. It was noted that this does not occur too often and given a score of 2.
One preventive control was identified through a positive safety culture but this was scored as inadequate.
One detective control was identified through colleague intervention and site supervision though this was scored as inadequate.
The severity of this failure is very high as should it occur, will result in a 'vehicle being left in an unbraked condition'. Only the requirement for a gradient prevented it receiving the highest possible score and ended with a score of 4.

1. Parking brake not applied when required (Risk Score: 9.5/15)

This failure mode pertained to the operator and was noted that this does not occur too often and given a likelihood score of 2.
'Driver competence' was noted as the sole preventive control and with regard to controlling the failure mode, was rated as good.
However, No detective controls exist for this failure mode.

The severity of this failure is very high as should it occur, will result in a 'vehicle being left in an unbraked condition'. Only the requirement for a gradient prevented it receiving the highest possible score and ended with a score of 4.

3. Driving technique not adapting to local conditions (Risk Score: 9.5/15)

This failure mode pertained to the driver and was noted that due to a tendency to be complacent, occur semi-regularly and was given a likelihood score of 3.
'Driver competence' was noted as the sole preventive control and with regard to controlling the failure mode, was rated as good.
However, No detective controls exist for this failure mode.
The result of this failure mode is an 'inability to regulate speed' therefore was given a severity score of 3 to reflect the moderate potential of a runaway event.

6. Regular brake tests not applied in adverse conditions (Risk Score: 9.5/15)

This failure mode pertained to the driver of the vehicle and it was noted that this is an infrequent occurrence so a likelihood score of 2 was given.
Two preventive controls exist in the form of 'driver competence' and 'use of the drivers' operating rulebook' which were scored as good and adequate accordingly.
However, No detective controls exist for this failure mode.
The severity of this failure is 'insufficient brake force' in adverse conditions and therefore has moderate potential for a runaway. Severity was thus scored as 3.

15. Incorrect marshalling of vehicles within a possession (Risk Score: 9.5/15)

This failure mode pertained to the marshall and their responsibilities within a possession and it was noted that this is an infrequent occurrence so a likelihood score of 2 was given.
Two preventive controls were identified, both in the form of competence (driver and marshall). Both were assessed as good.
However, No detective controls exist for this failure mode.
The severity of this failure is very high as should it occur, will result in a 'vehicle being left in an unbraked condition'. Only the requirement for a gradient prevented it receiving the highest possible score and ended with a score of 4.

8. Inadequate safety analysis at design stage (Risk Score: 9.5/15)

This failure mode pertained to the designer of the vehicle and those involved in authorisation and it was noted that this is an infrequent occurrence so a likelihood score of 2 was given.
Three preventive controls were identified. Two were assessed as adequate which were 'Manufacturers' Risk Assessment in accordance with Machinery Directive' and 'Engineering Acceptance in accordance with ROGS, RIR and CSM (RA)'. For the former, it was noted that it is a good process for new vehicles, though for older vehicles the control is weaker as overall there are more older vehicles than new. One preventive control was assessed as inadequate which was the 'Product Approval' process, citing the lack of a quality management system.
However, no detective controls exist for this failure mode.
The severity of the failure is an 'uncontrolled movement' which was given a severity score of 3.

5. Pre-use brake effectiveness tests not carried out (Risk Score: 8.5/15)

This failure mode pertained to the driver of the vehicle and it was noted that this is an infrequent occurrence so a likelihood score of 2 was given.
Two preventive controls exist for this failure mode. 'Driver Competence' was rated as good while 'Use of Drivers' Operating Handbook' (including OTM drivers handbook COP 0113) was scored as adequate.
However, no detective controls exist for this failure mode.
The severity of this failure is 'insufficient brake force' and therefore has moderate potential for a runaway. Severity was thus scored as 3.

9. Operating outside safe limits - load (Risk Score: 8.5/15)

This failure mode pertained to both the driver of the vehicle and the loader of the vehicle and it was noted that this is an infrequent occurrence so a likelihood score of 2 was given.
Two preventive controls exist for this failure mode. 'Load Examiner Competence' was scored as a good control while 'Driver Competence' with reference to this failure mode was scored as adequate.
However, no detective controls exist for this failure mode.
The severity of this failure is 'insufficient brake force' caused by the unstable load and therefore has moderate potential for a runaway. Severity was thus scored as 3.

10. Incorrect position of load-weigh valve (Risk Score: 8.5/15)

This failure mode pertained to the driver of the vehicle and those supplying relevant information to them and it was noted that this is an infrequent occurrence so a likelihood score of 2 was given.
Three preventive controls exist for this failure mode. One preventive control was scored as good which was 'Driver Competence'. The other two were rated as adequate which were 'supply of accurate consist information to driver' and the 'use of pre-start checks'.
However, no detective controls exist for this failure mode.
The severity of this failure is 'insufficient brake force' caused by the unstable load and therefore has moderate potential for a runaway. Severity was thus scored as 3.

13. Defects and damages not reported (Risk Score: 8.5/15)

This failure mode pertained to all those who observe defects and damages to vehicles including the driver and the maintainer amongst others. It was noted that this is an infrequent occurrence so a likelihood score of 2 was given.
Two preventive controls exist in the form of 'Driver Competence' and 'use of pre-start checks'. Driver Competence was rated as good while the use of pre-start checks were scored as adequate.
A detective control exists in the form of the reporting processes and repairs. This was rated as adequate.
The potential severity of this failure is 'braking system does not perform as intended' and scored highly (4) as it could lead to a runaway situation.

17. Vandalism or sabotage (Risk Score: 8.5/15)

This failure mode pertained to those internal or external to Network Rail and involves all deliberate acts that could threaten the safety of the vehicle. However it was noted that the likelihood is relatively low and was given a score of 1.
Three preventive controls were identified. 'Safe and secure storage' was identified as a key control though this was rated as inadequate as it was cited that often workers would not adequately use this

control was intended. ‘Driver Competence’ was identified as a good control to identify acts of vandalism or sabotage and ‘use of pre-start checks’ was also identified and was rated as adequate. However, no detective controls exist for this failure mode.
The severity of this failure is very high as should the failure mode occur, could result in a ‘vehicle being left in an unbraked condition’. Only the requirement for a gradient prevented it receiving the highest possible score and ended with a score of 4.

12. Braking system not maintained in accordance with maintenance plan (Risk Score: 7/15)

This failure mode pertained to the maintainer and it was noted that as it is well controlled, is a rare occurrence and therefore received a likelihood score of 1.
Two preventive controls are in existance for this failure mode and both were rated as good. These were ‘approved maintenance plan’, which is reviewed every two years, and ‘maintainer competence’.
Two detective controls were identified. ‘Maintenance Assurance’ was rated as good and fault and defect reporting and repairs was scored as adequate.
The severity of this failure is ‘braking system does not perform as intended’ and scored highly (4) as it can lead to a runaway situation.

Refer to Appendix B for the full register of failure modes, effects and identified controls and Appendix C for the full RPN table

Likelihood and Effects Analysis

Likelihood: Likelihood was consistently scored in terms of their collective risk rather on an individual basis.
Effects: As evident during the detailed analysis, many failure modes have the same overall effect and were scored in the context of a runaway and in relation to each other. A score of 5 was given where the effect should occur, a runaway is inevitable. Please see below for a list of all identified effects, ranging from high to low severity:

- Unable to retard vehicle: 5
- Vehicle left in unbraked condition: 4
- Inability to control vehicle: 4
- Braking system does not perform as intended: 4
- Unable to regulate speed: 3
- Insufficient brake force: 3
- Uncontrolled movement: 3
- Unable to achieve safe stopping distance: 2

Findings & Themes to Consider

Several key themes emerged as a result of undertaking this risk workshop, in addition to the analysis of each failure mode in isolation documented above. These are discussed in each sub-section below.

Recurring Controls

A few recurring controls appeared throughout the workshop, and should be noted for their apparent criticality:

- Driver Competence (occurs 10 times)
- Use of pre-start checks (occurs 3 times)

However, most controls identified during this workshop occurred only once.

Failure Modes with No Preventive Controls (or highest control rated as 5)

All failure modes identified had at least one preventive control rated 4 or higher. This suggests that for OTM and engineering trains, there is much better control associated with it as opposed to ironmen / trolleys and RRVs.

Failure Modes with no Detective Controls (or highest control rated as 5)

- 1. Parking brake not applied when required
- 3. Driving technique not adapting to local conditions
- 5. Pre-use brake effectiveness tests not carried out
- 6. Regular brake tests not applied in adverse conditions
- 7. Safe recovery procedure not applied following machine breakdown
- 8. Inadequate safety analysis at design stage
- 9. Operating outside safe limits – load
- 10. Incorrect position of load-weigh valve
- 11. Movement performed by non-competent person
- 14. Uncontrolled modifications to vehicle
- 15. Incorrect marshalling of vehicles within a possession
- 17. Vandalism or sabotage

Despite a small number of failure modes having a detective control, it must be stressed that most current detective controls rely on human intervention and a safe culture.

In contrast with the availability and effectiveness of preventive controls, it must be noted that should a failure mode occur, these will not usually be picked up via a detective control.

Driver Competence

Driver competence has emerged as a critical control and although this was evaluated as a strong control, it is imperative that this remains the case through strong leadership, training and experience.

Appendices

Appendix A – Full Methodology Pack

Runaways Risk Workshop

Ironmen / Trolleys:

Monday 17th August (Loughton 101, The Quadrant:MK)

RRV:

Tuesday 25th August (Furzton G04, The Quadrant:MK)

Engineering Train / OTM:

Thursday 10th September (Willen 203, The Quadrant:MK)

Background Information

Why are we doing this?

- In response to a deep dive action on Irregular Working (relating to Runaways)
- To find and understand key errors with poor detection methods associated with Unsafe Acts:

*"**Irregular Working Deep Dive Action A5***

Network Rail should undertake a ~~Failure Modes & Effects Analysis~~ Bowtie Risk Assessment to review the causes of Unsafe Acts, giving particular consideration to the use of in identifying the nature, severity, rate of occurrence and detectability of such events. Consideration should be given to using a Risk Priority Number methodology to assist in prioritising improvements to risk controls."*

**amended from FMEA to a bowtie due to retrospective nature of work. It has been identified that an FMEA approach is not the best fit for this exercise*

Background - Scope of Deep Dive

For the purposes of this Deep Dive Review 'Irregular Working' comprises Unsafe Acts by Network Rail (or its Contractors') staff that result, or could potentially result, in a train accident. Such Unsafe Acts include those that could result in Unsafe Condition of plant or equipment.

The scope of this review considers Irregular Working events that occur on Network Rail Managed Infrastructure (NRMI).

The scope considers those Irregular Working events that affect, or could potentially affect, passengers, the workforce and members of the public.

The following are outside the scope of this review:

- Close Calls and Near Misses that did not have the potential to result in a train accident;
- events included within the scope of the suite of train accident risk Deep Dive Reviews conducted to date; and
- events associated with train accident precursors that are not within the former Irregular Working main group of the industry Precursor Indicator Model (PIM) i.e. objects on the line (e.g. animals, trees, vehicles, vandalism), train failures (e.g. axle failure); and train accident risk not modelled within the PIM (e.g. train division, train fires).

The existing classification systems used in the Precursor Indicator Model (PIM) and Safety Risk Model (SRM) do not fully align with the definitions shown above. In conducting this Deep Dive Review it has been necessary to develop a categorisation system that specifically identifies Irregular Working events that could result in train accident risk.

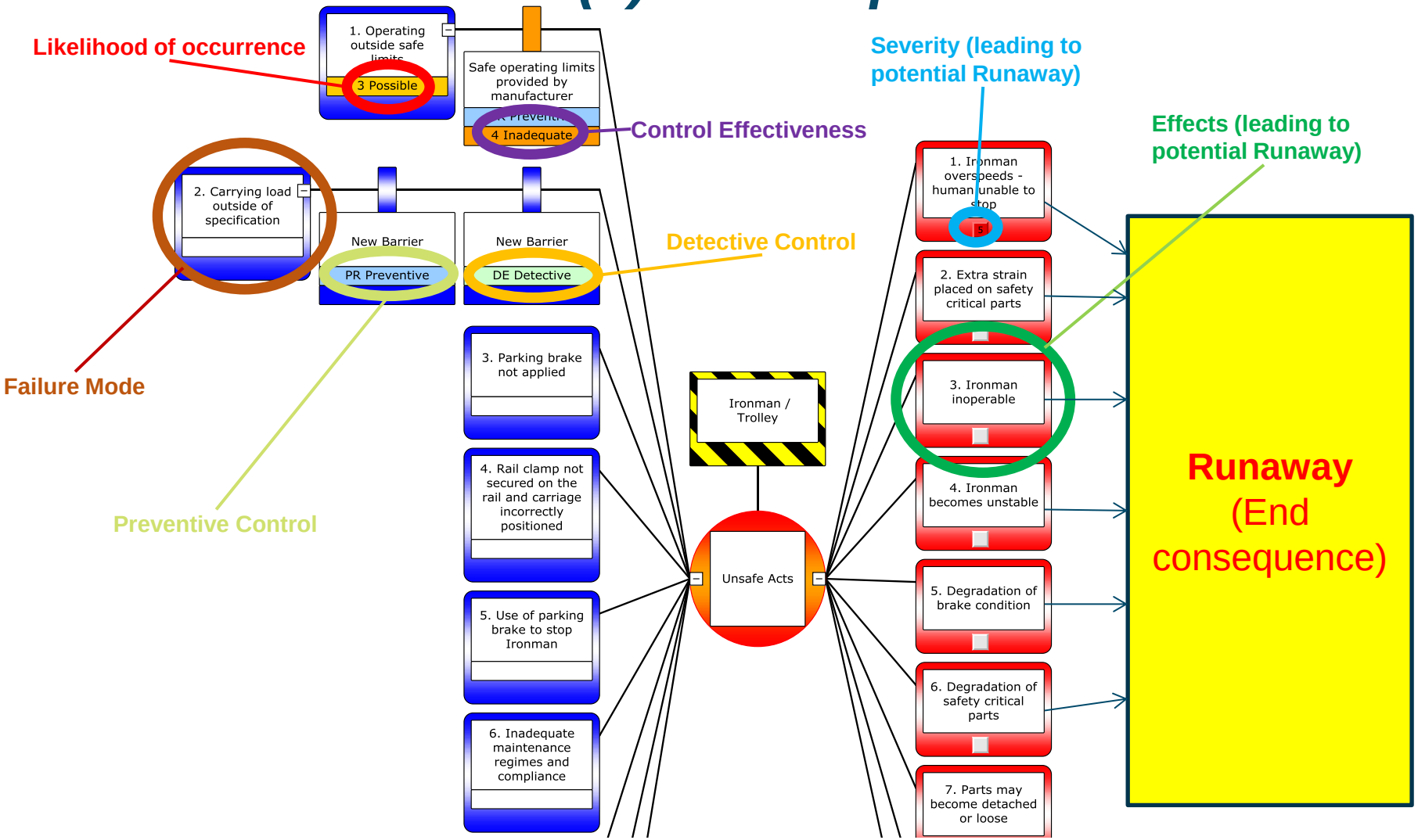
Methodology and Approach

Format of Session

Each workshop will use a BowTie format, to identify the following in relation to unsafe acts leading to runaways:

- Failure modes (and likelihood of occurrence 1-5)
- Effects (and their severity leading to a possible Runaway 1-5)
- Existing preventive controls (and their effectiveness 1-5)
- Existing detective controls (and their effectiveness 1-5)

Format of Session (2) – Example



Likelihood of Failure Mode Occurrence

Basis of Rating:

- Due to the lack of meaningful data in order to define a quantifiable rating, likelihood will be based on:
  - Knowledge of current behaviours
  - Known past events where a failure mode has occurred
  - Where appropriate, a likelihood will be classified in relation to other Failure Modes

Rating	Description
1	Remote possibility of occurrence
2	Low failure rate occurrence.
3	Moderate failure rate.
4	Frequent failure rate.
5	High probability of failure. It is almost certain the failure will occur.

Severity of Failure Mode Effects

Basis of Rating:

- Severity will be rated in relation to an overall consequence of a Runaway
- Due to the lack of meaningful data in order to define a quantifiable rating, severity will be based on:
  - Subject matter expert knowledge
  - Where appropriate, a severity rating will be classified in relation to other ratings

Rating	Description
1	Consequence of failure is negligible with little or no influence of a Runaway.
2	Consequence of failure is slight. Could influence a Runaway though other Failure Modes need to occur for this to happen.
3	Consequence of failure is moderate. Could directly trigger other Failure Modes or become a serious contributory factor of a Runaway.
4	Consequence of failure is serious with good chance of direct Runaway. Could trigger other multiple Failure Modes.
5	Consequence of failure is very serious and almost certain impact of a direct Runaway.

Existing Control Effectiveness

Rating	Description
1	• Highest probability of the Failure Mode will be detected before the Effects are realised. Should be a fully automated control with little or no reliance on human intervention. • A control that almost completely prevents a cause from occurring.
2	• Very high chance that the Failure Mode will be detected before the Effects are realised. Normally an automatic control with little or no reliance on human intervention. • A control that typically prevents the defect from occurring.
3	• Moderate chance that the Failure Mode will be detected before the Effects are realised. • A control that detects the cause after it has occurred.
4	• Low chance of the Failure Mode will be detected before the Effects are realised. Relies on a significant amount of human intervention. • Weak or no controls to prevent the cause, some controls to detect the cause.
5	• Lowest probability of the Failure Mode will be detected before the Effects are realised. Relies on human intervention. • No consistent controls to prevent or detect the cause.

Desired Output From The Session

- A comprehensive list of Failure Modes in relation to unsafe acts leading to runaways:
  - Description of Failure Mode
  - Likelihood score of Failure Mode occurrence (1-5)
  - Description of potential Failure Mode Effects
  - Severity score of Failure Mode Effects (1-5)
  - Current Preventive Controls in place
  - Current Detective Controls in place
  - Effectiveness of each Control (1-5)
- If there is ample time, each Failure Mode will be assigned a Risk Priority Number (RPN) and fed back to the group
- RPN = Likelihood + Severity + Control Effectiveness (lowest)

Next Steps and Actions

Following the sessions:

- A full RPN table will be produced
- A report will be written to summarise the findings of the session, highlighting those Failure Modes for action with a high RPN, including any particular weaknesses
- The report will be submitted to the Director, Risk, Analysis & Assurance in Safety, Technical & Engineering (original Deep Dive Action Owner) to be taken forward

Thank you for your participation

Appendix B: Full Registers of Failure Modes, Effects and Controls

Ironmen / Trolleys

Failure Modes		Effects
	Controls (P=Preventive) (D= Detective)	
• 1. Operating outside equipment safe limits - gradient		• 1. Unable to regulate speed
P	• Training for use of ironman / trolley	
P	• Safe operating limits provided by manufacturer and Network Rail	
	No Detective Control	
• 2. Operating outside equipment safe limits - load		• 2. Unable to regulate speed
P	• Safe working loads marked on ironman / trolley	
P	• Training for use of ironman / trolley	
	• No Detective Control	
• 3. Deliberate violation of braking system		• 3. Reduced or elimination of braking capacity
	No Preventive Control	
D	• Anti-Tamper Paint	
D	• Colleague intervention / site supervision	
• 4. Adverse distributed load		• 4. Reduced rail wheel frictional interface
P	• Training for use of ironman / trolley	
P	• Uniformly distributed loads marked on ironman / trolley	
D	• Colleague intervention / site supervision	
• 5. Braking design does not meet end user requirements		• 5. Increased deterioration of braking components
P	• Product Approval	
	No Detective Control	
	• Product Specification (future)	
• 6. Inadequate assembly on site		• 6. Reduced or no effectiveness of braking system
P	• Training for use of ironman / trolley	
D	• Colleague intervention / site supervision	
• 7. Ironman / trolley not stored or transported in a suitable and safe manner		• 7. Increased deterioration and damage of braking components
P	• Operating Instructions	
	No Detective Control	
• 8. Adequate pre-use checks not carried out		• 8. Unable to identify effectiveness of braking system
P	• Pre-Use Check Process	
	No Detective Control	
• 9. Ironman / trolley not adequately maintained		• 9. Reduced or elimination of braking capacity
P	• Maintenance Plans	
P	• Local maintenance	
P	• Supplier Assurance	
	No Detective Control	
	• RISQS Approval (future)	
• 10. Use of unspecified components		• 10. Reduced or elimination of braking capacity
P	• Supplier Quality Management System	
P	• Supplier Assurance	
	No Detective Control	
	• RISQS Approval (future)	
• 11. Repairs carried out with worn or defective components		• 11. Reduced or elimination of braking capacity
	No Preventive Control	
	No Detective Control	
• 12. Use of unauthorised equipment		• 12. Unable to identify effectiveness of braking system
P	• Product Approval	
	No Detective Control	
• 13. Supplier issues products with unauthorised modifications		• 13. Unable to identify effectiveness of braking system
P	• Supplier Quality Management System	

P	• Supplier Assurance	
P	• Product Approval	
	No Detective Control	
	• RISQS Approval (future)	
• 14. Planning does not account for risks and limitations		• 14. Unable to regulate speed
	No Preventive Control	
	No Detective Control	
• 15. Operators do not hold suitable competence		• 15. Unable to regulate speed
P	Sentinel card (NR) / Authority to work (contractor)	
	No Detective Control	
• 16. Inability to communicate on site		• 16. Unmanaged speed control
	No Preventive Control	
	No Detective Control	
• 17. Deliberate violation of operating instructions		• 17. Unable to regulate speed
P	• Training for use of ironman / trolley	
D	• Colleague intervention / site supervision	
• 18. Inadequate site supervision		• 18. Unmanaged speed control
P	• Planning and delivery of task	
D	• Monitoring / assurance	
• 19. Imbalanced utilisation of available ironmen / trolley		• 19. Increased deterioration of braking components
	No Preventive Control	
	No Detective Control	
• 20. Operating outside equipment safe limits - no. of people		• 20. Unable to regulate speed
P	• Safe System of Work	
P	• Training for use of ironman / trolley	
D	• Colleague intervention / site supervision	
• 21. Operating outside equipment safe limits - environmental factors		• 21. Reduced or elimination of braking capacity
P	• Training for use of ironman / trolley	
P	• Safe operating limits provided by manufacturer and Network Rail	
	No Detective Control	
• 22. Operating outside equipment safe limits - intentional overspeeding		• 22. Unable to regulate speed
P	• Training for use of ironman / trolley	
P	• Safe operating limits provided by manufacturer and Network Rail	
D	• Colleague intervention / site supervision	
• 23. Combined use of ironmen types		• 23. Reduced braking capacity
P	• Training for use of ironman / trolley	
	No Detective Control	

Rail Road Vehicles (RRVs)

Failure Modes		Effects
	Controls (P=Preventive) (D= Detective)	
• 1. Machine supplied with no direct wheel braking		• 1. Reduced or elimination of braking capacity
P	• Pre-Delivery Inspection	
P	• Compliance with RIS 1530	
P	• Compliance with Infrastructure Plant Manual	
P	• Training for operators and machine controllers	
P	• Product Acceptance	
D	• Pre-Use Check Process	
• 2. Trailer service brake line not connected		• 2. Reduced braking capacity
P	• Manufacturers Instructions	
P	• Training for operators and machine controllers	
P	• Compliance with Infrastructure Plant Manual	
	No Detective Control	
• 3. Operating outside safe limits - environmental factors		• 3. Unable to regulate speed
P	• Briefings	
P	• Training for operators and machine controllers	
P	• Manufacturers Instructions	
P	• Compliance with Infrastructure Plant Manual	
	No Detective Control	
• 4. Driver physically incapacitated		• 4. Uncontrolled movement
P	• Drugs and Alcohol Policy	
P	• Fatigue Policy (future)	
P	• Medical Standards	
D	• Colleague intervention / site supervision	
• 5. Operating outside safe limits - gradient		• 5. Unable to regulate speed
P	• OTP Planning and Briefing	
P	• Engineering Acceptance Certificate / Data Panel	
P	• Training for operators and machine controllers	
	No Detective Control	
	OTP Assurance (future)	
• 6. Operator puts machine in free wheel condition		• 6. Uncontrolled movement
P	• Training for operators and machine controllers	
P	• Manufacturers Instructions	
D	• Colleague intervention / site supervision	
• 7. Braking system not installed correctly		• 7. Reduced or elimination of braking capacity
P	• Training and competence of fitter	
P	• Supplier Quality Assurance	
P	• RISQS Approval	
D	• Pre-Use Check Process	
• 8. Braking system not maintained in accordance with maintenance plan		• 8. Reduced or elimination of braking capacity
P	• Approved Maintenance Plan	
P	• Supplier Quality Assurance	
P	• Supplier Quality Management System	
P	• Training and competence of fitter	
	No Detective Control	
• 9. Operating outside equipment safe limits - intentional overspeeding		• 9. Unable to regulate speed
P	• Emergency Speed Restriction Boards	
P	• Handbook 15 - Speeds	
P	• Speedometer / speed limiter	
P	• Training for operators and machine controllers	
P	• Engineering Acceptance Certificate / Data Panel	
D	• Data Logger	

D	• Colleague intervention / site supervision	
• 10. Operating outside equipment safe limits - load		• 10. Unable to regulate speed
P	• M&EE Codes of Practice	
P	• Training for operators and machine controllers	
P	• Compliance with Infrastructure Plant Manual	
P	• Engineering Acceptance Certificate / Data Panel	
D	• Data Logger	
• 11. Operator does not apply handbrake		• 11. Potential for uncontrolled movement
P	• Training for operators and machine controllers	
P	• Manufacturers Instructions	
	No Detective Control	
• 12. Operator fails to follow on / off tracking procedure		• 12. Potential for uncontrolled movement
P	• On / Off Tracking Interlocks	
P	• Training for operators and machine controllers	
P	• Compliance with Infrastructure Plant Manual	
D	• Colleague intervention / site supervision	
D	• Data Logger	
• 13. Vehicle Acceptance Body does not apply the RIS (1530)		• 13. Unable to identify effectiveness of braking system
P	• Signatory Process	
P	• RSSB Quality Assurance	
D	• On-site Monitoring	
• 14. Vehicle owner does not seek approval of engineering change		• 14. Unable to identify effectiveness of braking system
P	• Owner's Engineering Change Process	
P	• Compliance with RIS 1530	
P	• Compliance with Infrastructure Plant Manual	
D	• On-site Monitoring	
• 15. Braking system deliberately overriden		• 15. Significant reduction of braking capacity
P	• Training for operators and machine controllers	
P	• Training and competence of fitter	
D	• Colleague intervention / site supervision	
D	• Pre-Use Check Process	
• 16. Failure to report defective equipment		• 16. Reduced or elimination of braking capacity
P	• Users' Plant Management Arrangements	
P	• Training for operators and machine controllers	
P	• Training and competence of fitter	
P	• Compliance with Infrastructure Plant Manual	
D	• Pre-Delivery Inspection	
D	• On-site Monitoring	
• 17. Operators do not hold suitable competence		• 17. Unable to regulate speed
P	• Sentinel card (NR) / Authority to work (contractor)	
P	• Users' Competence Management System	
D	• On-site Monitoring	
• 18. Fitters do not hold suitable competence		• 18. Reduced or elimination of braking capacity
P	• Users' Competence Management System	
D	• Authority to Work cards	
D	• On-site Monitoring	
D	• RISQS Assured	
• 19. Braking system damaged in transit		• 19. Reduced or elimination of braking capacity
P	• Driver Certificate of Professional Competence	
D	• On-site Monitoring	
D	• Pre-Use Check Process	
	Machine Tie Down Plan (future)	
• 20. Repairs carried out with worn or defective components		• 20. Unable to identify effectiveness of braking system
P	• Manufacturers' Recommendations / Maintenance Plan	
P	• Users' Repair Policies	
P	• Training and competence of fitter	
D	• On-site Monitoring	
• 21. Diverse trailer types used in consist		• 21. Reduced braking capacity

P	• OTP Planning and Briefing
D	• On-site Monitoring

Engineering Train / OTM

Failure Modes		Effects
	Controls (P=Preventive) (D= Detective)	
• 1. Parking brake not applied when required		• 1. Vehicle left in unbraked condition
P	• Driver Competence	
	No Detective Control	
• 2. Operating outside equipment safe limits - overspeeding		• 2. Unable to achieve safe stopping distance
P	• Driver Competence	
P	• TPWS	
P	• Speed Restrictors (in work mode)	
D	• Speedometer	
D	• OTM Recorder	
• 3. Driving technique not adapting to local conditions		• 3. Unable to regulate speed
P	• Driver Competence	
	No Detective Control	
• 4. Contaminated railhead (not cleared up)		• 4. Unable to retard vehicle
P	• Use of Operators Manual	
P	• Use of provided spill kits	
D	• Real time reporting to NSC 24/7 and to route control	
• 5. Pre-use brake effectiveness tests not carried out		• 5. Insufficient brake force
P	• Driver Competence	
P	• Use of Drivers' Operating Rulebook	
	No Detective Control	
• 6. Regular brake tests not applied in adverse conditions		• 6. Insufficient brake force
P	• Driver Competence	
P	• Use of Drivers' Operating Rulebook	
	No Detective Control	
• 7. Safe recovery procedure not applied following machine breakdown		• 7. Vehicle left in unbraked condition
P	• Driver / Operator Competence	
P	• Use of Vehicle Handbook	
	No Detective Control	
• 8. Inadequate safety analysis at design stage		• 8. Uncontrolled movement
P	• Manufacturers' Risk Assessment in accordance with Machinery Directive	
P	• Engineering Acceptance in accordance with ROGS, RIR and CSM (RA)	
P	• Product Approval	
	No Detective Control	
• 9. Operating outside safe limits - load		• 9. Insufficient brake force
P	• Load Examiner Competence	
P	• Driver Competence	
	No Detective Control	
• 10. Incorrect position of load-weigh valve		• 10. Insufficient brake force
P	• Supply of accurate consist information to driver	
P	• Use of pre-start checks	
P	• Driver Competence	
	No Detective Control	
• 11. Movement performed by non-competent person		• 11. Inability to control vehicle
P	• Driver / Operator Competence	
	No Detective Control	
• 12. Braking system not maintained in accordance with maintenance plan		• 12. Braking system does not perform as intended
P	• Approved Maintenance Plan	
P	• Maintainer Competence	
D	• Maintenance Assurance	
D	• Fault / defect reporting and repairs	
• 13. Defects and damages not reported		• 13. Braking system does not perform as intended

P	• Driver Competence	
P	• Use of pre-start checks	
D	• Fault / defect reporting and repairs	
• 14. Uncontrolled modifications to vehicle		• 14. Vehicle left in unbraked condition
P	• Engineering Change Participant Competence	
P	• Engineering Change Process	
	No Detective Control	
• 15. Incorrect marshalling of vehicles within a possession		• 15. Vehicle left in unbraked condition
P	• Driver Competence	
P	• Marshall Competence	
	No Detective Control	
• 16. Deliberate override of safety system		• 16. Vehicle left in unbraked condition
P	• Positive safety culture	
D	• Colleague intervention / site supervision	
• 17. Vandalism or sabotage		• 17. Vehicle left in unbraked condition
P	• Safe, Secure Storage	
P	• Driver Competence	
P	• Use of pre-start checks	
	No Detective Control	

Appendix C: Full RPN Tables (in descending order by Risk Score)

Key:
L = Likelihood
S = Severity (in relation to a runaway event)
C= Control score (calculation: best preventive control score + best detective control score / 2)
Risk Score = L + S + C

Ironmen / Trolleys

Failure Mode	Effect (in relation to a runaway)	L	S	C	Risk Score
14. Planning does not account for risks and limitations	14. Unable to regulate speed	5	5	5	**15**
20. Operating outside equipment safe limits - no. of people	20. Unable to regulate speed	5	5	4.5	**14.5**
3. Deliberate violation of braking system	3. Reduced or elimination of braking capacity	5	4	5	**14**
21. Operating outside equipment safe limits - environmental factors	21. Reduced or elimination of braking capacity	5	4	5	**14**
1. Operating outside equipment safe limits - gradient	1. Unable to regulate speed	4	5	4.5	**13.5**
10. Use of unspecified components	10. Reduced or elimination of braking capacity	5	4	4.5	**13.5**
22. Operating outside equipment safe limits - intentional overspeeding	22. Unable to regulate speed	4	5	4.5	**13.5**
11. Repairs carried out with worn or defective components	11. Reduced or elimination of braking capacity	4	4	5	**13**
2. Operating outside equipment safe limits - load	2. Unable to regulate speed	3	5	4.5	**12.5**
5. Braking design does not meet end user requirements	5. Increased deterioration of braking components	5	3	4.5	**12.5**
17. Deliberate violation of operating instructions	17. Unable to regulate speed	4	5	3.5	**12.5**
7. Ironman / trolley not stored or transported in a suitable and safe manner	7. Increased deterioration and damage of braking components	3	4	5	**12**
9. Ironman / trolley not adequately maintained	9. Reduced or elimination of braking capacity	4	4	4	**12**
16. Inability to communicate on site	16. Unmanaged speed control	3	4	5	**12**
18. Inadequate site supervision	18. Unmanaged speed control	4	4	4	**12**
19. Imbalanced utilisation of available ironmen / trolley	19. Increased deterioration of braking components	4	3	5	**12**
4. Adverse distributed load	4. Reduced rail wheel frictional interface	4	3	4.5	**11.5**
8. Adequate pre-use checks not carried out	8. Unable to identify effectiveness of braking system	5	2	4.5	**11.5**
13. Supplier issues products with unauthorised modifications	13. Unable to identify effectiveness of braking system	5	2	4.5	**11.5**
6. Inadequate assembly on site	6. Reduced or no effectiveness of braking system	1	5	4.5	**10.5**
12. Use of unauthorised equipment	12. Unable to identify effectiveness of braking system	3	2	4.5	**9.5**
15. Operators do not hold suitable competence	15. Unable to regulate speed	1	5	3.5	**9.5**
23. Combined use of ironmen types	23. Reduced braking capacity	2	3	3.5	**8.5**

Rail Road Vehicles (RRVs)

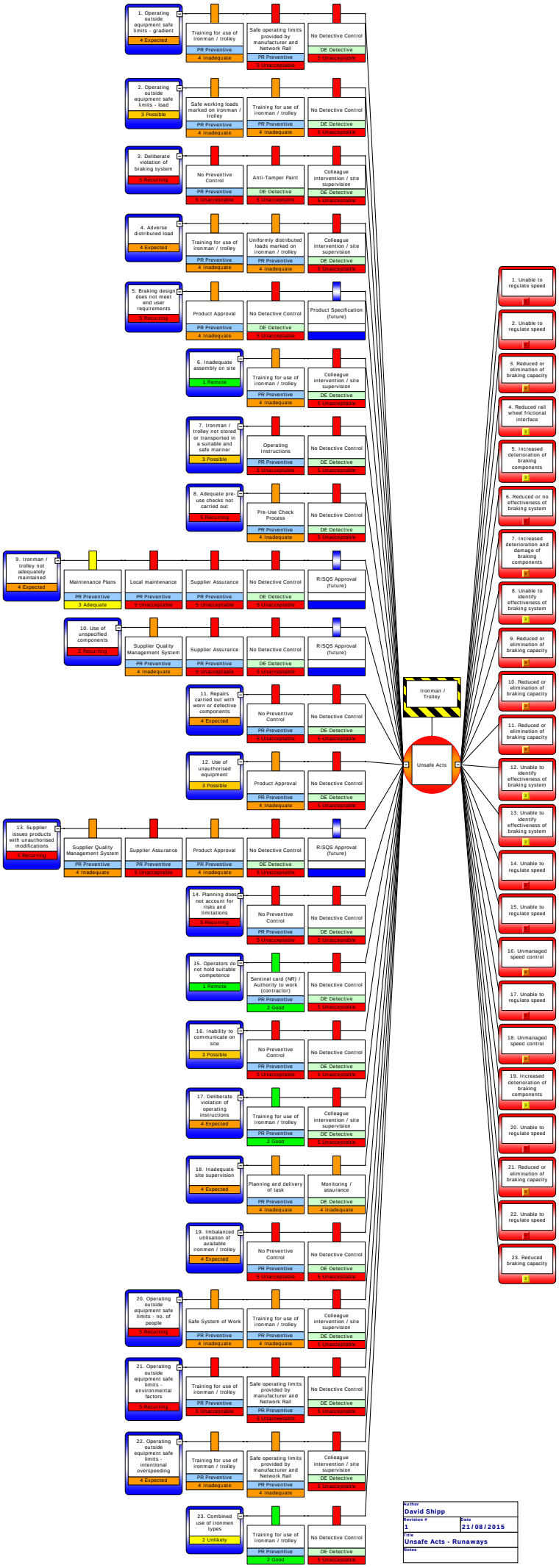
Failure Mode	Effect (in relation to a runaway)	L	S	C	Risk Score
6. Operator puts machine in free wheel condition	6. Uncontrolled movement	2	5	3.5	**10.5**
11. Operator does not apply handbrake	11. Potential for uncontrolled movement	3	3	4	**10**
3. Operating outside safe limits - environmental factors	3. Unable to regulate speed	4	2	3.5	**9.5**
8. Braking system not maintained in accordance with maintenance plan	8. Reduced or elimination of braking capacity	3	3	3.5	**9.5**
9. Operating outside equipment safe limits - intentional overspeeding	9. Unable to regulate speed	4	2	3.5	**9.5**
10. Operating outside equipment safe limits - load	10. Unable to regulate speed	4	2	3.5	**9.5**
14. Vehicle owner does not seek approval of engineering change	14. Unable to identify effectiveness of braking system	4	2	3.5	**9.5**
15. Braking system deliberately overriden	15. Significant reduction of braking capacity	2	4	3.5	**9.5**
16. Failure to report defective equipment	16. Reduced or elimination of braking capacity	3	3	3.5	**9.5**
18. Fitters do not hold suitable competence	18. Reduced or elimination of braking capacity	3	3	3.5	**9.5**
4. Driver physically incapacitated	4. Uncontrolled movement	1	5	3	**9**
12. Operator fails to follow on / off tracking procedure	12. Potential for uncontrolled movement	3	3	3	**9**
19. Braking system damaged in transit	19. Reduced or elimination of braking capacity	2	3	4	**9**
13. Vehicle Acceptance Body does not apply the RIS (1530)	13. Unable to identify effectiveness of braking system	3	2	3.5	**8.5**
20. Repairs carried out with worn or defective components	20. Unable to identify effectiveness of braking system	3	2	3.5	**8.5**
7. Braking system not installed correctly	7. Reduced or elimination of braking capacity	2	3	3	**8**
2. Trailer service brake line not connected	2. Reduced braking capacity	3	1	3.5	**7.5**
17. Operators do not hold suitable competence	17. Unable to regulate speed	2	2	3.5	**7.5**
21. Diverse trailer types used in consist	21. Reduced braking capacity	3	1	3.5	**7.5**
1. Machine supplied with no direct wheel braking	1. Reduced or elimination of braking capacity	1	3	2.5	**6.5**
5. Operating outside safe limits - gradient	5. Unable to regulate speed	1	2	3.5	**6.5**

Engineering Train / OTM

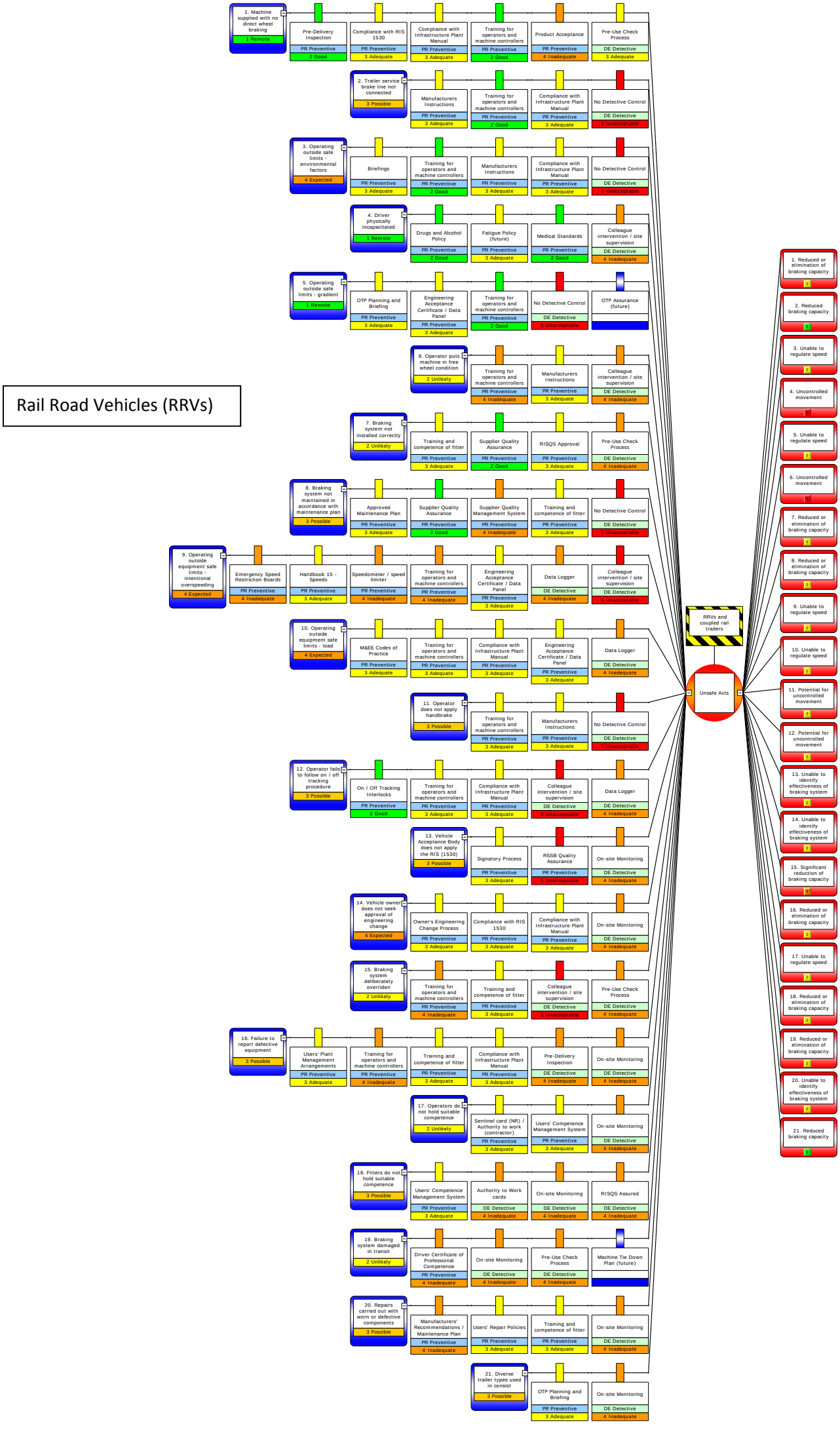
Failure Mode	Effect (in relation to a runaway)	L	S	C	Risk Score
4. Contaminated railhead (not cleared up)	4. Unable to retard vehicle	3	5	3	**11**
7. Safe recovery procedure not applied following machine breakdown	7. Vehicle left in unbraked condition	3	4	4	**11**
11. Movement performed by non-competent person	11. Inability to control vehicle	3	4	4	**11**
14. Uncontrolled modifications to vehicle	14. Vehicle left in unbraked condition	3	4	4	**11**
16. Deliberate override of safety system	16. Vehicle left in unbraked condition	2	4	4	**10**
1. Parking brake not applied when required	1. Vehicle left in unbraked condition	2	4	3.5	**9.5**
3. Driving technique not adapting to local conditions	3. Unable to regulate speed	3	3	3.5	**9.5**
6. Regular brake tests not applied in adverse conditions	6. Insufficient brake force	3	3	3.5	**9.5**
15. Incorrect marshalling of vehicles within a possession	15. Vehicle left in unbraked condition	2	4	3.5	**9.5**
8. Inadequate safety analysis at design stage	8. Uncontrolled movement	2	3	4	**9**
5. Pre-use brake effectiveness tests not carried out	5. Insufficient brake force	2	3	3.5	**8.5**
9. Operating outside safe limits - load	9. Insufficient brake force	2	3	3.5	**8.5**
10. Incorrect position of load-weigh valve	10. Insufficient brake force	2	3	3.5	**8.5**
13. Defects and damages not reported	13. Braking system does not perform as intended	2	4	2.5	**8.5**
17. Vandalism or sabotage	17. Vehicle left in unbraked condition	1	4	3.5	**8.5**
12. Braking system not maintained in accordance with maintenance plan	12. Braking system does not perform as intended	1	4	2	**7**

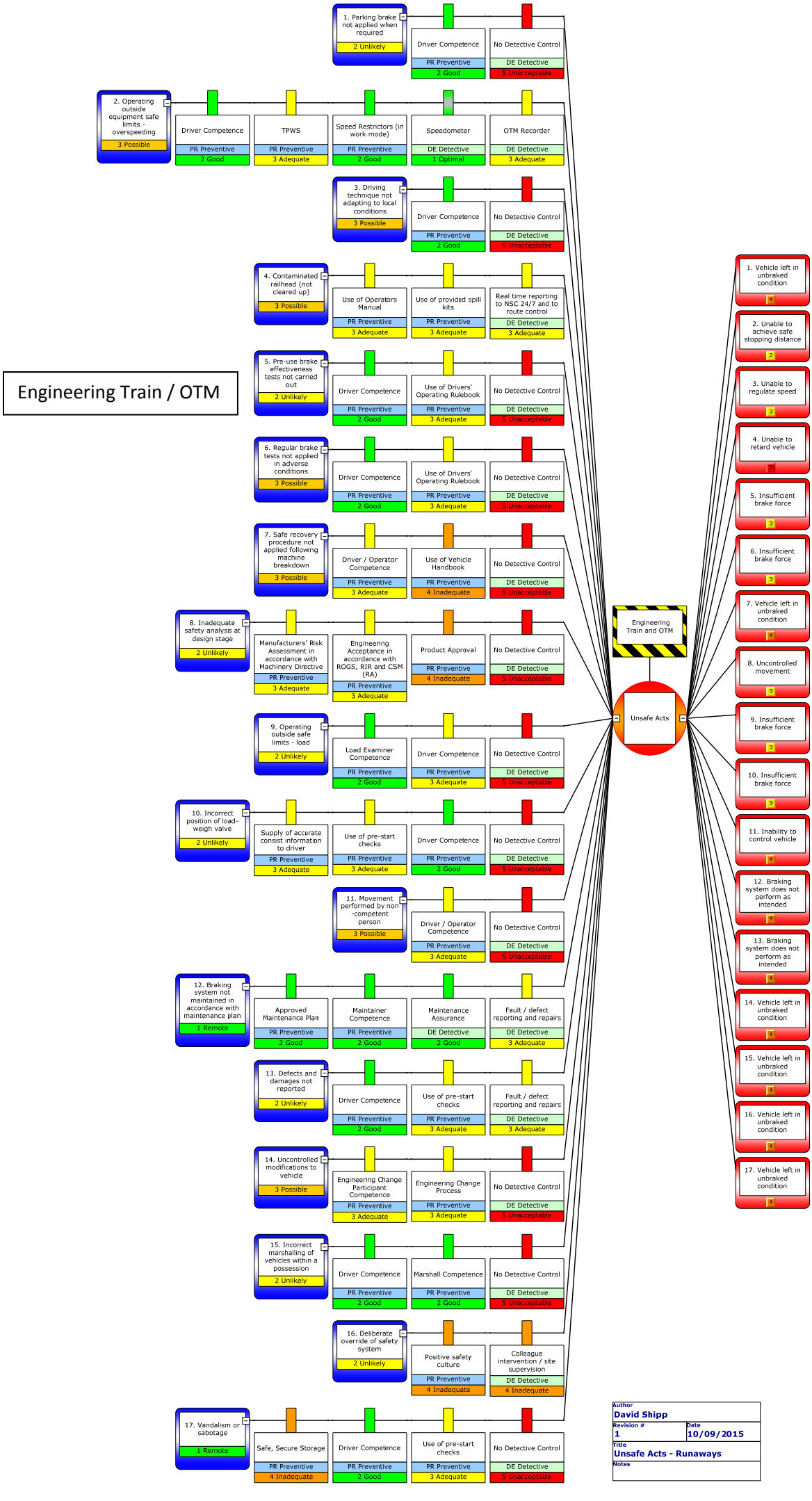
Appendix D: BowTie XP Outputs

Ironmen / Trolleys



Rail Road Vehicles (RRVs)




Engineering Train / OTM
1. Parking brake not applied when required
2 Unlikely
Driver Competence
PR Preventive
2 Good
No Detective Control
DE Detective
5 Unacceptable
2. Operating outside equipment safe limits - overspeeding
3 Possible
Driver Competence
PR Preventive
2 Good
TPWS
PR Preventive
3 Adequate
Speed Restrictors (in work mode)
PR Preventive
2 Good
Speedometer
DE Detective
1 Optimal
OTM Recorder
DE Detective
3 Adequate
3. Driving technique not adapting to local conditions
3 Possible
Driver Competence
PR Preventive
2 Good
No Detective Control
DE Detective
5 Unacceptable
4. Contaminated railhead (not cleared up)
3 Possible
Use of Operators Manual
PR Preventive
3 Adequate
Use of provided spill kits
PR Preventive
3 Adequate
Real time reporting to NSC 24/7 and to route control
DE Detective
3 Adequate
5. Pre-use brake effectiveness tests not carried out
2 Unlikely
Driver Competence
PR Preventive
2 Good
Use of Drivers' Operating Rulebook
PR Preventive
3 Adequate
No Detective Control
DE Detective
5 Unacceptable
6. Regular brake tests not applied in adverse conditions
3 Possible
Driver Competence
PR Preventive
2 Good
Use of Drivers' Operating Rulebook
PR Preventive
3 Adequate
No Detective Control
DE Detective
5 Unacceptable
7. Safe recovery procedure not applied following machine breakdown
3 Possible
Driver / Operator Competence
PR Preventive
3 Adequate
Use of Vehicle Handbook
PR Preventive
4 Inadequate
No Detective Control
DE Detective
5 Unacceptable
8. Inadequate safety analysis at design stage
2 Unlikely
Manufacturers' Risk Assessment in accordance with Machinery Directive
PR Preventive
3 Adequate
Engineering Acceptance in accordance with ROGS, RIR and CSM (RA)
PR Preventive
3 Adequate
Product Approval
PR Preventive
4 Inadequate
No Detective Control
DE Detective
5 Unacceptable
9. Operating outside safe limits - load
2 Unlikely
Load Examiner Competence
PR Preventive
2 Good
Driver Competence
PR Preventive
3 Adequate
No Detective Control
DE Detective
5 Unacceptable
10. Incorrect position of load-weigh valve
2 Unlikely
Supply of accurate consist information to driver
PR Preventive
3 Adequate
Use of pre-start checks
PR Preventive
3 Adequate
Driver Competence
PR Preventive
2 Good
No Detective Control
DE Detective
5 Unacceptable
11. Movement performed by non -competent person
3 Possible
Driver / Operator Competence
PR Preventive
3 Adequate
No Detective Control
DE Detective
5 Unacceptable
12. Braking system not maintained in accordance with maintenance plan
1 Remote
Approved Maintenance Plan
PR Preventive
2 Good
Maintainer Competence
PR Preventive
2 Good
Maintenance Assurance
DE Detective
2 Good
Fault / defect reporting and repairs
DE Detective
3 Adequate
13. Defects and damages not reported
2 Unlikely
Driver Competence
PR Preventive
2 Good
Use of pre-start checks
PR Preventive
3 Adequate
Fault / defect reporting and repairs
DE Detective
3 Adequate
14. Uncontrolled modifications to vehicle
3 Possible
Engineering Change Participant Competence
PR Preventive
3 Adequate
Engineering Change Process
PR Preventive
3 Adequate
No Detective Control
DE Detective
5 Unacceptable
15. Incorrect marshalling of vehicles within a possession
2 Unlikely
Driver Competence
PR Preventive
2 Good
Marshall Competence
PR Preventive
2 Good
No Detective Control
DE Detective
5 Unacceptable
16. Deliberate override of safety system
2 Unlikely
Positive safety culture
PR Preventive
4 Inadequate
Colleague intervention / site supervision
DE Detective
4 Inadequate
17. Vandalism or sabotage
1 Remote
Safe, Secure Storage
PR Preventive
4 Inadequate
Driver Competence
PR Preventive
2 Good
Use of pre-start checks
PR Preventive
3 Adequate
No Detective Control
DE Detective
5 Unacceptable
Engineering Train and OTM
Unsafe Acts
1. Vehicle left in unbraked condition
4
2. Unable to achieve safe stopping distance
2
3. Unable to regulate speed
3
4. Unable to retard vehicle
5
5. Insufficient brake force
3
6. Insufficient brake force
3
7. Vehicle left in unbraked condition
4
8. Uncontrolled movement
3
9. Insufficient brake force
3
10. Insufficient brake force
3
11. Inability to control vehicle
4
12. Braking system does not perform as intended
4
13. Braking system does not perform as intended
4
14. Vehicle left in unbraked condition
4
15. Vehicle left in unbraked condition
4
16. Vehicle left in unbraked condition
4
17. Vehicle left in unbraked condition
4
Author
David Shipp
Revision #
1
Date
10/09/2015
Title
Unsafe Acts - Runaways
Notes

Appendix E: Workshop Attendee Lists

Attendance list

Subject: Runaways Workshop – Ironman / Trolleys

Date: 17/08/2015

Name	Role	Signature
MALCOLM MINES	PRINCIPAL ENG L PLANT + T&RS	
DAVID McCALLUM	TRAINING DELIVERY SPECIALIST	
Phillip Brown	RPSE Western + Wales.	
Elyabeth de Mello	senior Ergonomist STE	
MIKE ROBINSON	On Track Plant Specialist	
Sam Barrett	Assistant Engineer [Plant & T&RS] STE	
LUKE TANDY	SENIOR ENGINEER [PLANT & T&RS] STE	
Peter Stone	Plant & Equipment Safety Advisor STE	
Martin Shillito	SEQ West Coast South	
DAVID SHIPP	RISK CONTROL ADVISOR	

Attendance list

Subject: Runaways Workshop – RRV

Date: 24/08/2015

Name	Role	Signature
LUKE TANDY	SENIOR ENGINEER [STE]	
Phillip Brown	RPSE	
DAVID McCALLUM	TDS.	
Peter Stone	Plant & Equipment Safety Advisor	
DAVID SHIPP	RISK CONTROL ADVISOR	

Attendance list

Subject: Runaways Workshop – Engineering Train / OTM

Date: 10/09/2015

Name	Role	Signature
ANDY KEY	FLEET MANAGER - STONEHAVEN / ACTING BUSINESS MANAGER CTMS	[illegible]
OLUFEMI OKEYA	SENIOR ENGINEER (Plant and TRS)	[illegible]
DAVID SHIPP	RISK CONTROL ADVISOR	[illegible]
PETER STONE	PLANT & EQUIPMENT SAFETY ADVISOR	[illegible]