



Actions required to improve safe operations

PHA results, Bow tie & actions

Wednesday 31 October 2012

Process Summary



PHA RESULTS & BOW TIE

Hazardous event	Potential Cause(s)	Potential Consequence(s)	Existing control(s)	Proposed control(s)
RRV Runaway	<p><u>Technical (technical failures)</u></p> <ul style="list-style-type: none"> • Equipment failure [Control ID: 1, 2, 3, 5, 6, 7, 8, 12, 14, 20, 22, 23, 24, 25, 26, 32, 33, 35, 36, 38] <ul style="list-style-type: none"> • Electro / hydraulic pneumatic / mechanical • Inadequate design (interlocking) [Control ID: 2, 3, 5, 39, 9, 11, 12, 18, 32, 33] • Unfit for purpose [Control ID: 1, 2, 3, 5, 6, 7, 9, 12, 14, 18, 22, 32, 33, 38, 39] • Inadequate maintenance [Control ID: 1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 32, 33, 38, 39] • Lack of pre-work inspection / daily checks [Control ID: 1, 6, 7, 8, 9, 10, 11, 13, 18, 38, 39] • Lack of annunciation [Control ID: 2, 3, 5, 6, 7, 9, 10, 11, 12, 13] • Lack of physical barriers (for stowage) [Control ID: 1, 6, 10, 13, 15, 16, 18, 21, 22, 23, 24, 38] <p><u>Environment (local conditions)</u></p> <ul style="list-style-type: none"> • Gradient / location / terrain [Control ID: 1, 4, 5, 6, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 29, 31, 32, 33, 35, 36, 37, 38] • Weather events [Control ID: 1, 10, 13, 16, 17, 18, 19, 26, 30, 35, 37, 38] • Bugs / insects [Control ID: as per weather events] • Rail / track interface (coefficient of friction), contamination [Control ID: 1, 2, 3, 6, 7, 9, 10, 14, 16, 17, 18, 21, 23, 24, 26, 35, 36, 37, 38, 39] • Lack of visibility [Control ID: 12, 10, 14, 15, 16, 17, 18, 19, 21, 26, 30, 31, 37, 38, 39] • Inadequate condition of base for on / off railing [Control ID: 1, 2, 3, 7, 9, 10, 14, 16, 18, 20, 21, 26, 30, 32, 35, 36, 38, 39] • Vandalism (during stowage) [Control ID: 1, 2, 3, 9, 10, 18, 21, 22, 23, 24, 21] • Site constraints [Control ID: 1, 2, 3, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 30, 31, 35, 36, 37, 38, 39] <p><u>People (individual / team actions)</u></p> <ul style="list-style-type: none"> • Fatigue [Control ID: 1, 8, 10, 13, 15, 34, 38] • Inadequate incident reporting [Control ID: 1, 5, 9, 10, 11, 13, 14, 18, 33, 38] • Operator error / violation [Control ID: 1, 5, 6, 8, 9, 10, 13, 15, 16, 17, 18, 20, 21, 25, 26, 27, 30, 33, 35, 36, 37] • Inadequate communication [Control ID: 1, 5, 6, 10, 12, 13, 19, 30, 38, 15] • Lack of visibility (???) • Error annunciation (???) • Human performance limitation (???) • Infrequent emergency rehearsals / contingency planning [Control ID: 1, 2, 5, 10, 13, 23, 37, 38] • Competency / capacity / knowledge / decision making [Control ID: 1, 5, 8, 10, 13, 38] • Driver incapacitation [Control ID: 1, 3, 5, 8, 10, 13, 36, 38] <p><u>Systems (organisational factors)</u></p> <ul style="list-style-type: none"> • Inadequate interface management between infrastructure contractors – inconsistent standards [Control ID: 1, 2, 4, 5, 6, 7, 11, 14, 16] • Inadequate incident reporting [Control ID: 1, 5, 10, 11] • Safe work practice (inc. SWMS, pre-work insp.etc.) [Control ID: 1, 4, 5, 18, 10, 11] • Inadequate policies / procedures / rules [Control ID: 1, 11, 16, 18] • Time, budget, resource constraints [Control ID: 1, 2, 6, 7, 12, 14, 33] • Poor organisation culture [Control ID: 11, 13, 18, 1, 4, 5, 10, 15, 38] • No MOU with emergency services [Control ID: 1, 6, 4, 5, 10, 11, 14, 18] • No road licence [Control ID: 1, 5, 6, 10, 13, 38] • Complexity of operation [Control ID: 1, 5, 7, 9, 10, 13, 38] 	<ul style="list-style-type: none"> • Collision with train / vehicle / other plant / infrastructure / personnel • Derailment / rollover • SPAD • Overrun territory • Overrun authority • Damage to plant, equipment, infrastructure, reputation • Personnel injury (LTI) / fatality • Loss of insurance / accreditation • Public liability • Prosecution • Electrocution • Loss to productivity 	<ol style="list-style-type: none"> 1. SOPs / JSAs / SWMS / Management standards 2. Technical and performance specifications 3. Design input 4. Accreditation of organisation / equipment 5. Technical registration / certification / training 6. System checks – sampling of procedural controls 7. Long-term monitoring 8. Fatigue, D&A management program 9. Maintenance / inspection schedules & plans 10. Inductions 11. Industry / regulator interactions / alerts 12. Procurement processes 13. People management – discipline arrangements / training / culture 14. Interface management 15. Possession management / coordination / network registration 16. Network rules 17. Route competency 18. Workplace inspections / management 19. Secondary / alternate comms. 20. Derailers / level crossing infrastructure 21. Catch points / derailleurs 22. Site security (for stowage) 23. Chocks for stowage (for stowage) 24. Stow vehicle off-track 25. derailleurs, skids, speed limiters 26. braking systems 27. speed board 28. data logger 29. GPS tracking 30. Comms. Protocols 31. Train protection 32. Asset lifecycle management 33. Change management 34. Health standards 35. on/off track pads 36. interlocks 37. Weather monitoring 38. supervision 39. Rail safety investigations 40. Driver safety systems 	

- Equipment failure
- Electro / hydraulic pneumatic / mechanical
- Inadequate design (interlocking)
- Unfit for purpose
- Inadequate maintenance
- Lack of pre-work inspection / daily checks
- Lack of annunciation
- Lack of physical barriers (for stowage)

Technical Failures (Technical)

- Gradient / location / terrain
- Weather events
- Bugs / insects
- Rail / track interface (coefficient of friction), contamination
- Lack of visibility
- Inadequate condition of base for on / off raiiling
- Vandalism (during stowage)
- Site constraints

Local Conditions (Environment)

- Fatigue
- Inadequate incident reporting
- Operator error / violation
- Inadequate communication
- Lack of visibility
- Error annunciation
- Human performance limitation
- Infrequent emergency rehearsals / contingency planning
- Competency / capacity / knowledge / decision making
- Driver incapacitation

Individual / Team Action (People)

- Inadequate interface management between infrastructure contractors – inconsistent standards
- Inadequate incident reporting
- Safe work practice (inc. SWMS, pre-work insp.etc.)
- Inadequate policies / procedures / rules
- Time, budget, resource constraints
- Poor organisation culture
- No MOU with emergency services
- No road licence
- Complexity of operation

Organisational Factors (Systems)

Refer to control slide

Runaway

Collision with train

Collision with vehicle / other plant

Collision with infrastructure

Collision with personnel

Derailment / rollover

SPAD

Overrun territory

Overrun authority

Damage to plant / infrastructure / equipment / reputation

Personnel injury (LTI) / fatality

Loss of insurance

Loss of accreditation

Public liability

Prosecution

Electrocution

Loss of productivity

Runaway control slide

Technical (technical failures)

- Equipment failure [Control ID: 1, 2, 3, 5, 6, 7, 8, 12, 14, 20, 22, 23, 24, 25, 26, 32, 33, 35, 36, 38]
 - Electro / hydraulic pneumatic / mechanical
- Inadequate design (interlocking) [Control ID: 2, 3, 5, 39, 9, 11, 12, 18, 32, 33]
- Unfit for purpose [Control ID: 1, 2, 3, 5, 6, 7, 9, 12, 14, 18, 22, 32, 33, 38, 39]
- Inadequate maintenance [Control ID: 1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 32, 33, 38, 39]
- Lack of pre-work inspection / daily checks [Control ID: 1, 6, 7, 8, 9, 10, 11, 13, 18, 38, 39]
- Lack of annunciation [Control ID: 2, 3, 5, 6, 7, 9, 10, 11, 12, 13]
- Lack of physical barriers (for stowage) [Control ID: 1, 6, 10, 13, 15, 16, 18, 21, 22, 23, 24, 38]

Environment (local conditions)

- Gradient / location / terrain [Control ID: 1, 4, 5, 6, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 29, 31, 32, 33, 35, 36, 37, 38]
- Weather events [Control ID: 1, 10, 13, 16, 17, 18, 19, 26, 30, 35, 37, 38]
- Bugs / insects [Control ID: as per weather events]
- Rail / track interface (coefficient of friction), contamination [Control ID: 1, 2, 3, 6, 7, 9, 10, 14, 16, 17, 18, 21, 23, 24, 26, 35, 36, 37, 38, 39]
- Lack of visibility [Control ID: 12, 10, 14, 15, 16, 17, 18, 19, 21, 26, 30, 31, 37, 38, 39]
- Inadequate condition of base for on / off railing [Control ID: 1, 2, 3, 7, 9, 10, 14, 16, 18, 20, 21, 26, 30, 32, 35, 36, 38, 39]
- Vandalism (during stowage) [Control ID: 1, 2, 3, 9, 10, 18, 21, 22, 23, 24, 21]
- Site constraints [Control ID: 1, 2, 3, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 30, 31, 35, 36, 37, 38, 39]

People (individual / team actions)

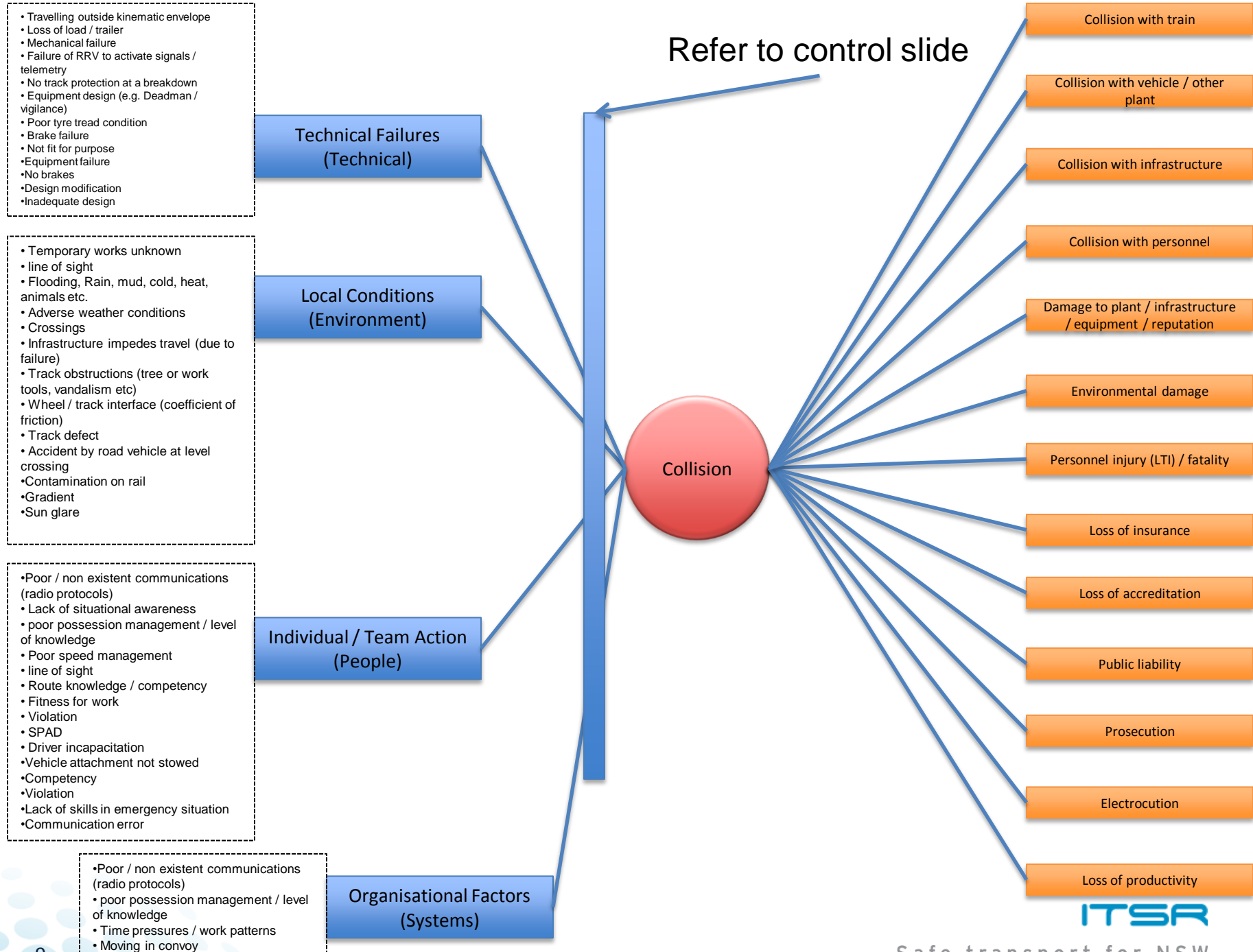
- Fatigue [Control ID: 1, 8, 10, 13, 15, 34, 38]
- Inadequate incident reporting [Control ID: 1, 5, 9, 10, 11, 13, 14, 18, 33, 38]
- Operator error / violation [Control ID: 1, 5, 6, 8, 9, 10, 13, 15, 16, 17, 18, 20, 21, 25, 26, 27, 30, 33, 35, 36, 37]
- Inadequate communication [Control ID: 1, 5, 6, 10, 12, 13, 19, 30, 38, 15]
- Lack of visibility (???)
- Error annunciation (???)
- Human performance limitation (???)
- Infrequent emergency rehearsals / contingency planning [Control ID: 1, 2, 5, 10, 13, 23, 37, 38]
- Competency / capacity / knowledge / decision making [Control ID: 1, 5, 8, 10, 13, 38]
- Driver incapacitation [Control ID: 1, 3, 5, 8, 10, 13, 36, 38]

Systems (organisational factors)

- Inadequate interface management between infrastructure contractors – inconsistent standards [Control ID: 1, 2, 4, 5, 6, 7, 11, 14, 16]
- Inadequate incident reporting [Control ID: 1, 5, 10, 11]
- Safe work practice (inc. SWMS, pre-work insp.etc.) [Control ID: 1, 4, 5, 18, 10, 11]
- Inadequate policies / procedures / rules [Control ID: 1, 11, 16, 18]
- Time, budget, resource constraints [Control ID: 1, 2, 6, 7, 12, 14, 33]
- Poor organisation culture [Control ID: 11, 13, 18, 1, 4, 5, 10, 15, 38]
- No MOU with emergency services [Control ID: 1, 6, 4, 5, 10, 11, 14, 18]
- No road licence [Control ID: 1, 5, 6, 10, 13, 38]
- Complexity of operation [Control ID: 1, 5, 7, 9, 10, 13, 38]

Hazardous event	Potential Cause(s)	Potential Consequence(s)	Existing control(s)	Proposed control(s)
RRV Collision	<p><u>Technical (technical failures)</u></p> <ul style="list-style-type: none"> • Travelling outside kinematic envelope [Control ID: 1, 2, 5, 10, 8, 17, 20, 25] • Loss of load / trailer [Control ID: 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 17, 19, 20, 22, 23, 25] • Mechanical failure [Control ID: 1, 2, 3, 5, 6, 10, 13, 15, 17, 18, 19, 20, 25] • Failure of RRV to activate signals / telemetry [Control ID: 1, 2, 3, 5, 7, 8, 10, 17, 19, 20, 25] • No track protection at a breakdown [Control ID: 1, 2, 3, 8, 17, 18, 20, 25] • Equipment design (e.g. Deadman / vigilance) [Control ID: 1, 2, 4, 5, 8, 10, 13, 15, 19, 20] • Poor tyre tread condition [Control ID: 1, 2, 3, 4, 5, 6, 8, 10, 13, 17, 19, 20, 23, 24, 25] • Brake failure [Control ID: 1, 2, 3, 5, 6, 10, 13, 15, 17, 18, 19, 20, 24, 25] • Not fit for purpose [Control ID: 1, 3, 2, 4, 5, 8, 10, 13, 15, 19, 20] <p><u>Environment (local conditions)</u></p> <ul style="list-style-type: none"> • Temporary works unknown [Control ID: 1, 2, 3, 6, 8, 9, 12, 13, 20, 17, 25, 14] • line of sight [Control ID: 1, 2, 3, 5, 6, 8, 9, 10, 12, 17, 20, 21, 24, 25] • Flooding, Rain, mud, cold, heat, animals etc. [Control ID: 2, 24, 4, 6, 21, 8, 10, 12, 13, 14, 20, 17, 24, 25] • Adverse weather conditions [Control ID: Refer to flooding etc.] • Crossings [Control ID: 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 17, 18, 20, 24, 25] • Infrastructure impedes travel (due to failure) [Control ID: 1, 2, 3, 6, 8, 12, 14, 17, 18, 20, 25] • Track obstructions (tree or work tools, vandalism etc) [Control ID: 2, 3, 6, 8, 12, 13, 17, 20, 25] • Wheel / track interface (coefficient of friction) [Control ID: 1, 2, 3, 4, 5, 6, 8, 9, 12, 10, 13, 17, 19, 25, 20, 24, 23] • Track defect [Control ID: 1, 2, 3, 4, 5, 6, 14, 8, 12, 17, 19, 20, 25, 24] <p><u>People (individual / team actions)</u></p> <ul style="list-style-type: none"> • Poor / non existent communications (radio protocols) [Control ID: 3, 17, 8, 10, 16, 25] • Lack of situational awareness [Control ID: 16, 8, 17, 21, 25, 24] • poor possession management / level of knowledge [Control ID: 25, 3, 8, 17, 18] • Poor speed management [Control ID: 6, 21, 3, 15, 16, 14, 24, 25] • line of sight [Control ID: 9, 6, 24, 8, 11, 21] • Route knowledge / competency [Control ID: 3, 6, 8, 14, 24, 25] • Fitness for work [Control ID: 3, 21, 25] • Violation [Control ID: 3, 8, 21, 6, 14, 15, 25, 17, 20] • SPAD [Control ID: 3, 6, 7, 5, 21, 8, 13, 18, 17, 25, 24] • Driver incapacitation [Control ID: 7, 21, 25] • Vehicle attachment not stowed [Control ID: 2, 3, 6, 8, 5, 23, 9, 10] <p><u>Systems (organisational factors)</u></p> <ul style="list-style-type: none"> • Poor / non existent communications (radio protocols) [Control ID: 8, 17, 18, 3, 5] • poor possession management / level of knowledge [Control ID: 3, 8, 20, 17, 25, 18] • Time pressures / work patterns [Control ID: 8, 20, 21, 25, 3] • Moving in convoy [Control ID: 1, 3, 6, 5, 10, 8, 9, 17, 12, 14, 25, 24, 18, 7] 	<ul style="list-style-type: none"> • Environmental damage • Collision with train / vehicle / other plant / infrastructure / personnel • Derailment / rollover • SPAD • Overrun territory • Overrun authority • Damage to plant, equipment, infrastructure, reputation • Personnel injury (LTI) / fatality • Loss of insurance / accreditation • Public liability • Prosecution • Electrocutation • Loss to productivity 	<ol style="list-style-type: none"> 1. OEM / RIM standards 2. Visual inspections 3. training 4. weight guides 5. vehicle maintenance 6. driving to conditions 7. vigilance system 8. Rules & procedures 9. Cameras, audible alarms (some RRVs) 10. Maintenance 11. 6m Rule (some) 12. 15km/h limit (some) 13. braking systems 14. speed board 15. data logger 16. GPS tracking 17. Comms. Protocols 18. Train protection and worksite protection 19. Asset lifecycle management 20. Change management 21. Health standards / fatigue management 22. on/off track pads 23. interlocks 24. Weather monitoring 25. supervision 	<p>Separation alarm systems</p> <p>All trailers brake system fitted</p> <p>Clarification of where vigilance control systems are required</p> <p>Clarify design consistency needs (RIM/OEM, engineering issues)</p> <p>Proximity sensors</p> <p>Audible alarms (loss of traction (better alarms automated))</p> <p>Coupling rules (physical connections rules in context with equipment)</p> <p>Emergency response (expanded scenarios)</p>

Hazardous event	Potential Cause(s)	Potential Consequence(s)	Existing control(s)	Proposed control(s)
RRV Collision (specific to off rail)	<p><u>Technical (technical failures)</u> [Control ID: 7, 8]</p> <ul style="list-style-type: none"> •Equipment failure •No brakes •Design modification •Inadequate design <p><u>Environment (local conditions)</u> [Control ID: 1, 3]</p> <ul style="list-style-type: none"> •Accident by road vehicle at level crossing •Contamination on rail •Gradient •Sun glare <p><u>People (individual / team actions)</u></p> <ul style="list-style-type: none"> •Travelling in convoy (poor communication protocol) [Control ID: 6, 7] •Not sticking to plan [Control ID: 6, 7] •Not competent on type of equipment [Control ID: 5] •Not questioning authority if in doubt (safety culture) [Control ID: 3] •Violations [Control ID: 1, 3, 5, 6, 7] •Fitness for duty – fatigue, D&A, incapacitation <p><u>Systems (organisational factors)</u></p> <ul style="list-style-type: none"> •Inadequate training processes [Control ID: 4, 5, 7, 8] •Inadequate procedures [Control ID: 9, 10] •Inadequate standards [Control ID: 9, 10] •Production demands [Control ID: 6, 7, 8, 9, 10] •Inadequate resourcing [Control ID: 5, 11] •Not competent on type of equipment [Control ID: 4, 5, 7, 8] •Inadequate change management [Control ID: 3, 7, 6] 	<ul style="list-style-type: none"> •Environmental damage •Collision with train / vehicle / other plant / infrastructure / personnel •Derailment / rollover •SPAD •Overrun territory •Overrun authority •Damage to plant, equipment, infrastructure, reputation •Personnel injury (LTI) / fatality •Loss of insurance / accreditation •Public liability •Prosecution •Electrocution •Loss to productivity •Delayed emergency services •Delay of services •Fire 	<ol style="list-style-type: none"> 1. Protection/Safeworking 2. Education 3. Communication 4. Up skilling 5. competencies 6. Network rules 7. Procedures 8. Standards 9. Project review 10. SMS review 11. Resourcing capacity 12. Fit to task / people / equipment 	
RRV Collision (specific to emergency off rail)	<p><u>Technical (technical failures)</u> [Control ID: 6, 8]</p> <ul style="list-style-type: none"> •Unable to move machine •No brakes •Design modification •Inadequate design <p><u>Environment (local conditions)</u> [Control ID: 1, 4, 6, 2]</p> <ul style="list-style-type: none"> •Off rail at non specified location / inappropriate location •contamination •Gradient •visibility •Terrain / infrastructure problem •Washaway •Bushfires / snow <p><u>People (individual / team actions)</u> [Control ID: 1, 2, 3, 4, 5, 6, 7, 8, 9]</p> <ul style="list-style-type: none"> •Competency •Violation •Lack of skills in emergency situation •Communication error <p><u>Systems (organisational factors)</u></p> <ul style="list-style-type: none"> •Safe work component [Control ID: 1, 2] •Inadequate consideration of all aspects of an “emergency” [Control ID: 1, 2, 3, 4] •production demands [Control ID: 1, 2, 7] •Inadequate training procedures [Control ID: 3, 6] •Inadequate resourcing [Control ID: 9, 6] •Inadequate procedure [Control ID: 10] 	<ul style="list-style-type: none"> •Environmental damage •Collision with train / vehicle / other plant / infrastructure / personnel •Derailment / rollover •SPAD •Overrun territory •Overrun authority •Damage to plant, equipment, infrastructure, reputation •Personnel injury (LTI) / fatality •Loss of insurance / accreditation •Public liability •Prosecution •Electrocution •Loss to productivity •Delayed emergency services •Delay of services •Fire 	<ol style="list-style-type: none"> 1. Protection / safetyworking 2. Communication 3. Training 4. Competencies 5. Fit to task / PPL and equipment 6. Procedures 7. Network rules 8. Engineering standards 9. Resourcing 10. SMS review 	



Collision control slide

Technical (technical failures)

- Travelling outside kinematic envelope [Control ID: 1, 2, 5, 10, 8, 17, 20, 25]
- Loss of load / trailer [Control ID: 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 17, 19, 20, 22, 23, 25]
- Mechanical failure [Control ID: 1, 2, 3, 5, 6, 10, 13, 15, 17, 18, 19, 20, 25]
- Failure of RRV to activate signals / telemetry [Control ID: 1, 2, 3, 5, 7, 8, 10, 17, 19, 20, 25]
- No track protection at a breakdown [Control ID: 1, 2, 3, 8, 17, 18, 20, 25]
- Equipment design (e.g. Deadman / vigilance) [Control ID: 1, 2, 4, 5, 8, 10, 13, 15, 19, 20]
- Poor tyre tread condition [Control ID: 1, 2, 3, 4, 5, 6, 8, 10, 13, 17, 19, 20, 23, 24, 25]
- Brake failure [Control ID: 1, 2, 3, 5, 6, 10, 13, 15, 17, 18, 19, 20, 24, 25]
- Not fit for purpose [Control ID: 1, 3, 2, 4, 5, 8, 10, 13, 15, 19, 20]

Environment (local conditions)

- Temporary works unknown [Control ID: 1, 2, 3, 6, 8, 9, 12, 13, 20, 17, 25, 14]
- line of sight [Control ID: 1, 2, 3, 5, 6, 8, 9, 10, 12, 17, 20, 21, 24, 25]
- Flooding, Rain, mud, cold, heat, animals etc. [Control ID: 2, 24, 4, 6, 21, 8, 10, 12, 13, 14, 20, 17, 24, 25]
- Adverse weather conditions [Control ID: Refer to flooding etc.]
- Crossings [Control ID: 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 17, 18, 20, 24, 25]
- Infrastructure impedes travel (due to failure) [Control ID: 1, 2, 3, 6, 8, 12, 14, 17, 18, 20, 25]
- Track obstructions (tree or work tools, vandalism etc) [Control ID: 2, 3, 6, 8, 12, 13, 17, 20, 25]
- Wheel / track interface (coefficient of friction) [Control ID: 1, 2, 3, 4, 5, 6, 8, 9, 12, 10, 13, 17, 19, 25, 20, 24, 23]
- Track defect [Control ID: 1, 2, 3, 4, 5, 6, 14, 8, 12, 17, 19, 20, 25, 24]

People (individual / team actions)

- Poor / non existent communications (radio protocols) [Control ID: 3, 17, 8, 10, 16, 25]
- Lack of situational awareness [Control ID: 16, 8, 17, 21, 25, 24]
- poor possession management / level of knowledge [Control ID: 25, 3, 8, 17, 18]
- Poor speed management [Control ID: 6, 21, 3, 15, 16, 14, 24, 25]
- line of sight [Control ID: 9, 6, 24, 8, 11, 21]
- Route knowledge / competency [Control ID: 3, 6, 8, 14, 24, 25]
- Fitness for work [Control ID: 3, 21, 25]
- Violation [Control ID: 3, 8, 21, 6, 14, 15, 25, 17, 20]
- SPAD [Control ID: 3, 6, 7, 5, 21, 8, 13, 18, 17, 25, 24]
- Driver incapacitation [Control ID: 7, 21, 25]
- Vehicle attachment not stowed [Control ID: 2, 3, 6, 8, 5, 23, 9, 10]

Systems (organisational factors)

- Poor / non existent communications (radio protocols) [Control ID: 8, 17, 18, 3, 5]
- poor possession management / level of knowledge [Control ID: 3, 8, 20, 17, 25, 18]
- Time pressures / work patterns [Control ID: 8, 20, 21, 25, 3]
- Moving in convoy [Control ID: 1, 3, 6, 5, 10, 8, 9, 17, 12, 14, 25, 24, 18, 7]

Collision control slide (off rail)

Non-emergency

Technical (technical failures) [Control ID: 7, 8]

- Equipment failure
- No brakes
- Design modification
- Inadequate design

Environment (local conditions) [Control ID: 1, 3]

- Accident by road vehicle at level crossing
- Contamination on rail
- Gradient
- Sun glare

People (individual / team actions)

- Travelling in convoy (poor communication protocol) [Control ID: 6, 7]
- Not sticking to plan [Control ID: 6, 7]
- Not competent on type of equipment [Control ID: 5]
- Not questioning authority if in doubt (safety culture) [Control ID: 3]
- Violations [Control ID: 1, 3, 5, 6, 7]
- Fitness for duty – fatigue, D&A, incapacitation

Systems (organisational factors)

- Inadequate training processes [Control ID: 4, 5, 7, 8]
- Inadequate procedures [Control ID: 9, 10]
- Inadequate standards [Control ID: 9, 10]
- Production demands [Control ID: 6, 7, 8, 9, 10]
- Inadequate resourcing [Control ID: 5, 11]
- Not competent on type of equipment [Control ID: 4, 5, 7, 8]
- Inadequate change management [Control ID: 3, 7, 6]

Emergency

Technical (technical failures) [Control ID: 6, 8]

- Unable to move machine
- No brakes
- Design modification
- Inadequate design

Environment (local conditions) [Control ID: 1, 4, 6, 2]

- Off rail at non specified location / inappropriate location
- contamination
- Gradient
- visibility
- Terrain / infrastructure problem
- Washaway
- Bushfires / snow

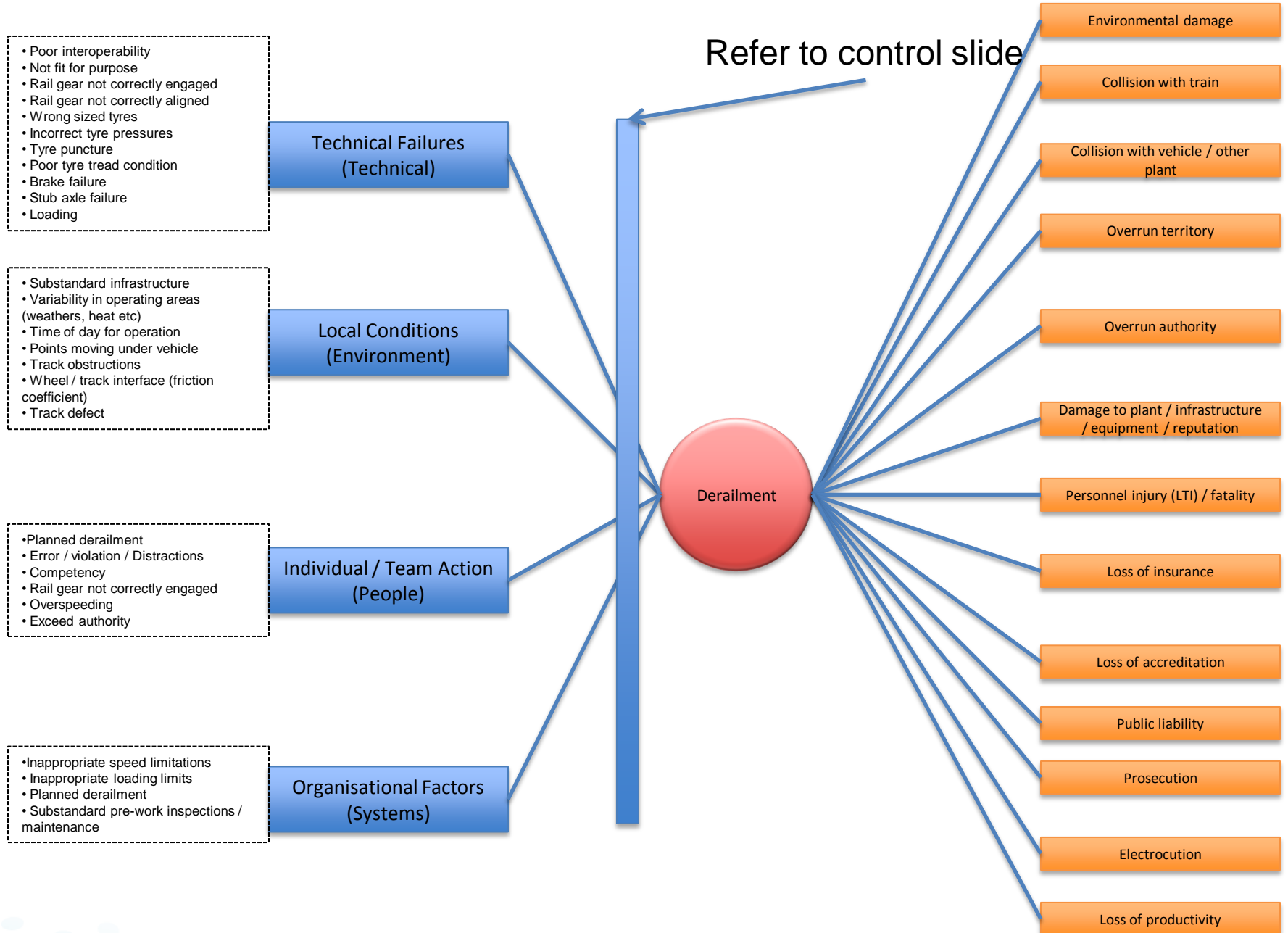
People (individual / team actions) [Control ID: 1, 2, 3, 4, 5, 6, 7, 8, 9]

- Competency
- Violation
- Lack of skills in emergency situation
- Communication error

Systems (organisational factors)

- Safe work component [Control ID: 1, 2]
- Inadequate consideration of all aspects of an “emergency” [Control ID: 1, 2, 3, 4]
- production demands [Control ID: 1, 2, 7]
- Inadequate training procedures [Control ID: 3, 6]
- Inadequate resourcing [Control ID: 9, 6]
- Inadequate procedure [Control ID: 10]

Hazardous event	Potential Cause(s)	Potential Consequence(s)	Existing control(s)	Proposed control(s)
RRV Derailment	<p><u>Technical (technical failures)</u></p> <ul style="list-style-type: none"> • Poor interoperability (machine, network, operator) [Control ID: 26, 1, 3, 20, 5, 6, 13, 7, 8, 9, 10, 11, 12, 16, 17, 22] • Not fit for purpose [Control ID: 1, 2, 3, 5, 4, 6, 8, 12, 13, 20, 23, 26] • Rail gear not correctly engaged [Control ID: 2, 3, 5, 8, 12, 23] • Rail gear not correctly aligned [Control ID: same as above] • Wrong sized tyres [Control ID: 1, 2, 3, 5, 8, 12, 23, 19] • Incorrect tyre pressures [Control ID: same as above] • Tyre puncture [Control ID: 2, 5] • Poor tyre tread condition [Control ID: 2, 5] • Brake failure [Control ID: 2, 13, 1, 5, 4, 6] • Stub axle failure [Control ID: 5, 3, 12, 13, 25, 23, 4] • Loading [Control ID: 1, 2, 3, 4, 6, 8, 12, 13, 20, 25] <p><u>Environment (local conditions)</u></p> <ul style="list-style-type: none"> • Substandard infrastructure [Control ID: 1, 2, 3, 6, 8, 13, 25] • Variability in operating areas (weathers, heat etc) [Control ID: 1, 3, 6, 8, 24] • Time of day for operation [Control ID: 6] • Points moving under vehicle [Control ID: 1, 3, 6, 8, 17] • Track obstructions [Control ID: 6, 17, 24] • Wheel / track interface (friction coefficient) [Control ID: 5, 2, 3, 1, 6, 8, 12] • Track defect [Control ID: 6, 8, 17, 14] <p><u>People (individual / team actions)</u></p> <ul style="list-style-type: none"> • Planned derailment [Control ID: 9, 3, 17] • Error / violation / Distractions [Control ID: 3, 6, 10, 11, 8, 12, 17, 14, 21, 25] • Competency [Control ID: 1, 38, 12, 17, 25] • Rail gear not correctly engaged [Control ID: 2, 3, 5, 8, 12, 23] • Overspeeding [Control ID: 3, 6, 8, 14, 17, 25] • Exceed authority [Control ID: 3, 8, 9, 17, 25] <p><u>Systems (organisational factors)</u></p> <ul style="list-style-type: none"> • Inappropriate speed limitations [Control ID: 1, 8, 14, 6, 25, 17] • Inappropriate loading limits [Control ID: 1, 2, 4, 3, 8, 12, 25] • Planned derailment [Control ID: 9, 3, 17] • Substandard pre-work inspections / maintenance [Control ID: 1, 3, 8, 25] 	<ul style="list-style-type: none"> • Environmental damage • Collision with train / vehicle / other plant / infrastructure / personnel • Derailment / rollover • SPAD • Overrun territory • Overrun authority • Damage to plant, equipment, infrastructure, reputation • Personnel injury (LTI) / fatality • Loss of insurance / accreditation • Public liability • Prosecution • Electrocution • Loss to productivity 	<ol style="list-style-type: none"> 1. OEM / RIM standards 2. Visual inspections 3. training 4. weight guides 5. vehicle maintenance 6. driving to conditions 7. vigilance system 8. rules & procedures 9. derailleurs, skids, speed limiters 10. D&A testing 11. Fatigue management 12. Pre-work inspections 13. braking systems 14. speed board (including TSR) 15. data logger 16. GPS tracking 17. Comms. Protocols 18. Train protection 19. Asset lifecycle management 20. Change management 21. Health standards 22. on/off track pads 23. interlocks 24. Weather monitoring 25. supervision 26. Ergonomics 	



Derailment control slide

Technical (technical failures)

- Poor interoperability (machine, network, operator) [Control ID: 26, 1, 3, 20, 5, 6, 13, 7, 8, 9, 10, 11, 12, 16, 17, 22]
- Not fit for purpose [Control ID: 1, 2, 3, 5, 4, 6, 8, 12, 13, 20, 23, 26]
- Rail gear not correctly engaged [Control ID: 2, 3, 5, 8, 12, 23]
- Rail gear not correctly aligned [Control ID: same as above]
- Wrong sized tyres [Control ID: 1, 2, 3, 5, 8, 12, 23, 19]
- Incorrect tyre pressures [Control ID: same as above]
- Tyre puncture [Control ID: 2, 5]
- Poor tyre tread condition [Control ID: 2, 5]
- Brake failure [Control ID: 2, 13, 1, 5, 4, 6]
- Stub axle failure [Control ID: 5, 3, 12, 13, 25, 23, 4]
- Loading [Control ID: 1, 2, 3, 4, 6, 8, 12, 13, 20, 25]

Environment (local conditions)

- Substandard infrastructure [Control ID: 1, 2, 3, 6, 8, 13, 25]
- Variability in operating areas (weathers, heat etc) [Control ID: 1, 3, 6, 8, 24]
- Time of day for operation [Control ID: 6]
- Points moving under vehicle [Control ID: 1, 3, 6, 8, 17]
- Track obstructions [Control ID: 6, 17, 24]
- Wheel / track interface (friction coefficient) [Control ID: 5, 2, 3, 1, 6, 8, 12]
- Track defect [Control ID: 6, 8, 17, 14]

People (individual / team actions)

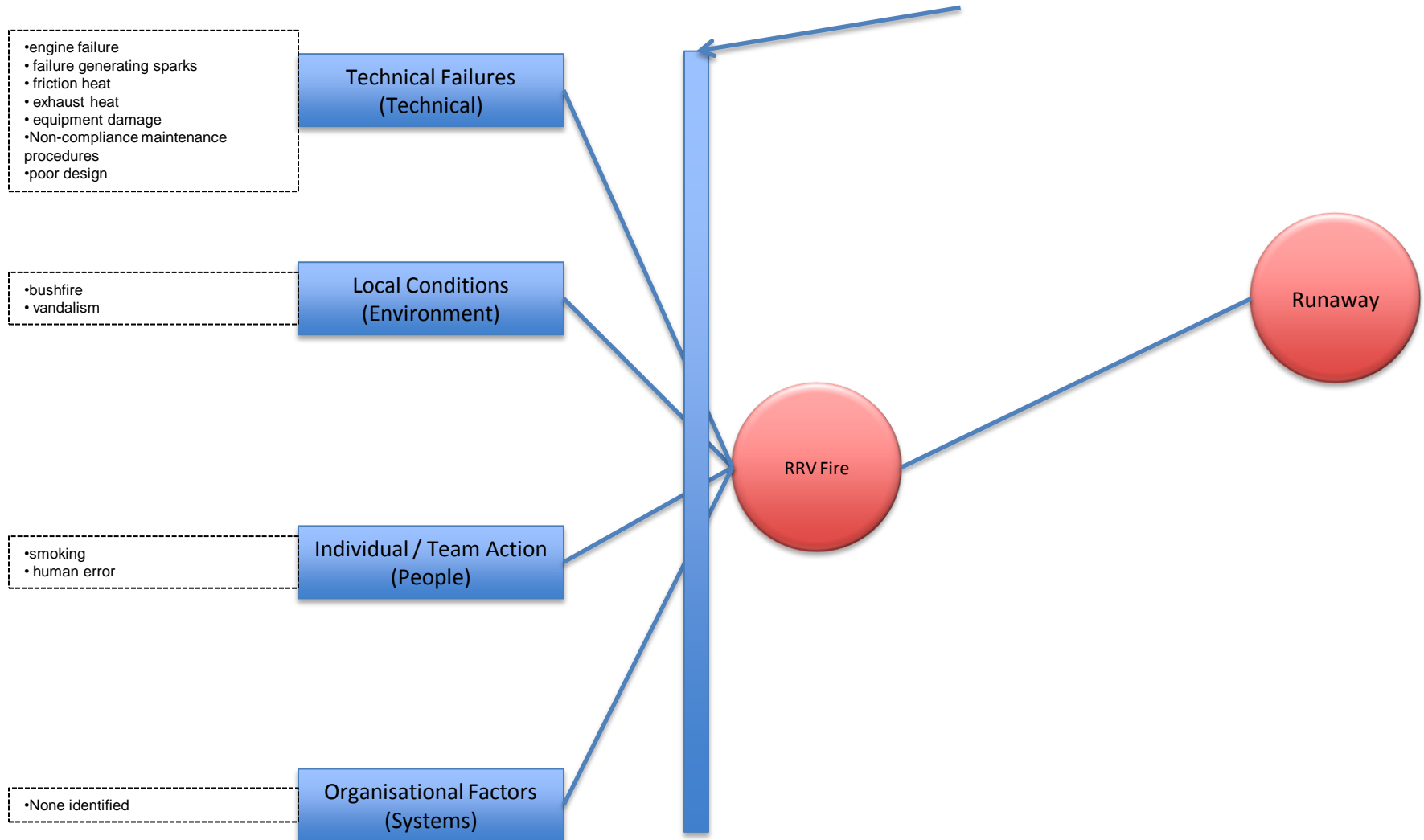
- Planned derailment [Control ID: 9, 3, 17]
- Error / violation / Distractions [Control ID: 3, 6, 10, 11, 8, 12, 17, 14, 21, 25]
- Competency [Control ID: 1, 38, 12, 17, 25]
- Rail gear not correctly engaged [Control ID: 2, 3, 5, 8, 12, 23]
- Overspeeding [Control ID: 3, 6, 8, 14, 17, 25]
- Exceed authority [Control ID: 3, 8, 9, 17, 25]

Systems (organisational factors)

- Inappropriate speed limitations [Control ID: 1, 8, 14, 6, 25, 17]
- Inappropriate loading limits [Control ID: 1, 2, 4, 3, 8, 12, 25]
- Planned derailment [Control ID: 9, 3, 17]
- Substandard pre-work inspections / maintenance [Control ID: 1, 3, 8, 25]

Hazardous event	Potential Cause(s)	Potential Consequence(s)	Existing control(s)	Proposed control(s)
RRV Fire	<u>Technical (technical failures)</u> <ul style="list-style-type: none"> • engine failure [Control ID: 1, 2, 3, 5, 6, 7, 8, 9, 10] • failure generating sparks [Control ID: 1, 2, 3, 6, 7, 8, 9] • friction heat [Control ID: 1, 2, 3, 6, 7, 8] • exhaust heat [Control ID: 1, 2, 3, 6, 7, 8] • equipment damage [Control ID: refer to engine failure] • Non-compliance maintenance procedures [Control ID: 1, 4, 6, 7, 9, 10] • poor design [Control ID: 3] <u>Environment (local conditions)</u> <ul style="list-style-type: none"> • bushfire [Control ID: 1, 9, 10, 7, 6, 4] • vandalism [Control ID: 6, 7, 9, 10, 4, 1, 7] <u>People (individual / team actions)</u> <ul style="list-style-type: none"> • smoking [Control ID: 1, 4, 6, 9, 10] • human error [Control ID: as above] <u>Systems (organisational factors)</u> [Control ID: 1, 6, 9, 10]	Runaway	<ol style="list-style-type: none"> 1. Extinguishers 2. spark suppression (some) 3. design standards 4. Rules & procedures 5. Dust suppression (some) 6. Maintenance procedures / SOPs 7. Pre-work inspections 8. System checks 9. People management / training / culture 10. Supervision 	

Refer to control slide



Fire control slide

Technical (technical failures)

- engine failure [Control ID: 1, 2, 3, 5, 6, 7, 8, 9, 10]
- failure generating sparks [Control ID: 1, 2, 3, 6, 7, 8, 9]
- friction heat [Control ID: 1, 2, 3, 6, 7, 8]
- exhaust heat [Control ID: 1, 2, 3, 6, 7, 8]
- equipment damage [Control ID: refer to engine failure]
- Non-compliance maintenance procedures [Control ID: 1, 4, 6, 7, 9, 10]
- poor design [Control ID: 3]

Environment (local conditions)

- bushfire [Control ID: 1, 9, 10, 7, 6, 4]
- vandalism [Control ID: 6, 7, 9, 10, 4, 1, 7]

People (individual / team actions)

- smoking [Control ID: 1, 4, 6, 9, 10]
- human error [Control ID: as above]

Systems (organisational factors) [Control ID: 1, 6, 9, 10]

PROPOSED CONTROLS

Proposed controls

- Separation alarm systems
- All trailers brake system fitted
- Clarification of where vigilance control systems are required
- Clarify design consistency needs (RIM/OEM, engineering issues)
- Proximity sensors
- Audible alarms (loss of traction (better alarms automated))
- Coupling rules (physical connections rules in context with equipment)
- Emergency response (expanded scenarios)

PARKING LOT

Issues

- Standards
 - Applicability of current rolling stock standards
 - Proliferation of requirements (eg multiple RIMS etc)
 - Differing terminology /classification systems (UK/ local)
 - Potential for specific RRV national standard ?
 - Capture existing good work (LOR, JHR, V-line etc)
- Data
 - No national approach to incident data collection
 - Ability to trend data
 - RISSB building capacity for data collection/analysis
 - Will strengthen risk basis of RISSB standards

Issues

- Competence and culture
 - National approach, and
 - Vehicle specific training
 - Gangers vs head office
 - Low literacy may be an issue
- Risk management
 - Accidents/incidents occurring despite controls
 - Control effectiveness??
- Road authority vs. rail compatibility
 - Expense of crash testing

PROPOSED ACTIONS