



# Actions required to improve safe operations

PHA results, Bow tie & actions

Wednesday 31 October 2012

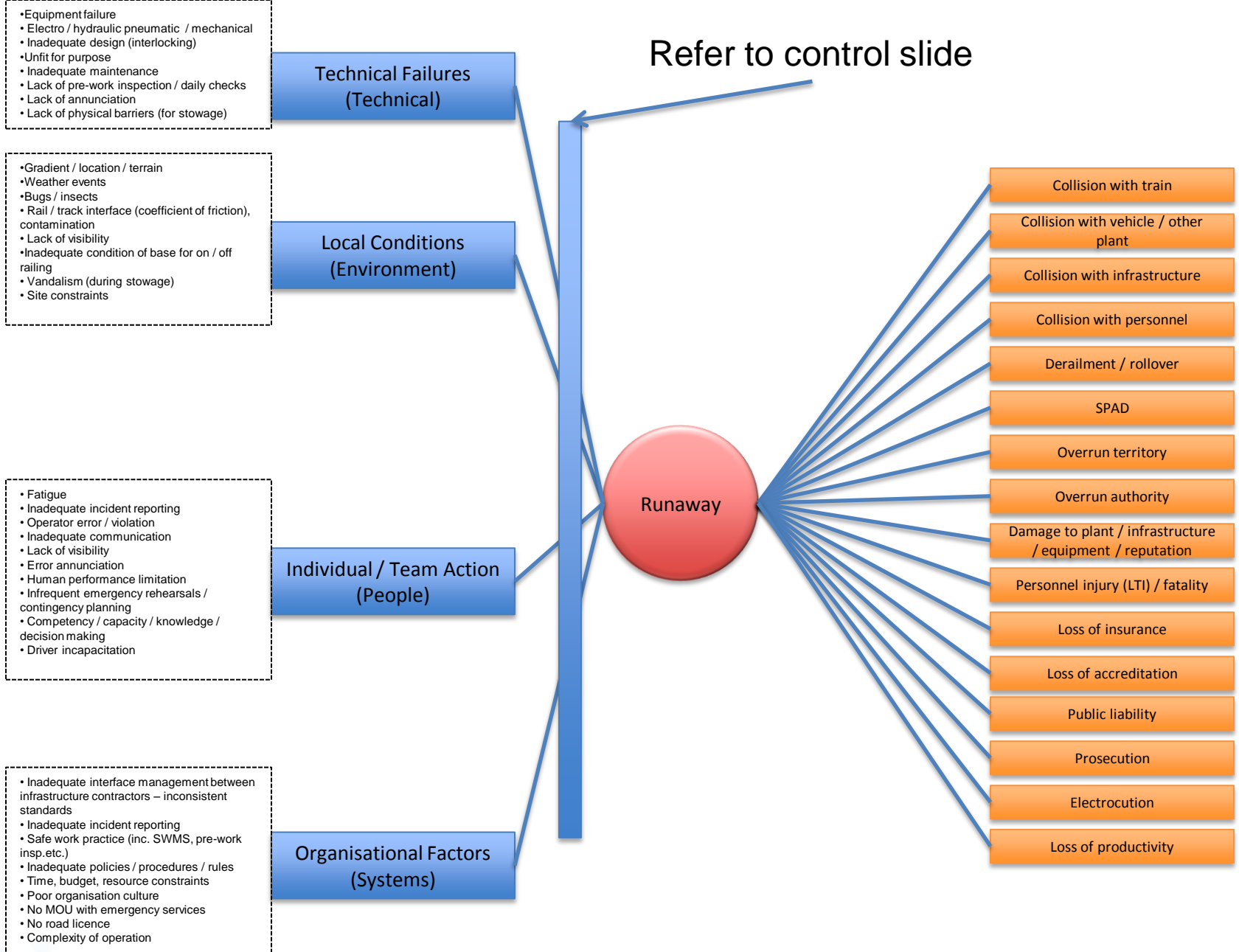
# Process Summary



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

Refer to control slide



# 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 raiiling [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"> <li>• Travelling outside kinematic envelope [Control ID: 1, 2, 5, 10, 8, 17, 20, 25]</li> <li>• Loss of load / trailer [Control ID: 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 17, 19, 20, 22, 23, 25]</li> <li>• Mechanical failure [Control ID: 1, 2, 3, 5, 6, 10, 13, 15, 17, 18, 19, 20, 25]</li> <li>• Failure of RRV to activate signals / telemetry [Control ID: 1, 2, 3, 5, 7, 8, 10, 17, 19, 20, 25]</li> <li>• No track protection at a breakdown [Control ID: 1, 2, 3, 8, 17, 18, 20, 25]</li> <li>• Equipment design (e.g. Deadman / vigilance) [Control ID: 1, 2, 4, 5, 8, 10, 13, 15, 19, 20]</li> <li>• Poor tyre tread condition [Control ID: 1, 2, 3, 4, 5, 6, 8, 10, 13, 17, 19, 20, 23, 24, 25]</li> <li>• Brake failure [Control ID: 1, 2, 3, 5, 6, 10, 13, 15, 17, 18, 19, 20, 24, 25]</li> <li>• Not fit for purpose [Control ID: 1, 3, 2, 4, 5, 8, 10, 13, 15, 19, 20]</li> </ul> <p><u>Environment (local conditions)</u></p> <ul style="list-style-type: none"> <li>• Temporary works unknown [Control ID: 1, 2, 3, 6, 8, 9, 12, 13, 20, 17, 25, 14]</li> <li>• line of sight [Control ID: 1, 2, 3, 5, 6, 8, 9, 10, 12, 17, 20, 21, 24, 25]</li> <li>• Flooding, Rain, mud, cold, heat, animals etc. [Control ID: 2, 24, 4, 6, 21, 8, 10, 12, 13, 14, 20, 17, 24, 25]</li> <li>• Adverse weather conditions [Control ID: Refer to flooding etc.]</li> <li>• Crossings [Control ID: 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 17, 18, 20, 24, 25]</li> <li>• Infrastructure impedes travel (due to failure) [Control ID: 1, 2, 3, 6, 8, 12, 14, 17, 18, 20, 25]</li> <li>• Track obstructions (tree or work tools, vandalism etc) [Control ID: 2, 3, 6, 8, 12, 13, 17, 20, 25]</li> <li>• 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]</li> <li>• Track defect [Control ID: 1, 2, 3, 4, 5, 6, 14, 8, 12, 17, 19, 20, 25, 24]</li> </ul> <p><u>People (individual / team actions)</u></p> <ul style="list-style-type: none"> <li>• Poor / non existent communications (radio protocols) [Control ID: 3, 17,8 ,10, 16, 25]</li> <li>• Lack of situational awareness [Control ID: 16, 8, 17, 21, 25, 24]</li> <li>• poor possession management / level of knowledge [Control ID: 25, 3, 8, 17, 18]</li> <li>• Poor speed management [Control ID: 6, 21, 3, 15, 16, 14, 24, 25]</li> <li>• line of sight [Control ID: 9, 6, 24, 8, 11, 21]</li> <li>• Route knowledge / competency [Control ID: 3, 6, 8, 14, 24, 25]</li> <li>• Fitness for work [Control ID: 3, 21, 25]</li> <li>• Violation [Control ID: 3, 8, 21, 6, 14, 15, 25, 17, 20]</li> <li>• SPAD [Control ID: 3, 6, 7, 5, 21, 8, 13, 18, 17, 25, 24]</li> <li>• Driver incapacitation [Control ID: 7, 21, 25]</li> <li>• Vehicle attachment not stowed [Control ID: 2, 3, 6, 8, 5, 23, 9, 10]</li> </ul> <p><u>Systems (organisational factors)</u></p> <ul style="list-style-type: none"> <li>• Poor / non existent communications (radio protocols) [Control ID: 8, 17, 18, 3, 5]</li> <li>• poor possession management / level of knowledge [Control ID: 3, 8, 20, 17, 25, 18]</li> <li>• Time pressures / work patterns [Control ID: 8, 20, 21, 25, 3]</li> <li>• Moving in convoy [Control ID: 1, 3, 6, 5, 10, 8, 9, 17, 12, 14, 25, 24, 18, 7]</li> </ul>	<ul style="list-style-type: none"> <li>•Environmental damage</li> <li>•Collision with train / vehicle / other plant / infrastructure / personnel</li> <li>•Derailment / rollover</li> <li>•SPAD</li> <li>•Overrun territory</li> <li>•Overrun authority</li> <li>•Damage to plant, equipment, infrastructure, reputation</li> <li>•Personnel injury (LTI) / fatality</li> <li>•Loss of insurance / accreditation</li> <li>•Public liability</li> <li>•Prosecution</li> <li>•Electrocution</li> <li>•Loss to productivity</li> </ul>	<ol style="list-style-type: none"> <li>OEM / RIM standards</li> <li>Visual inspections</li> <li>training</li> <li>weight guides</li> <li>vehicle maintenance</li> <li>driving to conditions</li> <li>vigilance system</li> <li>Rules &amp; procedures</li> <li>Cameras, audible alarms (some RRVs)</li> <li>Maintenance</li> <li>6m Rule (some)</li> <li>15km/h limit (some)</li> <li>braking systems</li> <li>speed board</li> <li>data logger</li> <li>GPS tracking</li> <li>Comms. Protocols</li> <li>Train protection and worksite protection</li> <li>Asset lifecycle management</li> <li>Change management</li> <li>Health standards / fatigue management</li> <li>on/off track pads</li> <li>interlocks</li> <li>Weather monitoring</li> <li>supervision</li> </ol>	<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"> <li>•Equipment failure</li> <li>•No brakes</li> <li>•Design modification</li> <li>•Inadequate design</li> </ul> <p><u>Environment (local conditions)</u> [Control ID: 1, 3]</p> <ul style="list-style-type: none"> <li>•Accident by road vehicle at level crossing</li> <li>•Contamination on rail</li> <li>•Gradient</li> <li>•Sun glare</li> </ul> <p><u>People (individual / team actions)</u></p> <ul style="list-style-type: none"> <li>•Travelling in convoy (poor communication protocol) [Control ID: 6, 7]</li> <li>• Not sticking to plan [Control ID: 6, 7]</li> <li>• Not competent on type of equipment [Control ID: 5]</li> <li>• Not questioning authority if in doubt (safety culture) [Control ID: 3]</li> <li>• Violations [Control ID: 1, 3, 5, 6, 7]</li> <li>•Fitness for duty – fatigue, D&amp;A, incapacitation</li> </ul> <p><u>Systems (organisational factors)</u></p> <ul style="list-style-type: none"> <li>•Inadequate training processes [Control ID: 4, 5, 7, 8]</li> <li>•Inadequate procedures [Control ID: 9, 10]</li> <li>•Inadequate standards [Control ID: 9, 10]</li> <li>•Production demands [Control ID: 6, 7, 8, 9, 10]</li> <li>•Inadequate resourcing [Control ID: 5, 11]</li> <li>•Not competent on type of equipment [Control ID: 4, 5, 7, 8]</li> <li>•Inadequate change management [Control ID: 3, 7, 6]</li> </ul>	<ul style="list-style-type: none"> <li>•Environmental damage</li> <li>•Collision with train / vehicle / other plant / infrastructure / personnel</li> <li>•Derailment / rollover</li> <li>•SPAD</li> <li>•Overrun territory</li> <li>•Overrun authority</li> <li>•Damage to plant, equipment, infrastructure, reputation</li> <li>•Personnel injury (LTI) / fatality</li> <li>•Loss of insurance / accreditation</li> <li>•Public liability</li> <li>•Prosecution</li> <li>•Electrocution</li> <li>•Loss to productivity</li> <li>•Delayed emergency services</li> <li>•Delay of services</li> <li>•Fire</li> </ul>	<ol style="list-style-type: none"> <li>1. Protection/Safeworking</li> <li>2. Education</li> <li>3. Communication</li> <li>4. Up skilling</li> <li>5. competencies</li> <li>6. Network rules</li> <li>7. Procedures</li> <li>8. Standards</li> <li>9. Project review</li> <li>10. SMS review</li> <li>11. Resourcing capacity</li> <li>12. Fit to task / people / equipment</li> </ol>	
RRV Collision (specific to emergency off rail)	<p><u>Technical (technical failures)</u> [Control ID: 6, 8]</p> <ul style="list-style-type: none"> <li>•Unable to move machine</li> <li>•No brakes</li> <li>•Design modification</li> <li>•Inadequate design</li> </ul> <p><u>Environment (local conditions)</u> [Control ID:1, 4, 6, 2]</p> <ul style="list-style-type: none"> <li>• Off rail at non specified location / inappropriate location</li> <li>•contamination</li> <li>•Gradient</li> <li>•visibility</li> <li>•Terrain / infrastructure problem</li> <li>•Washaway</li> <li>•Bushfires / snow</li> </ul> <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"> <li>•Competency</li> <li>•Violation</li> <li>•Lack of skills in emergency situation</li> <li>•Communication error</li> </ul> <p><u>Systems (organisational factors)</u></p> <ul style="list-style-type: none"> <li>• Safe work component [Control ID: 1, 2]</li> <li>•Inadequate consideration of all aspects of an “emergency” [Control ID: 1, 2, 3, 4]</li> <li>• production demands [Control ID: 1, 2, 7]</li> <li>•Inadequate training procedures [Control ID: 3, 6]</li> <li>•Inadequate resourcing [Control ID: 9, 6]</li> <li>•Inadequate procedure [Control ID: 10]</li> </ul>	<ul style="list-style-type: none"> <li>•Environmental damage</li> <li>•Collision with train / vehicle / other plant / infrastructure / personnel</li> <li>•Derailment / rollover</li> <li>•SPAD</li> <li>•Overrun territory</li> <li>•Overrun authority</li> <li>•Damage to plant, equipment, infrastructure, reputation</li> <li>•Personnel injury (LTI) / fatality</li> <li>•Loss of insurance / accreditation</li> <li>•Public liability</li> <li>•Prosecution</li> <li>•Electrocution</li> <li>•Loss to productivity</li> <li>•Delayed emergency services</li> <li>•Delay of services</li> <li>•Fire</li> </ul>	<ol style="list-style-type: none"> <li>1. Protection / safetyworking</li> <li>2. Communication</li> <li>3. Training</li> <li>4. Competencies</li> <li>5. Fit to task / PPL and equipment</li> <li>6. Procedures</li> <li>7. Network rules</li> <li>8. Engineering standards</li> <li>9. Resourcing</li> <li>10. SMS review</li> </ol>	



Refer to control slide

- Travelling outside kinematic envelope
- Loss of load / trailer
- Mechanical failure
- Failure of RRV to activate signals / telemetry
- No track protection at a breakdown
- Equipment design (e.g. Deadman / vigilance)
- Poor tyre tread condition
- Brake failure
- Not fit for purpose
- Equipment failure
- No brakes
- Design modification
- Inadequate design

Technical Failures (Technical)

- Temporary works unknown
- line of sight
- Flooding, Rain, mud, cold, heat, animals etc.
- Adverse weather conditions
- Crossings
- Infrastructure impedes travel (due to failure)
- Track obstructions (tree or work tools, vandalism etc)
- Wheel / track interface (coefficient of friction)
- Track defect
- Accident by road vehicle at level crossing
- Contamination on rail
- Gradient
- Sun glare

Local Conditions (Environment)

- Poor / non existent communications (radio protocols)
- Lack of situational awareness
- poor possession management / level of knowledge
- Poor speed management
- line of sight
- Route knowledge / competency
- Fitness for work
- Violation
- SPAD
- Driver incapacitation
- Vehicle attachment not stowed
- Competency
- Violation
- Lack of skills in emergency situation
- Communication error

Individual / Team Action (People)

- Poor / non existent communications (radio protocols)
- poor possession management / level of knowledge
- Time pressures / work patterns
- Moving in convoy

Organisational Factors (Systems)

Collision

- Collision with train
- Collision with vehicle / other plant
- Collision with infrastructure
- Collision with personnel
- Damage to plant / infrastructure / equipment / reputation
- Environmental damage
- Personnel injury (LTI) / fatality
- Loss of insurance
- Loss of accreditation
- Public liability
- Prosecution
- Electrocution
- Loss of productivity

# 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

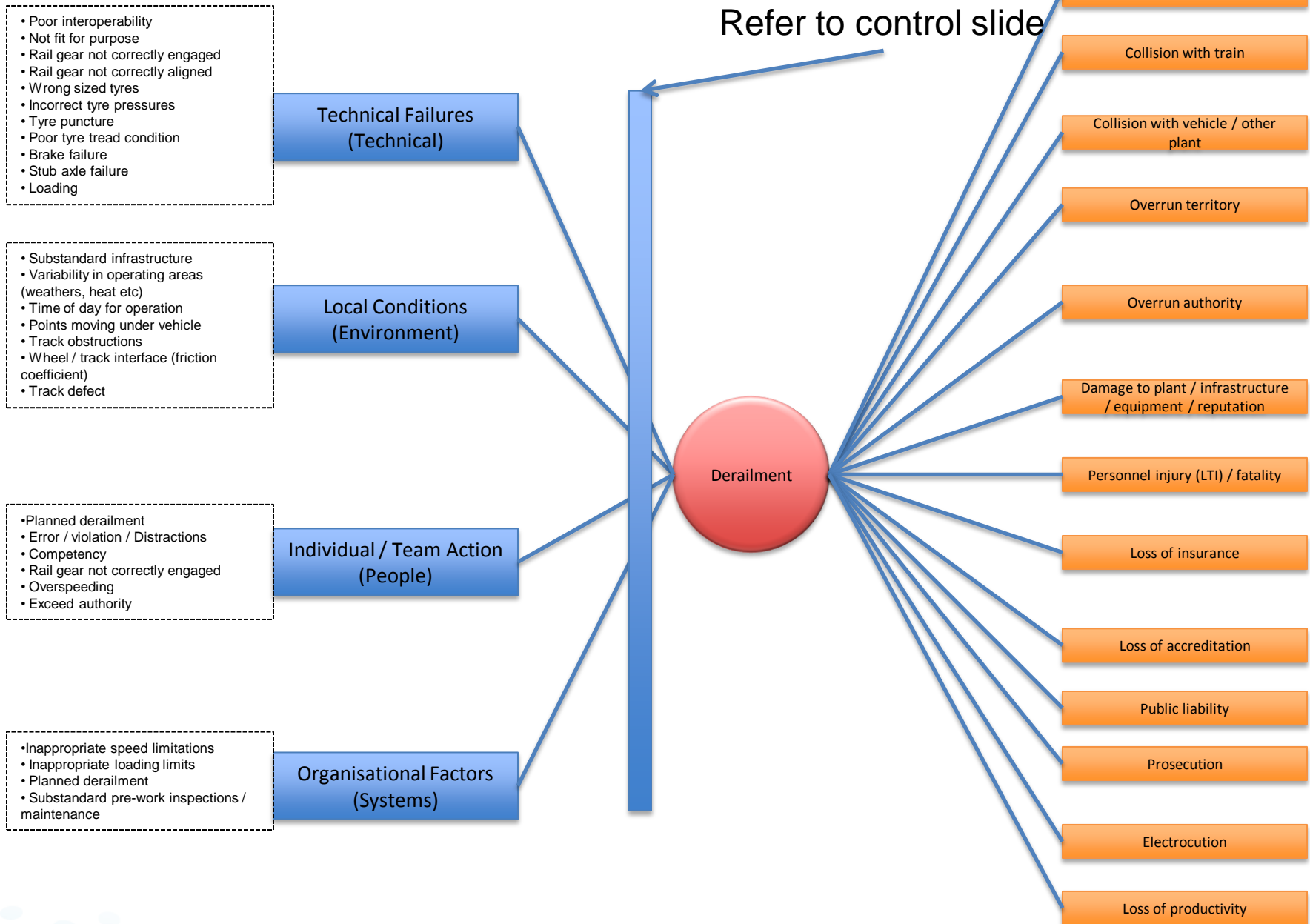
### People (individual / team actions) [Control ID: 1, 2, 3, 4, 5, 6, 7, 8, 9]

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



# 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)

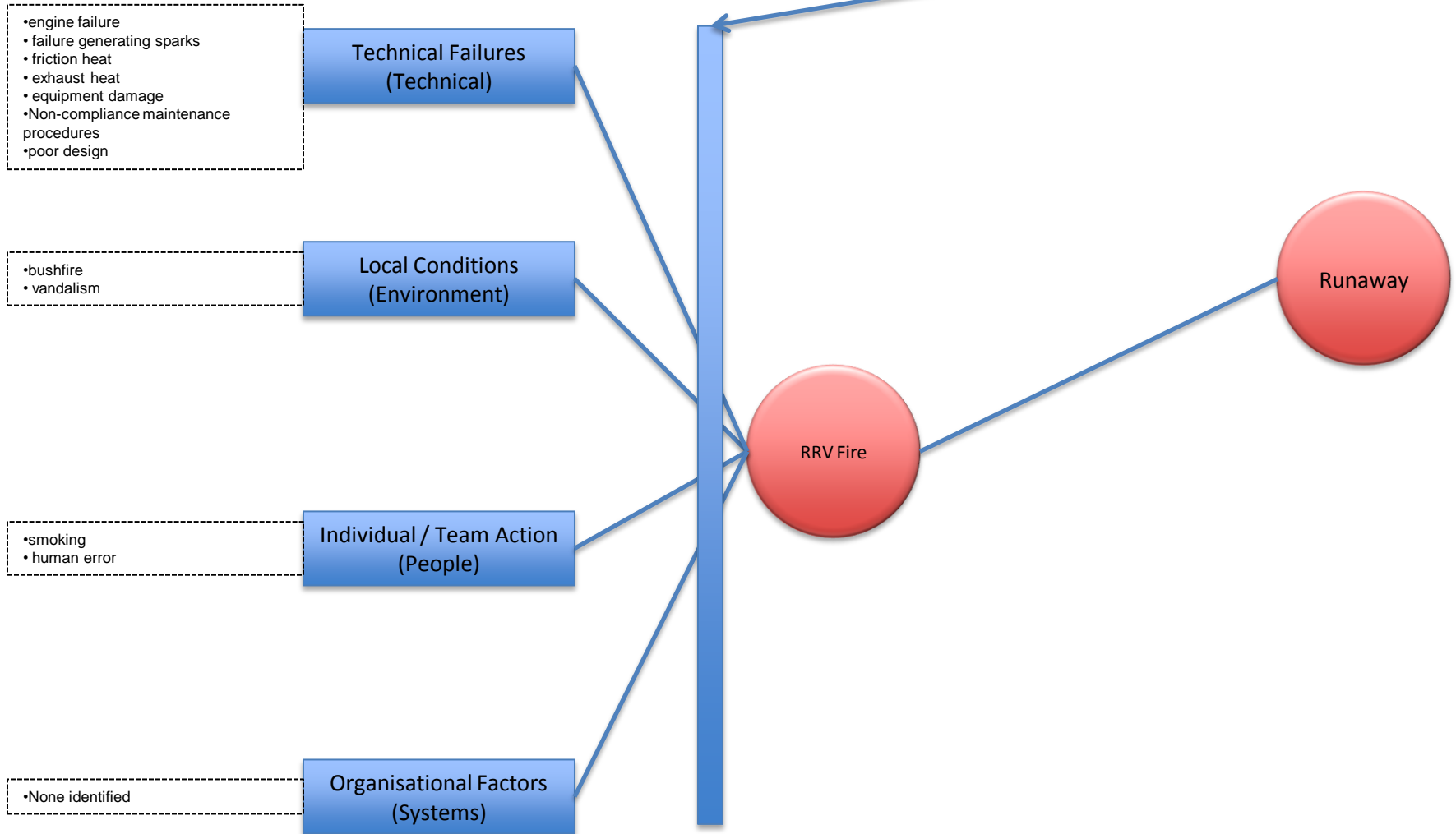
- Planned derailment [Control ID: 9, 3, 17]
- Error / violation / Distractions [Control ID: 3, 6, 10, 11, 8, 12, 17, 14, 21, 25]
- Competency [Control ID: 1, 38, 12, 17, 25]
- Rail gear not correctly engaged [Control ID: 2, 3, 5, 8, 12, 23]
- Overspeeding [Control ID: 3, 6, 8, 14, 17, 25]
- Exceed authority [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	<p><u>Technical (technical failures)</u></p> <ul style="list-style-type: none"> <li>• engine failure [Control ID: 1, 2, 3, 5, 6, 7, 8, 9, 10]</li> <li>• failure generating sparks [Control ID: 1, 2, 3, 6, 7, 8, 9]</li> <li>• friction heat [Control ID: 1, 2, 3, 6, 7, 8]</li> <li>• exhaust heat [Control ID: 1, 2, 3, 6, 7, 8]</li> <li>• equipment damage [Control ID: refer to engine failure]</li> <li>• Non-compliance maintenance procedures [Control ID: 1, 4, 6, 7, 9, 10]</li> <li>• poor design [Control ID: 3]</li> </ul> <p><u>Environment (local conditions)</u></p> <ul style="list-style-type: none"> <li>• bushfire [Control ID: 1, 9, 10, 7, 6, 4]</li> <li>• vandalism [Control ID: 6, 7, 9, 10, 4, 1, 7]</li> </ul> <p><u>People (individual / team actions)</u></p> <ul style="list-style-type: none"> <li>• smoking [Control ID: 1, 4, 6, 9, 10]</li> <li>• human error [Control ID: as above]</li> </ul> <p><u>Systems (organisational factors)</u> [Control ID: 1, 6, 9, 10]</p>	Runaway	<ol style="list-style-type: none"> <li>1. Extinguishers</li> <li>2. spark suppression (some)</li> <li>3. design standards</li> <li>4. Rules &amp; procedures</li> <li>5. Dust suppression (some)</li> <li>6. Maintenance procedures / SOPs</li> <li>7. Pre-work inspections</li> <li>8. System checks</li> <li>9. People management / training / culture</li> <li>10. Supervision</li> </ol>	

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