Appendix – Gold Field Ghana Limited, Tarkwa Mine Incident Data Analysis

GFGL Tarkwa Gold Mine provided a set of 133 vehicle incident reports during the preparation phase of the review. This data has been reviewed by Risk Mentor as detailed below.

The data were mapped to the Vehicle Interaction Control Framework to identify:

1. Which Required Operating State or States (ROS) was compromised
2. The Credible Failure Mode or Modes (CFM) dominantly involved in compromising the ROS, and
3. Which Business Inputs (BI) that could have constrained the CFM that was either not present or not effective.

Some general observations on the analysis are:

- There is a difference to the data sets from other open cut mining operations reviewed by Risk Mentor. The main differences are:
    - Much lower total number of incidents (for the 3-year time frame provided other sites have a count of reports well above 2,000 (for near miss, high potential, serious, and fatal combined)),
    - Failed equipment components (particularly tyres) and unwanted interactions with infrastructure represent a higher proportion of the total than other sites,
    - Clearance (ROS01) is consistent in being the dominant ROS compromised, and
    - The understanding and observance of separation and clearance Business Input is always a significant share of the total, but the 1/3rd of all incidents is higher than the usual 15 to 20% seen in other data sets. There is also a higher level of incidents arising due to road conditions at 5.4% than the usual 1 to 2% seen in other data sets.

The following tree-charts show these data which are presented as data tables at the end of this appendix.

Figure 1 – Required Operating States Compromised in Incident Data for ROS types connected to more than 3 incidents

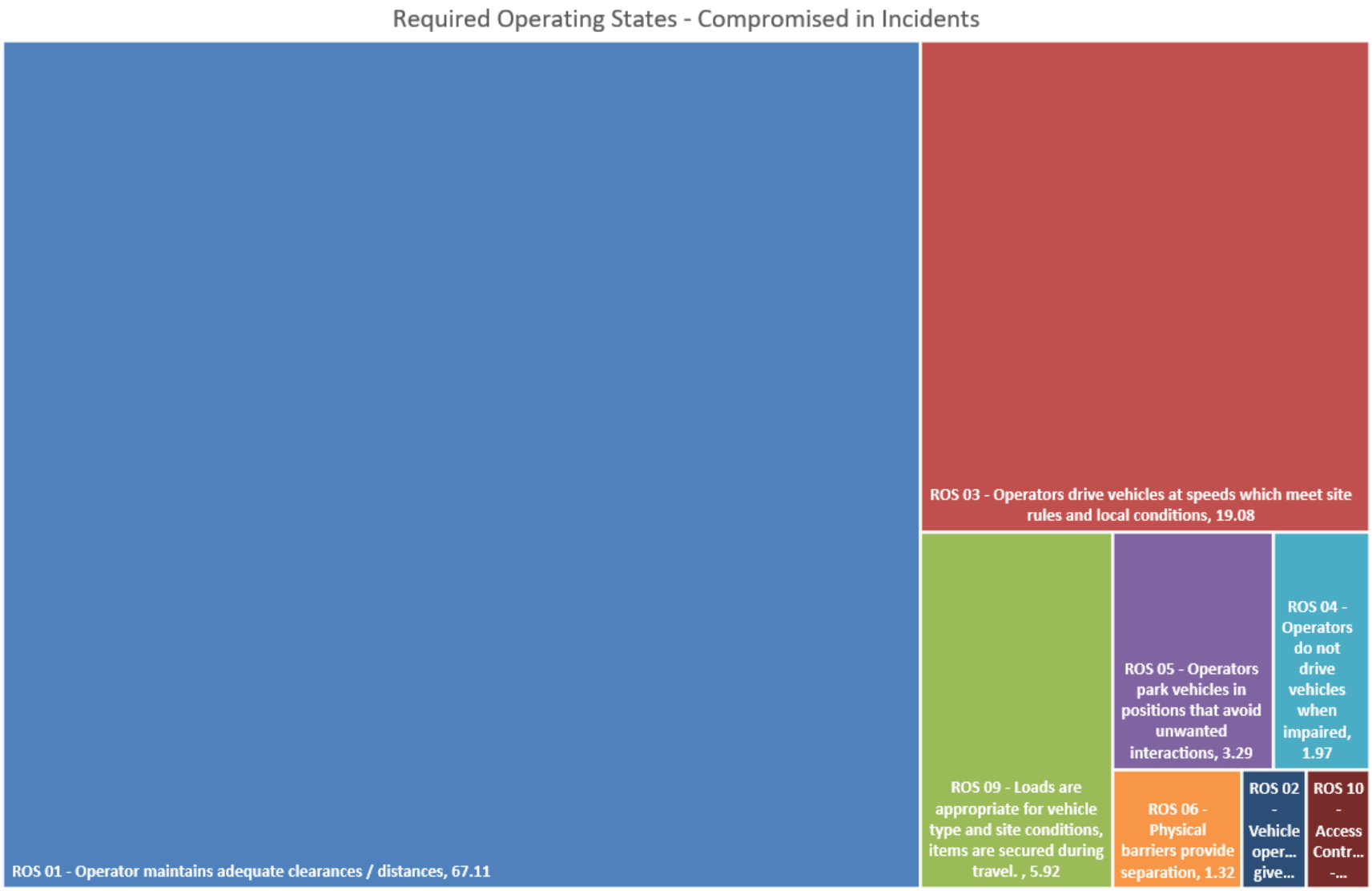

Figure 2 – Credible Failure Modes dominantly implicated in the Incident Data for CFM connected to more than 3 incidents

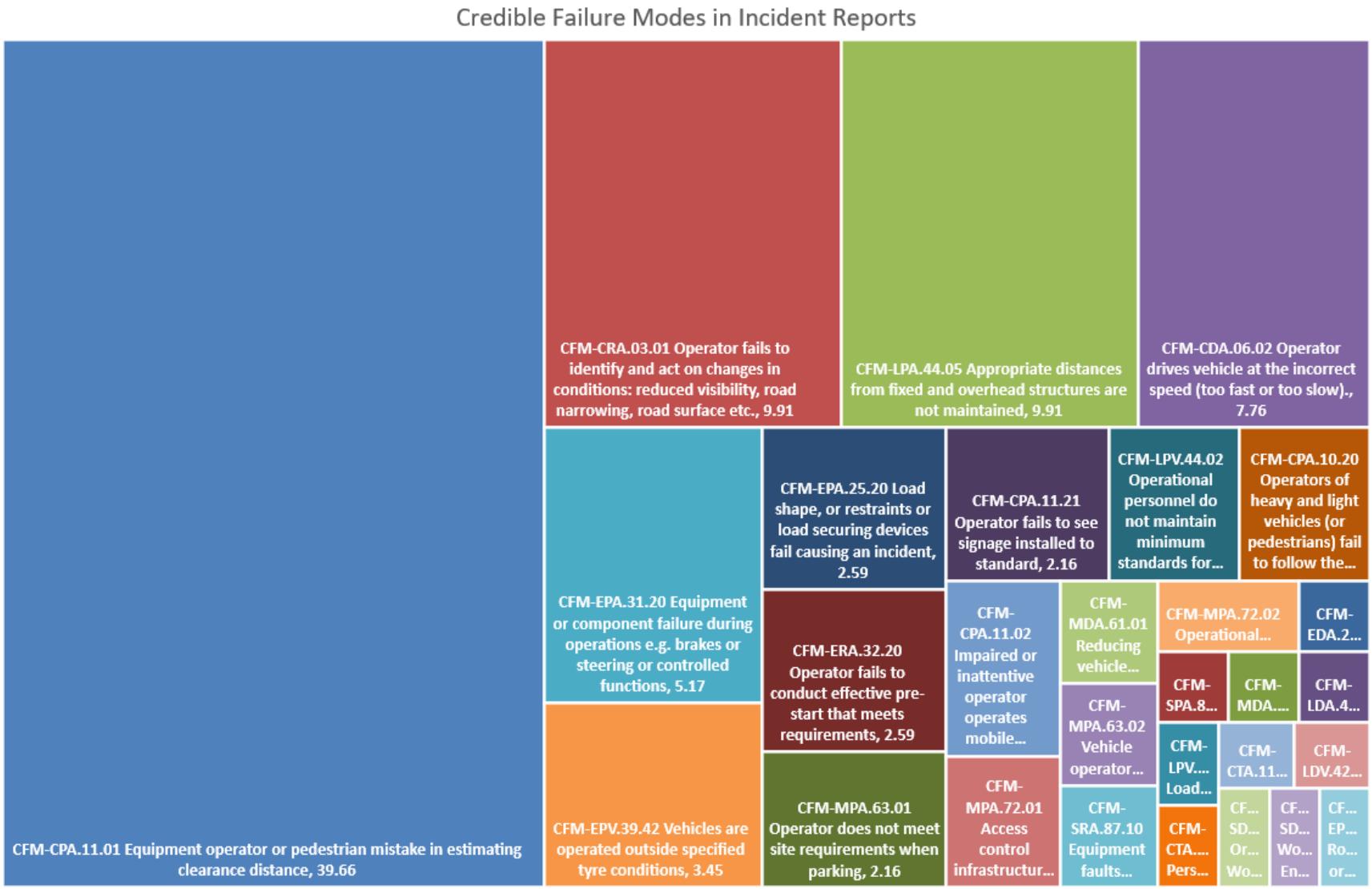

Figure 3 – Business Inputs which did not constrain the CFMs implicated in the Incident Data for BI connected to more than 4 incidents

Table - 1 – Percentage of Incidents for compromised Required Operating States

Required Operating State	Percentage of Incidents
ROS 01 - Operator maintains adequate clearances / distances	67.11
ROS 03 - Operators drive vehicles at speeds which meet site rules and local conditions	19.08
ROS 09 - Loads are appropriate for vehicle type and site conditions, items are secured during travel.	5.92
ROS 05 - Operators park vehicles in positions that avoid unwanted interactions	3.29
ROS 04 - Operators do not drive vehicles when impaired	1.97
ROS 06 - Physical barriers provide separation	1.32
ROS 02 - Vehicle operators give way appropriately to mobile plant and pedestrians	0.66
ROS 10 - Access Control - Vehicle operators limit movements / activities to designated areas	0.66

Table J - 2 – Percentage of Incidents for implicated Credible Failure Modes

Credible Failure Mode	Percentage
CFM-CPA.11.01 Equipment operator or pedestrian mistake in estimating clearance distance	39.66
CFM-CRA.03.01 Operator fails to identify and act on changes in conditions: reduced visibility, road narrowing, road surface etc.	9.91
CFM-LPA.44.05 Appropriate distances from fixed and overhead structures are not maintained	9.91
CFM-CDA.06.02 Operator drives vehicle at the incorrect speed (too fast or too slow).	7.76
CFM-EPA.31.20 Equipment or component failure during operations e.g. brakes or steering or controlled functions	5.17
CFM-EPV.39.42 Vehicles are operated outside specified tyre conditions	3.45
CFM-EPA.25.20 Load shape, or restraints or load securing devices fail causing an incident	2.59
CFM-ERA.32.20 Operator fails to conduct effective pre-start that meets requirements	2.59
CFM-MPA.63.01 Operator does not meet site requirements when parking	2.16
CFM-CPA.11.21 Operator fails to see signage installed to standard	2.16
CFM-LPV.44.02 Operational personnel do not maintain minimum standards for berms, windrows and other zone protection.	1.72
CFM-CPA.10.20 Operators of heavy and light vehicles (or pedestrians) fail to follow the designated travel path	1.72
CFM-CPA.11.02 Impaired or inattentive operator operates mobile equipment	1.72
CFM-MPA.72.01 Access control infrastructure is inadequate	1.29
CFM-MDA.61.01 Reducing vehicle interactions by maintaining clearances is inadequately considered routine work planning	0.86
CFM-MPA.63.02 Vehicle operator does not check pathway after being parked	0.86
CFM-SRA.87.10 Equipment faults arising from poor standard of maintenance	0.86
CFM-MPA.72.02 Operational access control (pedestrian and vehicle) is inadequate	0.86
CFM-EDA.21.10 Equipment or Component Design is not error tolerant	0.43
CFM-SPA.83.01 Operator fails to comply with site requirements	0.43
CFM-MDA.61.06 Inadequate work planning means that heavy vehicle operators approach fixed structures that are incidental to achieving operational outcomes	0.43
CFM-LDA.43.01 Vehicle parking, including emergency parking is inadequately considered in mine design and routine work planning	0.43
CFM-LPV.41.20 Loading requirements for vehicles inadequately considered in mine design, equipment selection and work planning	0.43
CFM-CTA.10.90 Personnel do not alert others to presence of hazards	0.43
CFM-CTA.11.01 Supervisor does not identify or act when operator is fatigued or intoxicated	0.43

Credible Failure Mode	Percentage
CFM-LDV.42.20 Reducing vehicle interactions through intersection design and traffic rules is inadequately considered in mine design and routine work planning	0.43
CFM-SDA.83 Organisation Work Scheduling and Planning is inadequate	0.43
CFM-SDA.86 Work Environment and Work Demands result in Fatigued Mobile Equipment Operators or other Health Affects	0.43
CFM-EPV.26.10 Routine or occasional overloading of vehicles	0.43

Table - 3 – Percentage of Incidents for missing or ineffective Business Inputs

Business Input	Percentage
BI-CPA.04.11 Site clearance requirements and processes for accurately estimating distances - information prepared for Operators	32.20
BI-CPA.04.10 Site specific travelling speed information prepared for vehicle operators	5.76
BI-CPA.03.01 Trained, Competent and Authorised Mobile Equipment Operators	5.76
BI-LPA.57.01 Mobile equipment operators follow road rules and adjust based on conditions and circumstances.	5.42
BI-ERA.32.01 Operator pre-start checks include safety and operational components	4.41
BI-CPA.04.06 Tyre hazard awareness for all personnel.	3.05
BI-CPA.04.13 Minimum requirements for parking in any situation - information prepared for operators	3.05
BI-EPA.31.01 Maintenance of safety and operational systems on mobile equipment	2.37
BI-CPA.04.01 General features by vehicle type - information prepared for operators	2.37
BI-MPA.76 Safe and Productive Movement of Loads	2.03
BI-LPA.42.20 Infrastructure protection using barriers or warning devices.	2.03
BI-ERA.31.08 Inspection and maintenance of mobile equipment key systems, brakes, steering, and wheel assemblies	2.03
BI-CPA.04.16 Minimum requirements for windrows (bunds) - information prepared for operators	1.69
BI-CPA.04.02 Sight lines and blind spots by vehicle type - information prepared for vehicle operators	1.36
BI-CDA.09.01 Fit for work processes with specific advice on self-management	1.36
BI-MRA.72.01 Controlled Access to Operational Areas	1.36
BI-LRA.41.10 Construction, inspection, and maintenance of site infrastructure and fixed plant	1.36
BI-LDA.41.01 Road design guidelines set minimum standards for the construction and maintenance of the road network	1.36
BI-LPA.42.04 Lighting, delineation and signs are installed and maintained to standards that meet minimum site road design requirements.	1.36
BI-LPV.56.01 Road surface changes are identified and managed by vehicle operators	1.02
BI-EPA.26 Fit-for-purpose equipment selection and Introduction to Site processes	1.02
BI-EDA.22.01 Specifications for operator displays	1.02
BI-MPV.64.02 Around vehicle inspection or use of spotters to identify hazards before moving	1.02

Business Input	Percentage
BI-MDV.65.31 Clear requirements for loading and unloading of trucks by excavator or loader	1.02
BI-ERA.31.02 Inspection and maintenance of mobile equipment cabin integrity, restraints, access and escape, auto shutdowns and other relevant protective systems.	1.02
BI-CPA.09.01 Site fatigue management processes are comprehensive and optimise work rosters	0.68
BI-MPV.61.01 Vehicle interactions are considered during short-term planning processes	0.68
BI-LDV.43 Road design guidelines specify minimum parking area requirements	0.68
BI-CRA.11.01 Supervisors and trainers provide clear performance management expectations by role	0.68
BI-CRA.09.21 Fatigue alert alarms	0.68
BI-CPA.04.15 Minimum requirements for hazard notification and demarcation - information prepared for operators	0.68
BI-LTA.56 Formal processes for managing changes in conditions	0.68
BI-CPA.02 Onboarding, orientation, and general induction processes	0.68
BI-SPA.82.11 Comprehensive fitness for work processes	0.68
BI-SPA.88.02 Site change management processes apply to changes in road networks and traffic flows	0.68
BI-MPV.64.01 Pedestrian working in operational area communication and operating protocols	0.68
BI-SPA.86 Hazard and incident reporting and response processes are in place, effective, and well used.	0.68
BI-EDA.26.05 Standards that set minimum requirements for cabin integrity, restraints, access and escape, auto shutdowns and other relevant protective systems	0.68
BI-CPA.04.14 Managing road works, including grader operations - information prepared for operators	0.34
BI-CDA.03 There is an appropriate and up-to-date training management system	0.34
BI-MDV.63.05 Established requirements for parking and resting in vehicles	0.34
BI-CPA.05.01 Skilled and experienced personnel are accountable for maintaining mobile equipment	0.34
BI-SDA.95.50 Consultation and Engagement with Regulators and Third Parties	0.34
BI-CPV.08 Protocols for site induction and operating areas access	0.34
BI-EDA.29.01 Mobile equipment operator interfaces consider ergonomics and cognitive loading	0.34
BI-MPV.65.02 Road demarcation for changing conditions, commissioning, and live testing	0.34
BI-CRA.09.22 Fatigue status data send	0.34

Business Input	Percentage
BI-SPV.81.05 Clear accountabilities for managers, superintendents, and supervisors in site relevant road design guidelines and traffic management plans	0.34
BI-SDA.86.02 Risk and Control Management for Routine Tasks in a non-standard or changing work setting.	0.34
BI-SPV.82.01 Traffic Management Plan consultation and communication	0.34
BI-ERA.31.04 Inspection and Maintenance of Mobile Equipment alarms, monitors, cameras, and other warning devices.	0.34
BI-SPV.81.10 Clear accountabilities for designers, surveyors, engineers, and planners in site relevant management plans	0.34