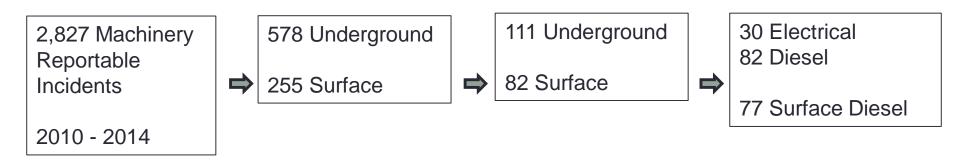
MOBILE EQUIPMENT SOUTH AFRICA

Interaction Risk – Incident Review

An analysis carried out on reportable incidents provided by the office of the DMR

6th May 2015





Remove incidents that were not TMM related

- Rail
 - Non mechanised

Remove incidents that were out of scope for Collision Management

- Hurt hand installing roofbolt
- Slipped accessing machine

Further split

- UG Elect/Diesel
- Surface Electric

Final incidents evaluated using limited data in the reports 'Very subjective'

UNDERGROUND MOBILE EQUIPMENT

SAMRAS Codes

• Data compiled from DMR reportable incidents 2010 to 2014

SAMRAS	Vahiala	Incid	ents
SAIVIKAS	Vehicle	Electric	Diesel
		30	82
0308B1	LHD Unit	0	54
0311A1	Roofbolter	7	0
0306B1	Mechanical miners	9	0
0308A1	Shuttle car	14	0
0309A2	LDV	0	14
0305A1	Tractor	0	11
0309B1	Bus	0	1
0309B2	Personnel transporter	0	2

Incident Count

Interactor	Object Code
LDV	UME_SDV
LHD Unit	UME_MUE
Shuttle Car / Hauler	UME_PRI
Continuous Miner	UCE_PCE
Tractor	UME_MUE
Roofbolter	UME_SEC
Bus	UME_SDV

Local **Remote Object** Object Code UME SEC UME MUE UME SDV UCE PCE UCE RCE UME PRI USP FSP USP TSP USP PSP OBS PER VOID UME PRI UME_SEC UME_MUE UME_SDV UCE_PCE UCE_RCE USP_FSP USP_TSP USP_PSP PER

N=112

Risk Exposure

Interactor	Object Code
LDV	UME_SDV
LHD Unit	UME_MUE
Shuttle Car / Hauler	UME_PRI
Continuous Miner	UCE_PCE
Tractor	UME_MUE
Roofbolter	UME_SEC
Bus	UME_SDV

			Con	sequence Lev	vel		
		Insignificant	Minor	Moderate	High	Major	Time Frame
	Almost Certain	11 (M)	16 (S)	20 (S)	23 (H)	25 (H)	<1 year
pc	Likely	7 (M)	12 (M)	17 (S)	21 (H)	24 (H)	1-3 yrs
Likelihood	Possible	4 (L)	8 (M)	13 (S)	18 (S)	22 (H)	3-10 yrs
Γİ	Unlikely	2 (L)	5 (L)	9 (M)	14 (S)	19 (S)	10-30 yrs
	Rare	1 (L)	3 (L)	6 (M)	10 (M)	15 (S)	>30 yrs

Local Object						Remote	Object					
Object Code	UME_PRI	UME_SEC	UME_MUE	UME_SDV	UCE_PCE	UCE_RCE	USP_FSP	USP_TSP	USP_PSP	PER	OBS	VOID
UME_PRI					18 (S)					21 (H)	13 (S)	
UME_SEC										18 (S)		
UME_MUE			18 (S)			14 (S)				21 (H)	18 (S)	21 (H)
UME_SDV		18 (S)		13 (S)						18 (S)	24 (H)	9 (M)
UCE_PCE	14 (S)									21 (H)	13 (S)	
UCE_RCE												
USP_FSP												
USP_TSP												
USP_PSP												
PER												

Weighted Risk

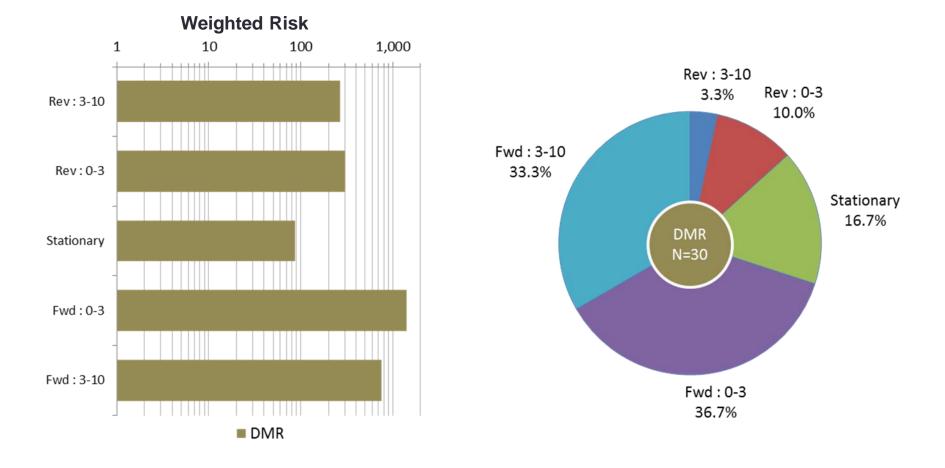
Interactor	Object Code
LDV	UME_SDV
LHD Unit	UME_MUE
Shuttle Car / Hauler	UME_PRI
Continuous Miner	UCE_PCE
Tractor	UME_MUE
Roofbolter	UME_SEC
Bus	UME_SDV

		V	Veighted Risk		
PxExSxN		Exposure x N	lumber of Pe	rsons (ExN)	
FALASAN	1	3	10	30	100
Probability			Severity (S)		
(P)	0.1	0.3	1	3	10
10	1	9	100	900	10000
3	0.3	2.7	30	270	3000
1	0.1	0.9	10	90	1000
0.3	0.03	0.27	3	27	300
0.1	0.01	0.09	1	9	100

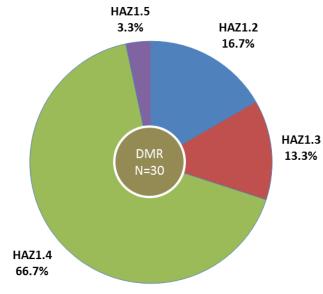
Local **Remote Object** UCE RCE Object Code UME PRI UME SEC UME MUE UME SDV UCE PCE USP FSP USP TSP USP PSP PER OBS VOID UME PRI UME_SEC UME_MUE UME_SDV UCE_PCE UCE_RCE USP_FSP USP_TSP USP_PSP PER

ELECTRIC UME

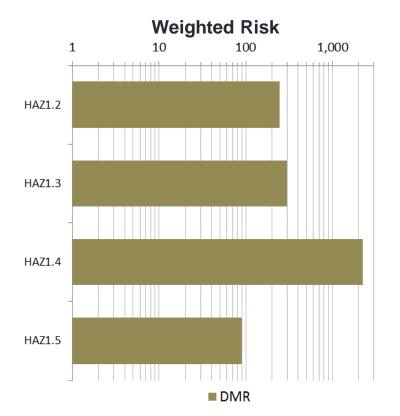
UG Electric - Local Object Speed

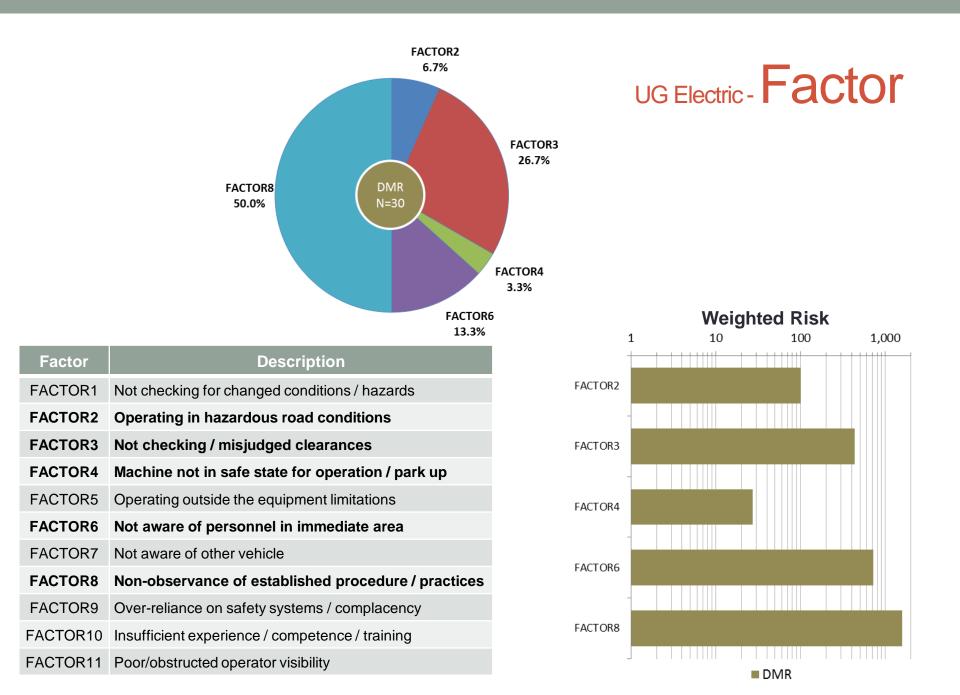


Hazard	Description
HAZ1.1	Stationary object in interaction zone
HAZ1.2	Potential hazard of another vehicle
HAZ1.3	Loss of control of vehicle
HAZ1.4	Moving into another vehicle's interaction zone
HAZ1.5	Machine left in unstable / unsafe state
HAZ1.6	Person in interaction zone
HAZ1.7	Falling object



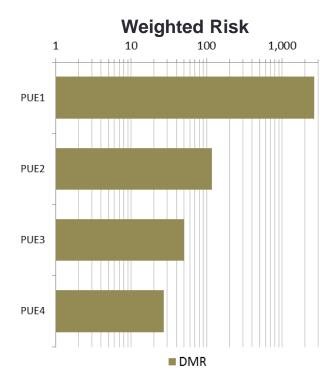
UG Electric - Hazard

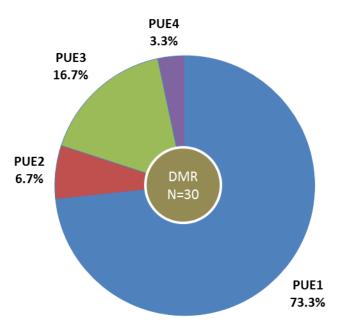




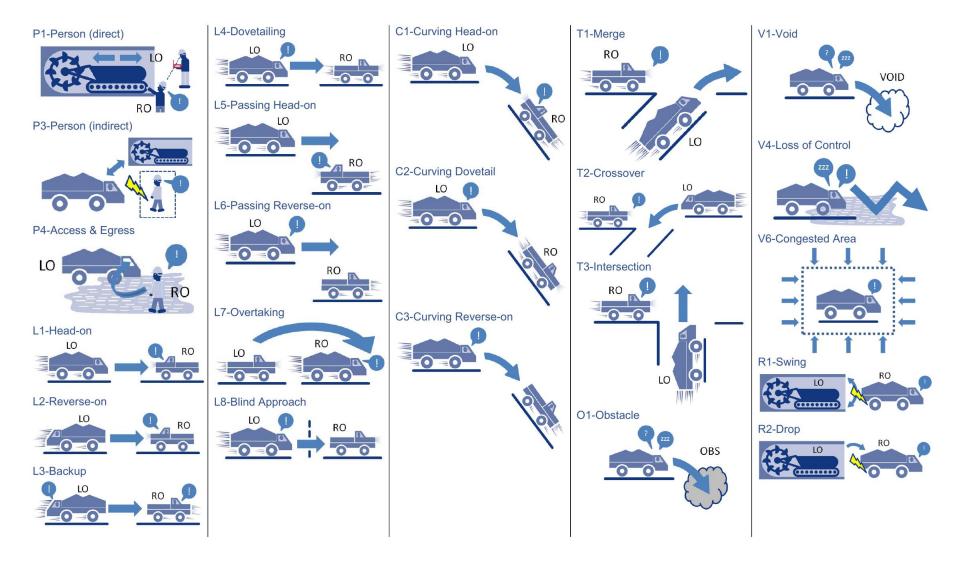
UG Electric - Unwanted Event

PUE	Object Code
PUE1	Equipment to Person Interaction
PUE2	Equipment to Equipment Interaction
PUE3	Equipment to Infrastructure Collision
PUE4	Uncontrolled Equipment / Attachment
PUE5	Equipment in Unstable Ground

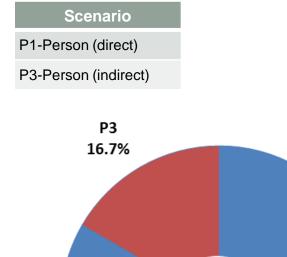




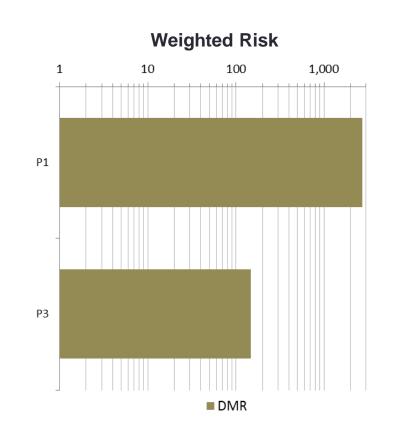
UG Electric - Scenarios



UG Electric - Scenarios



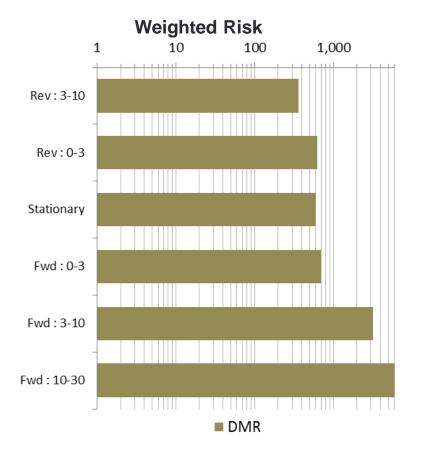
DMR N=30

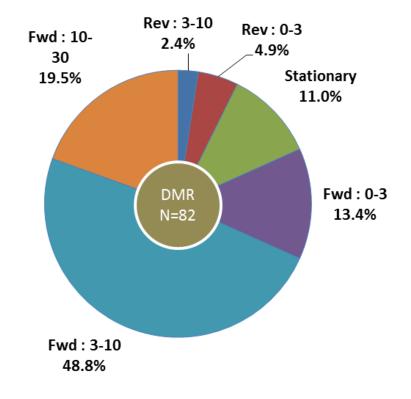


P1 83.3%

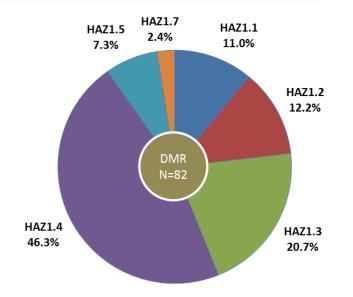
DIESEL UME

UG Diesel - Local Object Speed

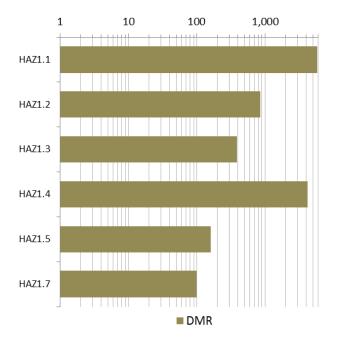




Hazard	Description
HAZ1.1	Stationary object in interaction zone
HAZ1.2	Potential hazard of another vehicle
HAZ1.3	Loss of control of vehicle
HAZ1.4	Moving into another vehicle's interaction zone
HAZ1.5	Machine left in unstable / unsafe state
HAZ1.6	Person in interaction zone
HAZ1.7	Falling object

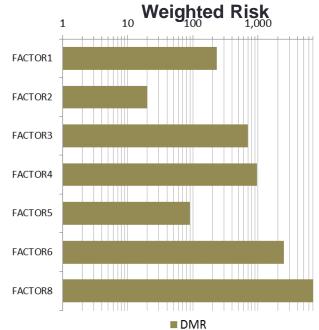


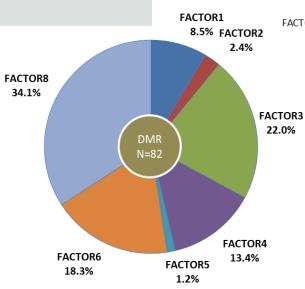
Weighted Risk



Factor	Description
FACTOR1	Not checking for changed conditions / hazards
FACTOR2	Operating in hazardous road conditions
FACTOR3	Not checking / misjudged clearances
FACTOR4	Machine not in safe state for operation / park up
FACTOR5	Operating outside the equipment limitations
FACTOR6	Not aware of personnel in immediate area
FACTOR7	Not aware of other vehicle
FACTOR8	Non-observance of established procedure / practices
FACTOR9	Over-reliance on safety systems / complacency
FACTOR10	Insufficient experience / competence / training
FACTOR11	Poor/obstructed operator visibility

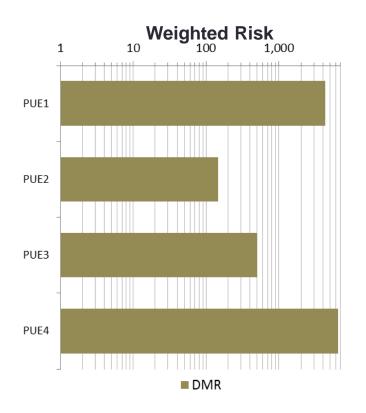


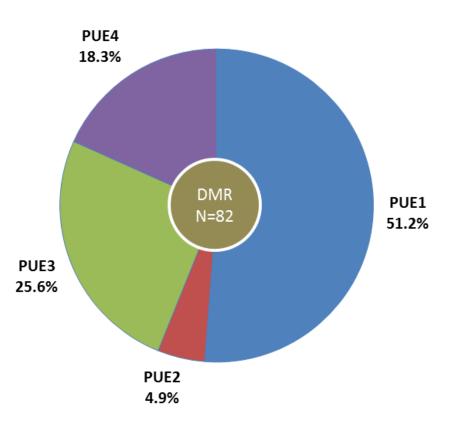




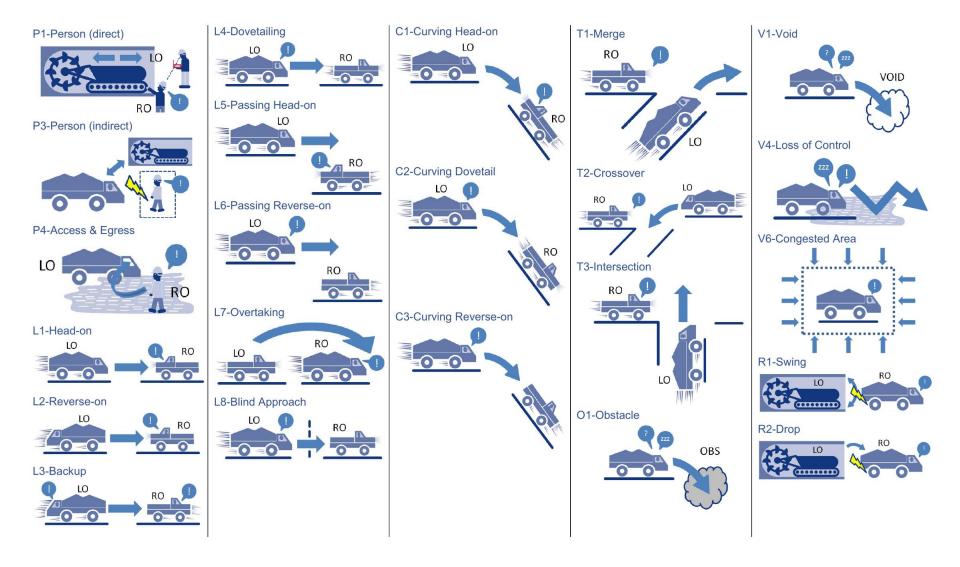
UG Diesel - Unwanted Event

PUE	Object Code
PUE1	Equipment to Person Interaction
PUE2	Equipment to Equipment Interaction
PUE3	Equipment to Infrastructure Collision
PUE4	Uncontrolled Equipment / Attachment
PUE5	Equipment in Unstable Ground





UG Diesel - Scenarios



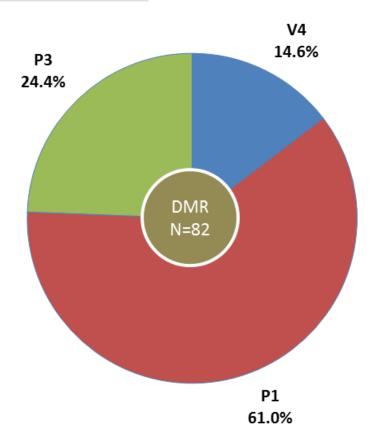
UG Diesel - Scenarios

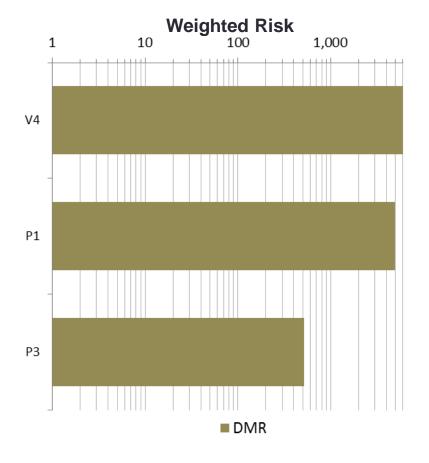


V4-Loss of Control

P1-Person (direct)

P3-Person (indirect)





SURFACE MOBILE EQUIPMENT

SAMRAS Codes

• Data compiled from DMR reportable incidents 2010 to 2014

SAMRAS	Vehicle	Incidents
		77
0308C3	20-99 ton Haultruck	24
0307C1	Excavator	4
0307F1	Front end loader	12
0309A2	LDV	11
0309C1	Trucks (excluding haultruck)	8
0310A1	Mobile crane	1
0308C4	100-199 ton Haultruck	6
0308C5	200-299 ton Haultruck	5
0308C6	>300 ton Haultruck	2
0312A1	Bulldozer	4

Incident Count

Interactor	Object Code
Haul Truck	SME_PRI
Wheel Loader	SME_SEC
ADT	SME_SEC
LDV	SME_SDV
Hydraulic Excavator	SME_PCE
Service Truck	SME_SEC
Track Dozer	SME_SEC

												IN-77
Local Object		Remote Object										
Object Code	SME_PRI	SME_SEC	SME_RTV	SME_SDV	SCE_PCE	SCE_RCE	SSP_FSP	SSP_TSP	SSP_PSP	PER	OBS	VOID
SME_PRI	3	0	0	3	0	0	0	0	0	7	10	6
SME_SEC	1	4	0	1	0	0	0	1	0	11	9	6
SME_RTV	0	0	0	0	0	0	0	0	0	0	1	0
SME_SDV	0	0	0	1	0	0	0	0	0	6	3	1
SCE_PCE	0	0	0	0	0	0	0	0	0	2	0	1
SCE_RCE	0	0	0	0	0	0	0	0	0	0	0	0
SSP_FSP	0	0	0	0	0	0	0	0	0	0	0	0
SSP_TSP	0	0	0	0	0	0	0	0	0	0	0	0
SSP_PSP	0	0	0	0	0	0	0	0	0	0	0	0
PER	0	0	0	0	0	0	0	0	0	0	0	0

N=77

Risk Exposure

Interactor	Object Code
Haul Truck	SME_PRI
Wheel Loader	SME_SEC
ADT	SME_SEC
LDV	SME_SDV
Hydraulic Excavator	SME_PCE
Service Truck	SME_SEC
Track Dozer	SME_SEC

			Con	isequence Lev	vel		
		Insignificant	Minor	Moderate	High	Major	Time Frame
	Almost Certain	11 (M)	16 (S)	20 (S)	23 (H)	25 (H)	<1 year
pc	Likely	7 (M)	12 (M)	17 (S)	21 (H)	24 (H)	1-3 yrs
Likelihood	Possible	4 (L)	8 (M)	13 (S)	18 (S)	22 (H)	3-10 yrs
Γİ	Unlikely	2 (L)	5 (L)	9 (M)	14 (S)	19 (S)	10-30 yrs
	Rare	1 (L)	3 (L)	6 (M)	10 (M)	15 (S)	>30 yrs

Local Object						Remote	Object					
Object Code	SME_PRI	SME_SEC	SME_RTV	SME_SDV	SCE_PCE	SCE_RCE	SSP_FSP	SSP_TSP	SSP_PSP	PER	OBS	VOID
SME_PRI	22 (H)		-	22 (H)						18 (S)	21 (H)	21 (H)
SME_SEC	13 (S)	18 (S)		14 (S)				18 (S)		21 (H)	18 (S)	18 (S)
SME_RTV											13 (S)	
SME_SDV				13 (S)						18 (S)	22 (H)	13 (S)
SCE_PCE										18 (S)		13 (S)
SCE_RCE												
SSP_FSP												
SSP_TSP												
SSP_PSP												
PER												

Weighted Risk

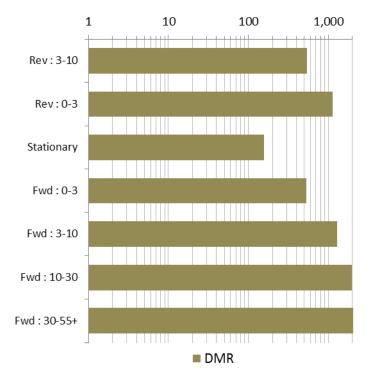
Interactor	Object Code
Haul Truck	SME_PRI
Wheel Loader	SME_SEC
ADT	SME_SEC
LDV	SME_SDV
Hydraulic Excavator	SME_PCE
Service Truck	SME_SEC
Track Dozer	SME_SEC

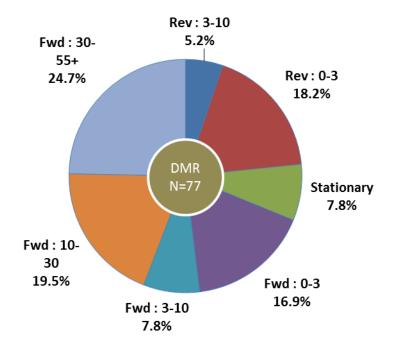
		V	Veighted Risk	(
PxExSxN		Exposure x N	lumber of Pe	rsons (ExN)	
PXEXSXIN	1	3	10	30	100
Probability			Severity (S)		
(P)	0.1	0.3	1	3	10
10	1	9	100	900	10000
3	0.3	2.7	30	270	3000
1	0.1	0.9	10	90	1000
0.3	0.03	0.27	3	27	300
0.1	0.01	0.09	1	9	100

Local **Remote Object** SME_PRI SME_SEC SME_RTV SME_SDV SCE PCE SCE RCE SSP_FSP SSP_PSP OBS **Object Code** SSP_TSP PER VOID SME PRI SME_SEC SME_RTV SME_SDV SCE_PCE SCE_RCE SSP_FSP SSP_TSP SSP_PSP PER

Surface Diesel - Local Object Speed

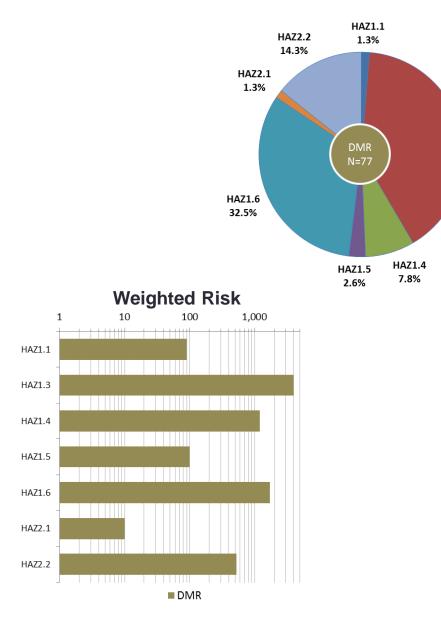
Weighted Risk





Surface Diesel - Hazard

HAZ1.3 40.3%

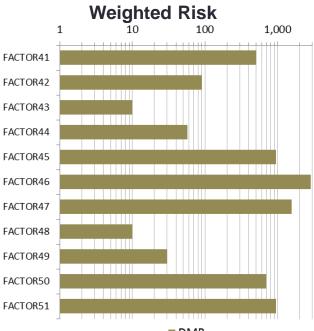


Hazard	Description
HAZ1.1	Stationary object in interaction zone
HAZ1.2	Potential hazard of another vehicle
HAZ1.3	Loss of control of vehicle
HAZ1.4	Moving into another vehicle's interaction zone
HAZ1.5	Machine left in unstable / unsafe state
HAZ1.6	Person in interaction zone
HAZ2.1	Falling object
HAZ2.2	Unstable / uneven ground / void / no-go area
HAZ3.1	Energised cable

Factor	Description
FACTOR41	Non-compliance of standard
FACTOR42	Insufficient guarding / protection
FACTOR43	Competence for operating equipment
FACTOR44	Area / vehicle inspection inadequate
FACTOR45	Positioned in the line of fire
FACTOR46	Driver fatigue / alertness / incapacity
FACTOR47	Driver distraction or lack of awareness
FACTOR48	Operating outside equipment limitations
FACTOR49	Not checking / misjudged clearances
FACTOR50	Deviation from standards and procedures
FACTOR51	Behaviour of operator

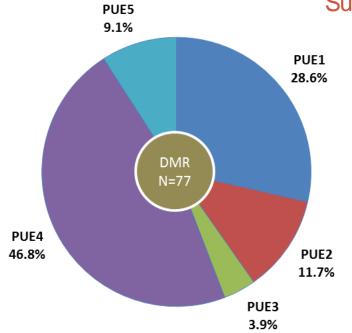
FACTOR41 FACTOR42 FACTOR51 11.7% 1.3% 16.9% FACTOR43 1.3% FACTOR44 FACTOR50 5.2% 15.6% DMR FACTOR45 18.2% FACTOR49 3.9% FACTOR48_ FACTOR47 FACTOR46 1.3% 9.1% 15.6%

Surface Diesel - Factor

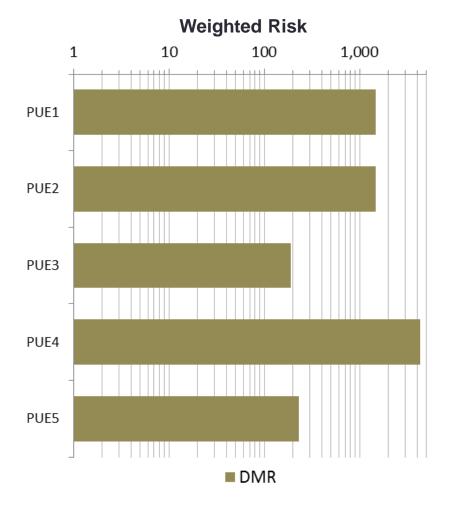




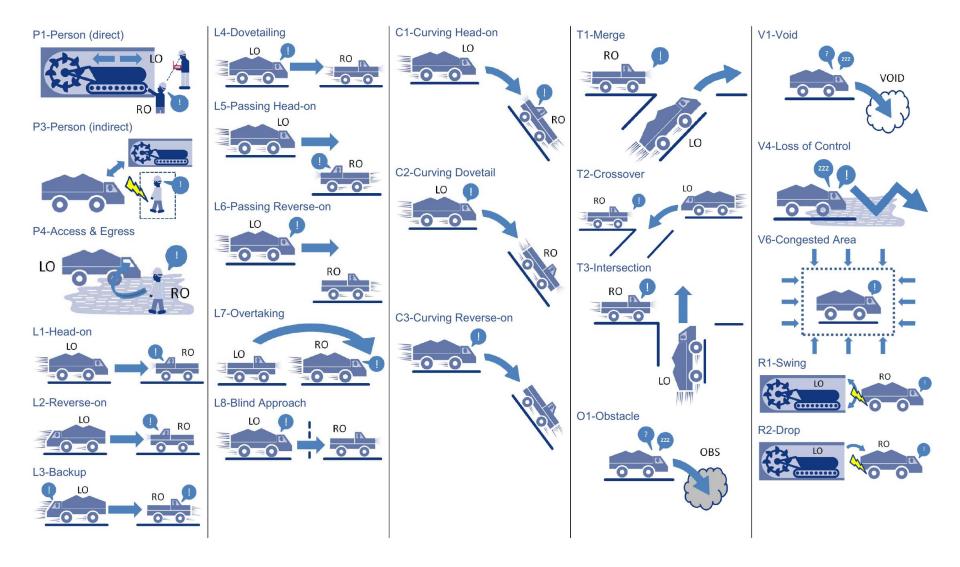
Surface Diesel - Unwanted Event



PUE	Object Code
PUE1	Equipment to Person Interaction
PUE2	Equipment to Equipment Interaction
PUE3	Equipment to Infrastructure Collision
PUE4	Uncontrolled Equipment / Attachment
PUE5	Equipment in Unstable Ground



Surface Diesel - Scenarios



Surface Diesel - Scenarios

Scenario

L2-Reverse-on

L4-Dovetailing

L5-Passing Head-on

V1-Void

V4-Loss of Control

O1-Obstacle

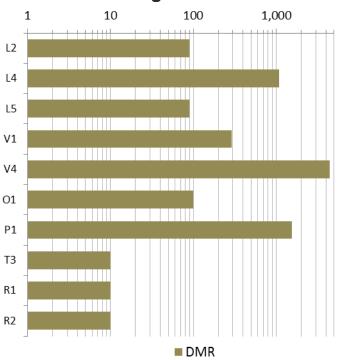
P1-Person (Direct)

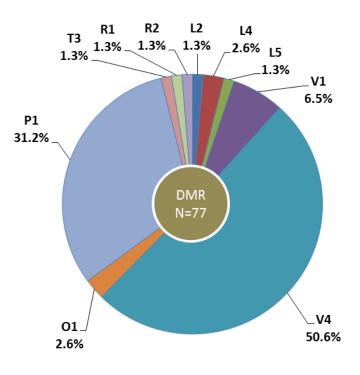
T3-Intersection

R1-Swing

R2-Drop

Weighted Risk





THANK YOU