SAFE MOBILE PLANT- we can make a difference.

4th. Atlantic Alliance Conference

Germany April 2007

Rory Graham

We can make a difference!

1. Brief summary of how we got to where we are now.
2. What the latest situation seems to be.
3. Looking forward: What still needs to be addressed to improve safety on Plant.

Quick Recap of Background.

Year 2000. Industry introduced Hard target 50% reduction in Injury incidents. .

Working Party set up in June 2003 by QNJAC:

- Cleaning
- Maintenance
- Inspection
- USE of mobile plant

January 2004 Duxford meeting with a few Manufacturers to discuss Access problems.

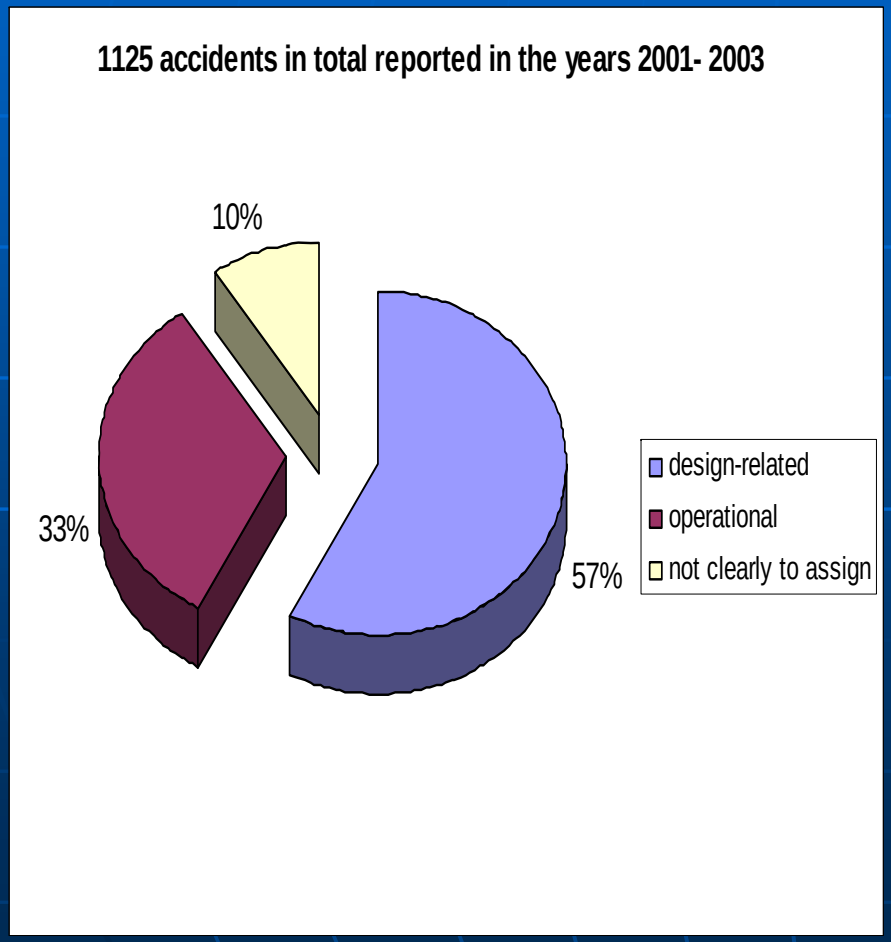
- Somerset April 2004 AIM: Users to agree on safety standards on machines.

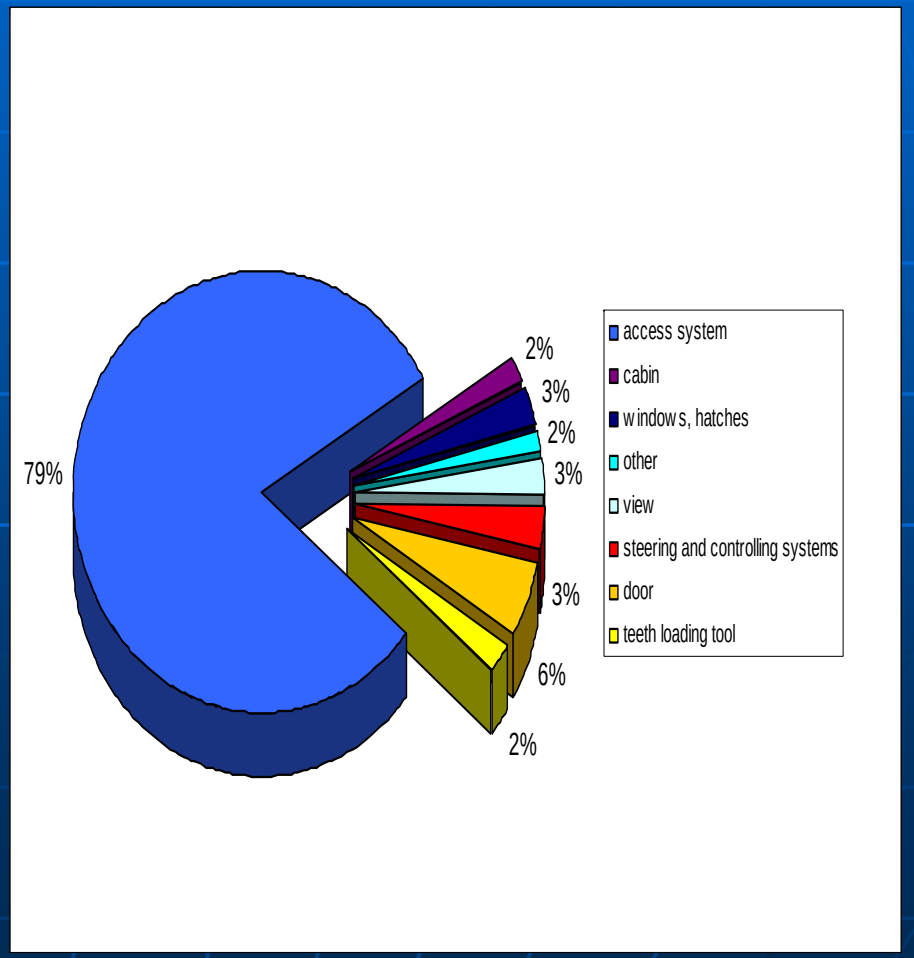
The Facts become clearer.

- Mid 2004 The FACTS: Mathius Konnecks/ Helmut Ehnes presentation to the QNJAC with the St BG. study.
- 57% of incidents design related.
- 79% of these related to Access systems
- Design related incidents occur 1.7 X more often than operational accidents
- Sweden, Australia and others confirmed access causing injury incidents.

Note: (Study from Department of Surface & International Miming and Inst. Of Mining Clausthal Univ.of Technology).

You may remember the pie charts





The Manufacturers Issues.

- QNJAC working party meetings in 2005/6.
- Manufactures and Suppliers saying:

1. machines comply with agreed ISO standards.
2. Users need to make up their minds on what safety specifications are wanted.
3. Why not raised before? Why not participated in the meetings on standards?
4. It takes 5 years min. from design to production?
5. No other countries complaining.
6. If we don't know how the injuries are being caused how can we change the design?

The Users Issues

- First:

1. Court cases by HSE for Machines not complying with UK Law.
2. Increased compensation for Injured workers.
3. Insurance premiums rising.
4. Pressure to meet ‘Hard Target’
5. Felt manufacturers were using ISO standards as maximum deliverable.
6. Few retrofit modifications
7. Concern for injured staff.
8. Felt manufacturers' not in tune with Industries complete change in safety culture

The Users Issues

- Secondly:
- Fair and reasonable to expect Users to agree on standardised Mobile plant specifications on major plant Excavators: Dumpers: Wheeled loaders: and Dump Trucks.

Draft example of Industry Specification

Mobile Plant Specification Working Group								
Rigid Dump Trucks	**PF**	**RG**	**SW**	**Geraint Morris Lafarge**	**CH**	**PR**	**JP**	**Total**
TEMPLATE								
COLOUR REVERSING CAMERA	2	2	2	2	2	2	2	14
SENSOR VISION REAR SAFETY SYSTEM	1	2	1	0	1	1	2	8
VMS RADAR BRAKING SYSTEM	0	0	2	0	0	1	1	4
All round heated mirror visibility package					2			2
HEATED CONVEX MIRRORS	0	2	0	1	0	0	2	5
ADDITIONAL CONVEX MIRRORS	2	2	2	2	0	2	2	12
FRONT VIEW MIRROR	2	2	2	2	0	2	2	12
AMBER FLASHING ROTATING BEACON	2	2	2	2	2	2	2	14
BRIGADE WHITE NOISE ALARM (BBS102)	0	2	2	2	2	2	2	12
BRIGADE SMART ALARM (SA917)	0	2	0	0	1	0	1	4
STANDARD REVERSE ALARM	2	0	0	0	0	2	0	4
AUTOMATIC FIRE SUPPRESSION SYSTEM	2	2	0	1	1	1	1	8
MANUAL FIRE EXTINGUISHER IN CAB	1	0	2	2	2	2	2	11
FRONT RADIATOR HANDRAIL	2	2	2	2	2	2	2	14
Cab Access handrails & Walkway					2			2
SEAT BELT WARNING DEVICE (Visual/Audible)	2	0	2	2	2	2	1	11
SKIP UP WARNING DEVICE (Audible)	2	2	2	2	2	2	2	14
STROBE REVERSE LIGHTS	0	0	2	2	2	2	2	10
Heppa Cab air filters					2			2
KEEP YOUR DISTANCE SIGNS	1	1	2	2	0	2	1	9
IN-BUILT SIMERET METER	0	2	1	1	0	2	1	7
SEAT ACTIVATED ENGINE SHUT-DOWN	0	1	1	1	1	1	1	6
RED & WHITE SAFETY CHEVRONS	1	1	2	2	2	2	2	12
AUTOLUBE SYSTEM	0	2	2	2	2	2	2	12
QUICK EVAC OIL CHANGE SYSTEM	0	1	1	0	1	2	1	6

The Users Issues

- Thirdly:

1. Need to obtain **International** agreement of Users safety concerns.
2. Atlantic Alliance Florida 2005:
3. Decision; Drew up with QNJAC a letter to all CEO's of major mobile plant manufacturers world wide to express the Industries concerns and requirements.
4. It has made a difference!

Where are we now?

- ISO 2867 being updated to 6th edition (from 1994 version) by Technical Committee ISO/TC 127 Earth-moving machinery – Access systems.
- Users have been invited to take part (invitation has always been there but not taken up) Our requests have been considered seriously, and changes have been proposed with ‘SOME’ success.

Access systems

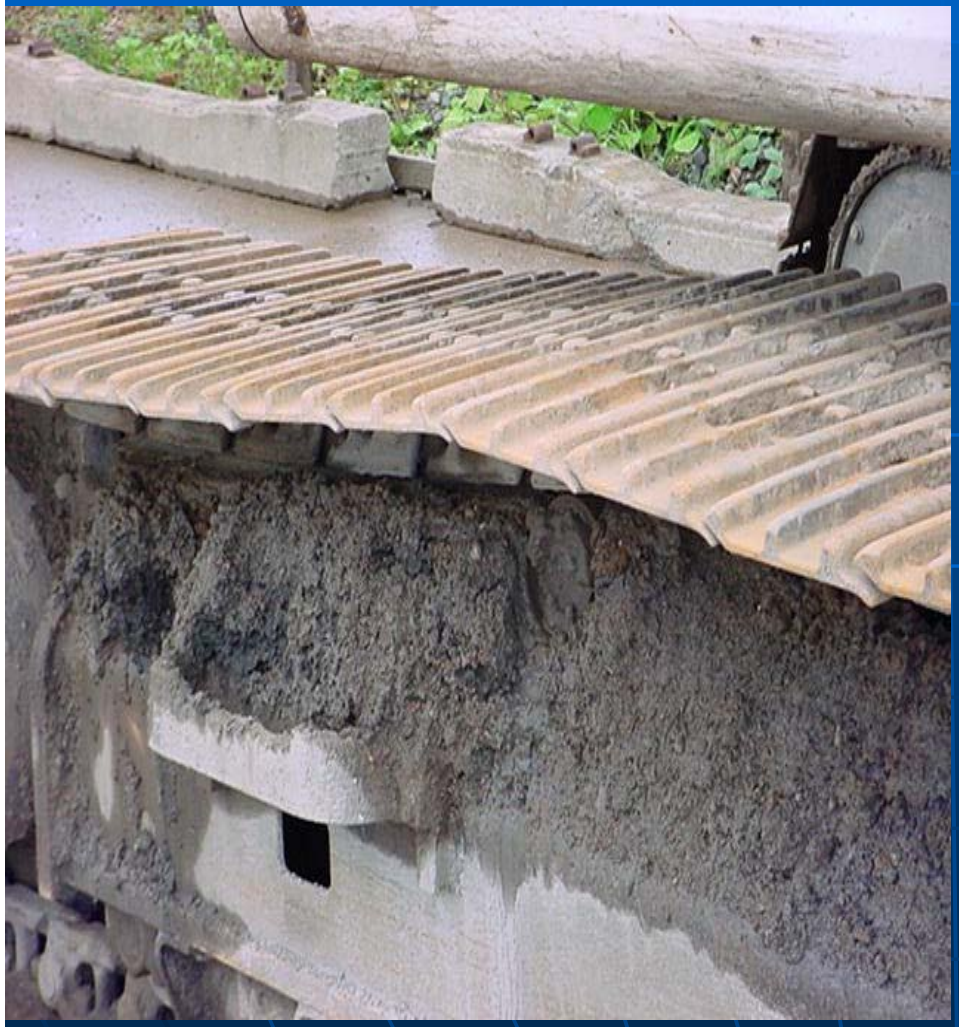
Asked for:

1. Access to cab Always via inclined stairway no steeper than 80
2. Round steps should not be used.
3. Not to use tracks or track pads as part of access

Proposed:

1. ‘When possible’ use stairways or use inclined ladders at an angle of 75 to 80 degrees instead of vertical ladders
2. ‘Round steps should not be used’.(circular tread depth Min19 max 60mm for ladders!)
3. ‘ when possible’ do not use track surface: Track shoe and pads accepted if 3 point support is provided: Use continuous handrail if using tracks max reach to handrails 750mm: Make evaluation in design to damage potential and masking to visibility. (a single step can be recessed on a track frame): If damage likely- replacement of access system should be easy.

Reason why tracks should not be used as access.



Access systems

Asked for:

1. Access to wheeled loaders via rear of machine where practical. For rigid dumpers stairway should traverse the front of the vehicle
2. FIRST step, same height off ground as other step risers approx 200mm.
3. First step RIGID or FIXED and made retractable.

Proposed:

1. Up to 3 steps can be vertical. Vertical ladders acceptable up to 2m (1m preferred) Inclined ladders to a height of 3m(1.8m preferred) Stairways to 6m (3m preferred).
2. For ladders steps and stairways basic height above ground 400mm max.600.mm
3. Flexible steps can move up to 80mm in any plane backwards or sideways if force 250N applied.

First step THE important step

Retractable Access systems

- Asked for

1. Retractable systems to be interlocked so machine can’t move with them down.
2. Designed so as not to trap hands when activated.
3. Have over ride system to lower or raise if power lost.

- Proposed

1. Will be interlocked.
2. Power actuated access systems will have a secondary means of egress if power lost.
3. Powered by a ‘’hold to operate control’
4. Operator to have direct visibility from control location
5. If access systems move operator must comply with ISO 20474-1

Access systems

Asked for:

1. **Handrails to be continuous**
2. **No grab irons on movable covers / hatches.**

Proposed:

1. **Continuous handrails preferred. Handrails and Handholds 'intuitive'.**
2. **If grab iron located on a cover it must have a redundant attachment latch to prevent movement of the cover.**

Access systems

Asked for:

1. **Access to the cab needs to be from a position of safety either from the ground or from a guard railed platform.**

Proposed:

1. **The cab door can still be opened from access steps but, the door 'should open and close without infringing on the operator, while standing with three points of contact (door not considered a point of contact.)**

This will still be acceptable.

Alternative Access System.

- Asked for

1. Emergency or 2nd exit on opposite side to stairway into cab. Vertical steps OK. Exit door clearly marked ‘For emergency only’

- Proposed

1. 2nd exit on a different location to the primary access if above 2m. Vertical ladders OK if height MORE than 2m. And lower step can be max 700mm high.
2. Exit path if not obvious it shall be identified.

Falls from Height.

- Asked for

1. Machines compliant with working at height regulations

- Proposed

1. Stairs and platforms ‘greater than 2 M. shall be provided with guardrails to the open side..’
2. Guardrails provided if platform or walkway is less than 1 M from the edge
3. Platforms less than 2M high of min width of 300m, if used for routine maintenance, only need grab irons or handrails.
4. Steps (d 240 w 320 min). can be used as platforms if less than 2M high.

This will still be acceptable.

- No need for Guardrail as:
- Platform less than 1 metre wide.
- Height less than 2 Metre high.
- Have handhold available but located on moving hatch cover.?

Lighting

- Asked for

1. Lights for access steps switched on from ground level

- Proposed

1. ‘Lights should be provided for access systems that are at a height of more than 2 m. Light activation shall be possible from ground level’

Visibility

- Asked for

1. Operator when seated at the driving position must be able to see an object 1m high and 1m out from side of machine.
2. UK will prosecute if higher than **1.5m** and 1m out

- Proposed

1. Not for ISO 2867.
2. ISO 5006 being updated Start up and working visibility will be 1.5mx1m blockages more than300mm shall be addressed by mirrors cameras etc.
3. Travelling visibility operator to see ground 12m radius from machine (24m for large machines) visibility aids to be fitted if blockages exceed the allowed criteria.

Maintenance

- Asked for

1. All standard maintenance functions such as re-fuelling, lubrication, greasing, radiator top up, drain down and reservoir sight glasses all from ground level especially re-fuelling.

- Proposed

1. Maintenance still under review.
2. Expect it to say: routine lubrication and maintenance designed to be carried out safely and design shall preferably permit lubrication and filling of tanks from the ground

Other safety & Health Issues

1. User friendly but effective seat belts to be fitted
2. Climate control in cab with dust filtration if operating in silicious environment.
3. Fire extinguisher system fitted
4. Steering control and ergonomic issues

1. EN 474 restraint systems ISO6683
2. Under ISO 10263. Standard states that cabs should be fitted with a contamination protective system if operating in an unhealthy environment.
3. If machine mass more than 1,500kgs then space for installing a fire extinguisher. New Project.
4. Come under ISO 10968:2004/6682 and 6011

Other safety & Health Issues

1. Noise to be compliant with new noise Regs. Ideally 5dB(A) below 1st action level i.e.75dB(A).
2. Need to Isolate all energy sources.
3. Whole Body Vibration to be compliant with Regs. Have a European standard for reporting data that users can understand

1. Not for ISO 2867 direct to manufacturers comes under ISO 6393/6
2. Under ISO 20474
3. Under ISO 25398 :Seating under EN ISO 7096:2000 Studies show an aggressive driver can increase vibration by 50% over competent operator on smooth ground. Many manufacturers introducing sophisticated dampening devices and excellent vibration information

Driving Down Vibration Booklet

- More detailed information about the EU Physical Agents Directive
- Vibration values for typical products and applications
- Three examples of how to calculate the vibration exposure
- Available in the EAME Sales Library, media number HEGQ3339

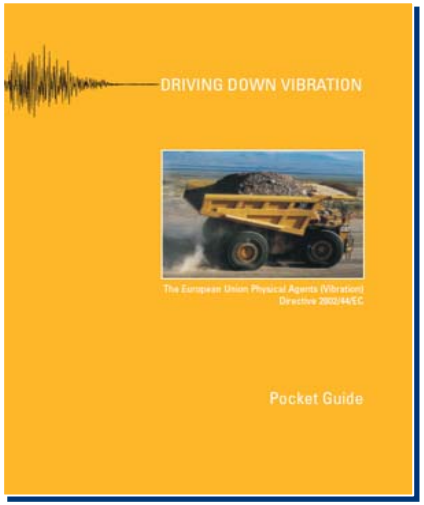


Table 2 TOTAL VIBRATION EXPOSURE POINTS ($P_{E\,tot}$) VALUES

Vibration level (with scenario factor applied) [m/s²]	0,1 (6 mins)	0,2 (12 mins)	0,5 (30 mins)	1 (60 mins)	2 (120 mins)	3 (180 mins)	4 (240 mins)	5 (300 mins)	6 (360 mins)	8 (480 mins)
2,5	31	63	156	313	625	937	1250	1563	1875	2500
2,4	29	58	144	288	576	864	1152	1440	1728	2304
2,3	26	53	132	265	529	794	1058	1323	1587	2116
2,2	24	48	121	242	484	726	968	1210	1452	1936
2,1	22	44	110	221	441	662	882	1103	1323	1764
2,0	20	40	100	200	400	600	800	1000	1200	1600
1,9	18	36	90	181	361	542	722	903	1083	1444
1,8	16	32	81	162	324	486	648	810	972	1296
1,7	14	29	72	145	289	434	578	723	867	1156
1,6	13	26	64	128	256	384	512	640	768	1024
1,5	11	23	56	113	225	338	450	563	675	900
1,4	10	20	49	98	196	294	392	490	588	784
1,3	8	17	42	85	169	254	338	423	507	676
1,2	7	14	35	72	144	216	288	360	432	576
1,1	6	12	30	61	121	182	242	303	363	484
1,0	5	10	25	50	100	150	200	250	300	400
0,9	4	8	20	41	81	122	162	203	243	324
0,8	3	6	16	32	64	96	128	160	192	256
0,7	2	5	12	25	49	74	98	123	147	196
0,6	2	4	9	18	36	54	72	90	108	144
0,5	1	3	6	13	25	38	50	63	75	100
0,4	1	2	4	8	16	24	32	40	48	64
0,3	0	1	2	5	9	14	18	23	27	36
0,2	0	0	1	2	4	6	8	10	12	16

Exposure Limit Value 529

Exposure Action Value 100

Exposure duration

Example 2 WHEEL LOADER AND TRACK EXCAVATOR
(Scenario: average vibration exposure)

Wheel loader
- normal working conditions (smooth terrain)
- experienced operator
- typical operating conditions
- v-shape motion (loading dumpers)
- duration, 4 hours

Track excavator
- typical operating conditions
- mining application
- duration: 3 hours

Look up the x, y and z axes vibration levels for the wheel loader and crawler excavator in Table 1. As this is an average vibration exposure scenario, no scenario factors are applied to the vibration level values.

Determine the P_E values (x, y and z) for the wheel loader and crawler excavator by using the exposure duration and vibration levels in Table 2 on page 14.

machine (working condition)	exposure duration	X axis vibration level	P_{Ex}	Y axis vibration level	P_{Ey}	Z axis vibration level	P_{Ez}
Wheel loader (V-shape motion)	4 hours	0,80 (use 1,0)	200	0,64 (use 0,8)	102	0,54 (use 0,6)	72
Track excavator (mining application)	3 hours	0,85 (use 0,7)	74	0,42 (use 0,5)	38	0,61 (use 0,7)	74
Total			274		200		146

Vibration Calculations

The vibration levels and exposure duration are used to determine the number of exposure points for each machine type.

Table 1 TYPICAL VIBRATION LEVELS ALONG THREE AXES

MACHINE FAMILY	MACHINE TYPE	TYPICAL OPERATING ACTIVITY	VIBRATION LEVELS			SCENARIO FACTORS		
			X axis [m/s²]	Y axis [m/s²]	Z axis [m/s²]	X axis [m/s²]	Y axis [m/s²]	Z axis [m/s²]
Excavator	Compact Track Excavator	excavating	0,33	0,21	0,19	0,19	0,12	0,10
		hydraulic breaker app.	0,49	0,28	0,36	0,20	0,13	0,17
		transfer movement	0,45	0,39	0,62	0,17	0,18	0,28
	Track Excavator	excavating	0,44	0,27	0,30	0,24	0,16	0,17
		hydraulic breaker app.	0,53	0,31	0,55	0,30	0,18	0,28
		mining application	0,65	0,42	0,61	0,21	0,15	0,32
		transfer movement	0,48	0,32	0,79	0,19	0,20	0,23
	Wheel Excavator	excavating	0,52	0,35	0,29	0,26	0,22	0,13
		transfer movement	0,41	0,53	0,61	0,12	0,20	0,19
Loader	Backhoe Loader	excavating	0,28	0,26	0,20	0,09	0,16	0,06
	Skid Steer Loader	load & carry motion	0,86	0,73	0,93	0,30	0,33	0,35
	Multi Terrain Loader	v-shape motion	1,21	1,00	0,82	0,30	0,84	0,32
	Track Loader	load & carry motion	0,89	0,67	0,52	0,12	0,16	0,10
		transfer movement	0,58	0,49	0,60	0,18	0,12	0,15
		v-shape motion	1,24	0,93	0,63	0,41	0,35	0,18
	Compact Wheel Loader	load & carry motion	0,94	0,86	0,65	0,27	0,29	0,13
	Wheel Loader	load & carry motion	0,84	0,81	0,52	0,23	0,20	0,14
		mining application	1,27	0,97	0,81	0,47	0,31	0,47
		transfer movement	0,76	0,91	0,49	0,33	0,35	0,17
		v-shape motion	0,99	0,84	0,54	0,29	0,32	0,14

machine (working condition)	exposure duration	X axis vibration level	P_{Ex}
Wheel loader (V-shape motion)	4 hours	0,99 (use 1,0)	200
Track excavator (mining application)	3 hours	0,65 (use 0,7)	74
Total			274

Table 2 TOTAL VIBRATION EXPOSURE POINTS ($P_{E\,tot}$) VALUES

Vibration level (with scenario factor applied) [m/s²]	0,1 (6 mins)	0,2 (12 mins)	0,5 (30 mins)	1 (60 mins)	2 (120 mins)	3 (180 mins)	4 (240 mins)	5 (300 mins)	6 (360 mins)	8 (480 mins)
2,5	31	63	156	313	625	937	1250	1563	1875	2500
2,4	29	58	144	288	576	864	1152	1440	1728	2304
2,3	26	53	132	265	529	794	1058	1323	1587	2116
2,2	24	48	121	242	484	726	968	1210	1452	1936
2,1	22	44	110	221	441	662	882	1103	1323	1764
2.0	20	40	100	200	400	600	800	1000	1200	1600
1,9	18	36	90	181	361	542	722	903	1083	1444
1,8	16	32	81	162	324	486	648	810	972	1296
1,7	14	29	72	145	289	434	578	723	867	1156
1,6	13	26	64	128	256	384	512	640	768	1024
1,5	11	23	56	113	225	338	450	563	675	900
1,4	10	20	49	98	196	294	392	490	588	784
1,3	8	17	42	85	169	254	338	423	507	676
1,2	7	14	36	72	144	216	288	360	432	576
1,1	6	12	30	61	121	182	242	303	363	484
1.0	5	10	25	50	100	150	200	250	300	400
0,9	4	8	20	41	81	122	162	203	243	324
0,8	3	6	16	32	64	96	128	160	192	256
0,7	2	5	12	25	49	74	98	123	147	196
0,6	2	4	9	18	36	54	72	90	108	144
0,5	1	3	6	13	25	38	50	63	75	100
0,4	1	2	4	8	16	24	32	40	48	64
0,3	0	1	2	5	9	14	18	23	27	36
0,2	0	0	1	2	4	6	8	10	12	16

Exposure duration

Exposure Limit Value 529

Exposure Action Value 100

Plant Safety looking forward.

1. Users need representation on National and International Standards Committees, to make our views known. We are invited!
2. Standard on ‘Earth moving machinery-access systems’ perhaps split up standards to make them relevant for different machine categories. Almost impossible to have one standard fit both track machines and wheeled loaders.

Plant Safety looking forward

1. Suppliers to seek out and pass on to Standards committee CUSTOMERS views as realistically they won't attend the meetings.
2. Users feel ISO standards are Minimum deliverable.
3. Perhaps the Atlantic Alliance could pool international issues combine into one document and make available for all the different ISO Committee Chairmen. Example: Australia has same issues as ourselves plus, Slope inclination: Labelling: Collision avoidance: Tyre Maintenance.

Plant Safety looking forward

1. Need to fast track changes in design standards. Standards must keep up with European safety Directives.
2. Manufacturers offer retrofits for existing machines more proactively.
3. Standards need to reflect changing demographics. Workforce Older, weaker, less supple & flexible. More females (smaller size and reach). Retirement age could be 70 soon.

A plea for Safe Fixed Plant design Also.

1. **Access** - a significant and repetitive root cause of injury incidents.
2. Gap between screen decks unacceptably narrow (height 260 to 300mm) now have to select small fitters, no room to swing hammers, difficulty to work on side therefore working blind on back or front,
3. Access into conveyor feed chutes always too small. Need constant access due to wear.

Wear plates

1. Fitting wear plates cause countless hand crush injuries and manual handling problems.
2. Tried reducing plates to 50mm x 300mm and 14mmm thick but wear out too fast.
3. Tried magnetic handles to carry them.
4. Possibly design chutes with overhead beams to lift in one complete plate.
5. Perhaps look at root cause first: Keep wear to minimum Design conveyors to feed
   - directly onto following conveyor
   - Via small bin kept filled up: stone on stone.
   - follow on conveyors auto stop if feed chute starts to empty: stone on stone.

Access Hatches

- Standard minimum size 400mm wide for Hoppers Silos and tanks with 500mm for Asphalt mixers and drums.
- Law requires emergency plan for evacuating injured staff, especially if work is under a permit to work. Hatches too small.
- Hatches often located incorrectly.
- Often located on top of bins so everything must be lifted up and then down inside. Injured people require vertical lift. Make Hatches at lowest point and large for easy access/egress, ease of manually lifting in heavy items, also aids ventilation.

Think Maintenance.

- Design in far more **LIFTING BEAMS**
- Lifting beams over chutes, vulcanising platforms, for changing conveyor belts, (sheeting: for environmental reasons fit sliding roofs or wide doors for cranes).
- Have experienced fitters check and have a say on final design.
- ISO standards as MINIMUM deliverable.

Together we can make a difference.

- Machines now are bigger, but they are also far safer.
- Safety awareness , expectation, regulation and litigation are at a higher level than has ever been in the past.
- With more globalisation we need forums like the Atlantic Alliance to meet, listen to each others needs and problems and find the solutions.

Thank You.