



EMESRT

Earth Moving Equipment Safety Round Table

DESIGN PHILOSOPHY 5: MACHINE OPERATION AND CONTROL



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Objective

The objective is to prevent harm, during machine operation and control, to as low as reasonably practical, including consideration in design for foreseeable human error.



General outcome

The intended fit for purpose design outcome should:

- Eliminate the risk of collision with people, mobile and fixed equipment and other objects in the vicinity of machine operation
- Warn operators of any condition that threatens machine health and stability
- Automatically prevent operation outside gravity limits for stability, including speed and/or load
- Minimise harm for all operators from inadequate diversity of ergonomic and anthropometric range, e.g.
 - Seat suspension adjustment range does not allow for light or heavy weight operators
 - Footrests and pedals unreachable
 - Steering wheel adjustment inadequate
 - Dozer operator not being able to see ripper tip from a normal seated position
- Minimise operator physical and mental fatigue that causes slips and lapses
- Minimise unwanted vehicle interactions by:
 - Monitoring and providing enhanced situational awareness
 - Warning operators and pedestrians of people in the vicinity
 - Preventing vehicle motion into objects, structures or pedestrians without requiring operator systems activation
- Provide engineered controls which are fully functional under a range of operational and environmental conditions
- Provide controls and displays that are appropriately located, intuitive to use, consistent and failsafe
- Provide communication systems that are accessible and able to be understood from the normal operating position, e.g., two-way radio
- Provide warnings and alarms that are designed to be detectable, unambiguous, simple, meaningful and integrated so as not to mentally overload the operator
- Provide labels that are relevant, durable, clear in meaning and appropriately positioned
- Provide ability for operator to adjust mirrors



Causal Pathways

5.1 Harm from restricted or impeded operator field of vision of the surrounding environment and for tool operation, due to:

- Cab layout, location of windows and external structures (catwalks, handrails, protective structures, line of site mirrors, etc)
- Inadequately located or designed internal attachments, such as screens, hardware, equipment displays, sun blinds, etc



5.2 Harm from incorrect use of equipment controls, incorrect/inaccurate calibration or ineffective maintenance due to inadequately designed controls and displays, including:

- Lack of understanding or misunderstanding about function of the control or display
- Counter-intuitive design and configuration
- Inconsistency in display or function in comparison with other controls or displays (within vehicle)
- Not appropriately considering simultaneous control operation
- Ability for unintentional operation or selection
- Unexpected operating mode (mode errors)
- Frequently used and/or safety critical controls not being located within the zone of reach
- Insufficient clearance around controls and other workstation equipment



5.3 Harm from misinterpretation of information due to displays or labels being:

- Illegible
- Incomprehensible
- Not visible
- Inappropriately located
- Not using universal symbols or standardised terminology
- Not durable



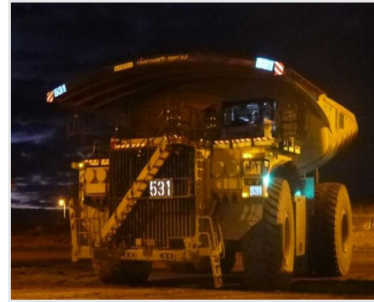
5.4 Harm, including cognitive impairment, causing warnings and alarms to be overlooked, ignored or not heard due to:

- Not being seen/heard or understood
- Not being reliable or sufficiently sensitive
- Being oversensitive
- Not fully integrated or interlocked with other warning systems
- Being over-used, tampered with or compromised in any way e.g., being turned off
- Alarming control and discrimination (normalisation)



5.5 Harm from impaired visibility (including distorted or degraded vision) or impaired awareness of hazards in a variety of operating conditions due to:

- Inadequate lighting for headlights, tail, reversing, turn, brake, strobe, flashing lights, etc
- Inadequately lit inspection areas
- Lack of fit for purpose receptacles for light fittings that suit standard and alternative lights
- Devices (mirrors, cameras, windscreen wipers and washers, etc) that are not fit for purpose



5.6 Musculoskeletal harm due to inadequate diversity of ergonomic and anthropometric range in the workstation design, including seat and seatbelt design, openings and cab height, that creates compromised postures, e.g.,:

- Inappropriate or compromised head / neck posture due to restricted visibility and/or control and display positioning
- Inappropriate or compromised hand/wrist posture due to mechanism required to manipulate/grasp control
- Inappropriate or compromised shoulder and back posture due to extended reach to controls
- Excessive forces required to appropriately operate buttons, triggers, hand and foot controls, levers and other devices
- Inappropriate or compromised posture due to lack of adjustability of seat, pedals, steering wheel / controls, monitors/displays
- Postures arising from inadequate seat and belt design, resulting in improper operator utilisation e.g.
 - Inadequate lumbar support and adjustability
 - Inadequate reduction of exposure to whole-body vibration



5.7 Harm or illness from physical and/or mental fatigue due to:

- Inadequate control of environmental conditions in the cab e.g. heat, cold, dust
- Inadequate illumination of cab and displays
- Glare from reflective sources
- Whole-body and hand/arm vibration



5.8 Harm due to workstation design and external structures, including:

- Protruding structures
- Sharp edges
- Structures not adequately fixed to equipment
- Roll over protection structures (ROPS)
- Intrusion into the cab by other equipment, such as the tray of another haul truck (e.g., visibility)

