

CATERPILLAR SAFETY SERVICES

DRIVER SAFETY SYSTEM

SPECIFICATIONS AND TECHNICAL OVERVIEW



CATERPILLAR®

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THE CAT[®] DRIVER SAFETY SYSTEM

The Cat[®] Driver Safety System (DSS) is a non-intrusive way to manage safety in real-time. Outside the vehicle, 24/7 monitoring provides site supervisors visibility to the full impact of fatigue and distraction on their operations.

Fatalities, injuries, property and equipment damage are four of the biggest risks our customers face every day. Customers that can manage these risks benefit from higher employee engagement, lower expenses and more projects completed on time. This paper will focus on fatigue, an often significant contributing factor to all four risks.

'93% OF HAULAGE TRUCK ACCIDENTS ARE DUE TO HUMAN ERROR', WITH '60 – 70% OF HUMAN ERROR ACCIDENTS FOUND TO BE FATIGUE-RELATED'

Despite efforts to improve sleep facilities, provide adequate rest breaks and support worker health and wellbeing, fatigue remains one of the leading causes of risk to equipment operators. With shifts averaging approximately 12 hours in duration, plus travel time to accommodation facilities around an hour, it's no surprise fatigue is one of the leading causes of risk to the equipment operator. What's more, employees recognize the risk of fatigue, with studies showing that 40% of nighttime workers admit to nodding off during their shift.

DSS: PAST, PRESENT AND FUTURE

DSS technology was developed in 1999 in Canberra, Australia. Using patented eye and head tracking algorithms the DSS is a leader in fatigue and distraction field. An independent cross-industry study of fatigue technologies in 2007-2008 by thought leaders in mining, human factors, medicine and transportation revealed that the most desirable long-term fatigue detection technologies would not require sensors on the operator, and would combine operator and machine data as part of the detection system. The DSS, untested at the time of the study, was evaluated and identified as a highly credible fatigue technology option requiring industry trials.

Due to the potential of the DSS technology and the long-term viability of the product, Caterpillar entered a partnership to assist in developing and trialling the technology with a global mining company. The results of the trial exceeded expectations and have been seen and the technology has set the benchmark for fatigue and distraction detection.

As recently as 2015 the DSS won the Business Review Weekly's Most Innovative Product Award and was the focus of attention at CES 2015 with Intel and Jaguar showing the future of driver safety technology in cars. The patented DSS technology is embedded in 10-20 automotive platforms with potential release between 2016 and 2020.

With proactive monitoring and intervention, the Driver Safety System helps protect your most valuable asset – people. It does not exist to replace safe, recommended and responsible equipment operating practices. It is not a substitute for comprehensive safety training, or safe behavior by equipment operators

DSS PRODUCT OVERVIEW

Using proactive monitoring and intervention, the DSS delivers instant, real-time fatigue and distraction intervention when a driver is about to nod-off, providing a sound and vibration alert in the seconds it takes for a micro-sleep to occur.

The DSS is a comprehensive two-part system that mitigates fatigue risk using multiple points of intervention.

Incab Intervention

In cab, the DSS uses a non-intrusive device that requires no interaction with the driver. Unlike other systems that require driver interaction, calibration or forethought for the technology to operate, the DSS operates directly from the vehicle battery, which ensures it's working every time the vehicle is on. Integrating into any truck brand, the DSS is customizable to individual site operational requirements, including altering operation to situations where the handbrake isn't on and operating only at or above set speeds.

Utilizing infrared light and optical sensors to track eye movement, eye closures and head pose, the DSS builds a 3D face model, enabling it to detect micro-sleeps in real-time. In the seconds it takes for a micro-sleep to be detected,

the DSS activates an in-cab audible alarm and a powerful seat rumbler to intervene, mitigating the risk of incident. Further, the DSS automatically archives the event clip and event data such as speed and GPS location for further assessment.

External Intervention

In addition to in-cab fatigue intervention, analysis by an independent 24/7 Analytics and Reporting Center (ARC) is available within minutes. Configurable to the site's WIFI or cellular technology options, the DSS is able to transmit the clip to the 24/7 ARC for determination of the type and/or severity of the incident. Detailed site reporting and communication purposes. Staffed by professional Safety Advisors, the 24/7 ARC is equipped to review, analyse and respond to any recorded incident within minutes and ensure communication flows are tailored to individual site needs.

Supported by expert Fatigue Consultants, technology experts and Caterpillar's Global Dealer network, every site utilizing the DSS has access to unparalleled support and expert advice to ensure the DSS can be relied upon to reduce the risk of fatigue and distraction on site.

HARDWARE AND TECHNICAL INFORMATION

HARDWARE

The following hardware and software components are installed by a trained Cat Dealer or experienced Caterpillar Safety Services technician. The technician will install the DSS for optimal performance, ensuring all software is configured for timely communication and reporting between the vehicle and the 24/7 ARC. The technician will provide onsite support during the installation process and provide quality assurance and testing of the installation as required.

TECHNICAL OVERVIEW

The DSS uses real-time head tracking algorithms for precise detection and measurement of the front and sides of the face and head, creating a comprehensive model of the face. The DSS coordinates all facial features, their current state and their rate of change, including blink rates and eyelid aperture, to detect fatigue in the seconds it takes for a microsleep to occur.

The DSS consists of:

- » Processor unit including software
- » Sensor and infra-red (IR) illuminators
- » Vibration motor
- » Speaker
- » GPS Receiver

Processor unit /software – connected directly to the vehicle battery for ignition-controlled power-up and shut-down, the processor is enclosed in a specially designed, ruggedized industrial grade hub for environmental protection. The processor has 0dB silent operations with no moving parts.

- » Rugged industrial grade IP-67 waterproof screw type front panel connectors
- » Custom face and eye tracking algorithm

- » Fully customizable configuration parameters to suit different needs
- » Enhanced hardware control and diagnostics
- » Rapid initialization and robust tracking of face and eye acquisition <500 milliseconds
- » Reduced network footprint

DIMENSION	LENGTH
Width	308.1mm(12.13in)
Length	247.9mm (9.76in)
Height	81.4mm (3.2in)
WEIGHT	4.6 kg(10.14Lb)

- » Wide supply voltage: 12-32VDC

Sensor and infra-red (IR) illuminators – configurable full face or eye only image capture of detected events, the sensor is fitted to the dashboard and/or internal mounts, the IR illuminators are fitted to the left and right of the sensor. The IR illuminators provide face tracking capabilities in all lighting conditions. IR light is invisible to the human eye, although you may be able to notice a faint red glow as some of the light does enter the visible spectrum.

- » 3D face model built off points tracked at 60Hz
- » Eye closure detection, duration and head pose
- » 640x480 Grey Scale progressive scan images

Vibration motor – configurable vibration levels, the motor is affixed under or at the back of the drivers seat for optimal effectiveness.

- » Powerful vibration at around 3000rpm

Speaker – configurable speaker that can be located inside the cab

- » Differential amplifier
- » Voice alarm and configurable languages
- » Configurable by event type: microsleap, distraction, field of view exceptions

GPS Receiver – The receiver is affixed outside of the cab in a weather-proof casing for protection.

- » High-sensitivity GPS Receiver
- » Water and weatherproof

The DSS mining product has proven unaffected by environmental conditions such as dust, vibration, weather and lighting, however, the DSS should not be fitted to the outside of the vehicle and is not water resistant.

Site Network Information required for configuration:

- » IP Addresses
- » Subnet Masks
- » Default Gateway
- » Relay server IP Address

Events Captured:

- » Fatigue
- » Distraction
- » Vehicle speed, over-speed, hard breaking and swerve events detection
- » GPS location
- » Cellular phone usage (optional)

Continuous Improvement Processes:

- » Measure and refine the Fatigue Management Plan
- » Build multiple layers of risk protection around employees
- » Change management consulting to engage operators and supervisors in processes to reduce fatigue and enhance personal accountability for fatigue management

UPGRADES AND MAINTENANCE

UPGRADES

Upgrade costs, software corrections, patches and other required software changes are included in the DSS licence fee.

Most DSS software upgrades and/or updates will happen automatically and will not impact operations. However, any large software upgrades that may impact systems will be communicated by your Dealer.

MAINTENANCE

The DSS is largely maintenance-free however it is advisable to include some basic practices into the vehicle's maintenance schedule. Practices include:

- » Check tightness of all bolts/attachments of the unit and peripherals
- » Check driver-facing sensor alignment by testing the tightness of the mounting screws
- » Use a lint-free cloth to wipe both IR illuminators and the lens cover to remove any dirt or grease

24/7 SAFETY ANALYTICS AND REPORTING CENTER

The 24/7 Analytics and Reporting Center (ARC), interpret DSS data for fatigue and distraction, quickly and effectively communicating the results of any high risk situation to site.

Staffed by experienced Safety Advisors, the 24/7 ARC receives small clips of fatigue and distraction incidents from the DSS moments after they occur. Safety Advisors review and classify each event captured to verify if fatigue has occurred before they follow the pre-determined site-specific response procedure, as outlined in the Fatigue Intervention Plan.

With direct communication lines to the site, the Safety Advisors are able to deliver timely, comprehensive updates regarding operator fatigue risk, providing management teams with the opportunity to intervene before an accident can occur.

Safety Advisors also provide independent, in-depth analysis of DSS and machine data. Combining the data to create a comprehensive picture of driver fatigue and distraction and the impact these events are having on machine outputs such as fuel burn and tire abuse. When used in conjunction with GPS data, widespread site risk mapping for fatigue and distraction can provide additional safety improvement opportunities.

REPORTING

Weekly event reporting provides consistent feedback about your fatigue and distraction risk management journey. Reporting is structured to provide you with information you can act on quickly to improve safety on site.

	In-cab DSS Intervention	24/7 ARC Intervention	Site Feedback
Notification	Driver instantly alerted to fatigue and distraction in real-time	Event analysis, classification and evaluation	Weekly management reporting
Notification Method	Seat rumbler and audible alarm	Fatigue Intervention Plan procedure: phone call and/or email and/or text message	Email distributed reports and risk analysis assessment
Communication System	Automatic noise and vibration triggered via DSS	Wireless network data transmissions	Cat Dealer support and independent, remote 24/7 ARC calls/emails
Communication Content	Configurable fatigue detected or distraction detected message	Event location, incident duration, classification, over speed and hard breaking information	Average truck speeds, total events recorded, most at risk shifts/teams and high risk locations.

COMMON QUESTIONS AND ANSWERS

HOW DO DIFFERENT MINING ENVIRONMENTS AFFECT THE DSS?

The DSS has a configurable system that allows it to operate effectively in almost all mining environments.

In open cut mines, the DSS uses global positioning technology to detect when the vehicle is operating and activate event monitoring. As the system is configurable, additional parameters can be added as required.

In underground operations the DSS utilizes the handbrake instead of global positioning to initiate event monitoring. The DSS is easily adapted to use the wireless network system on site or can accommodate its own transmission system to ensure communication with the 24/7 ARC is established.

In the event of a delay due to underground conditions, the DSS continues to instantly alert the driver when fatigue or distraction is detected. The 24/7 ARC will be notified as soon as possible once the network is established.

WHAT IS THE DIFFERENCE BETWEEN PREDICTIVE AND REAL-TIME FATIGUE DETECTION?

Predictive technologies rely on historical data to determine future fatigue and/or alertness levels. The data used to predict can include performance data, vehicle data and sleep/wake times. Some predictive technologies also rely on standard circadian rhythms of alertness to predict future states.

Real-time driver monitoring occurs in-vehicle and uses either physiological measures, psychomotor skills, vehicle kinematics, or driver input. These systems react to fatigue events as they begin to occur and are the last stop-gap countermeasure to warn the driver before further risky driving behavior or a crash could occur.

The DSS provides real-time fatigue detection.

WHAT IS PERCLOS

PERCLOS is one of several fatigue technology options currently available. The DSS uses PERCLOS in conjunction with other more significant fatigue tracking algorithms to detect fatigue in real-time.

PERCLOS (Percent Eye Closure) is a method whereby fatigue events are determined by eye closure averages over a time period, such as 5 seconds. By measuring the averages of eyes open versus eyes closed and calculating a rolling percentage, the alarm or notification will signal if the percentage exceeds the acceptable threshold. PERCLOS is a system of fatigue detection that isn't "real-time." Instead, PERCLOS relies on historical data to predict fatigue in an operator.

The DSS uses a custom face and eye tracking algorithm that builds a 3D face model from a range of points on the human face. The system uses both eye closure duration averages (PERCLOS), head pose and side models of the head – depending on orientation, to detect fatigue in real-time. It uses rapid initialization as well as face and eye acquisition at <500 milliseconds to detect and alarm operators about fatigue.

IS THE DSS EFFECTIVE WITH GLASSES?

Extensive testing of glasses, sunglasses and safety glasses has been undertaken to ensure the DSS provides unmitigated fatigue and distraction protection with a large range of glasses.

While each case is unique, Caterpillar Safety Services may make recommendations for safety glasses that perform most effectively with the system. There are a small number of lenses in sunglasses and/or safety glasses that aren't recommended.

Glasses	Transmittance	Reflectance	Comments
Veratti GT	60.5%	5.4%	Recommended
UVEX S3200 MC161200	99.1%	7.5%	Recommended
UVEX S6901X Replacement Lens	98.2	7.4%	Recommended
Bolle Prism Smoke 1614402	36.0%	5.0%	NOT Recommended
Bolle Prism Smoke / Bronze 1614404	33.3%	5.0%	NOT Recommended
Eyres Terminator 102-OP-IO	76.3	10.8	Recommended
Mack DUO ME524	31.6%	5.7%	NOT Recommended

*Additional information regarding the testing of these glasses available upon request

HOW IS PRIVACY PROTECTED

The DSSi system, Caterpillar Safety Services and Caterpillar Inc. comply with all data privacy, collection, distribution and management laws as required in the countries in which they operate.

Data from the DSS is collected in a secure server that can only be accessed through the DSSi system by authorized users. The data is housed in an externally owned monitoring center to ensure confidentiality and information security and operator clips are not visible to any person without rights to the material, and cannot be shared or downloaded.

The DSS data and clips are used to support employee coaching and to assist with personal fatigue management. Used by a coach or other authorized person, the data is provided as an educational tool for demonstrating fatigue events and risk.

WHAT IS THE WARRANTY PERIOD AND CONDITIONS?

All Caterpillar hardware has a 12-month manufacturer's warranty starting from the date of sale to the first purchaser. The warranty purports that the hardware will be free from manufacturing defects and that the hardware will perform in all material aspects in accordance with the functional specifications for the product.

The warranty does not cover any accidental or intentional damage to the hardware caused by the customer or their agents.

For more information on the terms, conditions and responsibilities pertaining to the DSS, contact your local Cat Dealer.

Your DSS licence fee covers the release of software patches, upgrades and temporary files.

WHAT IS A FATIGUE INTERVENTION PLAN (FIP)?

A FIP is a tailored fatigue risk management plan for your site. Discussed and outlined in conjunction with your experienced Caterpillar Safety Services fatigue consultant, the FIP outlines the specific steps, actions and response requirements for the 24/7 ARC and your site staff if a fatigue or distraction event occurs. The FIP provides support for dealing with fatigue and distraction during a shift, alerting the drivers to their fatigue and implementing steps to ensure the safety of all employees on site.

For a confidential discussion about how we can help you tailor your site Fatigue Intervention Plan, contact:

Asia Pacific/Africa: 1800 000 228

Americas: 1 866 936 3551

Other: safetyservices@cat.com

*All information contained in this document relates to: DSS version 3.1 computer, version 4 software



CATERPILLAR SAFETY SERVICES PHILOSOPHY

Caterpillar believes in the importance of safety and we want our customers to arrive Safely home. Everyone. Every day.™ This requires safe and reliable equipment, well-trained operators, properly designed job sites and a commitment to safety throughout the organization. Wherever you are in your safety journey, Caterpillar Safety Services is committed to providing you the tools, resources and knowledge to develop a sustainable culture of safety excellence.

For more information email safetyservices@cat.com or call:

Americas: 1 866 936 3551

Asia Pacific/Africa: 1800 000 228

Additional resource material can be found at: CAT.COM/SAFETY

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