Queensland Mining Industry Health & Safety Conference 2015 Innovation Award Submission

Automatic Brake Application System (ABAS)

The Problem

The Jeebropilly coal mine is located within close proximity to heavily populated areas. A gazetted and heavily trafficked road is located through the mining lease with minable reserves situated either side of the road. The Coal Handling and Preparation Plant (CHPP) is located on the southern side of the road along with site infrastructure (including the Heavy Equipment Maintenance Workshop).

Coal is mined utilising a truck shovel configuration on the northern side of the highway utilising a Hitachi EX1800 hydraulic excavator and a fleet of Caterpillar 785 Off-Highway Trucks. The trucks travel under the existing highway (as per the below picture) as they haul coal to the CHPP and return empty to the operational area of the mine. Additionally, trucks are required to travel under the highway to locate to the 'hardstand' and/or maintenance workshop for shift change and maintenance activities. There may also be instances where hydraulic excavators (up to 350 tonne class) are required to traverse under the highway

Due to the clearance height associated with travelling under the highway, there is an inherent risk of equipment making contact with the bridge structure should off-highway truck trays be in a raised position while travelling and/or excavators trammed with attachments at heights exceeding bridge clearance. Contact with the bridge structure without intervention presented an unacceptable level of risk based on the potential consequences to the health and safety of mine personnel and persons travelling the highway. It also presented a corporate risk in reputation should the bridge be damaged and use of it not permitted for a period.

The Solution

Upon evaluation of the associated risks in hauling and moving equipment under the existing highway, it was determined that by applying the hierarchy of control, alarms and operators ability to suitably react to a situation would not lower the risk profile to an acceptable level (being procedural). It was determined that an engineering solution would be required that would automatically take action should an insufficient clearance height be detected prior to approaching the bridge.

An internal solution was sought and as a result, a trip wire (connected to a 'pull switch') was installed to present an early alarm should minimum clearance not be achieved in approaching the bridge. Once in contact with the trip wire, it will activate the 'pull switch' opening a 'normally closed' electrical circuit energising a transmitter mounted on the base of the trip wire pole. The now energised transmitter will send a signal via radio frequency (RF) to a RF receiver mounted in the cab of the off-highway truck. The receiver in the truck will activate an audible alarm in the cab alerting the operator prior to releasing the air pressure from the park brake release system after a 2 second delay. The slow release of air pressure from the park brake release system will allow a controlled application of the park brake, bringing the truck to a controlled stop. The transmitter range for truck brake application has been calibrated to 60m with a stopping distance of approximately 15m at maximum speed.

With the exception of external technical assistance on the radio frequency technology and design of RF transmitter/receivers, the system has been a New Hope Group design with internal labour utilised for the design and installation for all truck brake application systems. A comprehensive change management process was applied with input from all stakeholders ensuring a robust system with effective outcomes. Although effectively only an input for application of the park brake system has been introduced, the Original Equipment Manufacturer (OEM) has been engaged to ensure that no truck capabilities have been compromised in the implementation of the ABAS system. Similarly, we have detailed the system to the Qld Mining Mechanical Inspector, seeking input or potential oversights in the implementation.

Fail Safe: The ABAS is designed to be failsafe via utilisation of a solar charged two battery powered transmitter system. In the event that adequate sunlight is not available to the solar panel, the transmitter's main battery has sufficient capacity to maintain the system for over 5 days. Furthermore, in the event of a battery or power failure to the main system, the second battery provides sufficient power for the transmitter to send a signal and activate the brake receiver system in the trucks, alerting that the system has faulted. The truck's cab mounted radio frequency receiver must supply power to the electric air solenoid valve or the brakes will not be released, meaning a fault in system will not allow the park brakes to be released until any fault is rectified.

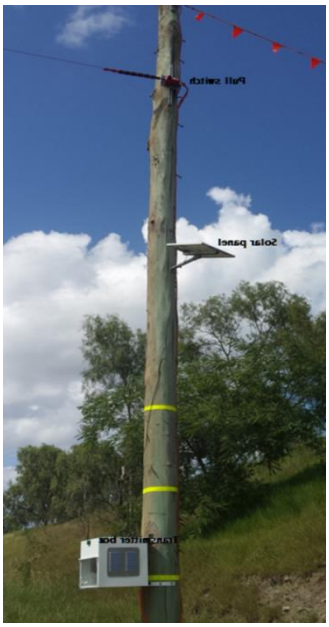
In addition, an electric solenoid valve has been added into the park brake release system that provides an additional level of warning for following trucks that brakes have been applied by activating the existing brake lights when the park or emergency brakes are applied. This modification combined with site procedures for maintaining safe travel distances between machines alerts operators of the application of brakes due to a system failure or unexpected application of the brakes.

Implementation testing has been comprehensive with numerous dynamic tests completed at varying speeds and in differing operating conditions (see below table for a snapshot of results). Testing has been recoded via video for future reference and to demonstrate modulated application preventing wheel 'lock up' and potential for 'skidding'.

Dynamic brake application test results

DATE	MACHINE	LOCATION	INCLINE	SPEED	GEAR	STOPPING DISTANCE	COMMENTS
18.02.2015	CAT 785 #12305	Overapss pit southern ramp	6%	12 km/h	1st	9m	Body down, No skidding
18.02.2015	CAT 785 #12305	Overapss pit southern ramp	6%	55 km/h	6th	Bakes applied @ 15.3m Stopped @ 58.4m	Body down, skidding , A light shower of rain had fallen before the test Truck came to rest 90m before the bridge


RF receiver box


Pull switch
Solar panel
Transmitter box

Benefits / Effects

The major benefits of the ABAS system is the utilisation of existing truck systems to automatically apply a control that will physically avoid contact with the bridge infrastructure in the event of insufficient clearance. A physical breaking of the trip wire is required to initiate action reducing the potential for 'false' applications and combined with a routine testing schedule provides for a reliable, robust protection system. All parts are readily available and easily sourced from local suppliers.

The system presents a low cost engineering solution to a high risk application removing reliance upon human awareness and intervention/action and effectively lowering the risk profile to an acceptable level.

Transferability

The ABAS is transferrable to most applications with similar technologies. It presents enormous potential in the application of 'collision avoidance' technologies where automated action can be taken without manual input in the event of projected collision trajectory between operating units.

Innovation

While RF technology is utilised widely within many industries, to the best of our knowledge the application of the technology in the activation of braking systems in a dynamic environment presents a totally innovative approach in the mining industry. The real value of the system, is its integration and utilisation of existing off-highway truck braking systems (mechanical drive) with the simple introduction of an input for controlled application of the park brake. The controlled application of on-board systems in potential impact situations removes the risks associated with operator awareness and reaction times/abilities, and the modulated application controls the associated risks of sudden brake application.

The inclusion of the illumination of the brake lights in system application adds further redundancy, visually alerting 3rd parties of the application and the requirement for the system to be manually reset before releasing the brakes and returning the truck to normal operation after application supports maintaining the integrity of an incident scene for investigational purposes and the ability to modify operator behaviour where found to be required.

Approximate Costs

The cost of the system (excluding trip wire poles) is minimal compared to the controlled outcomes and risk mitigation. The below table details system costs for the transmitter and inclusion receiver on 14 x Caterpillar Off-Highway Trucks (this is a material cost and excludes internal labour costs for system installation);

ABAS Component	**Number of Units**	**Cost per unit**
Transmitter	2	$1,247
Receiver	14	$476
Trip Wire (& switch)	2	$1,000
TOTAL		**$11,158**