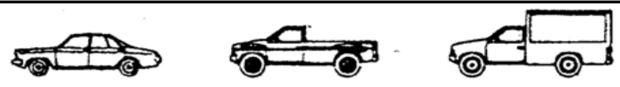
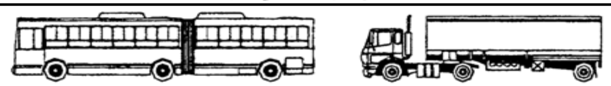
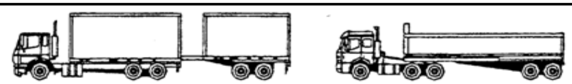
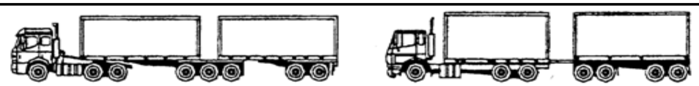
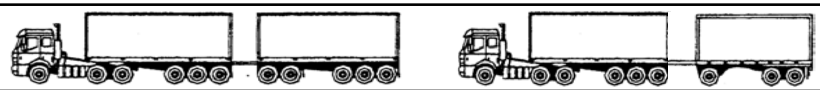
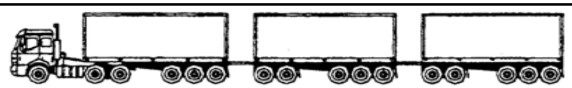
AUSTROADS Vehicle Classification System

Level 1 Length (indicative)	Level 2 Axles and Axle Groups		Level 3 Vehicle Type	AUSTROADS Classification		
Type	Axles	Groups	Typical Description	Class	Parameters	Typical Configuration
			LIGHT VEHICLES			
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	**1**	d(1) ≤ 3.2m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	**2**	groups = 3 d(1) ≥ 2.1m, d(1) ≤ 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
			HEAVY VEHICLES			
	2	2	**Two Axle Truck or Bus**	**3**	d(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	**4**	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	**5**	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	**6**	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	**7**	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	**8**	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	**9**	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	**10**	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	**11**	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	**12**	groups > 6 and axles > 6	

Definitions:
Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)

d(1): Distance between first and second axle
d(2): Distance between second and third axle

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Terry George

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Cooled vs non-cooled Thermal Imaging Sensors

Contents

1. Purpose

This report details further trials conducted for the Roads & Maritime Services (RMS), which tested the efficacy of differing thermal imaging technology for brake and tyre screening of vehicles. Previous trials have shown poor efficacy rates using standard thermal imaging sensors for sensing potentially defective or faulty brakes on vehicles. This was due to various reasons, especially the speed limitation of normal thermal imaging sensors. That is, most thermal imaging cameras are only effective up to speeds of 50km/h. Vehicles travelling on highways can travel up to 100km/h, and thus the thermal imaging solution required needs to be enhanced to cater for this.

A potential solution is to use cooled thermal imaging cameras which in theory have a higher detail level when compared to non-cooled thermal imaging sensors. This would be beneficial for moving vehicles to establish whether brakes/tyres on a vehicle are potentially defective and therefore dangerous.

2. Background

As previously documented, during the 12 months to the end of June 2016, 208 people died from 182 fatal crashes involving heavy trucks or buses.

These included:

• 111 deaths from 96 crashes involving articulated trucks

• 79 deaths from 68 crashes involving heavy rigid trucks

• 25 deaths from 22 crashes involving buses. Statistics published January 2014 show that one in seven (15%) single heavy vehicle crashes had an equipment failure reported for that truck. Of these faults, brake failure made up 16%, tyre failure made up 22% and wheel/suspension failure made up 6% of documented incidents. Thermal imaging has the potential to detect these types of faults, which equate to 44% of total equipment related failures.

3. Technology and Theory

This report focuses particularly on the potential for using cooled thermal imaging cameras for the applications documented above and to compare to data collected from previous thermal camera trials using standard uncooled thermal cameras which had poor efficacy rates in their undeveloped states.

Cooled thermal imaging detectors are fundamentally different to uncooled systems. These cameras are also known as “photonic” detectors and measure infrared radiation by counting incoming photons of energy, rather than requiring individual pixel elements to increase in temperature. Thermal imaging cameras with a cooled detector offer some advantages over thermal imaging cameras with an uncooled detector. However, they are more expensive. A modern cooled thermal imaging camera has an imaging sensor that is integrated with a cryocooler, which lowers the sensor temperature to cryogenic temperatures. This reduction in sensor temperature is necessary to reduce thermally-induced noise to a level below that of the signal from the scene being imaged.

For some high-speed applications, a cooled thermal imaging camera will be required. Cryocoolers have moving parts made to extremely close mechanical tolerances that wear out over time, as well as helium gas that slowly works its way past gas seals. Eventually a rebuild for the cryocooler is required after 10,000-13,000 hours of operation. This is usually managed as part of a cameras annual service and calibration check process.

4. Method

Data collected and observations from the cooled camera were collected and this report offers an independent review and recommendations for future use potential and to recommend any enhancements which could be required to meet the RMS's goal of an automated thermal imaging system for detecting faulty brakes or tyres on a vehicle.

RMS have advised various applications where they would potentially deploy these technologies for screening brakes and/or tyres on vehicles, particularly heavy vehicles in NSW:

1) Heavy vehicle safety station - screening lanes
2) Major highways – especially those with steep downhill slopes which are known to exacerbate already defective brakes and tyre issues.
3) On road enforcement bays in NSW – to screen for defective brakes and tyres once the vehicle is already intercepted.

Due to these varied applications, and multitude of thermal camera installation options (side vehicle, under vehicle, tripod mounted etc.), it is not possible to make a single conclusion or recommendation which is important to note. It is recommended that RMS in future specify the exact mounting requirement for a technology and a single application from the list above to reduce time and effort costs. The primary data was collected from an RMS cooled thermal camera:

A successful result would show that the cooled camera solution successfully:

1. Detected 100% of vehicles.
2. On road enforcement bay: vehicles travelling at an average of 5km/h in the on road enforcement bay:
    a. Correctly measured temperature (with a 10 degrees Celsius variance allowed) of brakes 100% of the time (when compared with the data collected from the RMS handheld temperature gun).
3. Major Highway: vehicles travelling at an average of 80km/h on Picton rd:
    a. Captured the temperature of all passing axles of a heavy vehicle on the highway.
    b. Viewed images on the cooled camera are not blurred at these high speeds.

5. Results

1. Detected 100% of vehicles

   a. Results:

Detection Rate on road enforcement bay	Detection Rate Highway
100%	100%

Manual matching of the output and actual vehicles sighted showed perfect detection rates with this solution. No vehicles were missed up to 100km/h on both the on road enforcement bay and the highway.

2. Correctly measured temperature Results at on-road enforcement bay:

Result
85%

The cooled camera correctly measured temperatures on brakes and tyres intercepted 85% of the time. It should be noted however that errors in temperature readings were generally not due to a failure in the cooled thermal camera; errors were generally caused by other objects other than brakes and tyres being detected, such as exhausts, fuel tanks etc.

3. Major Highway: vehicles travelling at an average of 80km/h on Picton rd:

   a. Results:

Captured the temperature of all passing axles of a heavy vehicle on the highway.
90%

The cooled camera efficacy at high speeds were very good. The efficacy was much higher than any other non-cooled thermal camera tested previously. This clearly shows that for high speed applications, the cooled thermal camera should definitely be recommended.

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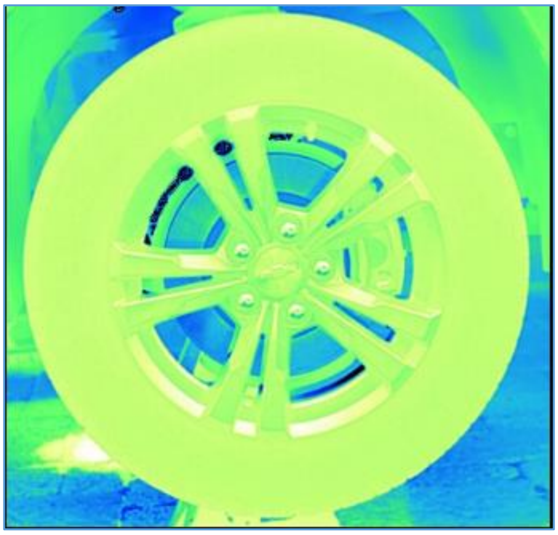
b. Results:

Viewed images on the cooled camera are not blurred at these high speeds.
95%

The cooled camera showed excellent resolution of brakes and tyres passing the on-road enforcement bay. 95% of the axles viewed were not blurred. The average speed of vehicles passing was 80km/h.



Example of an axle travelling at approximately 70km/h. No blurring visible, unlike the previously tested non-cooled thermal cameras which were very blurred at these speeds.

6. Conclusion

Regarding cooled vs uncooled thermal imaging sensors for the purpose of detecting potentially defective brakes and tyres, it can be concluded that for high speed applications, a cooled camera has outstanding efficacy and should be used where speeds exceed 20km/h, that is for heavy vehicle safety station screening lanes and major highways.

If the RMS want to see the minute temperature differences in brakes and tyres on vehicles, and if they need the best image quality for fast / high speed applications or if RMS want to synchronize the thermal imaging camera with other ITS equipment, then a cooled thermal imaging camera is the instrument of choice. However, due to the higher costs and maintenance required of these cooled thermal cameras, they would not necessarily be required for slow speed applications such as at on road enforcement bays.

Based on the results, it is clear that false positives would occur with all current thermal cameras trialled due to the lack of smart software screening. That is, the thermal camera needs to be able to differentiate between a brake and a vehicle exhaust so as to exclude other high temperature items from causing false positives.

Additionally, as the cooled and uncooled thermal cameras were tripod mounted, they were only capturing one side of each vehicle passing, meaning that two cameras of this mounting type would be required to capture both sides of a vehicle. This means that the cost increases, and RMS should investigate solutions where the thermal camera is installed in the roadway so that vehicles drive over the thermal sensor which could capture both wheels of an axle with a single camera.

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Houston Radar Length Detection System

Contents

1. Purpose

This report provides an independent review of the Houston Radar length detection system which is being trialled at RMS sites such as Galston Gorge. RMS wishes to deploy length detection systems at various locations across many locations for over-length vehicle enforcement. The locations range from roads such as Galston Rd at Galston Gorge which has a 7.5m vehicle length limit placed on this road, and other high risk/priority sites such as tunnels, bridges etc where vehicle length would preferably be recorded for data analysis and future planning. The Houston radar system selected is the SpeedLanePro which offers more features than just length detection/measurement of moving vehicles at very low power consumption rates which is why it was selected, especially for rural site deployment which may not have fixed power and require portable power such as batteries or renewable energy power sources such as solar power. This report will touch briefly on these features to discuss potential for multi-program enforcement such as over-length vehicle enforcement and speed enforcement using a single technology.

2. Background

Galston Gorge has seen countless heavy vehicles become trapped over the past decade, with almost 100 over-length trucks becoming stuck in the past year alone.

Traffic bottlenecks resulting from the trapped heavy vehicles have caused significant delays for motorists over the years as it acts as a link for vehicles travelling on the pacific highway north of Sydney to the Western suburbs.

These continued incidents have led RMS to seek a suitable technology for over-length detection and enforcement, particularly an automated and gazetted enforcement system which is able to issue infringements without requiring a human to manually measure the length of the vehicle which is time consuming and not practical. A gazetted system must be accurate enough that the data and imagery from the technology are admissible in a court of law. Any major variances in accuracy would make the technology not able to pass gazettal testing and therefore would not be recommended.

3. Technology and Theory

Houston Radar SpeedLanePro is a dual beam, low power side-fire radar. It is designed to accurately detect lane, speed and class of individual vehicles and compute per lane volume, occupancy, gap and average speed.

Houston Radar SpeedLane Pro ™®

- World's lowest power usage highly integrated multi-lane traffic measurement radar. At 0.85 Watts SpeedLanePro™® requires 10X less power than competing products.
- Mounts on the side of the road for non-intrusive traffic data collection and works in all weather and lighting conditions.
- Simultaneously measures all vehicles in 8 user defined lanes.
- All traffic measurements are on per-vehicle, per-lane basis, available in real-time and stored in device memory.
- Lane-by-lane vehicle counts, length based class, average speeds, occupancy and gap measurements.
- Companion Windows application provides intuitive GUI to set all configuration parameters, display real time plots of targets and view snapshots & streaming HD video.
- Built-in long range Class I 2.1+EDR Bluetooth, RS232/RS485 serial ports and Ethernet.
- 512 Mbytes of on-board storage plus µSD card expansion slot.
- Built-in 1.3MP HD video camera for sighting makes setup a snap and allows convenient remote monitoring of traffic.
- Optional built-in UPS with rechargeable battery keeps unit running for over 24hrs on loss of external power.
- Optional MPPT solar charger for optimal winter and cloudy day charging.
- Optional internal 96Whr LiFePO4 battery for temporary or solar installations.
- Optional penta band 3G GSM cellular modem for remote access.
- Optional PoE (Power over Ethernet).

4. Method

Reports and observations from the Houston Radar system were collected and this report offers an independent review and recommendations for future use potential and to recommend any enhancements which could be required to meet the RMS's goal of an automated and gazetted over-length vehicle detection system.

Various applications exist where they would potentially deploy this type of technology for vehicle enforcement and data collection:

1) Galston Gorge – gazetted over-length vehicle enforcement/detection system.
2) Tunnels – data collection for vehicle count and vehicle speed enforcement.
3) Bridges – data collection for vehicle count and vehicle speed enforcement.
4) General Roads - data collection for vehicle count and vehicle speed enforcement.

A successful result would show that the Houston Radar system successfully:

1. Detected 100% of vehicles – compared to manual visual counting.
2. Accurately measured the length of 99% of vehicles – compared to benchmark austroads 9 classes vehicle lengths.
3. Accurately measured the speed of 99% of vehicles – compared to a handheld speed measuring device.

5. Results

1. Detected 100% of vehicles – compared to manual visual counting.
    a. Results:

Detection Rate
90%

Matching of the data and actual vehicles sighted showed 90% detection rate in a single lane road. There were no obvious reasons, either environmentally or otherwise which seem to have caused missed vehicles.

2. Accurately measured the length of 99% of vehicles:

Result
15%

The Houston Radar system measured vehicle lengths in this scenario particularly poorly. Although the benchmark was a desktop with austroads 9 vehicle class lengths, the Houston radar length measurement was either extremely inaccurate in its measurements, or failed to measure many vehicles at all. RMS reports of the Houston Radar also show that the software used is particularly poor and seemingly only in a developmental/beta phase which is not suitable, particularly for a solution which is required to be gazetted for over-length vehicle enforcement.

3. Accurately measured the speed of 99% of vehicles Results:

Result
30%

The Houston Radar system measured vehicle speeds particularly poorly. Again, there were no obvious reasons in the hardware or software implementation why the result was far below par other than the previous assumption that the technology is still in a developmental phase and not ready or suitable for a production deployment. Additionally, the speed measurement was so inaccurate in most of the cases, that a comparison with the handheld measuring device was not even needed. For example, several vehicles were recorded by the Houston Radar as driving at ~10km/h, when they were visibly driving at approximately 40km/h.

6. Conclusion

Based on the results, the Houston Radar system cannot be recommended for the applications which RMS requires. Although the technology has a potential for many applications listed in this report, the technology is seemingly only in a developmental phase and is not ready for a production system, particularly one which requires the solution to be gazetted. The detection rate result was the only factor which may ascertain that the technology could be used, for vehicle counting etc, however, it was not 100% so the data will be inaccurate. The speed and vehicle length measurements were very poor. Additionally the GUI software for this Houston Radar was also very dysfunctional making it near impossible for real-time monitoring which was seen by RMS users.

Several factors should be considered for future potential solutions. Firstly the mounting options; side mounted technology such as this Houston Radar will sometimes miss vehicle detections, if a vehicle in lane one hides/obfuscates the vehicle in lane 2. A pole or gantry of at least 6m is required for full visibility which is not always possible or economical.

Secondly, the power requirements; most traditional vehicle measuring (length and speed) such as road mounted solutions are far more practical where permanent power is available. Technology such as this Houston Radar would only be beneficial is cases where no fixed power is available.

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Improved Mass Screening:

Weight-In-Motion and TIRTL integration

Contents

1 . Purpose

This report details the trial conducted for the Roads & Maritime Services (RMS), which tested the efficacy of integrating two stand-alone ITS technologies. The weight in motion system is primarily used for weighing vehicles travelling over it at speeds up to 100km/h. Although the WIM has a method to detect axle spacing (electromagnetic loops installed), it is particularly poor at doing so. For this reason, RMS integrated the TIRTL with the WIM to assess whether this integrated solution can improve axle spacing measuring at the WIM, and consequently improve the WIM weight classification. The problem is such that if the axle spacing is measured incorrectly, the WIM does not know what category of vehicle it is, hence it applies the incorrect maximum weight of the vehicle and potentially incorrectly intercepts a vehicle which is actually mass compliant. This is a big problem for the heavy vehicle industry due to the loss of time and productivity. Additionally, inspecting vehicles which are otherwise compliant wastes RMS inspector’s time and resources.

The integration was tested at Mt White and Marulan (heavy vehicle safety stations), and the purpose of this trial is to understand whether the integrated solution enhances and improves vehicle classification and mass screening at HVSS's.

2 . Background

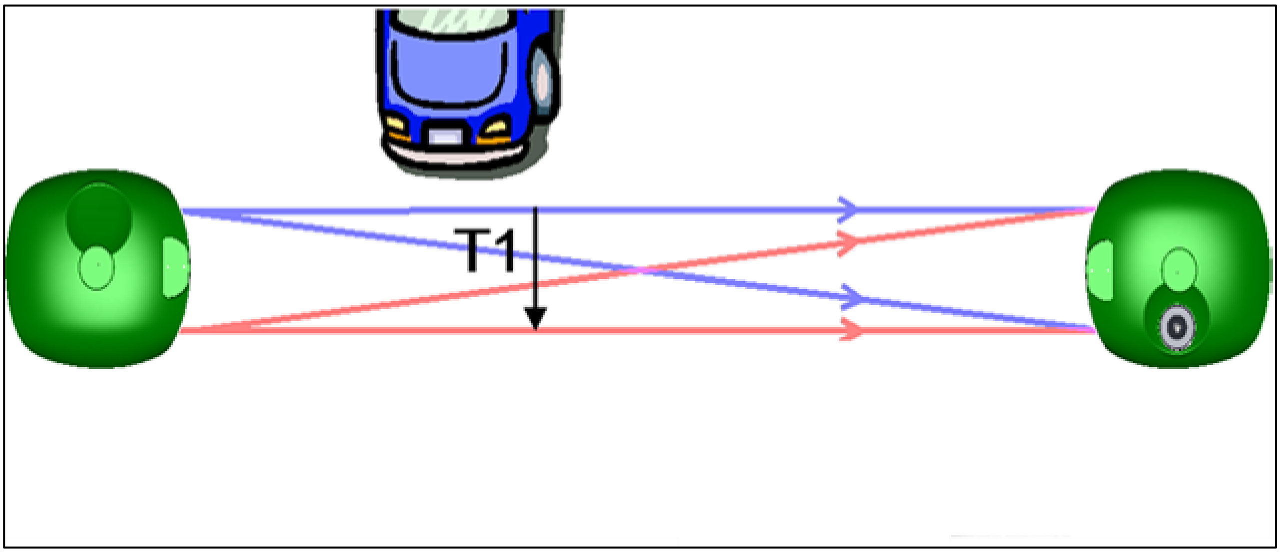
Screening lanes in heavy vehicle safety stations in NSW are used to screen certain vehicle parameters so as to intercept only non-compliant vehicles. The weight of the vehicle of amongst the most important factors for vehicle safety. For this reason, RMS requires a solution for correctly weighting and classifying vehicles in their screening lanes. RMS has utilised PAT WIM's for over 20 years due to their long life, however they require a different solution for correctly classifying vehicles into the various categories so the correct maximum vehicle weight can be applied.

3 . Technology and Theory

The PAT Bending Plate from IRD is used for Weigh-in-Motion (WIM) solutions in heavy vehicle safety stations in NSW. The importance of measuring the loads of driving road vehicles has increased enormously. Traffic safety, the protection of road infrastructure and statistical data are the main purpose of Weigh-in-Motion equipment. These WIM's are rated up to a weight accuracy of 10%+- of the axle weight up to 200km/h.

Although the WIM itself is a globally world leading solution for weight vehicles, its solution for measuring axle spacing is poor. Electromagnetic loops installed in the roadway do not meet the requirements for a screening lane which requires at least 95% of vehicles to be weighed correctly. Loops regularly miss-trigger or double trigger on vehicle axles resulting in the WIM miss-classifying the vehicle and applying an incorrect maximum weight tolerance. For this reason, RMS has integrated the world leading axle classification tool, the TIRTL into the WIM to improve classification and vehicle weighing accuracy.

The TIRTL was primarily designed as a vehicle detection solution which has many other potential implementations and integrations such as this. It is a proven technology for measuring number of axles, axle spacing, and vehicle speed.



RMS has theorised that integrating the TIRTL with the WIM could resolve the long standing issue with the WIM/loop system incorrectly classifying vehicles a large proportion of the time, resulting in otherwise compliant vehicles being intercepted.

4 . Method

RMS has advised that CEOS and PAT/IRD have worked together to complete the software integration.

The efficacy of this solution was reviewed. In theory, if the TIRTL correctly measures axle spacing, then the vehicle classification will be correct, hence the correct weight can be applied to the specific vehicle. If the correct maximum weight is applied, then there should be no false positive intercepts of vehicles at heavy vehicle safety stations.

A successful result would show that the integrated solution successfully:

1. Detected 100% of vehicles
2. 95%+ correct axle spacing measured
3. 95%+ correct vehicle classification recorded

5 . Results

1. Detected 100% of vehicles
    a. Results:

Detection Rate
100%

Manual matching of the output and actual vehicles sighted showed perfect detection rates with this solution. No vehicles were missed up to 100km/h.

2. 95%+ correct axle spacing measured
    a. Results:

Result
95%

The results showed that the initial trial had only a few errors per day. This was a marked improvement from the previous solution which regularly had up to 100 errors per day.

3. 95%+ correct vehicle classification recorded
    a. Results:

Result
95%

Due to the high successful axle spacing measurements, this meant that the correct vehicle classification was also selected 95% of the time.

6 . Conclusion

The integration of the weight in motion and TIRTL solution proved to be a complete success. This shows that a simple modification of the input data (axle spacing in this case) of a complex ITS solution such as the WIM can have marked improvements in the overall results of the system.

It is highly recommended that RMS implements this solution at all other heavy vehicle safety stations across NSW to improve overall weight compliance in NSW of heavy vehicles.

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PAT/IRD 10C III

Contents

1. Purpose

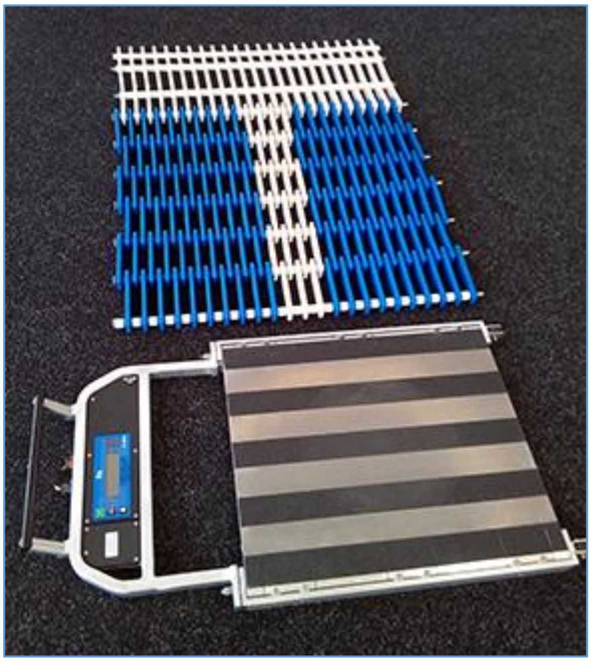
RMS has procured a set of the PAT/IRD 10C III portable scales. With the major increase in infrastructure in NSW, and hence a major spike in heavy vehicle freight movement, new portable weighing solutions are being considered by RMS.

2. Background

The dynamic capability is especially if interest in the Sydney area where a much higher vehicle throughout is required which is increasing due to the upcoming construction of new major roads such as the westconnex and northconnex and other thoroughfares, thus requiring heavy vehicle mass enforcement to be much more efficient. Weighing a vehicle with a standard static weigh scale can take up to 30minutes by RMS inspectors. A dynamic scale, if used at on road enforcement bays, can potentially weigh a vehicle in under 2minutes, however this technology and solution is currently unproven and untested, hence the requirement for this scoping study.

3. Technology and Theory

The PAT/IRD 10C III claims to have static and dynamic weighing capability which RMS has advised is particularly of interest to them as these scales can fit directly into the existing vehicle docks without modification.



The 10C III solution enables dynamic weighing using a flex frame / lead-up mat which the heavy vehicle is required to drive on before and after being weighed on the scale itself.

10C III Specifications and uses

- Dynamic measurement for overload indication
- Dual-scale system configuration with computer-based processing for reporting, protocol printing and data archiving

- Application of SAW scales for static and dynamic weighing operation
- Pre-selection of overloaded trucks
- High vehicle throughput
- High accuracy
- Very efficient weight enforcement
- Low profile, lightweight
- Rugged design, corrosion resistant
- Twin-tire weighing
- Flex frame for higher accuracy
- Designed to meet OIML R134

4. Report

Hardware: During pre-trial review, RMS have come to the conclusion that due to the very large size and weight of the flex frames / lead-up mats pictured below, that in fact there is no current way that they can be transported in the current RMS vehicles. The flex frames themselves would require a secondary trailer to be towed by each vehicle which RMS have advised is unrealistic.

Software: Although the software for the dynamic weighing capability was available for RMS to trial, they have advised also that the software is by no means in a production ready state. Poor stability of the software, crashing of the application, failing Bluetooth connectivity all made it impossible for the trial to properly be made possible.

4. Conclusion

We are of the understanding that RMS has requested a refund of these units due to their lack of meeting the stated specifications and basic requirements. Due to this, no further recommendations for this unit are possible and it should be noted that IRD have failed to respond to our phone calls which we were attempting to discuss with them the future potential for this solution if/when it will be in a production ready state.

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TIRTL & LTI dimension scanner integration

Contents

1 . Purpose

This report details the trial conducted for the Roads & Maritime Services (RMS), which tested the efficacy of integrating two stand-alone measuring/detection systems to measure all dimensions of a heavy vehicle, being height, length width. The LTI laser system can supposedly detect vehicle height accurately, and the TIRTL can detect vehicle length and width accurately(axle to axle, not chassis base).

The system was installed at the Marulan HVSS(heavy vehicle safety station), and the purpose of this trial is to understand whether the integrated solution accurately detects vehicles passing while accurately measuring the vehicle's dimensions in one 'packet'. Ie/ one record to include height, width length.

2 . Background

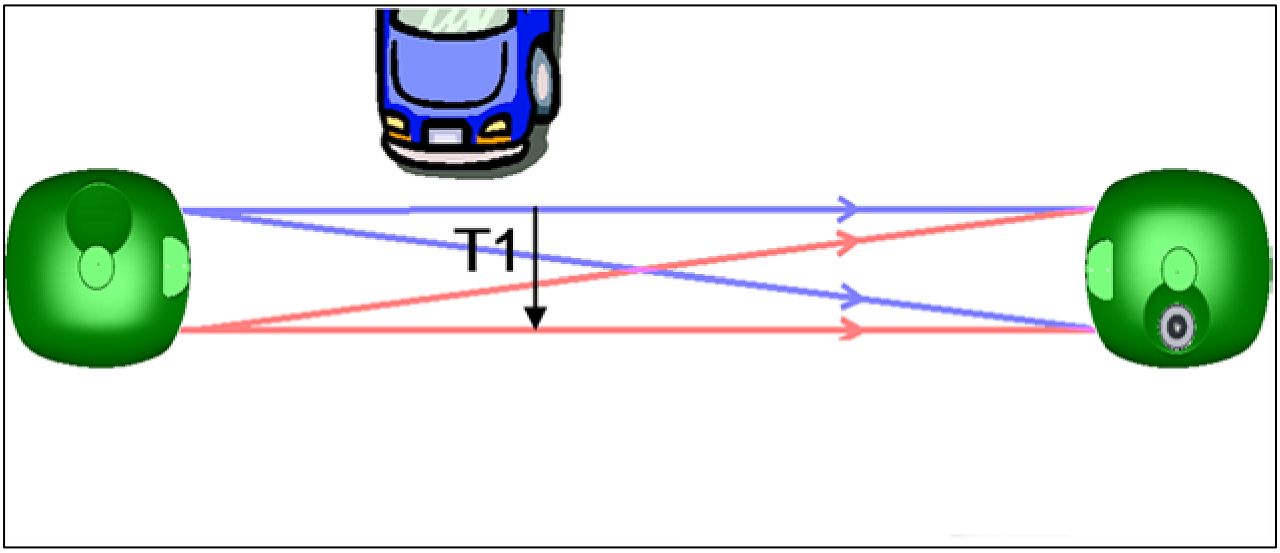
Due to an increase in infrastructure build in NSW, more bridges and tunnels and expected to be built over the coming 10 years. For this reason, RMS has advised that they are interested in assessing potential solutions for not only triggering on over-dimension vehicles, but also for measuring the actual measurement for future analysis and potential prosecution. This also assists in pre-screening vehicle to target only non-compliant vehicles for inspection.

A working solution not only enables more intelligent vehicle enforcement, but also enables increased asset protection and potential vehicle warning systems for vehicles which are too large to enter a tunnel, for example.

3 . Technology and Theory

The LTI laser scanner was primarily designed as an overhead vehicle detection solution.
Ie/ placed on bridges and overpasses etc, it can supposedly accurately detect the height of a vehicle passing.

The TIRTL was primarily designed as a vehicle detection solution which has many other potential implementations and integrations such as this. It is a proven technology for measuring number of axles, axle spacing, vehicle speed.



RMS has theorised that the combination of these 2 technologies could provide a single record vehicle measuring system which can be used for the aforementioned purposes.

4 . Method

For this trial, RMS installed the camera at Marulan HVSS. The LTI laser was installed on a gantry. The TIRTLs were available at ground level in the HVSS screening lane where heavy vehicles are required to enter for screening.

Tests were performed to determine the success or lack thereof of the integration of the TIRTL with this LTI laser system. More specifically, if these two technologies are a good 'fit' for further development of an automated vehicle dimension measuring system which can be installed at various locations for vehicle compliance, asset protection and driver warning.

A successful result would show that the LTI/TIRTL integrated solution successfully:

1. Detected 95%+ of vehicles passing, up to 100km/h
2. Accurately Measured the height of vehicles passing 95% of the time
3. Accurately Measured the width of vehicles passing 95% of the time
4. Accurately Measured the length of vehicles passing 95% of the time

5 . Results

1. Detected 95%+ of vehicles passing, up to 100km/h

    a. Results:

Detection Rate
100%

Manual matching of the output and actual vehicles sighted showed perfect detection rates with this solution. No vehicles were missed up to 100km/h at the test site. This may or may not differ at different types of sites where different variables such as multi lane highways exist.

2. Accurately Measured the height of vehicles passing 95% of the time

    a. Results:

Height Measurements
80%

Data collected from the inspectors following the trial showed that only 80% of vehicles correctly had their height measured. The inspectors manually measured the vehicle intercepted and recorded it. This was then compared with the integrated solution measurement which showed inaccuracies 20% of the time.

3. Accurately Measured the width of vehicles passing 95% of the time
   a. Results:

Width Measurements
70%

Data collected from the inspectors following the trial showed that only 70% of vehicles correctly had their width measured. The inspectors manually measured the vehicle intercepted and recorded it. This was then compared with the integrated solution measurement which showed inaccuracies 30% of the time. Most differing reads were due to the mirrors of the vehicle. The LTI laser system did not always detect the mirrors which meant the system measurement was sometimes smaller than it actually was.

4. Accurately Measured the length of vehicles passing 95% of the time
   a. Results:

Length Measurements
95%

Data collected from the inspectors following the trial showed that 95% of vehicles correctly had their length measured. The inspectors manually measured the vehicle intercepted and recorded it. This was then compared with the integrated solution measurement which showed inaccuracies 5% of the time. It should be noted that the integrated solution measurement is axle to axle, not the entire chassis length. Ie things like bumper bars and overhand at the front or rear of the vehicle were not detected by this solution.

6 . Conclusion

Individually, each of the 2 technologies performed accurately for their own designed function.

However, the integrated solution did not reflect the actual vehicle dimensions accurately enough for it to be implemented elsewhere.

The main point of focus here is that this solution does not cater for vehicle overhand such as mirrors, bumpers, aerials etc. This is important for compliance and asset protection.

AZH has performed some further analysis to provide recommendations and there are some laser 'curtain' solutions available in the ITS market which would detect overhand and may be of interest to RMS.

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Heavy Vehicle Safety & Trends Report - NSW

Contents

1. Purpose

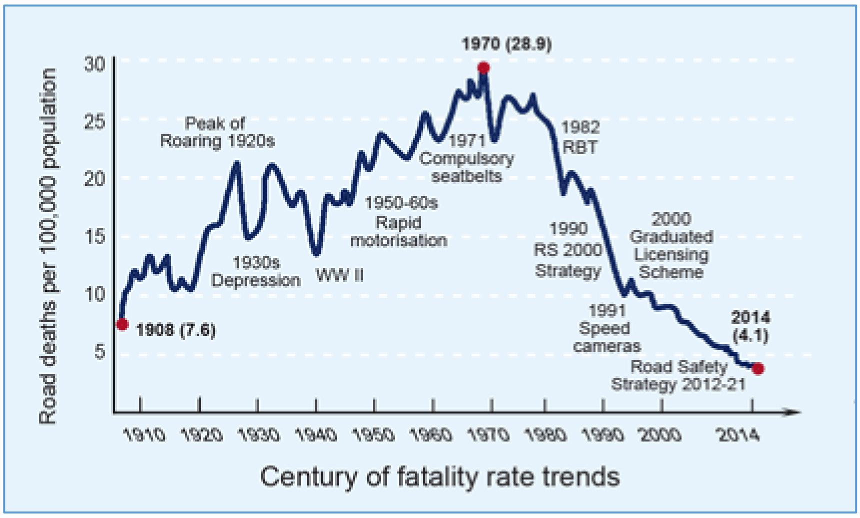
With major infrastructure build on the increase in NSW, RMS is interested to collect and collate reports on trends of heavy vehicle safety particularly to ascertain where regulatory improvements can be made and to ensure regulatory funds are funnelled to highest risk programs.

A Heavy Truck Crash is defined as any crash involving a Heavy Rigid Truck (rigid lorry and rigid tanker with a tare weight in excess of 4.5 tonnes) or an Articulated Truck (articulated tanker, semi-trailer, low loader, road train or B-double) on a road that results in death, injury or towed vehicle and is reported to the police.

A Heavy Truck Fatality is defined as a person who dies within 30 days from injuries received in a heavy truck crash.

2. Background

The Centre for road safety in Transport for New South Wales has documented that since the 1970's, fatal crashes have drastically reduced, until a spike in 2014 and following years.



Continued government investment and key road safety interventions, such as the compulsory use of seatbelts and the introduction of random breath testing, have had a significant impact on reducing the fatality rate – at the same time as NSW roads have become much busier. In 2017, there were more than 6 million registered motor vehicles in NSW, up from about 4000 motor vehicles in 1910.

Heavy truck fatal crashes, five years Heavy truck fatal crashes, five years five years 2013 to 2017:

- 266 fatal crashes involving heavy trucks, on average 53 fatal crashes per year
- 296 fatalities from heavy truck crashes, on average 59 people killed per year
- 6835 injuries from heavy truck crashes, on average 1367 injuries per year
- This includes 2015 serious injuries, on average 403 serious injuries per year

This report will pulls together many data sources, published and unpublished and expert opinions to provide independent analysis and recommendations for RMS for future guarding against further increases in road deaths in NSW, particularly those involving heavy vehicles.

3. Report

Heavy truck occupants — counts of casualties by type/severity

	Hospitalisations	HTTL Hospitalisations	Reported Injuries	Fatalities
2006	453	147	-	43
2007	469	150	-	60
2008	567	149	840	47
2009	432	156	721	51
2010	473	145	767	34
2011	562	180	882	33
2012	511[a]	171[a]	775	40
2013	485[a]	166[a]	661	25
2014	-	-	639	35

Note: Hospitalisations and fatalities have since increased from 2015 to current.

Economic Impact of non-increasing heavy vehicle enforcement

The average cost of a life lost on a NSW road for the period 2011-2015 was $7.21 million.

The average cost of someone being seriously injured on a NSW road for the period 2011-15 was $289,417.

For the period 2011-2015 there was a five per cent increase in the number of serious injuries (matched) to 33,560 from 31,971. This cost to the community is $9.71 billion compared to $9.35 billion for the period 2006 to 2010.

Regional Areas Requiring Increased Heavy Vehicle Enforcement

The Illawarra and Hunter regions of NSW saw the highest increase in road fatalities and injuries.

There was a massive increase in the number of lives lost on the Oxley Highway in particular, from 11 to 25 in 2006-2010 and 2011-2015 respectively. To put it in perspective, that's up by a whopping 127.3%.

Crashes broken down based on posted speed limit

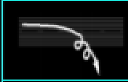
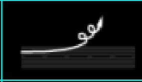
Fatal crashes

	≤ 50	60	70-80	≥ 90	Total
Involving a heavy rigid truck	10%	23%	18%	48%	100%
Involving an articulated truck	4%	11%	15%	70%	100%
Involving a light motor vehicle	11%	18%	20%	51%	100%
All fatal crashes	13%	19%	19%	49%	100%

Reported Injury crashes

	≤ 50	60	70-80	≥ 90	Total
Involving a heavy rigid truck	17%	32%	26%	24%	100%
Involving an articulated truck	8%	20%	24%	48%	100%
Involving a light motor vehicle	29%	36%	19%	16%	100%
All fatal crashes	30%	35%	19%	16%	100%

Single Vehicle Fatal Crash – Crash Type

Main category	Examples	
Off Path (Straight)		
Off Path (Curve)		
Other	 On Path–animal	

Single-vehicle casualty crashes—by crash type

	Off Path – Straight	Off Path – Curve	Other	Number of casualty crashes
Involving a heavy rigid truck	50%	39%	11%	693
Involving an articulated truck	43%	51%	5%	1,201
Involving a light 4-wheeled motor	54%	37%	9%	41,409
All SVC	53%	37%	10%	28,130

Single-vehicle casualty crashes—by crash type and SUA,

	SUA				Non-SUA				χ^2_2
	Off Path – Straight	Off Path – Curve	Other		Off Path – Straight	Off Path – Curve	Other		
Involving a heavy rigid truck	50%	28%	22%	100%	46%	42%	12%	100%	21 ***
Involving an articulated truck	41%	48%	12%	100%	41%	48%	11%	100%	0.2
Involving a light motor vehicle	56%	28%	16%	100%	44%	41%	15%	100%	960 ***
All SVC	56%	27%	17%	100%	41%	43%	16%	100%	1,925 ***

The continued high rate of Off-Path (**straight**) crashes involving heavy vehicles indicates high likelihood of fatigue based crashes. Other data in this report supports this theory.

Distance travelled vs registration rate of heavy vehicles

		Heavy rigid Involved		Articulated Involved		Passenger Car Involved	
		Single vehicle	All	Single vehicle	All	Single vehicle	All
	2006	0.24	2.50	2.93	19.95	-	-
	2007	0.20	2.71	4.17	19.62	-	-
	2008	0.36	2.79	2.91	16.30	0.33	0.74
	2009	0.23	2.35	3.57	14.90	0.32	0.76
	2010	0.22	2.16	1.82	14.92	0.28	0.69
	2011	0.19	1.89	2.09	14.42	0.25	0.61
	2012	0.16	2.64	2.05	14.09	0.24	0.62
	2013	0.12	1.96	0.88	9.79	0.22	0.54
	2014	0.21	2.31	1.70	10.76	0.20	0.52
	2015	0.18	2.23	1.90	10.53	-	-
% change per year	last 5 years	-2.5%	+1.4%	-3.5%	-8.2%	-8.6%	-7.2%
Trend		—	—	↘ ***	↘ ***	↘ ***	↘ ***

Rates of annual fatal crashes per kilometre travelled

	Greater Capital City			Rest of State		
	10^8 VKT	Fatal crashes	Rate per 10^8 VKT	10^8 VKT	Fatal crashes	Rate per 10^8 VKT
2008	4.5	46	1.0	4.4	35	0.8
2009	4.4	36	0.8	4.3	34	0.8
2010	4.5	35	0.8	4.5	29	0.6
2011	4.7	24	0.5	4.6	30	0.7
2012	4.8	32	0.7	4.7	47	1.0
2013	4.9	30	0.6	4.8	29	0.6
2014	5.0	40	0.8	4.9	35	0.7
Trend	↗ ***	—	—	↗ ***	—	—

Causality

Approximately 60 per cent of fatal crashes involving a heavy truck also involve a light vehicle.

Approximately 26 per cent involve a vulnerable road user (33 per cent for fatal heavy rigid crashes, and 21 per cent for fatal articulated crashes). A representative selection of published findings on critical pre-crash events follows:

• The large truck Crash Causation study (LTCCS 2005) states that in around 55 per cent of fatal crashes involving a heavy truck and a passenger vehicle, the critical factor was associated with the light vehicle. In two-vehicle crashes involving a large truck and a passenger vehicle (not necessarily fatal), the passenger vehicle was assigned the critical reason in 56 percent of the crashes and the large truck in 44 per cent.

• In the US DoT Large truck and bus Crash Facts (LTBCF 2013), the heavy truck's movements are coded as critical pre-crash events in approximately 23 per cent of fatal crashes.

• In a 2014 summary presentation on heavy truck safety produced by the NSW Centre for Road Safety (NSW 2014), key-vehicle status in fatal multi-vehicle heavy truck crashes was assigned to the truck in 18 per cent of cases.

• NTI (2015): In fatal crashes involving a truck and other vehicle, no fault was found for the truck driver in 84% of cases.

• The Australian Road Transport Suppliers Association (ARTSA 2015) presents a number of analyses of crashes involving heavy trucks ≥12t including fault and crash type.

4. Conclusion

Several factors have seemingly contributed to the continued increase in fatalities in NSW since 2014, especially those involving a heavy vehicle. Although no singular causal factor can be ascertained, it is clear that the increase in infrastructure build in NSW has led to dramatically higher freight on NSW roads. Commercial benefits from overloading heavy vehicles and heavy vehicle drivers driving longer than the allowed fatigue management laws allow are key factors which regulators should consider. As road freight has increased in NSW, there has not been a matching increase in heavy vehicle safety stations or other mechanisms to weigh overloaded heavy vehicles, and no increase in regulatory fatigue management cameras in NSW. This has also contributed to the fact that regional NSW has a higher proportion of road fatalities than metro NSW. Economically, the dramatic cost of a life lost on NSW roads far outweighs any potential regulatory cost increases incurred by the state.

Fatalities in regional NSW represent a disproportionate share of the NSW road toll, while serious, moderate, and minor injuries represent are larger proportion of casualties in the Sydney region. In 2011-15, 67.1 per cent of fatalities occurred in regional NSW. By comparison, 55 per cent of serious injuries in 2011-15 occurred in the Sydney region.

Additionally, it is imperative to note that although crashes heavy vehicles are over-represented in crashes, the data has shown that the heavy vehicle, or heavy vehicle driver is predominantly not at fault. This leads to the requirement for more stringent driver education for vulnerable vehicles (light vehicles etc), regarding how to drive within proximity of a heavy vehicle.

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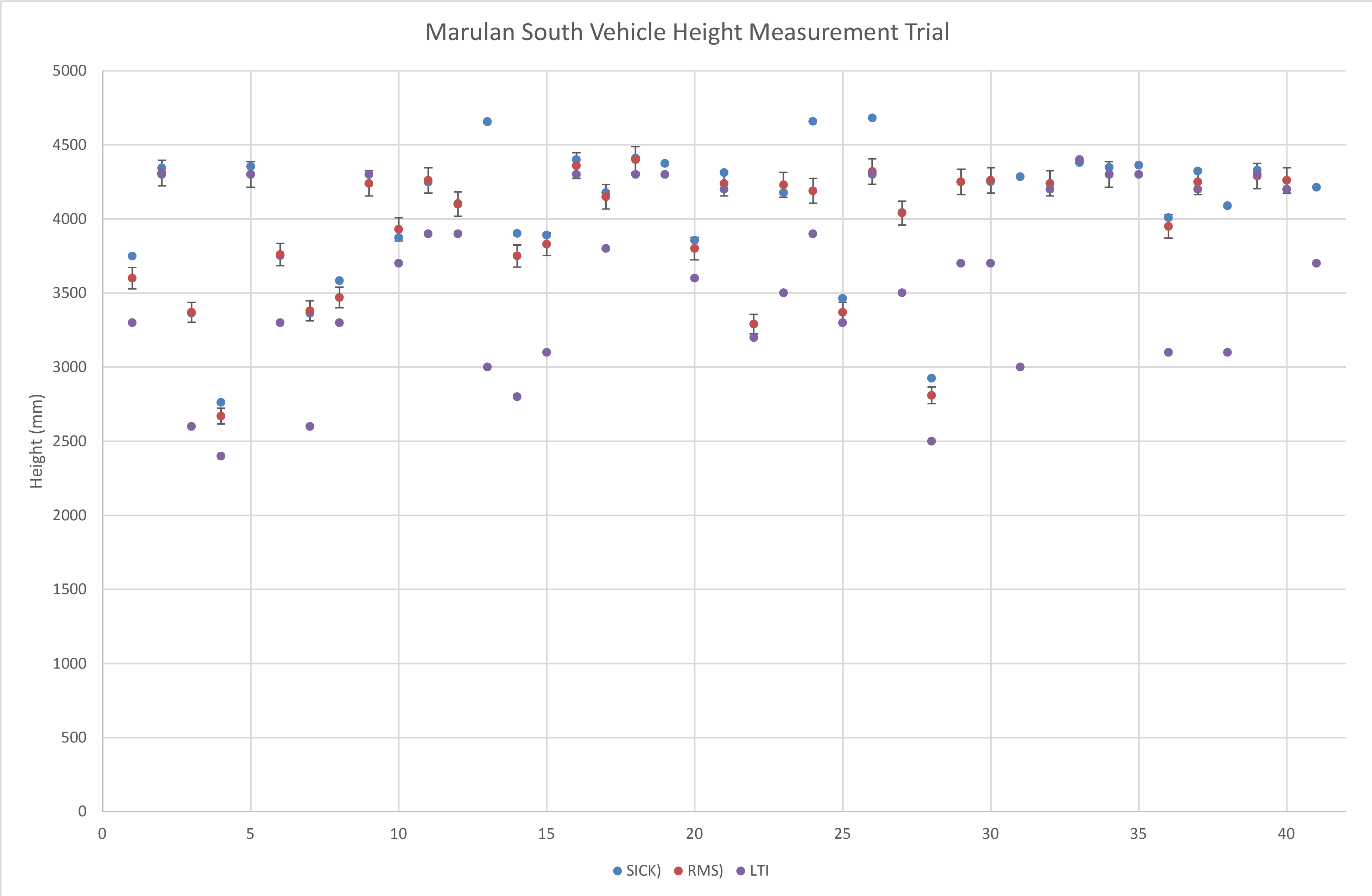
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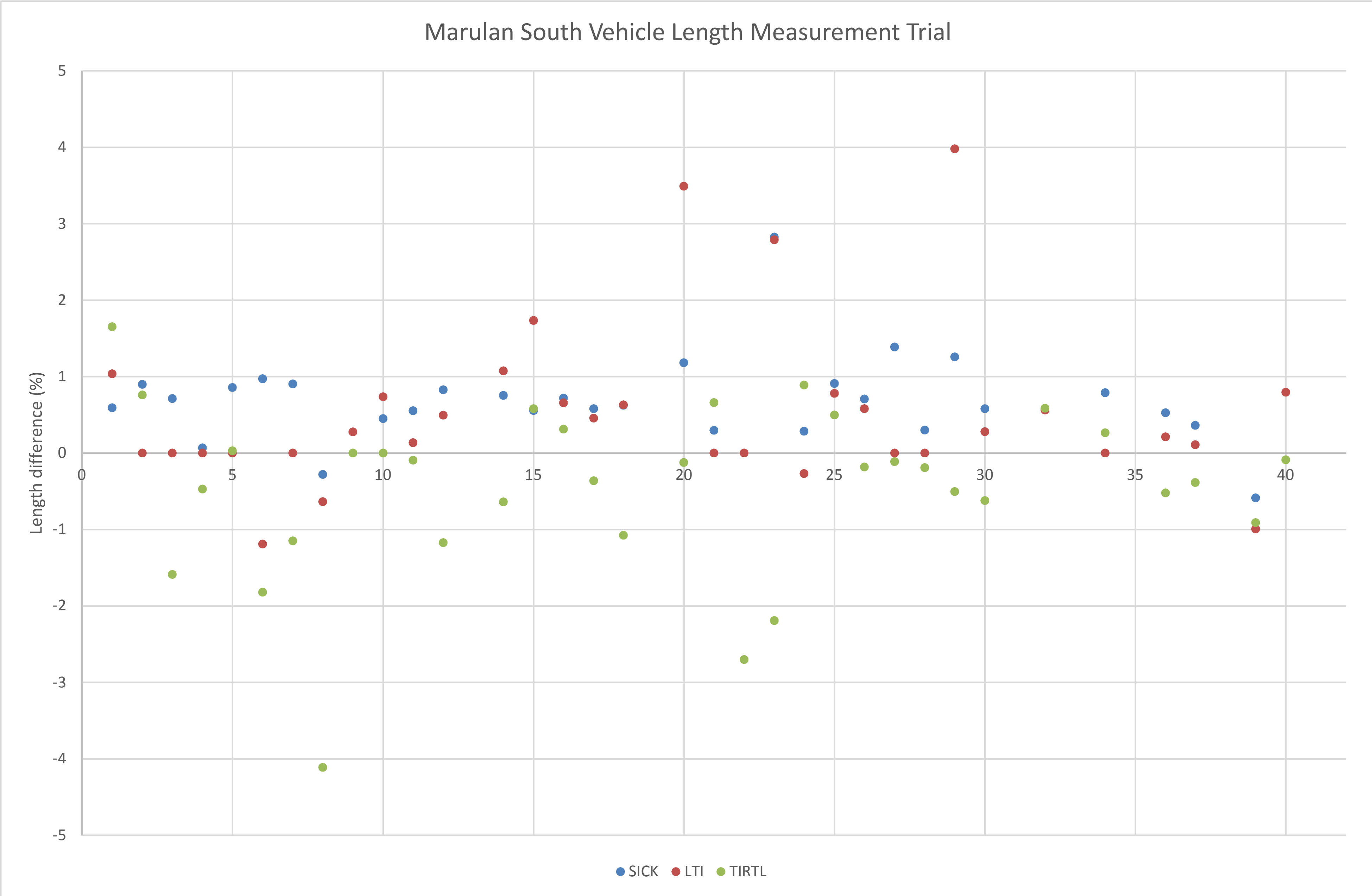

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3	2017-03-06 11:24:54	YZF196	3370	7300	3364	7352	52 (0.7%)	2600	7300	0 (0.0%)	7184	-116 (-1.6%)
4	2017-03-06 11:28:29	WPD354	2670	8900	2762	8906	6 (0.1%)	2400	8900	0 (0.0%)	8858	-42 (-0.5%)
5	2017-03-06 11:44:26	WX66AS	4300	25900	4354	26122	222 (0.9%)	4300	25900	0 (0.0%)	25907	7 (0.0%)
6	2017-03-06 11:52:44	YHI961	3760	16800	3752	16963	163 (1.0%)	3300	16600	-200 (-1.2%)	16494	-306 (-1.8%)
7	2017-03-06 11:57:52	CG95QI	3380	11300	3364	11402	102 (0.9%)	2600	11300	0 (0.0%)	11170	-130 (-1.2%)
8	2017-03-06 12:05:47	1IH1ES	3470	15700	3583	15656	-44 (-0.3%)	3300	15600	-100 (-0.6%)	15054	-646 (-4.1%)
9	2017-03-06 12:19:17	BW74TB	4240	18150				4300	18200	50 (0.3%)	18150	0 (0.0%)
10	2017-03-06 12:20:12	359DOG	3930	13600	3874	13661	61 (0.4%)	3700	13700	100 (0.7%)	13600	0 (0.0%)
11	2017-03-06 12:37:21	VV10JH	4260	14880	4248	14962	82 (0.6%)	3900	14900	20 (0.1%)	14866	-14 (-0.1%)
12	2017-03-06 12:51:40	BD03WC	4100	10150	4104	10234	84 (0.8%)	3900	10200	50 (0.5%)	10031	-119 (-1.2%)
13	2017-03-06 14:08:00	IFLOAT			4655	18866		3000	18900		18392	
14	2017-03-06 14:16:40	BJM930	3750	18600	3903	18740	140 (0.8%)	2800	18800	200 (1.1%)	18481	-119 (-0.6%)
15	2017-03-06 14:34:39	OUR9OH	3830	17300	3891	17396	96 (0.6%)	3100	17600	300 (1.7%)	17400	100 (0.6%)
16	2017-03-06 15:03:02	YUM952	4360	25930	4401	26116	186 (0.7%)	4300	26100	170 (0.7%)	26011	81 (0.3%)
17	2017-03-06 15:21:28	AQ05HA	4150	17620	4178	17722	102 (0.6%)	3800	17700	80 (0.5%)	17556	-64 (-0.4%)
18	2017-03-06 15:33:14	1JE4DT	4400	15900	4411	15999	99 (0.6%)	4300	16000	100 (0.6%)	15729	-171 (-1.1%)
19	2017-03-06 15:40:35	NV18ID			4375	25792		4300	25700		25623	
20	2017-03-06 15:44:37	ZAL738	3800	25510	3856	25811	301 (1.2%)	3600	26400	890 (3.5%)	25478	-32 (-0.1%)
21	2017-03-07 11:10:34	BB33RD	4240	17500	4313	17552	52 (0.3%)	4200	17500	0 (0.0%)	17615	115 (0.7%)
22	2017-03-07 11:16:43	CB43XS	3290	7400				3200	7400	0 (0.0%)	7200	-200 (-2.7%)
23	2017-03-07 11:16:48	BU32ZN	4230	11480	4178	11804	324 (2.8%)	3500	11800	320 (2.8%)	11228	-252 (-2.2%)
24	2017-03-07 11:32:55	BR16YS	4190	18550	4658	18603	53 (0.3%)	3900	18500	-50 (-0.3%)	18715	165 (0.9%)
25	2017-03-07 11:51:58	914VBK	3370	14090	3463	14218	128 (0.9%)	3300	14200	110 (0.8%)	14160	70 (0.5%)
26	2017-03-07 11:57:03	ZXI258	4320	17300	4682	17422	122 (0.7%)	4300	17400	100 (0.6%)	17268	-32 (-0.2%)
27	2017-03-07 11:57:10	CE03YE	4040	23600	4044	23927	327 (1.4%)	3500	23600	0 (0.0%)	23573	-27 (-0.1%)
28	2017-03-07 12:12:08	CG55UW	2810	11400	2925	11434	34 (0.3%)	2500	11400	0 (0.0%)	11378	-22 (-0.2%)
29	2017-03-07 12:16:27	979RYS	4250	17600	4250	17821	221 (1.3%)	3700	18300	700 (4.0%)	17511	-89 (-0.5%)
30	2017-03-07 12:29:24	NV85HD	4260	17950	4252	18054	104 (0.6%)	3700	18000	50 (0.3%)	17838	-112 (-0.6%)
31	2017-03-07 12:29:33	JTY004			4285	25091		3000	25200		24848	
32	2017-03-07 13:44:01	MEC400	4240	17800				4200	17900	100 (0.6%)	17904	104 (0.6%)
33	2017-03-07 13:45:33	1JI4HE			4380	25529		4400	25600		25271	
34	2017-03-07 13:55:28	NV87GQ	4300	25900	4348	26104	204 (0.8%)	4300	25900	0 (0.0%)	25968	68 (0.3%)
35	2017-03-07 14:02:36	ZRV309			4363	25425		4300	25300		25121	
36	2017-03-07 14:02:50	806WXU	3950	18960	4009	19060	100 (0.5%)	3100	19000	40 (0.2%)	18861	-99 (-0.5%)
37	2017-03-07 14:45:23	WDF093	4250	18580	4323	18647	67 (0.4%)	4200	18600	20 (0.1%)	18508	-72 (-0.4%)
38	2017-03-07 14:53:04	BU90MM			4089	18659		3100	18700		18532	
39	2017-03-07 14:54:00	1ER6VA	4290	19090	4329	18978	-112 (-0.6%)	4300	18900	-190 (-1.0%)	18916	-174 (-0.9%)
40	2017-03-07 15:19:02	BR01RE	4260	17660				4200	17800	140 (0.8%)	17644	-16 (-0.1%)
41	2017-03-07 15:32:29	DTC222			4213	19175		3700	19300		18990	

	SICK	LTI	TIRTL
1	0.590674	1.036269	1.647668
2	0.896175	0	0.759563
3	0.712329	0	-1.58904
4	0.067416	0	-0.47191
5	0.857143	0	0.027027
6	0.970238	-1.19048	-1.82143
7	0.902655	0	-1.15044
8	-0.28025	-0.63694	-4.11465
9		0.275482	0
10	0.448529	0.735294	0
11	0.551075	0.134409	-0.09409
12	0.827586	0.492611	-1.17241
13			
14	0.752688	1.075269	-0.63978
15	0.554913	1.734104	0.578035
16	0.717316	0.655611	0.312379
17	0.578888	0.45403	-0.36322
18	0.622642	0.628931	-1.07547
19			
20	1.179929	3.488828	-0.12544
21	0.297143	0	0.657143
22		0	-2.7027
23	2.8223	2.787456	-2.19512
24	0.285714	-0.26954	0.889488
25	0.908446	0.780696	0.496806
26	0.705202	0.578035	-0.18497
27	1.385593	0	-0.11441
28	0.298246	0	-0.19298
29	1.255682	3.977273	-0.50568
30	0.579387	0.278552	-0.62396
31			
32		0.561798	0.58427
33			
34	0.787645	0	0.262548
35			
36	0.527426	0.21097	-0.52215
37	0.360603	0.107643	-0.38751
38			
39	-0.58669	-0.99529	-0.91147
40		0.792752	-0.0906
41			

File Size:
44,172

File Type:
Microsoft 2007 Excel Spreadsheet

GUID:
17d35995-1679-4ade-b2e8-c7fb8d834dc5

Item Date:
Monday, November 26, 2018 at 11:51:02 AM Australian Eastern Daylight Time

MD5 Digest:
0caa75c00e40b101bd6e13d927317336

Path Name:
/E18-0281-AS-4-4-PR-0008/E18-0281-AS-4-4-PR-0008.E01/[Unnamed Disk Image]/[Unnamed Partition]/[File System Root]

Shannon Entropy:
7.702159683763014

Property Source:
E18-0281-AS-4-4-PR-0008

AppName:
Microsoft Excel

AppVersion:
15.0300

Created:
Wednesday, March 8, 2017 at 5:00:29 PM Australian Eastern Daylight Time

DocSecurity:
0

EntryCount:
41

Excel Freeze Panes:
false

Excel Hidden Columns:
false

Excel Hidden Rows:
false

Excel Hidden Sheets:
false

Excel Hidden Sheets Count:
0

Excel Hidden Workbook:
false

Excel Pivot Tables:
false

Excel Print Areas:
false

Excel Protected Sheets:
false

Excel Very Hidden Sheets:
false

Excel Very Hidden Sheets Count:
0

FAT Directory Index:
176

FAT Short File Name:
RMS002~2.XLS

File Accessed:
Thursday, November 29, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Monday, November 26, 2018 at 11:51:01 AM Australian Eastern Daylight Time

File Modified:
Monday, November 26, 2018 at 11:51:02 AM Australian Eastern Daylight Time

File Offset:
17,006,592

File Start Cluster:
581

File Start Sector:
33,216

HyperlinksChanged:
false

Last Printed:
Friday, March 10, 2017 at 11:01:02 AM Australian Eastern Daylight Time

Last Saved:
Friday, March 10, 2017 at 11:04:55 AM Australian Eastern Daylight Time

LinksUpToDate:
false

MS-DOS Archive:
true

MS-DOS Hidden:
false

MS-DOS Read-only:
false

MS-DOS System:
false

Name:
RMS002 - measurements v2 - Copy.xlsx

Physical Start Sector:
33,248

Scale Crop:
false

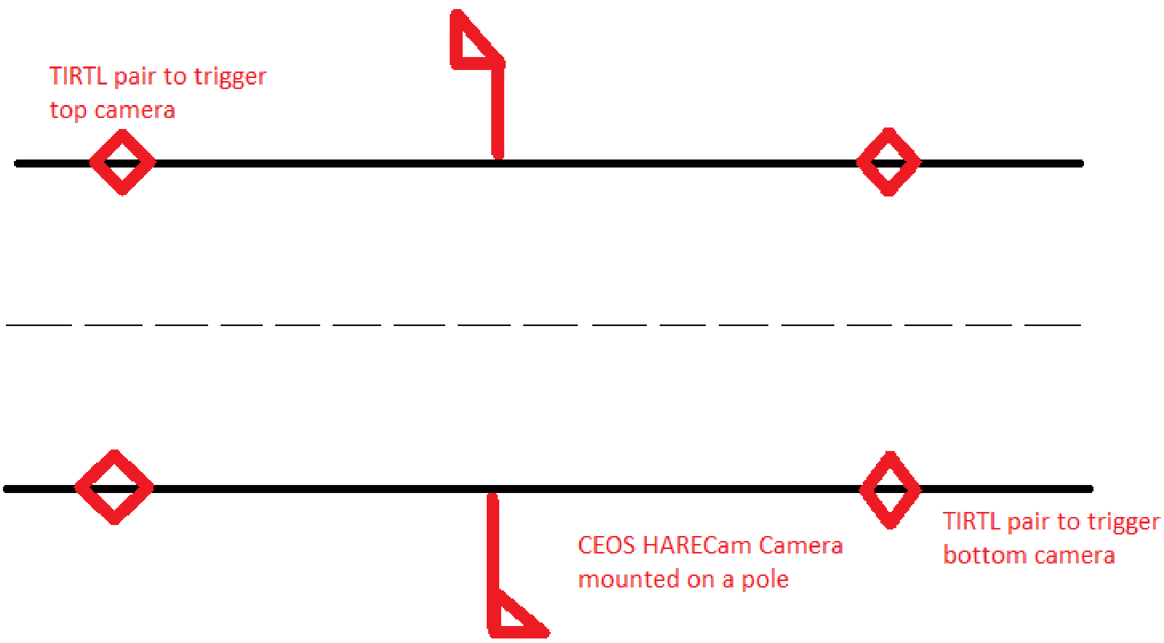
Shared Doc:
false

1) **Information Gathering:** Anywhere on Picton Rd is a suitable location. No STC sites exist in the area.
2) **Propose and design new fixed (permanently mounted on the road-side) camera solutions:**

Install:

1) 2 CEOS HARECAM's on a pole. Each capturing a single direction of traffic. Ie/2 cameras will capture both traffic directions.
2) 2 pair's of CEOS TIRTL's – 1 pair required to trigger each camera.

   Note for power and communications: If there is no fixed power anywhere on Picton Rd, use a portable TIRTL which uses batteries and/or solar panels. If there is insufficient 3g/4g, data can be stored locally on the HARECam and collected at intervals when batteries are replaced.



3) **Deploy/Install**:
   C.I.C Engineering to install entire solution. Chris Patterson: 0401714236

   1) Maintenance: CIC required to visit site at regular intervals to replace batteries if the installation site does not have fixed power(ie/ if the cameras and TIRTL's are running off batteries)

4) **Analysis**
   a. Collect data after 3 months and list in a table for each vehicle sighted:

   Time, ANPR, HV class and the prime mover image

5) **Detailed Scoping Study Report:**
   to be commenced after data collection

File Size:
27,883

File Type:
Microsoft 2007 Word Document

GUID:
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Item Date:
Thursday, November 22, 2018 at 2:19:30 PM Australian Eastern Daylight Time

MD5 Digest:
ecaff2dd8b069207f92ade5d04af3377

Path Name:
/E18-0281-AS-4-4-PR-0008/E18-0281-AS-4-4-PR-0008.E01/[Unnamed Disk Image]/[Unnamed Partition]/[File System Root]

Shannon Entropy:
7.59451415497661

Property Source:
E18-0281-AS-4-4-PR-0008

AppName:
Microsoft Office Word

AppVersion:
15.0000

Char Count:
986

CharactersWithSpaces:
1,156

Contains Hidden Text:
false

Contains Track Changes:
false

Contains White Text:
false

Created:
Thursday, November 22, 2018 at 1:55:00 PM Australian Eastern Daylight Time

DocSecurity:
0

EntryCount:
13

FAT Directory Index:
160

FAT Short File Name:
PROJEC~2.DOC

File Accessed:
Tuesday, November 27, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Thursday, November 22, 2018 at 2:13:52 PM Australian Eastern Daylight Time

File Modified:
Thursday, November 22, 2018 at 2:19:30 PM Australian Eastern Daylight Time

File Offset:
18,825,216

File Start Cluster:
692

File Start Sector:
36,768

HyperlinksChanged:
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Last Saved:
Thursday, November 22, 2018 at 2:19:00 PM Australian Eastern Daylight Time

Lines:
8

LinksUpToDate:
false

MS-DOS Archive:
true

MS-DOS Hidden:
false

MS-DOS Read-only:
false

MS-DOS System:
false

Name:
Project Plan 19 - Copy.docx

Page Count:
1

Paragraphs:
2

Physical Start Sector:
36,800

Scale Crop:
false

Shared Doc:
false

Template:
Normal.dotm

TotalTime:
19

Word Count:
172

Note: Desktop exercise draft completed for RMS using RMS's scales they had on stock and previous data for HAENNI. Draft Hard copy sent.

<u>Project Plan for full comprehensive side-by-side comparison of static scales to be completed before 2020:</u>

1) **Procurement**:
    - **a.** PAT/IRD 15CIII – 6 scales. Confirm with IRD who local distributor are? No online information.
    - **b.** HAENNI WL103 – 6 scales. No NSW distributor. Confirm whether HAENNI in QLD can supply.
    - **c.** Intercomp LP600™ Low-Profile Wheel Load Scales – 6 scales. Accuweigh are the local distributor.

2) **trial at RMS recommended site in 2019:**
    - a. Confirm with RMS which site they would like this solution trialled at.

3) **Collect required data**. Note: do not keep sensitive information such as vehicle regos.

4) **Report on results.**

File Size:
13,806

File Type:
Microsoft 2007 Word Document

GUID:
8d927154-969a-41dc-96d3-6d7eba0aae36

Item Date:
Monday, November 26, 2018 at 11:49:02 AM Australian Eastern Daylight Time

MD5 Digest:
c14553d18c0a5030ac14008feef011e7

Path Name:
/E18-0281-AS-4-4-PR-0008/E18-0281-AS-4-4-PR-0008.E01/[Unnamed Disk Image]/[Unnamed Partition]/[File System Root]

Shannon Entropy:
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Property Source:
E18-0281-AS-4-4-PR-0008

AppName:
Microsoft Office Word

AppVersion:
15.0000

Char Count:
726

CharactersWithSpaces:
852

Contains Hidden Text:
false

Contains Track Changes:
false

Contains White Text:
false

Created:
Monday, November 26, 2018 at 10:46:00 AM Australian Eastern Daylight Time

DocSecurity:
0

EntryCount:
12

FAT Directory Index:
164

FAT Short File Name:
PR9E1B~1.DOC

File Accessed:
Thursday, November 29, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Monday, November 26, 2018 at 11:49:00 AM Australian Eastern Daylight Time

File Modified:
Monday, November 26, 2018 at 11:49:02 AM Australian Eastern Daylight Time

File Offset:
16,957,440

File Start Cluster:
578

File Start Sector:
33,120

HyperlinksChanged:
false

Last Saved:
Monday, November 26, 2018 at 11:48:00 AM Australian Eastern Daylight Time

Lines:
6

LinksUpToDate:
false

MS-DOS Archive:
true

MS-DOS Hidden:
false

MS-DOS Read-only:
false

MS-DOS System:
false

Name:
Project Plan 15 - Copy.docx

Page Count:
1

Paragraphs:
1

Physical Start Sector:
33,152

Scale Crop:
false

Shared Doc:
false

Template:
Normal.dotm

TotalTime:
23

Word Count:
127

Project Plan for new HAENNI Dynamic weighing Solution:

1) **Procure:**
    a. HAENNI: New dynamic solution – Wheel Load Strip Sensor WL 400

2) **trial at RMS recommended site in 2018:**
    a. Confirm with RMS which site they would like this solution trialled at.

3) **Collect required data**. Note: do not keep sensitive information such as vehicle regos.
4) Report on results.

Note: Project 11 OR 13 was not progressed by RMS.

File Size:
12,712

File Type:
Microsoft 2007 Word Document

GUID:
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Item Date:
Monday, November 26, 2018 at 11:49:40 AM Australian Eastern Daylight Time

MD5 Digest:
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Path Name:
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Shannon Entropy:
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Property Source:
E18-0281-AS-4-4-PR-0008

AppName:
Microsoft Office Word

AppVersion:
15.0000

Char Count:
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CharactersWithSpaces:
397

Contains Hidden Text:
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Contains Track Changes:
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Contains White Text:
false

Created:
Monday, November 26, 2018 at 11:02:00 AM Australian Eastern Daylight Time

DocSecurity:
0

EntryCount:
12

FAT Directory Index:
172

FAT Short File Name:
PROJEC~1.DOC

File Accessed:
Thursday, November 29, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Monday, November 26, 2018 at 11:49:39 AM Australian Eastern Daylight Time

File Modified:
Monday, November 26, 2018 at 11:49:40 AM Australian Eastern Daylight Time

File Offset:
16,973,824

File Start Cluster:
579

File Start Sector:
33,152

HyperlinksChanged:
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Last Saved:
Monday, November 26, 2018 at 11:06:00 AM Australian Eastern Daylight Time

Lines:
2

LinksUpToDate:
false

MS-DOS Archive:
true

MS-DOS Hidden:
false

MS-DOS Read-only:
false

MS-DOS System:
false

Name:
Project Plan 11 or 13 - Copy.docx

Page Count:
1

Paragraphs:
1

Physical Start Sector:
33,184

Scale Crop:
false

Shared Doc:
false

Template:
Normal.dotm

TotalTime:
2

Word Count:
59

Technology Option 1:

New model (with vehicle trigger) Optris Thermal Camera distributed by “temperature control systems”.

Technology Option 2:

IMC(industrial monitoring and control) – Purchase FLIR thermal camera with NEW housing, or alternatively just their NEWEST MODEL **untested** recommended thermal camera(without housing) for vehicle speeds up to 10km/h.

Tim Snell: 1300 870 588

Installation:

Install at Orchard Hills(near penrith) on-road enforcement bay(round hole already cut into the ground to fit the FLIR camera housing and cabling)

Or

picton rd on-road enforcement bay.

File Size:
12,060

File Type:
Microsoft 2007 Word Document

GUID:
c47b4d8f-fddc-493d-921a-c007ddeaad72

Item Date:
Thursday, November 22, 2018 at 2:32:06 PM Australian Eastern Daylight Time

MD5 Digest:
0a95c334d2af62505248a62c626ee6f1

Path Name:
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Shannon Entropy:
7.121792263145543

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AppName:
Microsoft Office Word

AppVersion:
15.0000

Char Count:
497

CharactersWithSpaces:
583

Contains Hidden Text:
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Contains Track Changes:
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Contains White Text:
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Created:
Thursday, November 22, 2018 at 2:20:00 PM Australian Eastern Daylight Time

DocSecurity:
0

EntryCount:
11

FAT Directory Index:
168

FAT Short File Name:
PROJEC~3.DOC

File Accessed:
Tuesday, November 27, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Thursday, November 22, 2018 at 2:32:05 PM Australian Eastern Daylight Time

File Modified:
Thursday, November 22, 2018 at 2:32:06 PM Australian Eastern Daylight Time

File Offset:
18,874,368

File Start Cluster:
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File Start Sector:
36,864

HyperlinksChanged:
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Last Saved:
Thursday, November 22, 2018 at 2:31:00 PM Australian Eastern Daylight Time

Lines:
4

LinksUpToDate:
false

MS-DOS Archive:
true

MS-DOS Hidden:
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MS-DOS Read-only:
false

MS-DOS System:
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Name:
Project Plan 16 - Copy.docx

Page Count:
1

Paragraphs:
1

Physical Start Sector:
36,896

Scale Crop:
false

Shared Doc:
false

Template:
Normal.dotm

TotalTime:
11

Word Count:
87

AZH CONSULTING
PTY LTD

TIRTL & Thermal scanner integration

Contents

AZH CONSULTING PTY LTD

1 . Purpose

This report details the trial conducted for the Roads & Maritime Services (RMS), which tested the efficacy of integrating stand-alone thermal scanner and a stand-alone vehicle detection method. The hardware is installed at Mt Ousley Rd south-bound, before an on-road enforcement bay.

Mt Ousley Rd south bound is notorious for accidents, predominantly related to to its steep downhill slope causing some vehicles braking systems to fail and/or exceed their maximum temperature utilisation making them perform poorly.

Currently the inspection of vehicles at the on-road enforcement bay is on a randomised basis. Each vehicle inspection takes around thirty minutes and the number of vehicles inspected is a very small percentage of the total vehicles travelling on the road. The purpose of this report is to assess whether an integrated thermal camera and vehicle detection sensor can quickly assess whether a vehicle has potentially defective brakes to enable RMS inspectors to intercept and inspect the vehicle before an accident occurs.

At the time of writing this document, no 'turnkey' solution exists which has an integrated thermal scanner and vehicle detection method, hence these recent trials to assess which product could be developed into an automated solution.

An automated thermal inspection system will allow trucks with potential defects to be identified for manual inspection. This would allow the inspectors' time to be used more effectively, by allowing targeted rather than random inspections to take place.

The methods used and the results of the trial are summarised within this report, along with a summary of how the technology can be applied for automated inspection.

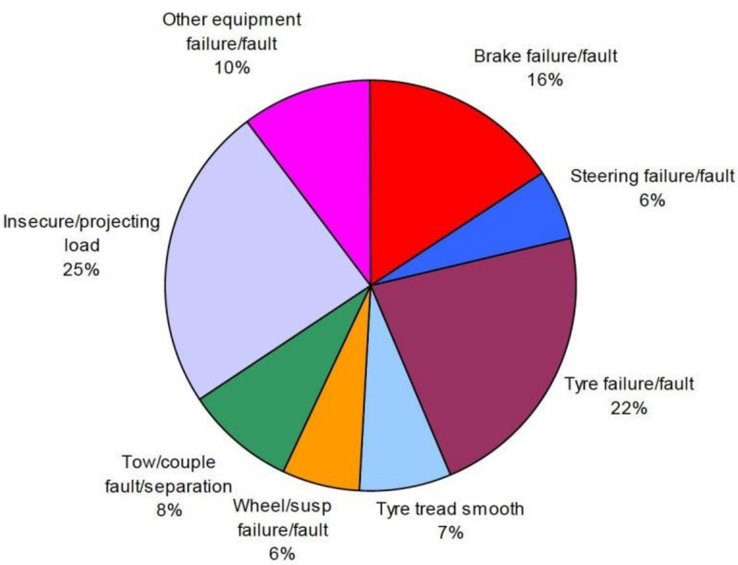
2 . Background

During the 12 months to the end of June 2016, 208 people died from 182 fatal crashes involving heavy trucks or buses. These included:

- 111 deaths from 96 crashes involving articulated trucks
- 79 deaths from 68 crashes involving heavy rigid trucks
- 25 deaths from 22 crashes involving buses.

Statistics published January 2014 show that one in seven (15%) single heavy vehicle crashes had an equipment failure reported for that truck. Of these faults, brake failure made up 16%, tyre failure made up 22% and wheel/suspension failure made up 6% of documented incidents. Thermal imaging has the potential to detect these types of faults, which equate to 44% of total equipment related failures.

Heavy Trucks in Single Vehicle Crashes with Equipment Factor, 2010 to 2012,Type of Vehicle Equipment Factor



3 . Technology and Theory

Thermal imaging cameras, such as the optris thermal camera, detect and display differences in temperatures by detecting the intensity of thermal radiation. The raw sensor data from the camera is sent to an industrial processor, over Ethernet connection, where the processor assesses and analyses the images, in real-time.

Preliminary investigations have determined that conditions such as malfunctioning brakes, overheated bearings and other tire risks, can be detected by thermal anomalies that are identifiable by the thermal imaging camera. For example, defective or non-functioning brakes are typically colder than a vehicle's operational brakes. This difference is clearly visible on a thermal image.

4 . Method

For this trial, RMS installed the camera after a VMS(variable message sign) – to enable access to power. It was approximately 500m before an on-road inspection bay which we believe is not an ideal distance to allow safe interception of vehicles. This is due to the steep gradient of the road, and heavy vehicles especially would require at least 800m stopping distance for a safe interception.

At the time of this trial, the Mt Ousley Rd on-road south bound site was closed due to other unrelated WHS concerns. This meant that no vehicles were allowed to be intercepted to perform inspections.

Tests were performed to determine the success or lack thereof of the integration of the TIRTL with this Optris thermal camera. More specifically, if these two technologies are a good 'fit' for further development of an automated thermal camera screening system.

A successful result would show that the TIRTL successfully:

1. detected 95%+ of vehicles passing the thermal camera in both lane 1 and lane 2
2. triggered the thermal camera to capture an image of the vehicle's wheel/brake on 95%+ of detections.
3. The temperature was recorded of each wheel/brake for 95%+ of detections.
4. the above could occur at speeds up to 80km/h.

5 . Results

1. detected 95%+ of vehicles passing the thermal camera in both lane 1 and lane 2:
   a. Results:

Lane 1 Detection Rate	Lane 2 Detection Rate
80%	10%

Manual matching of the visual output and actual vehicles sighted showed poor detection rates, particularly for lane 2 due to most vehicles in lane 2 being 'hidden' behind vehicles travelling in lane 1.

2. Triggered the thermal camera to capture an image of the vehicle's wheel/brake on 95%+ of detections.
   a. Results:

Lane 1 Trigger Rate	Lane 2 Trigger Rate
90%	90%

Manual matching of the visual output and actual vehicles sighted showed good overall trigger rates of the TIRTL correctly triggering the thermal camera. However, due to varying speeds of vehicles passing (30km/k – 100km/h), the brakes/wheel of the majority of vehicles was not actually captured in frame. Ie/ the timing of the trigger needs to be enhanced for varying vehicle speeds.

3. The temperature was recorded of each wheel/brake for 95%+ of detections.
   a. Results:

Lane 1 Temperature Recorded	Lane 2 Temperature Recorded
10%	2%

Manual matching of the visual output and actual vehicles sighted showed very poor temperature detection. This is due to, as mentioned above, incorrect trigger timing of the thermal camera. Further software and hardware development would be required to enhance this variable to allow correct trigger times. Additionally, as vehicle speeds increased, as too did the inaccuracy of the trigger.

4. The above could occur at speeds up to 80km/h.
   a. Results:

Lane 1 Maximum Speed	Lane 2 Maximum Speed
20km/h	20km/h

The results here show that this model of the Optris thermal camera is not capable of capturing the required vehicle speeds on Mt Ousley Rd. Other models should be considered for highways. This model could potentially be used for very slow moving traffic such as in on-road enforcement bays.

9

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6 . Conclusion

Although thermal imaging technology can effectively identify truck brake issues when monitoring the side of a vehicle, this integrated solution did not pass efficacy. However, it should be noted that this type of integration of a thermal scanner and a vehicle detection system has not been attempted or tested anywhere else in Australia, and possible globally and warrants further investigation into other models and integrations which could enable an automated thermal imaging camera solution to detect faulty/defective brakes and tyres on vehicles.

Further, Truck speed has a significant impact on image quality. Selecting a suitable camera for each installation location will be important to ensure accurate results.

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File Size:
138,374

File Type:
Microsoft 2007 Word Document

GUID:
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Thursday, November 22, 2018 at 12:52:50 PM Australian Eastern Daylight Time

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Shannon Entropy:
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Property Source:
E18-0281-AS-4-4-PR-0008

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Microsoft Office Word

AppVersion:
15.0000

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Created:
Monday, November 19, 2018 at 1:26:00 PM Australian Eastern Daylight Time

DocSecurity:
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EntryCount:
26

FAT Directory Index:
399

FAT Short File Name:
SC9AB7~1.DOC

File Accessed:
Tuesday, November 27, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Thursday, November 22, 2018 at 12:52:49 PM Australian Eastern Daylight Time

File Modified:
Thursday, November 22, 2018 at 12:52:50 PM Australian Eastern Daylight Time

File Offset:
24,002,560

File Start Cluster:
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File Start Sector:
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Monday, November 19, 2018 at 2:06:00 PM Australian Eastern Daylight Time

Lines:
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LinksUpToDate:
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MS-DOS Archive:
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MS-DOS Hidden:
false

MS-DOS Read-only:
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MS-DOS System:
false

Name:
Scoping Study 3 - Copy.docx

Page Count:
9

Paragraphs:
15

Physical Start Sector:
46,912

Scale Crop:
false

Shared Doc:
false

Template:
Normal.dotm

TotalTime:
40

Word Count:
1,151

INVOICE

AZH CONSULTING PTY LTD

AZH Consulting Pty Ltd

ABN: 22615844954

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Email: manager@azhconsulting.com.au

Attn: Jai Singh
Client: Roads And Maritime Services
PO Reference # : **4200006093**
Invoice # : RMS001
Quote # : RMS001
Date of Issue: 02/02/2017
Payment due by: 02/03/2017

Invoice for *IMC/FLIR Thermal Camera Field Trial and Scoping Study*

Service/Goods Description	Quantity	Price	Total
Field Trial at RMS selected site(s): FLIR A615 brake & tyre compliance scanner. Scoping Study – FLIR A615 brake & tyre compliance scanner. With the understanding that RMS is currently investigating automated thermal scanning technologies to detect potentially defective heavy vehicle axles (tyres, brakes and wheel hubs).	**1**	**$29,000 excluding GST**	**$29,000 excluding GST**
		GST	**$2,900**
		Sub-Total	**$31,900**

Payment Details:
Bank Transfer: AZH Consulting Pty Ltd, BSB 032108, A/C 141389
Payment Advice: Please email payment details (including date and amount) to manager@azhconsulting.com.au
Cheque/money order: Please mail your order payable to AZH Consulting Pty Ltd, PO Box 235, Castle Hill, NSW 1765

File Size:
125,366

File Type:
Portable Document Format

GUID:
851cd36e-0ba0-4a3a-84b7-3f4c6c0de264

Item Date:
Friday, November 16, 2018 at 7:38:28 PM Australian Eastern Daylight Time

MD5 Digest:
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Application Created:
Tuesday, January 31, 2017 at 1:31:37 PM Australian Eastern Daylight Time

Application Modified:
Tuesday, January 31, 2017 at 1:31:37 PM Australian Eastern Daylight Time

FAT Directory Index:
90

FAT Short File Name:
RMS001~1.PDF

File Accessed:
Monday, November 19, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Monday, November 19, 2018 at 11:56:08 AM Australian Eastern Daylight Time

File Modified:
Friday, November 16, 2018 at 7:38:28 PM Australian Eastern Daylight Time

File Offset:
15,728,640

File Start Cluster:
503

File Start Sector:
30,720

MS-DOS Archive:
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MS-DOS Hidden:
false

MS-DOS Read-only:
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MS-DOS System:
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Name:
RMS001 IMC FLIR Thermal Camera Field Trial and Scoping Study.pdf

Page Count:
1

PDF Certification Level:
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PDF Contains Annotations:
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PDF Contains Comments:
false

PDF Creator:
Microsoft® Word 2016

PDF Encryption Level:
None

PDF Images JPEG:
1

PDF Javascript Present:
false

PDF Metadata Encrypted:
false

PDF Portfolio:
false

PDF Producer:
Microsoft® Word 2016

PDF Version:
5

Physical Start Sector:
30,752

INVOICE

AZH CONSULTING PTY LTD

AZH Consulting Pty Ltd

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Attn: Jai Singh
Client: Roads And Maritime Services
PO Reference # : **4200006283**
Invoice # : RMS003
Quote # : RMS003
Date of Issue: 27/03/2017
Payment due by: 27/04/2017

Invoice for *TIRTL & Optris thermal scanner integration field trial and scoping study*

Service/Goods Description	Quantity	Price	Total
Field Trial at Mt Ousley Road South-Bound: TIRTL & Optris thermal scanner integration field trial and scoping study.	**1**	**$30,000 excluding GST**	**$30,000 excluding GST**
Scoping Study: TIRTL & Optris thermal scanner integration trial. With the understanding that RMS is currently investigating automated thermal scanning technologies to detect potentially defective heavy vehicle axles (tyres, brakes and wheel hubs) at Mt Ousley Road South-Bound.			
		GST	**$3000**
		Sub-Total	**$33,000**

Payment Details:
Bank Transfer: AZH Consulting Pty Ltd, BSB 032108, A/C 141389
Payment Advice: Please email payment details (including date and amount) to manager@azhconsulting.com.au
Cheque/money order: Please mail your order payable to AZH Consulting Pty Ltd, PO Box 235, Castle Hill, NSW 1765

File Size:
22,384

File Type:
Portable Document Format

GUID:
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Item Date:
Friday, November 16, 2018 at 7:40:08 PM Australian Eastern Daylight Time

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Application Created:
Wednesday, March 29, 2017 at 12:55:55 PM Australian Eastern Daylight Time

Application Modified:
Wednesday, March 29, 2017 at 12:55:55 PM Australian Eastern Daylight Time

Author:
Zoe hamidi

FAT Directory Index:
105

FAT Short File Name:
RMS003~1.PDF

File Accessed:
Monday, November 19, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Monday, November 19, 2018 at 11:56:08 AM Australian Eastern Daylight Time

File Modified:
Friday, November 16, 2018 at 7:40:08 PM Australian Eastern Daylight Time

File Offset:
15,941,632

File Start Cluster:
516

File Start Sector:
31,136

MS-DOS Archive:
true

MS-DOS Hidden:
false

MS-DOS Read-only:
false

MS-DOS System:
false

Name:
RMS003 TIRTL & Optris thermal scanner integration field trial and scoping study.pdf

Page Count:
1

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Not Certified

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PDF Contains Comments:
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PDF Creator:
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PDF Encryption Level:
None

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1

PDF Javascript Present:
false

PDF Metadata Encrypted:
false

PDF Portfolio:
false

PDF Producer:
Microsoft® Word 2013

PDF Version:
5

Physical Start Sector:
31,168

INVOICE

AZH CONSULTING
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Attn:	Jai Singh
Client:	Roads And Maritime Services
PO Reference # :	**4200006306**
Invoice # :	RMS004
Quote # :	RMS004
Date of Issue:	27/03/2017
Payment due by:	27/04/2017

Invoice for *TIRTL & LTI dimension scanner integration field trial and scoping study*

Service/Goods Description	Quantity	Price	Total
Field Trial at RMS selected site(s): TIRTL & LTI dimension scanner integration field trial and scoping study.	**1**	**$30,000 excluding GST**	**$30,000 excluding GST**
Scoping Study – TIRTL & LTI dimension scanner integration field trial and scoping study. With the understanding that RMS is currently investigating automated vehicle over-dimension screening technologies to enforce heavy vehicle over-dimension regulations in NSW.			
		GST	**$3000**
		Sub-Total	**$33,000**

Payment Details:
Bank Transfer: AZH Consulting Pty Ltd, BSB 032108, A/C 141389
Payment Advice: Please email payment details (including date and amount) to manager@azhconsulting.com.au
Cheque/money order: Please mail your order payable to AZH Consulting Pty Ltd, PO Box 235, Castle Hill, NSW 1765

File Size:
184,739

File Type:
Portable Document Format

GUID:
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Friday, November 16, 2018 at 7:41:36 PM Australian Eastern Daylight Time

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Application Created:
Thursday, February 9, 2017 at 12:02:28 PM Australian Eastern Daylight Time

Application Modified:
Thursday, February 9, 2017 at 12:02:28 PM Australian Eastern Daylight Time

Author:
Zoe hamidi

FAT Directory Index:
113

FAT Short File Name:
RMS004~1.PDF

File Accessed:
Monday, November 19, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Monday, November 19, 2018 at 11:56:08 AM Australian Eastern Daylight Time

File Modified:
Friday, November 16, 2018 at 7:41:36 PM Australian Eastern Daylight Time

File Offset:
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File Start Sector:
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MS-DOS Read-only:
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RMS004 TIRTL & LTI dimension scanner integration field trial and scoping study.pdf

Page Count:
1

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PDF Metadata Encrypted:
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PDF Portfolio:
false

PDF Producer:
www.ilovepdf.com

PDF Version:
7

Physical Start Sector:
31,232

INVOICE

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Attn:	Jai Singh
Client:	Roads And Maritime Services
PO Reference # :	**4200006324**
Invoice # :	RMS005
Quote # :	RMS005
Date of Issue:	03/04/2017
Payment due by:	03/05/2017

Invoice for *TIRTL & WIM integration field trial and scoping study*

Service/Goods Description	Quantity	Price	Total
Field Trial at RMS selected site(s): TIRTL & WIM integration field trial and scoping study			
Scoping Study – TIRTL & WIM integration field trial and scoping study. With the understanding that RMS is integrating mass screening devices(WIM's) with the TIRTL devices to enhance and improve vehicle classification and mass screening at HVSS's.	**1**	**$28,000 excluding GST**	**$28,000 excluding GST**
		GST	**$2,800**
		Sub-Total	**$30,800**

Payment Details:
Bank Transfer: AZH Consulting Pty Ltd, BSB 032108, A/C 141389
Payment Advice: Please email payment details (including date and amount) to manager@azhconsulting.com.au
Cheque/money order: Please mail your order payable to AZH Consulting Pty Ltd, PO Box 235, Castle Hill, NSW 1765

File Size:
187,657

File Type:
Portable Document Format

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Item Date:
Friday, November 16, 2018 at 7:40:46 PM Australian Eastern Daylight Time

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Shannon Entropy:
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Application Created:
Thursday, February 9, 2017 at 12:10:19 PM Australian Eastern Daylight Time

Application Modified:
Thursday, February 9, 2017 at 12:10:19 PM Australian Eastern Daylight Time

Author:
Zoe hamidi

FAT Directory Index:
119

FAT Short File Name:
RMS005~1.PDF

File Accessed:
Monday, November 19, 2018 at 12:00:00 AM Australian Eastern Daylight Time

File Created:
Monday, November 19, 2018 at 11:56:08 AM Australian Eastern Daylight Time

File Modified:
Friday, November 16, 2018 at 7:40:46 PM Australian Eastern Daylight Time

File Offset:
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File Start Cluster:
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File Start Sector:
31,584

MS-DOS Archive:
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MS-DOS Hidden:
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MS-DOS System:
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Name:
RMS005 TIRTL & WIM integration field trial and scoping study.pdf

Page Count:
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PDF Encryption Level:
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PDF Images JPEG:
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PDF Producer:
www.ilovepdf.com

PDF Version:
7

Physical Start Sector:
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