



THE NEXT GENERATION OF SAFETY

The World's 1<sup>st</sup> Autonomous TMA Truck

THERE ARE **764 DEATHS PER YEAR** IN WORK ZONES

Source: Fatality Analysis Reporting System (FARS) 2016 ARF, NHTSA

*Royal*   
TRUCK & EQUIPMENT INC.  
**PRESENTS**

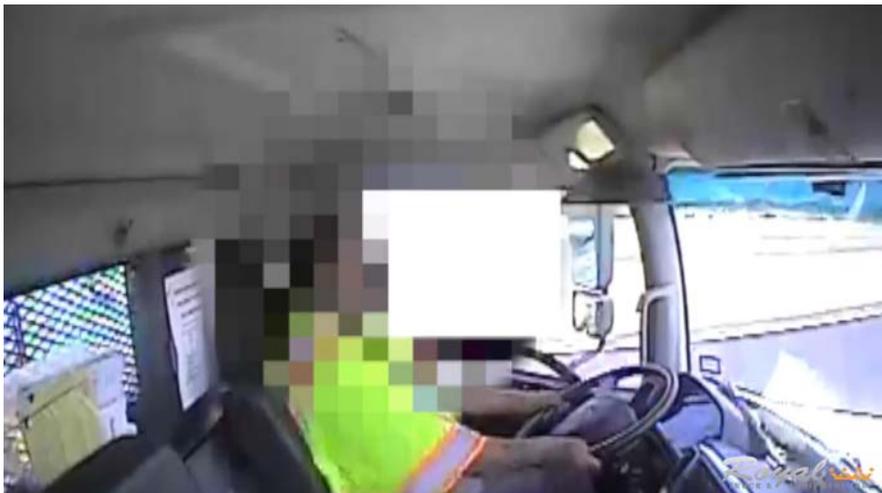
# TOP 3 REASONS TO REMOVE A TMA TRUCK DRIVER



#1 Save the driver from injury or death

#2 Remove human instinct

#3 Remove human error



# TOP THREE TMA TRUCK BEST PRACTICES



# AUTONOMOUS TMA TRUCK **BENEFITS**

- ✓ Increase Safety For Workers
- ✓ Cost Reductions
- ✓ Safer Work Site
- ✓ Work Zone Optimization
- ✓ Use For Rolling Operations



# TWO CURRENT PROGRAMS USING THE NEW TECHNOLOGY

Colorado Department of Transportation | Fort Collins, CO



Colas Ltd. | London, UK



AFTER 2000 MILES OF TESTING – NOW IN OPERATION!

**Royal**  
TRUCK & EQUIPMENT INC.

**KRATOS**  
DEFENSE & SECURITY SOLUTIONS  
FROM STRENGTH TO SUCCESS™

# ATMA LEADER/FOLLOWER SYSTEM – HOW IT WORKS!

## Leader Vehicle Kit



Operator Control Unit



Vehicle Control Module



GPS & Datalink Antenna

## INSTALLATION



Steering Actuator



Brake/Accel. Actuators



GPS Antenna



Obstacle Detection



Operator Control Unit



Vehicle Control Module



E-Stop



Datalink Antenna

# CDOT ATMA LAUNCH

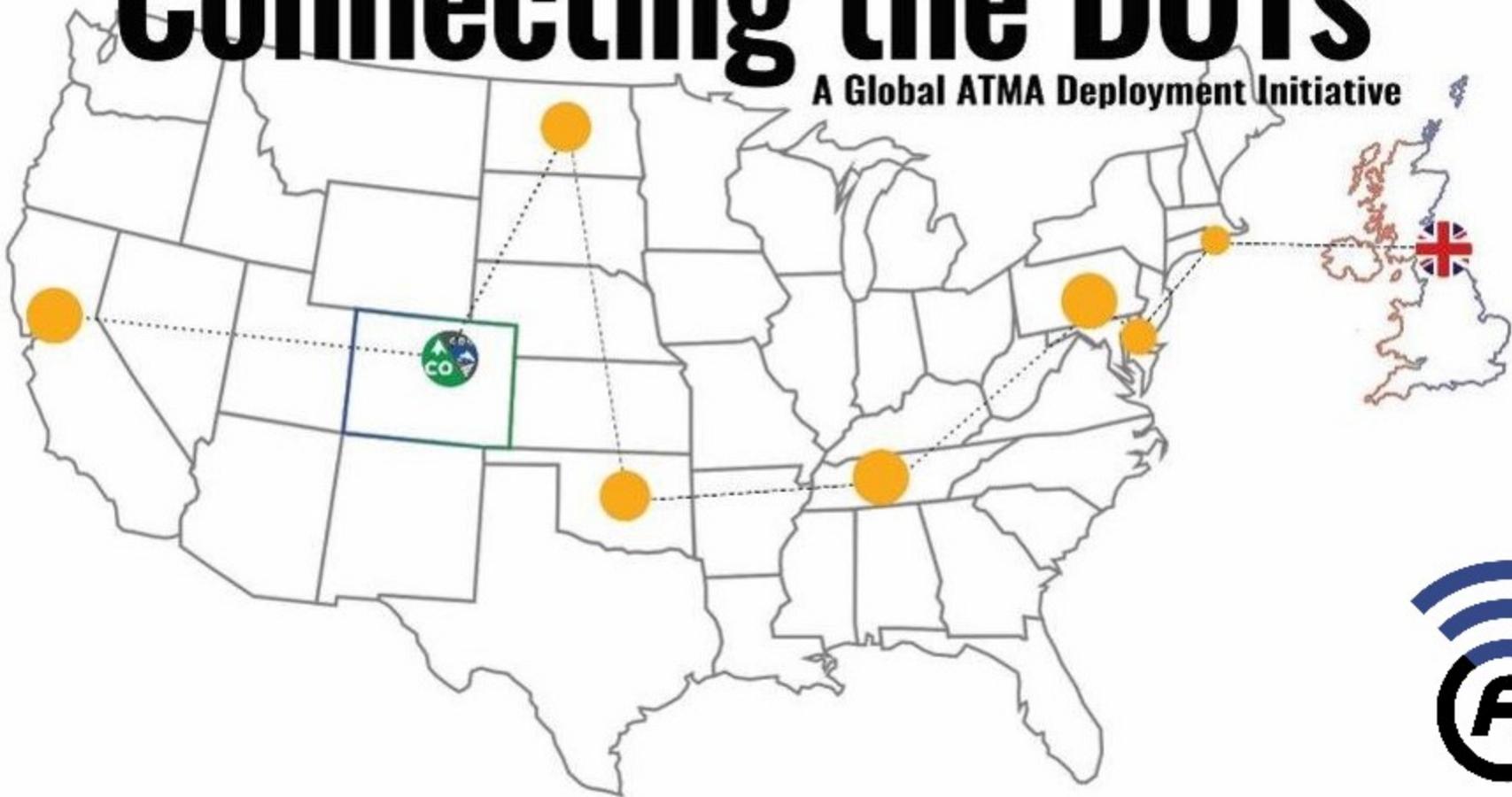
The beginning of an aggressive 5 year program to **protect** every CDOT mobile maintenance operation.



AUTONOMOUS REGULATION CHANGES WILL **SAVE** LIVES

# Connecting the DOTs™

A Global ATMA Deployment Initiative





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# THANK YOU

Keep updated on the ATMA by visiting:

[www.royaltruckandequipment.com/autonomous](http://www.royaltruckandequipment.com/autonomous)

**TESTIMONY WITH RESPECT TO PA S.B. 1096/H.B. 1958**  
**BEFORE THE PA SENATE COMMITTEE ON TRANSPORTATION**  
**JUNE 13, 2018**

Royal Truck & Equipment, Inc. (Royal) is grateful for the opportunity to discuss S.B.1096/H.B.1958 with respect to Autonomous Impact Protection Vehicles (AIPV), also known as Autonomous Truck Mounted Attenuators (ATMA) in work zones. We thank Senator Rothman and Senator Browne for their sponsorship of this important legislation. We also thank Senator Rafferty for his invitation to today's hearing.

In this written testimony, Royal would like to discuss our interest in S.B.1096/H.B.1958, our role within the industry that provides products for highway workzone safety, the benefits and dangers regarding workzone maintenance equipment and its operation, and the guidelines that we believe should inform the legislative process to ensure a safe and efficient handling of highway maintenance operations augmented with new autonomous technologies. Royal would also like to convey its support of this legislation.

The Challenges of mobile/stationary workzones

Performing highway maintenance is extremely dangerous work because distracted, preoccupied drivers are navigating their cars or trucks at high speeds through stationary and mobile work zones. Mobile highway work zones are especially dangerous because maintenance vehicles are moving at a very slow speed in relation to traffic in an area that doesn't seem like a work zone since sometimes it is only one or two vehicles painting lines in an otherwise normal highway. These slow-moving maintenance vehicles are generally protected from impact from the rear by an IPV (Impact Protection Vehicle) also known as TMA (Truck Mounted Attenuator). An attenuator, also known as a crash cushion, on the protection vehicle saves the life of the person who makes the mistake of entering a work zone. The TMA truck also saves the lives of the crew in the work zone ahead by shielding them from the collision. However, this begs the question, what about the driver of the TMA truck? Until now, that IPV or TMA truck was driven by the lowest man on the highway worker totem pole. That person's job was to drive the truck that protected everyone but themselves. Drivers of TMA trucks have lost their lives or sustained serious injuries that can affect them for the rest of their lives. This is a cost we should be unwilling to accept. Our role and mission as a truck manufacturer is to constantly increase the safety of highway workers by developing new technologies and safety features in our trucks.

### TMA best practices

To have a safe Autonomous TMA, the base TMA truck must be built to the following minimum standards that Royal promotes and that a few states have adopted. There is no federal regulation on the proper build of a TMA truck, it is up to the states. This three-part minimum standard ensures the TMA truck performs as expected when hit. The truck must have 20,000 lbs. total weight that ballasts and balances the truck to withstand the impact with minimal roll ahead distance. This ballast must be contained and not be released to cause more injury upon impact. A common violation of this principle occurs when an operator places “Jersey Barriers” on the bed to add weight. When hit, the concrete barriers break loose and undo the lifesaving work the attenuator just performed. The second necessary ingredient is air brakes. Unlike traditional hydraulic brakes, air brakes are much more affective in holding the vehicle in place following a collision. According to Smart Drive Test, air brakes are specifically designed with numerous fail safes, such as air reservoirs, one-way check valves, dual air brake systems, an air compressor, pressure protection valve, and spring brakes, in place so that if there is a malfunction of the system they engage. They will withstand impact and still hold the vehicle. The third ingredient is an attenuator to absorb the impact of the vehicle erroneously entering the workzone. There are many makes and models but only 2 are currently able to fulfill the new Manual for Assessing Safety Hardware (MASH) requirements for this class of traffic control devices which will be implemented within the next year. Royal currently uses one of these, the Scorpion II, in many of its TMA trucks, including the Autonomous TMA (ATMA) truck.

### ATMA added benefits

There are three major benefits to the ATMA system. The first and most significant benefit is the removal of the driver from harm’s way, including potential death or lifelong injury. Second, in an ATMA truck the human instinct for self-preservation is removed with the driver. Automated vehicles will not flee oncoming errant vehicles as human drivers have been shown to do, leaving the lead vehicle and its crew unprotected. Third, by using an ATMA system human error is also removed with the driver. Automated vehicles maintain the gap distance with near perfect accuracy while human drivers will often come too close to their protected vehicle thereby endangering them with a secondary impact.

### How the system works

Mobile highway maintenance operations travel at a slow speed of 5 – 15 miles per hour and as such they provide a perfect use for this technology. The ATMA system is a leader / follower system where an

unmanned TMA truck follows exactly where the lead vehicle goes. The system uses GPS and Real Time Kinematics (RTK) “e-crumbs” - Vehicle to Vehicle (V2V) communications from the manned lead vehicle to the unmanned following vehicle about position, speed, and heading. These e-crumbs are dropped at a rate of ten times per second allowing the following vehicle to travel with accuracy of +/- 4in. of the path of the lead vehicle. Safety “e-Stop” buttons in both vehicles and on the exterior of the following vehicle will stop the ATMA when pressed. A Remote e-Stop, which is in the hands of the person assigned to monitoring the vehicle from the lead vehicle, operates outside of the ATMA system and brings the ATMA to a controlled stop when activated. Any loss of connectivity will also stop the system. A Radar system detects an intrusion into the area between the trucks and stops the ATMA if something comes between them. An automatic sensor (longitudinal accelerometer) also detects impact from the rear, automatically applies the airbrakes, and shuts off the engine. The ATMA also employs a wide range of Cybersecurity precautions, including a combination of technologies, processes, and practices that protect the network, computers and data from attack, damage, or unauthorized access. The system computers and V2V communications are prevented from accessing any internal/external vehicle interfaces. Additionally, there are no Wi-Fi, Bluetooth, or cellular interfaces installed on the system, completely isolating it from external wireless networks to minimize cyber-attack vulnerabilities. Cyber security risks are further mitigated by limited physical access, vulnerability management, and system hardening techniques. This autonomous system is “bolt on” technology and can be added to existing vehicles. Once added it can be driven in either autonomous mode or manually.

#### Future additional uses for this technology attainable within 2 years

In the next 2 years we predict that there will be many other mobile operations besides line painting such as road sweeping, rolling lane closures, roadside mowing that will use ATMAs. ATMAs could also begin to be used for “stop and go” operations like highway storm drain cleaning, highway light bulb changing, bridge “snoopers” assessing bridge condition, and debris removal operations. ATMAs with offset capabilities could run behind another vehicle while being offset to stagger the protection on teamed vehicles.

#### Current deployments in United States and worldwide

Colas, an international highway contractor in England and Highways England, the maintenance arm of the UK Department of Transport, are currently performing 10 weeks of live highway work with the

ATMA. Highways England has been working closely with Colas in the deployment of their vehicle and during over 1000 miles of testing and validation on Goodwood Test Circuit in London this past year.

Colorado Department of Transportation (CDOT) has been the first government agency in the US to adopt this technology. After the testing, launch, and deployment of the ATMA this past fall, CDOT has discussed with Royal plans to put one as a protection vehicle behind every kind of mobile operation within 5 years. This includes their current use behind line painting trucks and future uses behind sweeper trucks, cone setting trucks, behind roadside mowing operations in dangerous areas and crack sealing operations to name a few.

Colorado, through Federal Highway Administration's (FHWA) Transportation Pooled Fund (TPF) Program has initiated a solicitation on Autonomous Maintenance Technology (AMT) to support and promote collaborative research efforts in the field of autonomous technologies in work zone applications to improve safety, efficiency and quality of work efforts. There are nine member states who have contributed to this endeavor to date. The intense interest in this system can be attributed to the fact that this technology will save lives and because this is "ice breaker" technology that is easily adopted.

#### ATMA as icebreaker technology - advance highway safety and early adoption of innovations

With anticipation for the day autonomous vehicles become ubiquitous; this technology is available now and can be easily adopted without any infrastructure improvements. It operates at a slow speed (5-15mph) in a controlled environment, the highway workzone. States can take a small step to utilize new innovations and save lives at the same time. Ice breaker technology appeals to everyone and opens the door to potential acceptance of other uses. It can help the public see the possible uses of autonomous technology. This could lead to greater acceptance to autonomous vehicles and to a lowering of highway fatalities.

#### Conclusion

Royal Truck and Equipment thanks the Senate Transportation Committee for the opportunity to provide this testimony on a topic that is of immense importance to our highway maintenance workers in Pennsylvania. We hope these comments provide a useful framework for policymakers to think about the many challenges and opportunities associated with autonomous vehicles used in work zones on Pennsylvania highways. We will continue to develop and advance new technologies with the goal of helping make Pennsylvania's highways some of the safest in the United States.